



*High Performance Single-phase
Thyristor Unit*

THV-A1

Instruction Manual
[Detailed version]

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

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

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.



WARNING

- To prevent injury to persons, damage to the instrument and the equipment, a suitable external protection device shall be required.
- All wiring must be completed before power is turned on to prevent electric shock, fire or damage to the instrument and the equipment.
- This instrument must be used in accordance with the specifications to prevent fire or damage to the instrument and the equipment.
- This instrument is not intended for use in locations subject to flammable or explosive gases.
- Do not touch high-voltage connections such as power supply terminals, etc. to avoid electric shock.
- When the withstand voltage test or each test is performed, please contact RKC sales office or the agent. If you make a mistake in the test method, the instrument failure may result.
- RKC is not responsible if this instrument is repaired, modified or disassembled by other than factory-approved personnel. Malfunction may occur and warranty is void under these conditions.



High temperature caution:

Do not touch the heat radiation fin while the power is turned on or just after the power is turned off as it may be at high temperatures. If touched, burning may result.

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 Environment A instrument (20 to 100 A types). In a domestic environment, this instrument may cause radio interference, in which case the user may be required to take additional measures.
- This instrument (20 to 100 A types) is protected from electric shock by reinforced insulation. Provide reinforced insulation between the wire for the input signal and the wires for instrument power supply, source of power and loads.
- Be sure to provide an appropriate surge control circuit respectively for the following:
 - If input/output or signal lines within the building are longer than 30 meters.
 - If input/output or signal lines leave the building, regardless the length.
- This instrument is manufactured on the assumption that it is mounted within a control panel. All high-voltage connections such as power supply terminals must be enclosed in the control panel to avoid electric shock to operating personnel.
- All precautions described in this manual should be taken to avoid damage to the instrument or equipment.
- All wiring must be in accordance with local codes and regulations.
- Always use this product at the rated power supply voltage, load current and power frequency.
- All wiring must be completed before power is turned on to prevent electric shock, instrument failure, or incorrect action.
- To prevent instrument damage as a result of failure, protect the power line and the input/output lines from high currents with a suitable overcurrent protection device with adequate breaking capacity such as a fuse, circuit breaker, etc.
- If this product is used for phase control, higher harmonic noise may be generated. Therefore in this case, take such measures as separating the power line from the high-voltage line for load drive.
- Prevent metal fragments or lead wire scraps from falling inside instrument case to avoid electric shock, fire or malfunction.
- Tighten each terminal screw to the specified torque found in the manual to avoid electric shock, fire or malfunction.
- For proper operation of this instrument, provide adequate ventilation for heat dissipation.
- Do not connect wires to unused terminals as this will interfere with proper operation of the instrument.
- Turn off the power supply before cleaning the instrument.
- Do not use a volatile solvent such as paint thinner to clean the instrument. Deformation or discoloration may occur. Use a soft, dry cloth to remove stains from the instrument.
- To avoid damage to the instrument display, do not rub with an abrasive material or push the front panel with a hard object.
- Do not connect modular connectors to telephone line.
- 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.

SYMBOLS

WARNING

: This mark indicates precautions that must be taken if there is danger of electric shock, fire, etc., which could result in loss of life or injury.

CAUTION

: This mark indicates that if these precautions and operating procedures are not taken, damage to the instrument may result.



: This mark indicates that all precautions should be taken for safe usage.



: This mark indicates important information on installation, handling and operating procedures.



: This mark indicates supplemental information on installation, handling and operating procedures.



: This mark indicates where additional information may be located.

Character Symbols:

0	1	2	3	4	5	6	7	8	9	Minus	Period
0	1	2	3	4	5	6	7	8	9	-	.

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

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

V	W	X	Y	Z	Degree	/	Prime
V	W	X	Y	Z	°	/	'

8.	Dim lighting
8.	Bright lighting

DOCUMENT CONFIGURATION

There are eight manuals pertaining to this product. Please be sure to read all manuals specific to your application requirements. If you do not have a necessary manual, please contact RKC sales office, the agent, or download from the official RKC website.

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

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

Manual	Manual Number	Remarks
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-A1 Installation Manual	IMR02D01-E□	This manual is enclosed with instrument. This manual explains the mounting and wiring, front panel name, and the operation mode outline.
150 A/200 A THV-A1 Installation Manual	IMR02D06-E□	
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-A1 Quick Operation Manual	IMR02D02-E□	This manual is enclosed with instrument. This manual explains the basic key operation, mode menu, and data setting.
150 A/200 A THV-A1 Quick Operation Manual	IMR02D07-E□	
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-A1 Communication Quick Manual	IMR02D03-E□	This manual is enclosed with instrument. (Only THV-A1 provided with the communication function) This manual explains the connection method with host computer, communication parameters, and communication data.
150 A/200 A THV-A1 Communication Quick Manual	IMR02D08-E□	
THV-A1 Instruction Manual [Detailed version] *	IMR02D04-E10	This manual explains the method of the mounting and wiring, the operation of various functions, and troubleshooting.
THV-A1 Communication Instruction Manual [Detailed version] *	IMR02D05-E□	This manual explains Modbus relating to communication parameters setting.

* Sold separately



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

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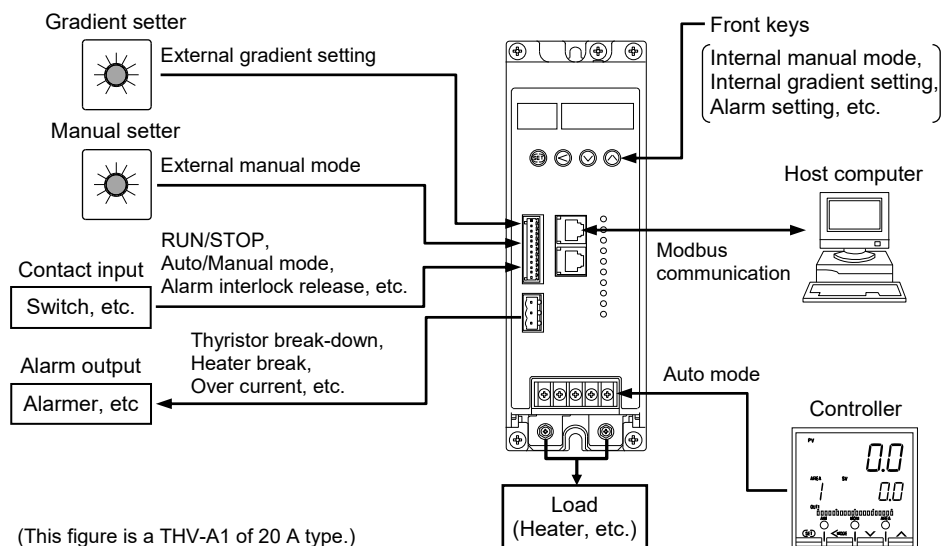
MEMO

1. OUTLINE

1.1 Features

This instrument is a single-phase thyristor unit for power supply voltage 100 to 240 V AC.

It is possible to adjust power supplied to heaters, etc. by setting the signal from the controller, setter (variable resistor) or front keys.



■ The rated currents of eight types are available.

Power supply voltage	100 to 240 V AC							
Rated current	20 A	30 A	45 A	60 A	80 A	100 A	150 A	200 A

■ The input signal and set value can be checked on the display unit.

The display unit can check the input signal, phase angle, power frequency, current value, voltage value, power value and set value of each parameter, etc.

■ The front keys can set the gradient setting and manual setting.

In addition to the setting by an ordinary setter (variable resistor), it is possible to set internal gradient setting and internal manual setting values by the front keys while checking these numeric values shown on the display unit.

■ The control of three types can be selected.

It is possible to select by the front keys and then use any one of phase control, zero-cross control (continuous) and zero-cross control (input synchronous type).

■ Adding a communication function (optional)

Modbus communication can be used to set values for the internal gradient setting, internal manual setting, and other settings while checking the values on the host computer.

1.2 Checking the Product

Before using this product, check each of the following:

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

THV – A1 PZ □ - □ * □ □ □ □ □ - □ (- □.....)*
 (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

* The code shown in (10) is printed on the nameplate when the relevant accessory is specified as an option.
 The code for accessory will be more than one if the product has more than one accessory.

(1) Power supply

1: Single-phase 100 to 240 V AC

(2) Control method

PZ: Phase control/Zero-cross control (Configurable: The factory set value is the phase control.)

(3) Rated current

020: 20 A AC	045: 45 A AC	080: 80 A AC	150: 150 A AC
030: 30 A AC	060: 60 A AC	100: 100 A AC	200: 200 A AC

(4) Input signal

4: Voltage input 0 to 5 V DC	7: Current input 0 to 20 mA DC
5: Voltage input 0 to 10 V DC	8: Current input 4 to 20 mA DC
6: Voltage input 1 to 5 V DC	

(5) Output mode

6: Standard ¹ and Constant voltage control ²
 (Prior to factory shipment, the output mode is set to constant voltage control.)

E: Standard ¹, Constant voltage control ² and Constant current control ³
 (Prior to factory shipment, the output mode is set to constant current control.)

W: Standard ¹, Constant voltage control ² and Constant power control ^{3,4}
 (Prior to factory shipment, the output mode is set to constant power control.)

¹Output mode of standard: Proportional phase angle to input, Proportional voltage to input and
 Proportional square voltage (electric power) to input

²With square voltage feedback

³With heater break alarm, thyristor break-down alarm, memory area, current limiter, over current alarm and
 protection function for control of primary side of a transformer

⁴With constant current control



To control the primary side of the transformer, it is recommended to purchase a THV-A1 with a protection function for control of primary side of a transformer.

(6) Fuse

N: No fast-blow fuse is provided

F: Built-in fast-blow fuse

(7) Alarm output

N: No alarm

A: Alarm output 2 points

(8) Heat sink temperature detection function/Non-linear resistance heater break alarm (ARC-HBA)

N: No function

A: Heat sink temperature detection function¹B: Non-linear resistance heater break alarm²C: Heat sink temperature detection function and Non-linear resistance heater break alarm^{1, 2}¹ When the thyristor of 150 A type or 200 A type is used, select a code of either A or C.² When the output mode is specified to E or W code, this alarm can be selected.

When the non-linear resistance heater break alarm is selected, memory area function cannot be used.

(9) Communication function

N: No communication function

4: RS-422A

5: RS-485

(10) Accessories

1: Setter (potentiometer, knob and scale plate) [1 set] and Input connector (plug)

2: Setter (potentiometer, knob and scale plate) [2 sets] and Input connector (plug)

9: Input connector (plug)

B: Alarm output connector (plug)

■ Accessories (Order Separately)

When you order accessories after this instrument purchase, please specify it with the following code.

Details	Code
Setter (potentiometer, knob and scale plate)	THV1P-S01
Input connector (plug)	THWP-C01
Connector for Alarm output (plug)	THVAP-C01

Details	Code	Fuse rating
THV-A1 built-in fast-blow fuse	20 A	THVAP-F20
	30 A	THVAP-F30
	45 A	THVAP-F45
	60 A	THVAP-F60
	80 A	THVAP-F45 ¹
	100 A	THVAP-F60 ³
	150 A	THVAP-FB0 ⁴
	200 A	THVAP-FC0 ⁵

¹ The 80 A type uses two 45 A fast-blow fuses (THVAP-F45).² This is rating of one fast-blow fuse.³ The 100 A type uses two 60 A fast-blow fuses (THVAP-F60).⁴ The 150 A type uses two fast-blow fuses (THVAP-FB0).⁵ The 200 A type uses two fast-blow fuses (THVAP-FC0).For replacing of fast-blow fuses, refer to **6.4 Replacement of the Fast-Blow Fuse (P. 156)**.

■ **The accessories attached to product**

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

THV-A1 Installation Manual (IMR02D01-E□)	1
THV-A1 Quick Operation Manual (IMR02D02-E□)	1
Short bar (The short bar is connected to the “input terminals.”).....	1
[When the communication function is provided]	
THV-A1 Communication Quick Manual (IMR02D03-E□)	1

150 A/200 A types:

THV-A1 Installation Manual (IMR02D06-E□)	1
THV-A1 Quick Operation Manual (IMR02D07-E□)	1
Short bar (The short bar is connected to the “input terminals.”).....	1
[When the communication function is provided]	
THV-A1 Communication Quick Manual (IMR02D08-E□)	1

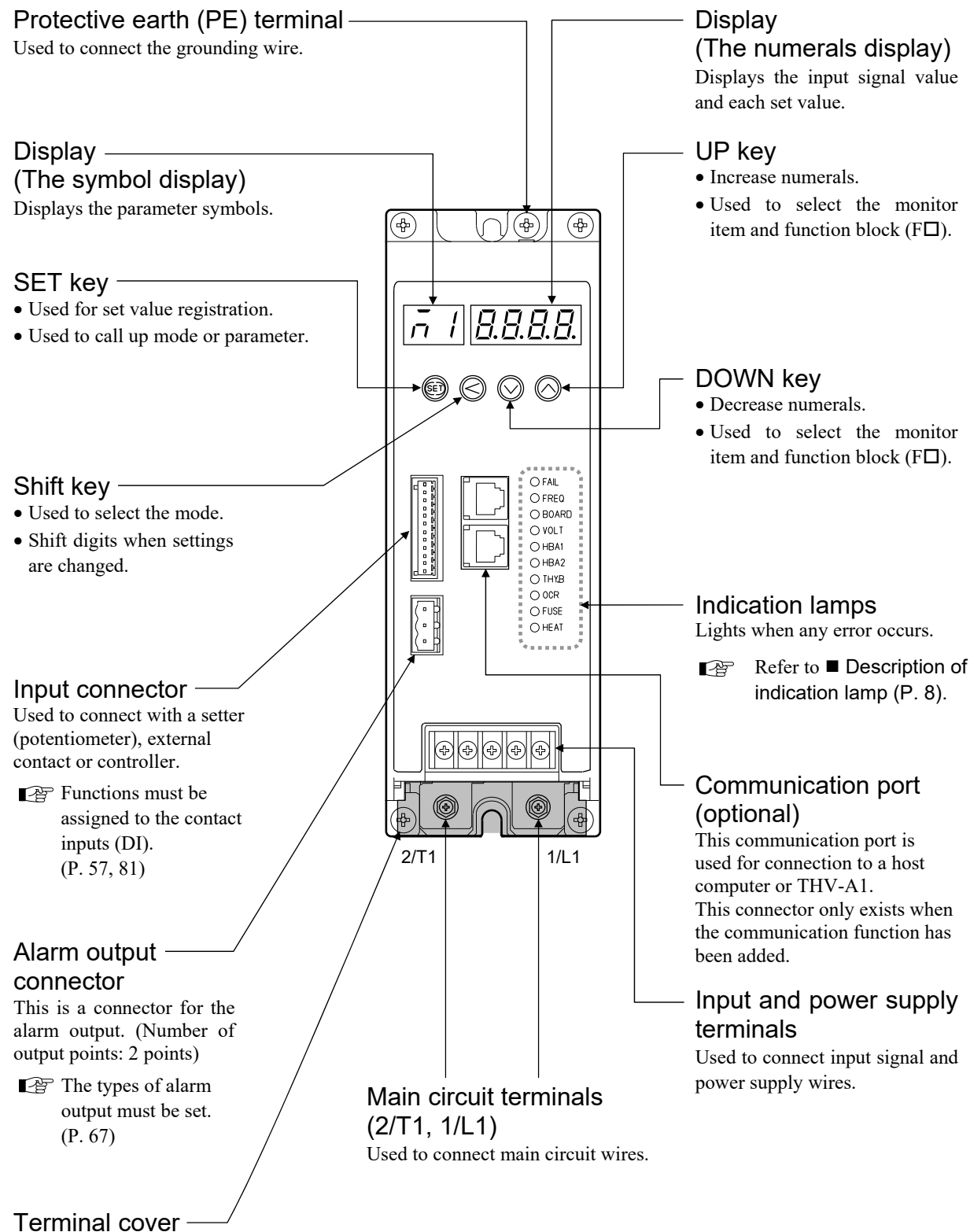


If any of the above are missing, damaged, or if your manual is incomplete, please contact RKC sales office or the agent.

1.3 Parts Description

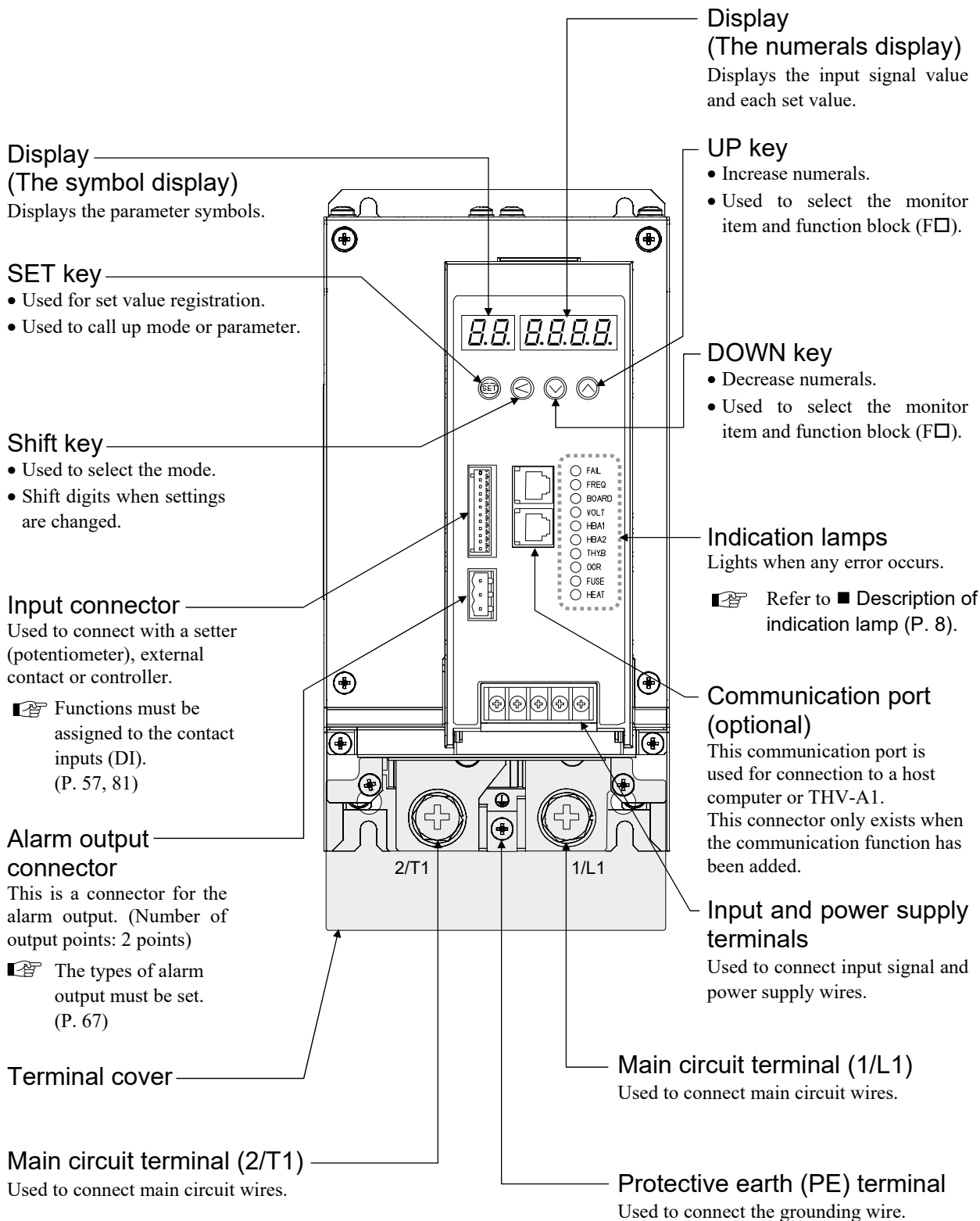
■ 20 A/30 A/45 A/60 A/80 A/100 A types:

The name is the same as for each type (20 A to 100 A).



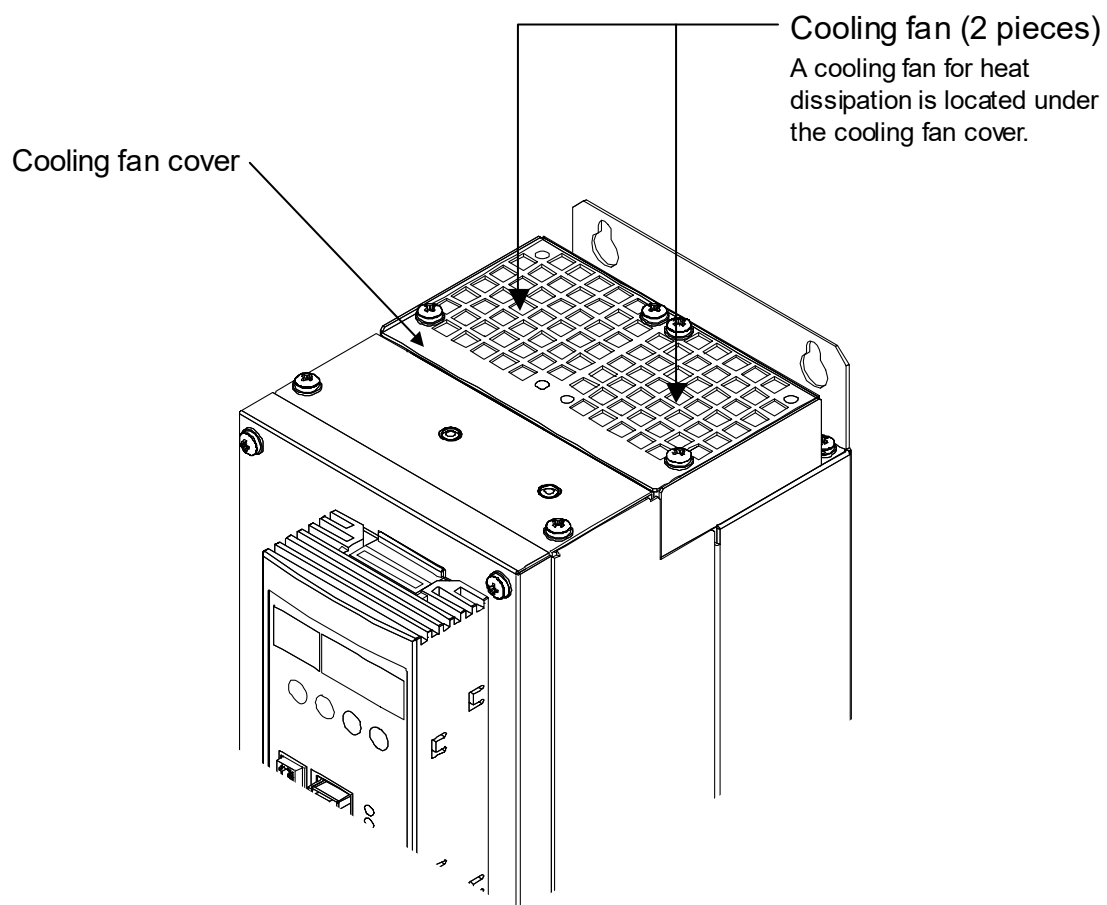
■ 150 A/200 A types:

The name is the same as for each type (150 A/200 A).





The customer should never remove the cooling fan cover.



When an abnormality occurs in the cooling fan, refer to **6.3 Troubleshooting (P. 154)**.

■ Description of indication lamp

Symbol	Name	Description	Action taken when an error occurs
FAIL	FAIL alarm	This lamp lights to indicate an error detected by the watchdog timer of the self-diagnosis function or the CPU power monitor.	THV-A1 action stop
FREQ	Power frequency error	This lamp lights if power frequency is out of the allowable range (detecting range) when power is turned on or during operation. (Detection range: 45.0 to 64.9 Hz)	THV-A1 output OFF The output can be turned ON when the error is canceled.
BOARD	Board error	This lamp lights if a board error of this instrument is detected by the self-diagnosis function.	THV-A1 output OFF
VOLT	Power supply voltage error	20 A to 100 A types: This lamp lights if the power voltage exceeds 264 V when the power is turned on or during operation. [Note that this includes measurement error. Measurement error: $\pm (3 \% \text{ of input voltage})$ or $\pm 5 \text{ V}$] 150 A, 200 A types: This lamp lights if the power voltage exceeds 264 V when the power is turned on or during operation. In addition, this lamp lights if the power voltage drops less than 90 V. [Note that this includes measurement error. Measurement error: $\pm (3 \% \text{ of input voltage})$ or $\pm 5 \text{ V}$]	THV-A1 output OFF The output can be turned ON when the error is canceled.
HBA1	Heater break alarm 1	Lights when heater break alarm 1 output is turned on. This alarm function is available on the instrument with a constant current control or constant power control.	Control is continued.
HBA2	Heater break alarm 2	Lights when heater break alarm 2 output is turned on. This alarm function is available on the instrument with a constant current control or constant power control.	Control is continued.
THY.B	Thyristor break-down alarm	Lights when thyristor break-down alarm output is turned on. This alarm function is available on the instrument with a constant current control or constant power control.	Control is continued. When shorted: THV-A1 output continues to be turned ON
OCR	Over current	This lamp lights if the current of more than 1.2 times the rating of this instrument flows. This alarm function is available on the instrument with a constant current control or constant power control.	THV-A1 output OFF
FUSE	Fuse break	This lamp lights if the fast-blow fuse in this instrument blew. This alarm function is available on the instrument with a built-in fast-blow fuse.	THV-A1 output OFF
HEAT	Heat sink temperature abnormality	This lamp lights if the temperature of the semiconductor controlled rectifier (SCR) rises above 120 °C. This alarm function is available on the instrument with a heat sink temperature detection function.	THV-A1 output OFF



When an abnormality occurs, refer to **6.3 Troubleshooting (P. 154)**.

2. MOUNTING



WARNING

- In order to prevent electric shock or instrument failure, always mount or remove this instrument after power supplied to the entire system is turned off.
- As the temperature of this instrument becomes high, mount the instrument on a non-inflammable material (metal plate, etc.).
- As this instrument generates a large amount of heat, it is cooled by circulating air by convection. Therefore, if mounted in any direction other than specified, accident or failure may result.
- When carrying this instrument, hold the heat radiation fin. In addition, always carry it with the heat radiation fin cooled. If held by the main body, deformation or damage to the main body may result.

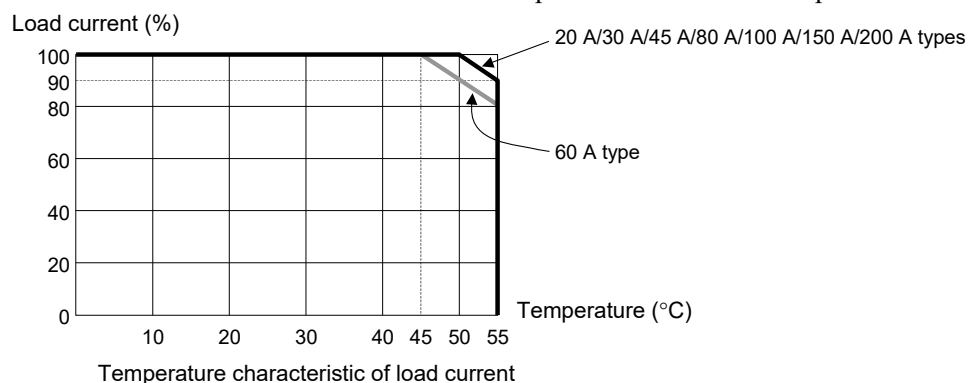
2.1 Mounting Environment

(1) This instrument is intended to be used under the following environmental conditions.

- 20 A/30 A/45 A/60 A/80 A/100 A types: IEC 61010-1 OVERVOLTAGE CATEGORY II, POLLUTION DEGREE 2, Indoor use, Altitude up to 2000 m
- The 150 A/200 A types: UL508, C22.2 No.14 (cUL) POLLUTION DEGREE 2

(2) Use this instrument within the following environment conditions.

- Allowable ambient temperature: 0 to 50 °C (20 A/30 A/45 A/80 A/100 A/150 A/200 A types)¹
¹ The rated current drops when the ambient temperature exceeds 50 °C.
0 to 45 °C (60 A type)²
² The rated current drops when the ambient temperature exceeds 45 °C.



- Allowable ambient humidity: 5 to 95 %RH
(Absolute humidity: MAX. W. C 29.3 g/m³ dry air at 101.3 kPa)

(3) Avoid the following conditions when selecting the mounting location:

- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Such a place where there are inflammable materials near this instrument.

Continued on the next page.

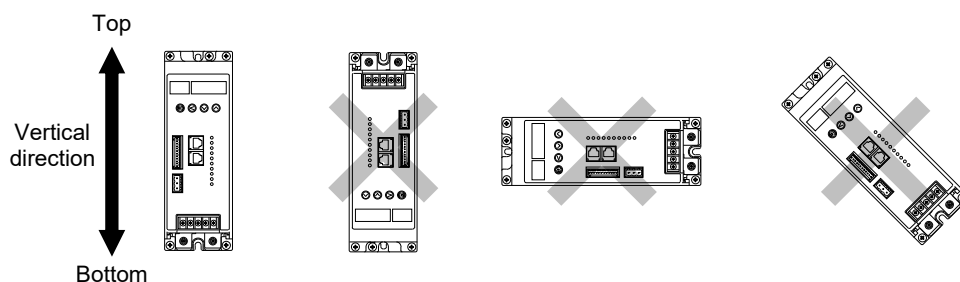
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- Direct vibration or shock to the instrument.
 - Water, oil, chemicals, vapor or steam splashes.
 - Excessive dust, salt or iron particles.
 - Excessive induction noise, static electricity, magnetic fields or noise.
 - Exposure to direct sunlight.
 - Excessive heat accumulation.
- (4) 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.

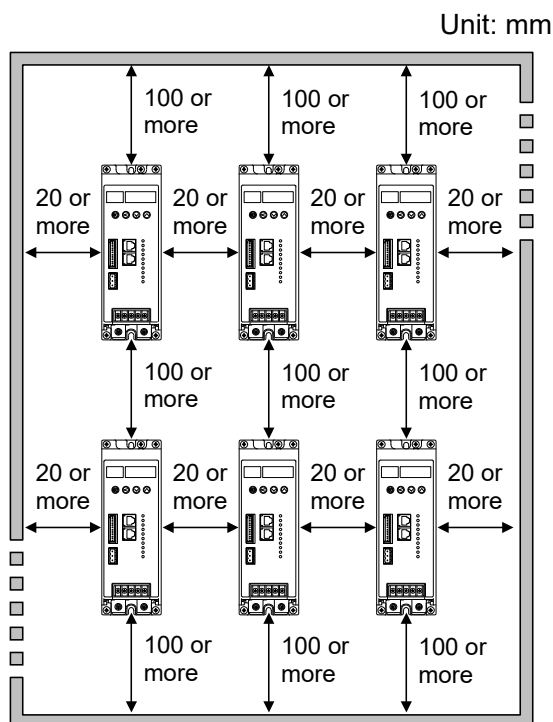
2.2 Mounting Cautions

Take the following points into consideration when mounting this instrument.

- For correct functioning mount this instrument in the direction shown below.



- Provide adequate heat radiation space so that heat does not build up.
- At least 20 mm is necessary on the left and right and at least 100 mm on the top and bottom.
(The diagram shows the 20 A type. The same space is required for the other types.)



- If the panel inside temperature rises due to self-generation of heat, install a cooling fan so that the panel inside is fully ventilated with the open air.

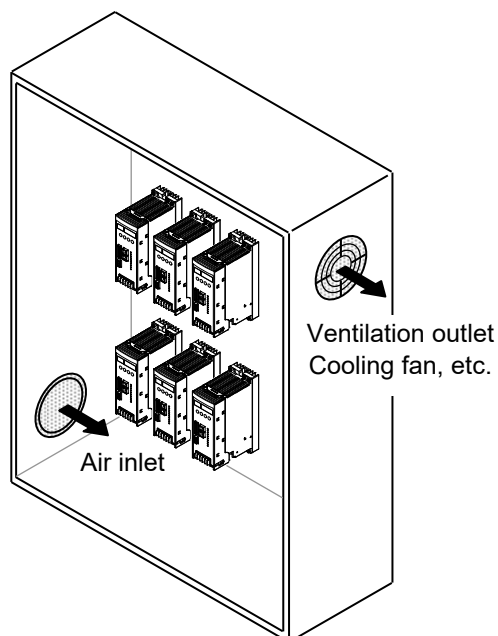


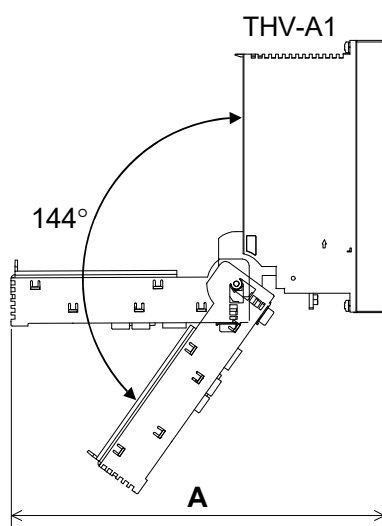
Table of calorific values
(100 to 240 V AC)

Rated current	Calorific values
20 A	23 W
30 A	34 W
45 A	56 W
60 A	72 W
80 A	95 W
100 A	116 W
150 A	190 W
200 A	245 W

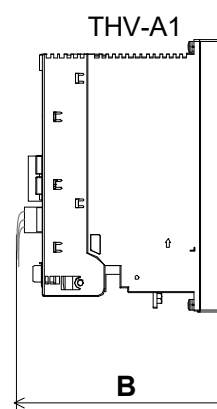
- The front of the instrument can be opened to allow replacement of the fast-blow fuse. When installing the instrument, leave enough space to allow the cover to be opened. If there is no fast-blow fuse, install with enough space for the wiring when the connector plug (optional) is inserted.

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

When the fast-blow fuse is provided



When the fast-blow fuse is not provided

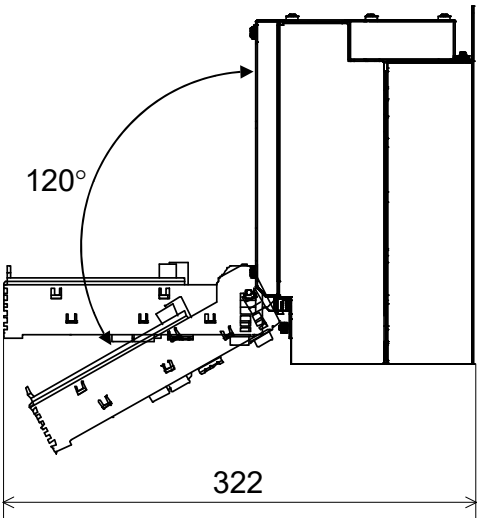


THV-A1 type	Dimensions A	Dimensions B
20 A/30 A types	276 mm	161.9 mm
45 A/60 A types	301 mm	186.9 mm
80 A/100 A types	311 mm	194.6 mm

150 A/200 A types:

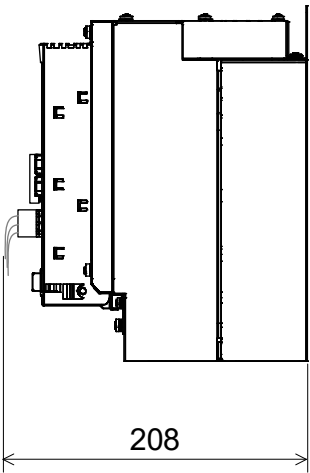
When the fast-blow fuse is provided

THV-A1



When the fast-blow fuse is not provided

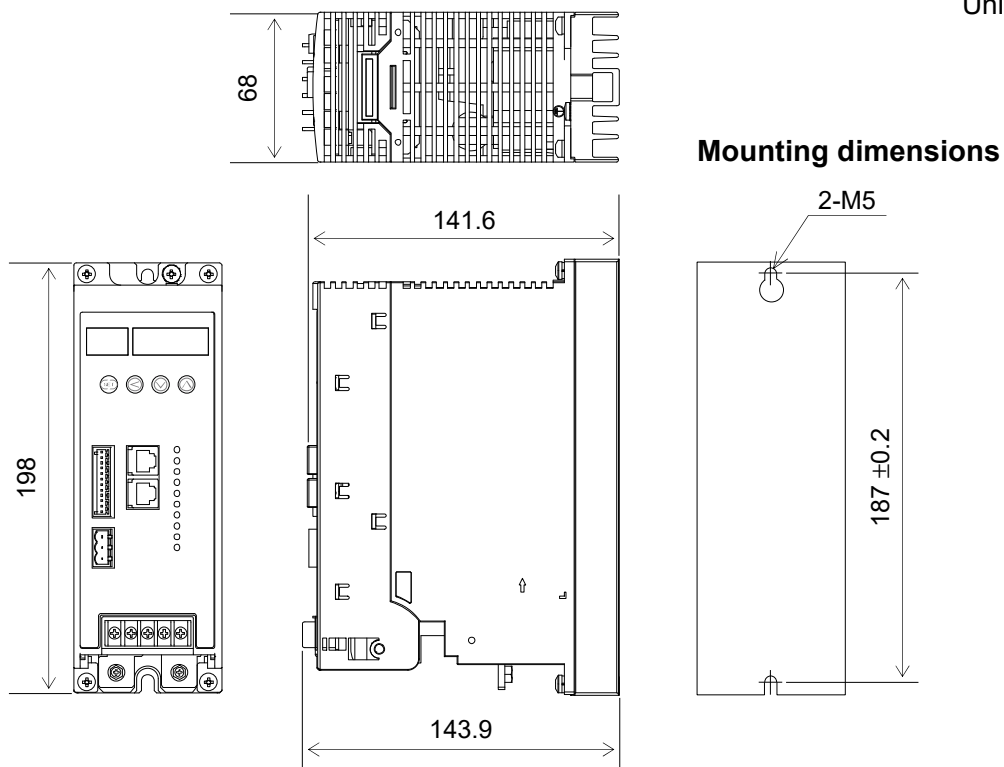
THV-A1



2.3 Dimensions

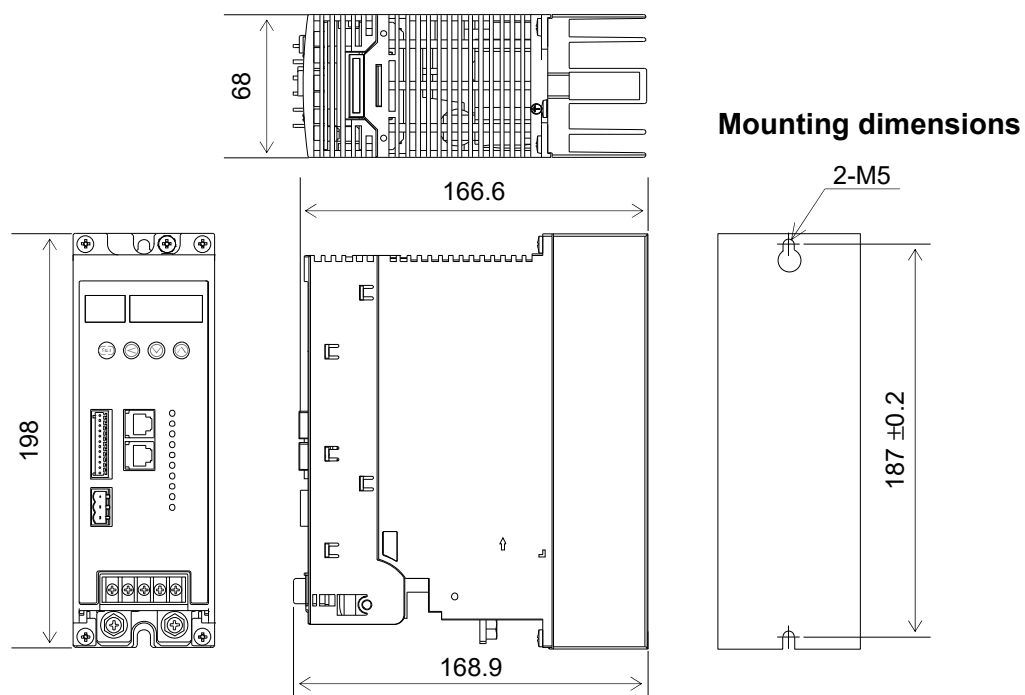
■ 20 A/30 A types

Unit: mm

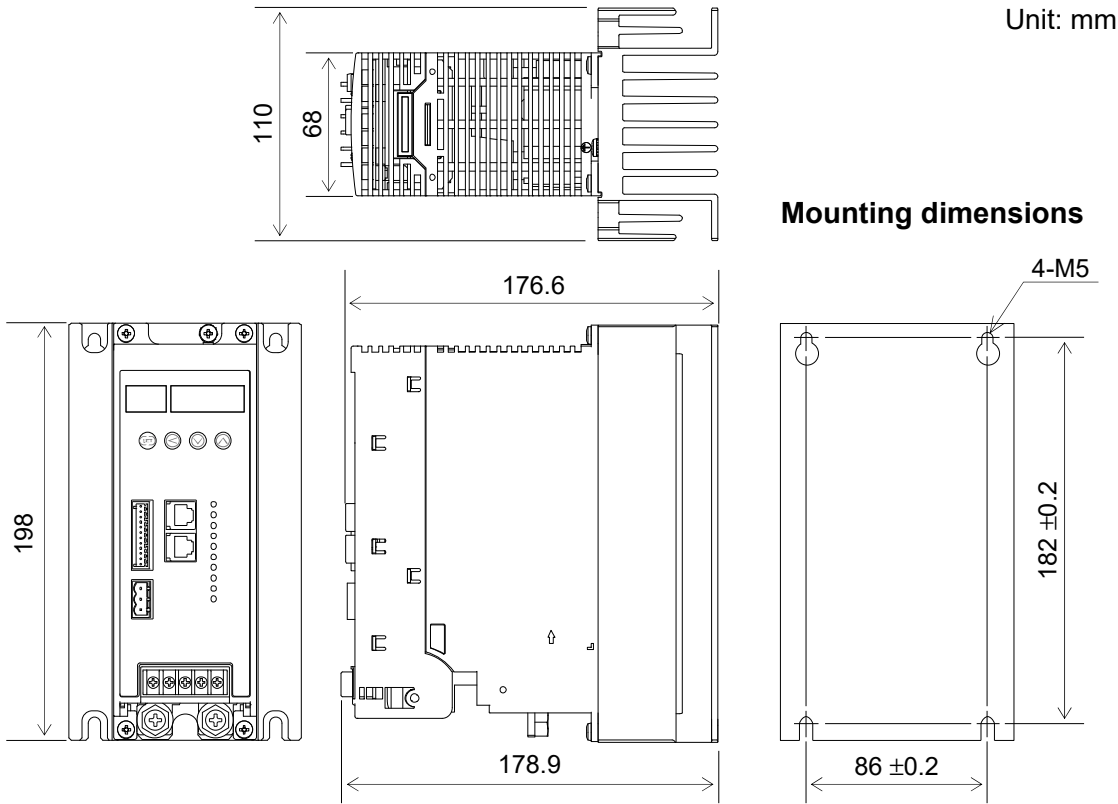


■ 45 A/60 A types

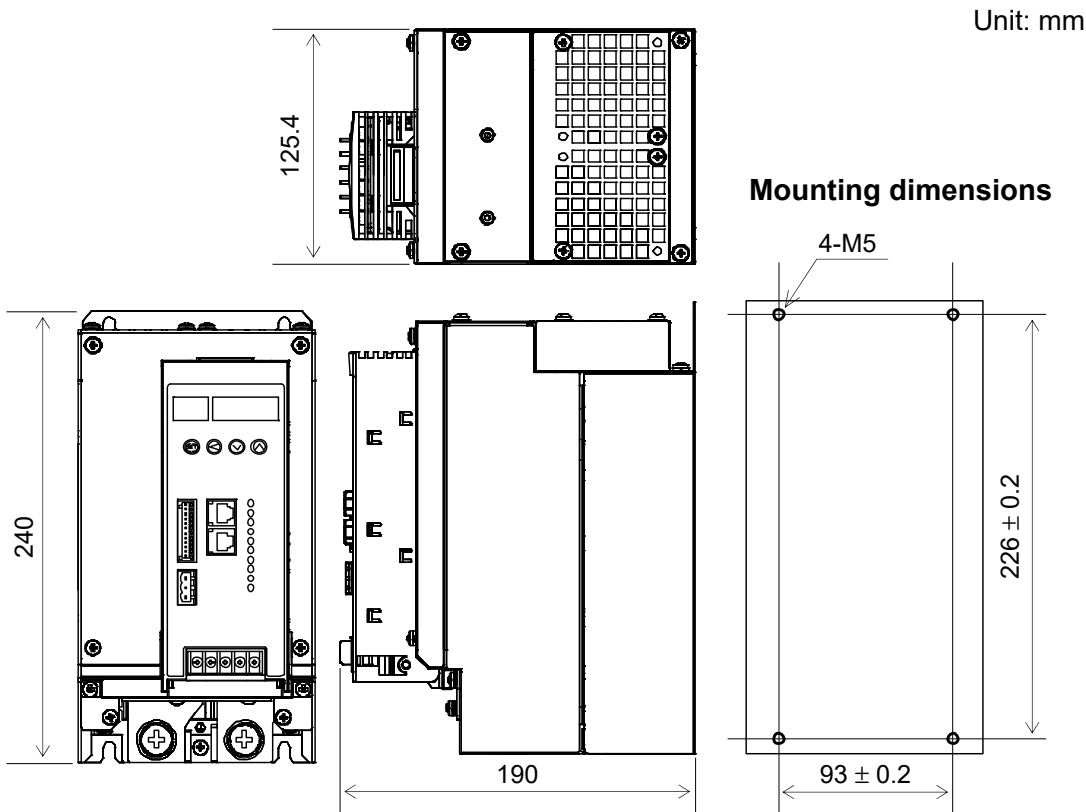
Unit: mm



■ 80 A/100 A types

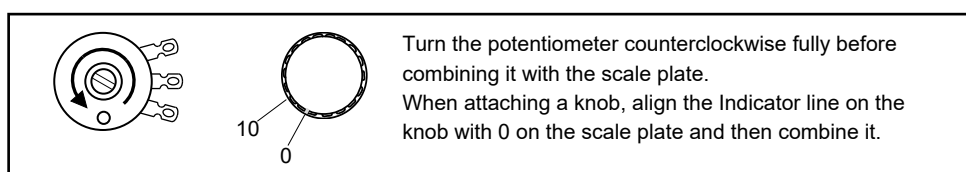
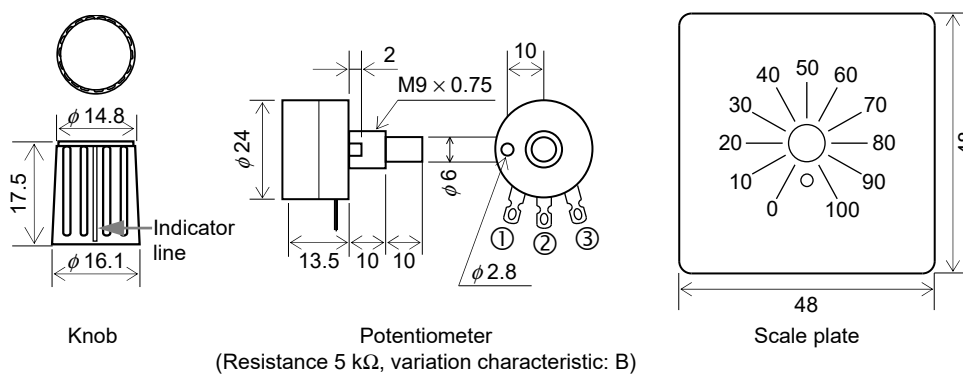


■ 150 A/200 A types



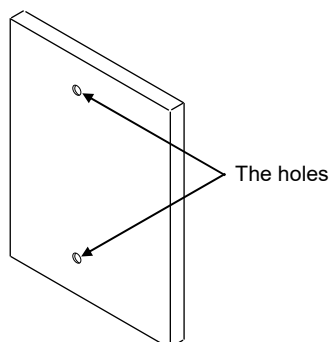
■ Setter (Potentiometer, Knob and Scale plate)

Unit: mm



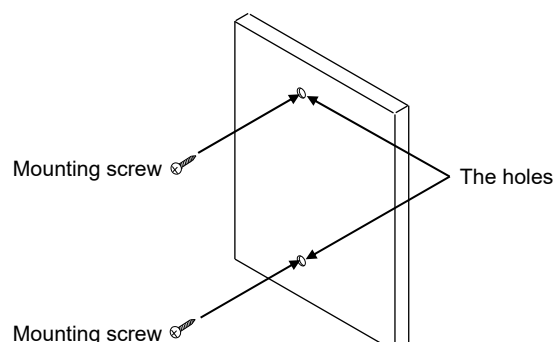
2.4 Mounting Procedures

1. Prepare the holes as specified in 2.3 Dimensions.



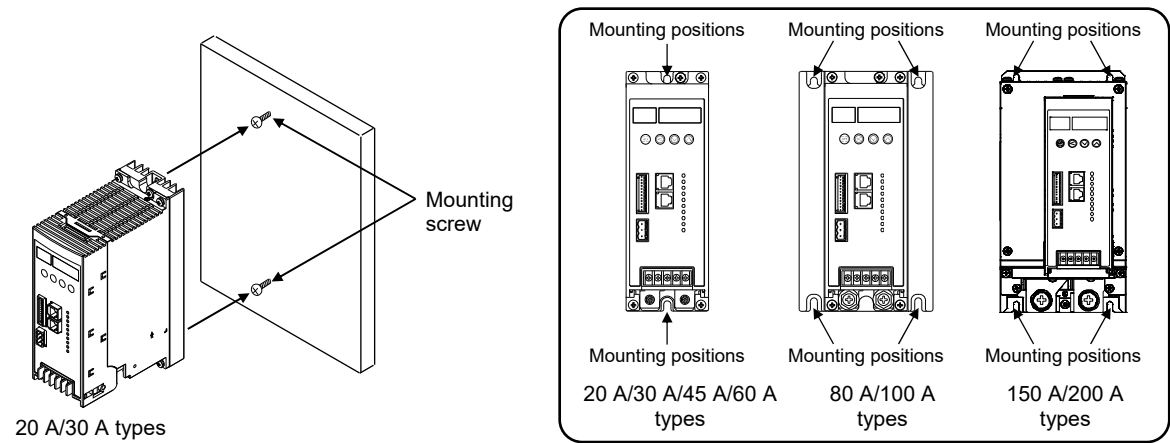
To mount an 80 A to 200 A type, four mounting holes must be made.

2. Insert the mounting screws into the holes.

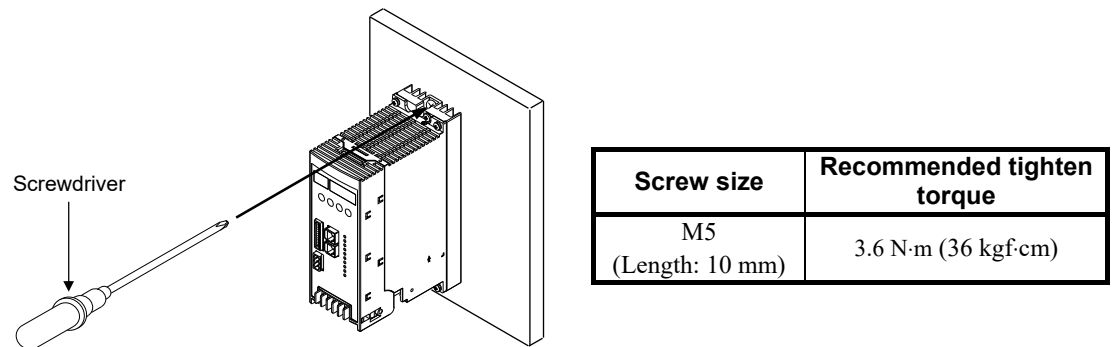


3. Hook the mounting positions (2 holes *) at the top and bottom of the instrument onto the partially mounting screws.

* There are 4 mounting positions on an 80 A to 200 A type.



4. Tighten the mounting screws with a screwdriver. Customer must provide the set of screws.



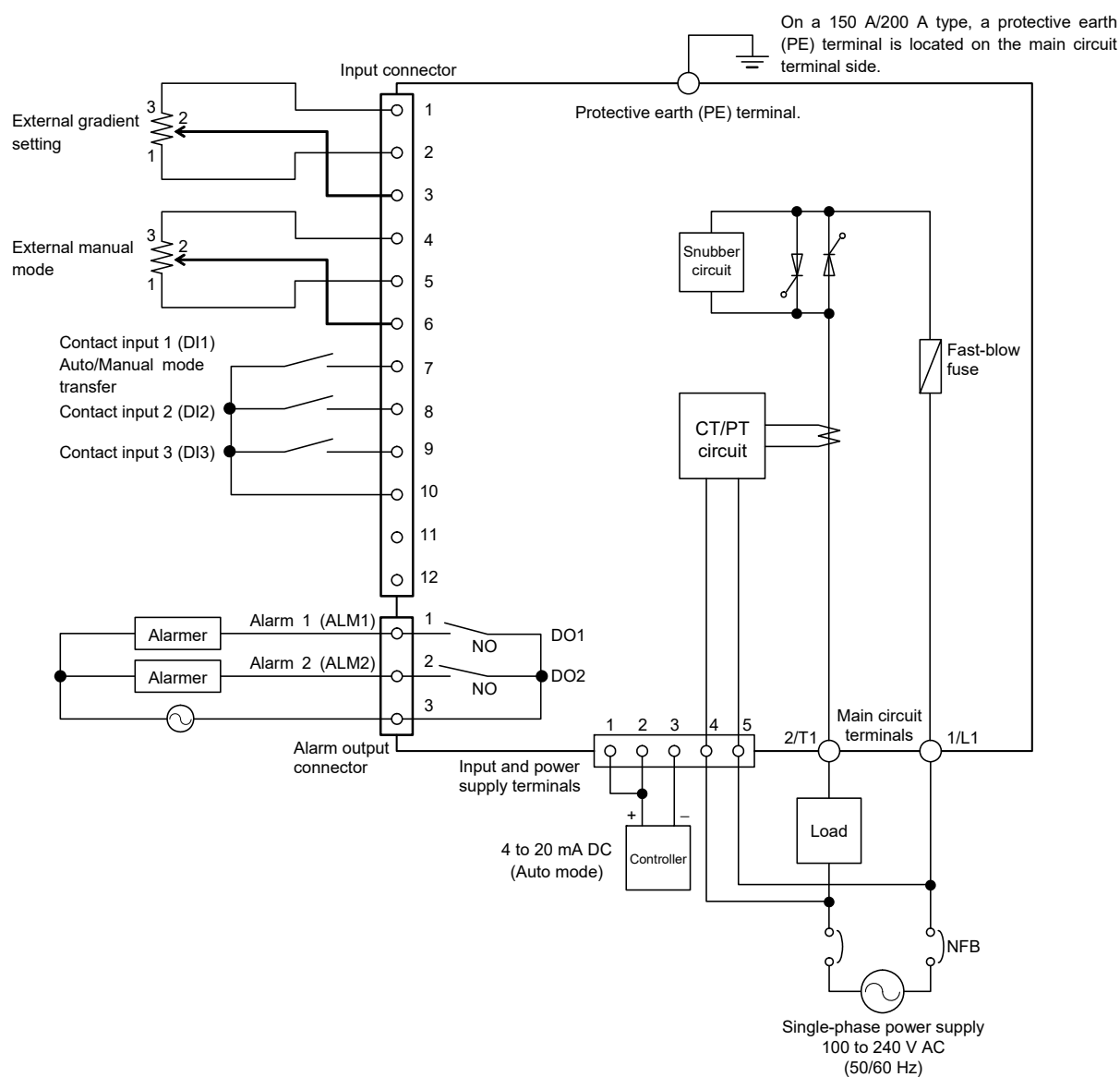
3. WIRING



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.

3.1 Circuit Block Diagram



The fast-blow fuse and CT are optional.



If the contact input (DI) is used, functions must be assigned to contact input.



Alarm types must be selected for the alarm outputs.

3.2 Wiring of Main Circuit

Conduct wiring by referring to the wiring diagram and the tightening torque table.

CAUTIONS

- Always conduct wiring so that the phase of the main circuit (2/T1) coincides with that of terminal No. 4 and the phase of the main circuit (1/L1), with that of terminal No. 5. Otherwise the instrument may not function properly or the load may be damaged.

- Caution for connecting a transformer to the load side of the instrument

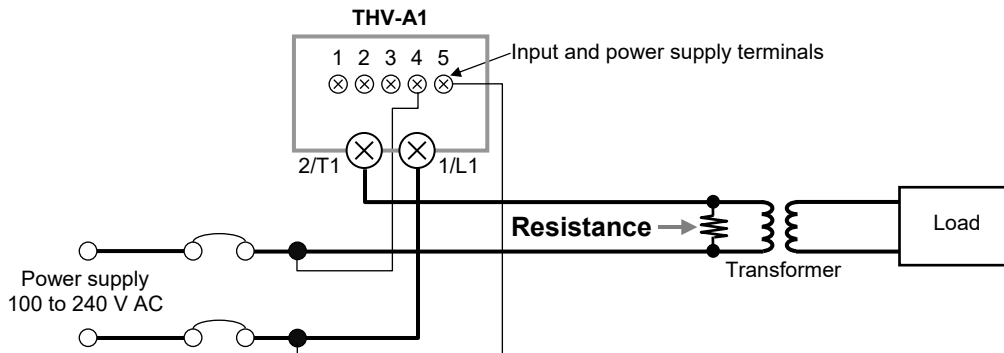
- (1) When a protection function for control of primary side of a transformer is not provided:
If the action of the device is influenced by excessive current (inrush current, current due to flux saturation of transformer), use a transformer 1.25 T (magnetic flux density) or less. Make sure soft-start time is appropriately set.

When connecting a transformer to the load side of this product, make sure that the current value of the primary side of the transformer is equal to or more than the minimum load current of this product. When the current value of the primary side of the transformer is less than the minimum load current value* of this product, connect a bleeder resistor in parallel with the primary side of the transformer, and allow the current more than the minimum load current to flow.

* Minimum load current value: 0.5 A

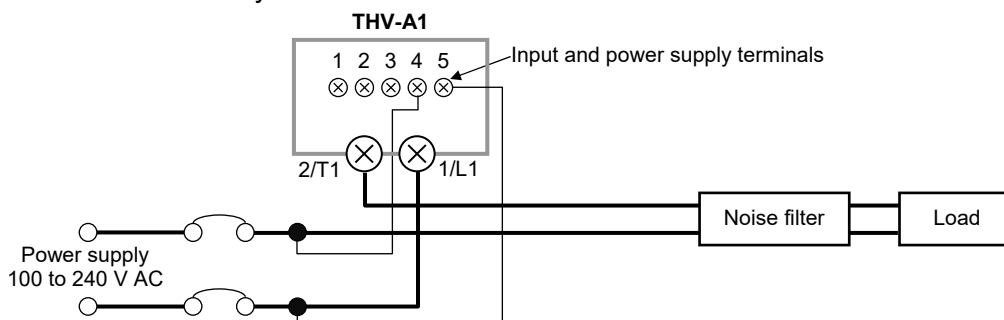
When control is started on this instrument without connecting a load to the transformer, it may result in heat generation or failure of the transformer. Control must be always conducted with the load connected.

- (2) When a protection function for control of primary side of a transformer is provided:
To conduct control of primary side of a transformer, make sure protection function for control of primary side of a control is set. Appropriately adjust the soft-start time for in case of secondary side breakdown depending on the operating condition.



- Caution for connecting a noise filter to the load side of the instrument

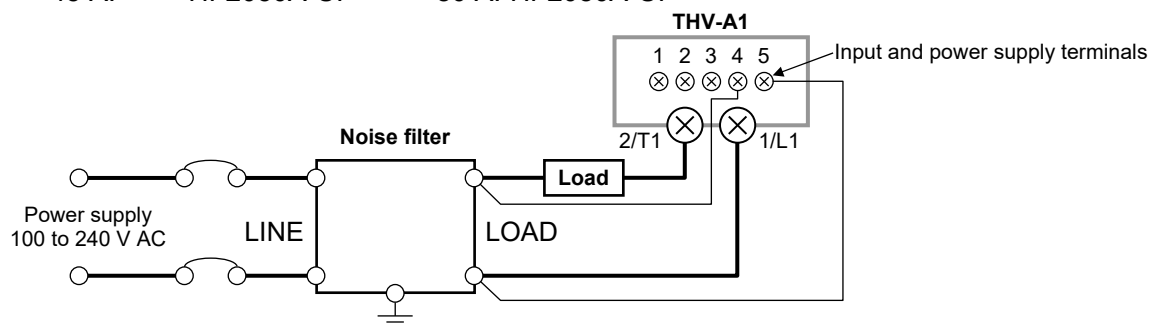
When the control of this instrument is started without connecting a load in a configuration where a noise filter is connected to the load side of the instrument, a large surge may occur to the noise filter and a damage of the instrument may result. Control must be always conducted with the load connected.



- THV-A1 of 20 A, 30 A, 45 A, 60 A, 80 A and 100 A types conforms to CE marking by using the noise filter.

The noise filter specified (SOSHIN ELECTRIC CO., LTD.)

- 20 A/30 A: HF2030A-UP • 60 A: HF2060A-UP • 100 A: HF2100A-UP
- 45 A: HF2050A-UP • 80 A: HF2080A-UP



- This instrument 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 the instrument.
 - Fuse type: Time-lag fuse
(Approved fuse according CSA C22.2 No. 248.14 and/or UL 248-14)
 - Fuse rating: Rated current: 2.5 A
- To avoid noise induction, keep input signal wire of controller away from instrument power line, load lines and power lines of other electric equipment. If wiring near high-voltage power is unavoidable, use shielded wires.
- For safety, always ground the protective earth (PE) terminal.
- Use wires satisfying the rated current capacity.
- Tighten the hexagon headed bolts on the main circuit terminals using a torque wrench. Always tighten each of them by contacting the diagonal surfaces of the wrench with those of each hexagon head.
- Firmly tighten the terminal screws or terminal hexagon headed bolts with the tightening torque specified below. Otherwise, electric shock, fire or heat generation may result.

Terminal hexagon bolt size and tightening torque list

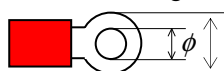
	Main circuit terminal (1/L1, 2/T1)			
	20 A/30 A	45 A/60 A	80 A/100 A	150 A/200 A
Hexagon bolt size	M4	M6	M8	M10
Recommended tightening torque	1.6 N·m (16 kgf·cm)	3.8 N·m (38 kgf·cm)	9.0 N·m (90 kgf·cm)	18 N·m (180 kgf·cm)

Input and power supply terminal screw size and tightening torque list

	Power supply terminal (No. 4, No. 5)
Screw size	M3
Recommended tightening torque	0.4 N·m (4 kgf·cm)

- When using a solderless terminal lug, use ring type.

Solderless terminal size



Ring terminal with insulator

	Power supply terminal (No. 4, No. 5)	Main circuit terminal (1/L1, 2/T1)			
		20 A/30 A	45 A/60 A	80 A/100 A	150 A/200 A
ϕ dimension	3.2 mm or more	4.3 mm or more	6.4 mm or more	8.4 mm or more	10.5 mm or more
D dimension	5.5 mm or less	9.5 mm or less	13.2 mm or less	22.6 mm or less	28.5 mm or less

- Make sure that during field wiring parts of conductors cannot come into contact with adjacent conductive parts.

■ Wiring diagram of main circuit (20 A to 100 A types)

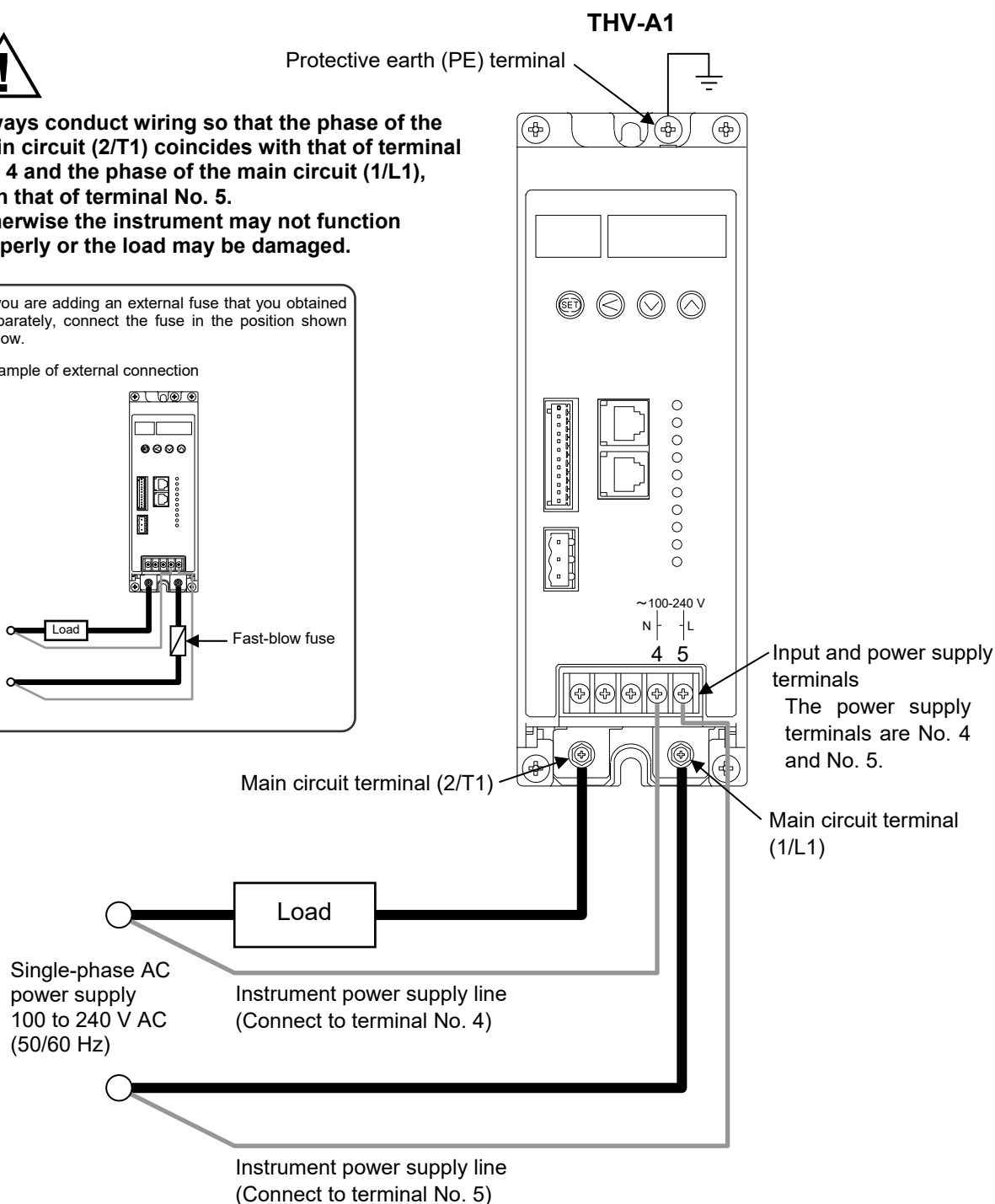
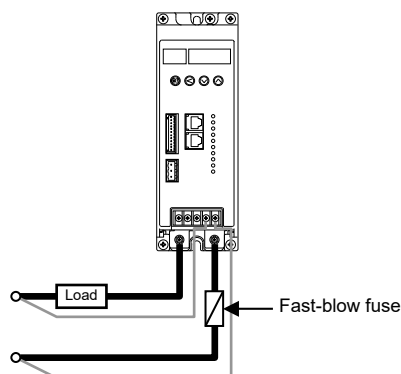


Always conduct wiring so that the phase of the main circuit (2/T1) coincides with that of terminal No. 4 and the phase of the main circuit (1/L1), with that of terminal No. 5.

Otherwise the instrument may not function properly or the load may be damaged.

If you are adding an external fuse that you obtained separately, connect the fuse in the position shown below.

Example of external connection



The fast-blow fuse and current transformer (CT) are optional.

A fast-blow fuse, current transformer (CT), and potential transformer (PT) are built into the THV-A1.



The Figure shows the type of 20 A/30 A. However, the wiring procedure is the same as for the type of 45 A to 100 A.

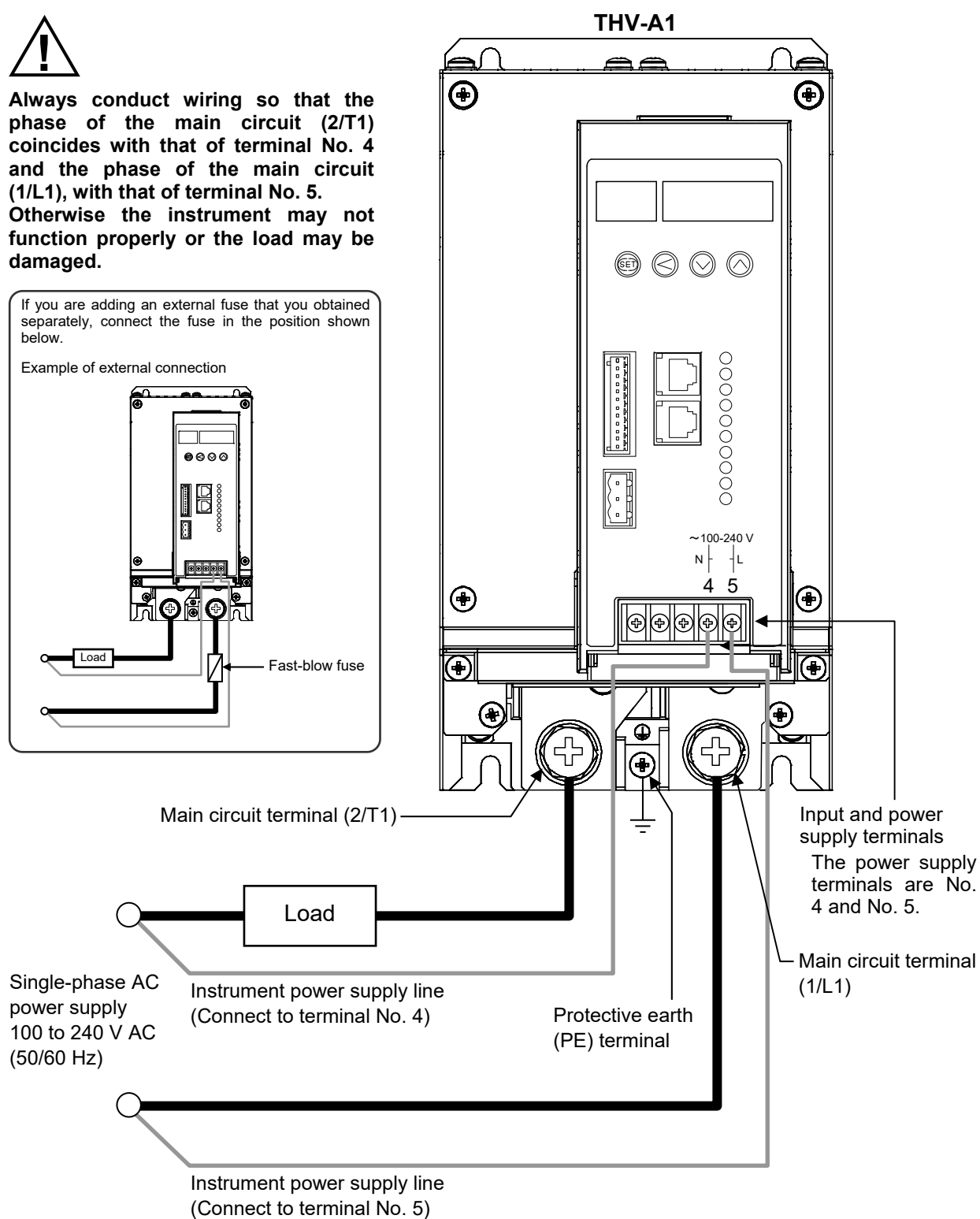
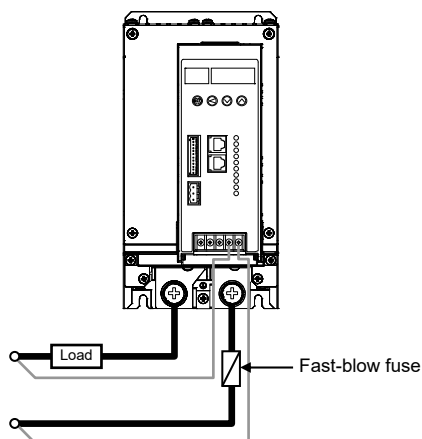
■ Wiring diagram of main circuit (150 A/200 A types)



Always conduct wiring so that the phase of the main circuit (2/T1) coincides with that of terminal No. 4 and the phase of the main circuit (1/L1), with that of terminal No. 5. Otherwise the instrument may not function properly or the load may be damaged.

If you are adding an external fuse that you obtained separately, connect the fuse in the position shown below.

Example of external connection

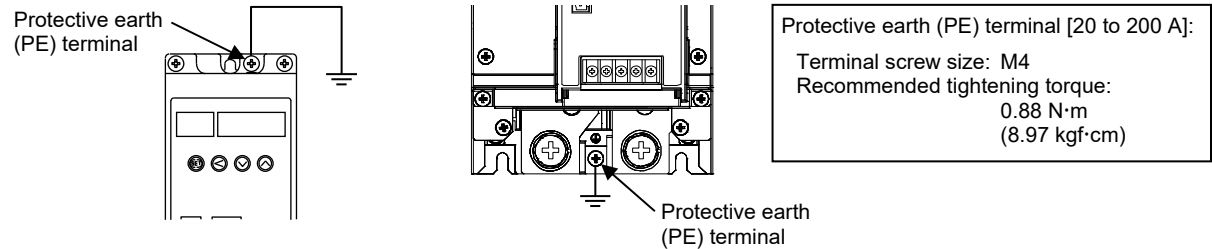


The fast-blow fuse and current transformer (CT) are optional.

A fast-blow fuse, current transformer (CT), and potential transformer (PT) are built into the THV-A1.

3.3 Wiring of Protective Earth (PE) Terminal

■ 20 A/30 A/45 A/60 A/80 A/100 A types ■ 150 A/200 A types

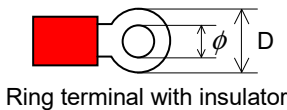


- Protective earth no other devices to the location where you earth this device.
- Avoid sharing earth lines with electric motors, motorized equipment, and other equipment that uses large amounts of electrify.
- In the earth system, be careful to earth each point and not to create a earth loop.
- Connect so that the earth resistance is no greater than 100 Ω.
- Use wire of at least 2.0 mm² (AWG14) for earth lines.

3.4 Wiring of Input Signal (Controller)

When using a solderless terminal lug, use ring type.

Solderless terminal size



	Input terminal (No. 1, No. 2 and No. 3)
ϕ dimension	3.2 mm or more
D dimension	5.5 mm or less
Recommended tightening torque	0.4 N·m (4 kgf·cm)

■ Wiring caution

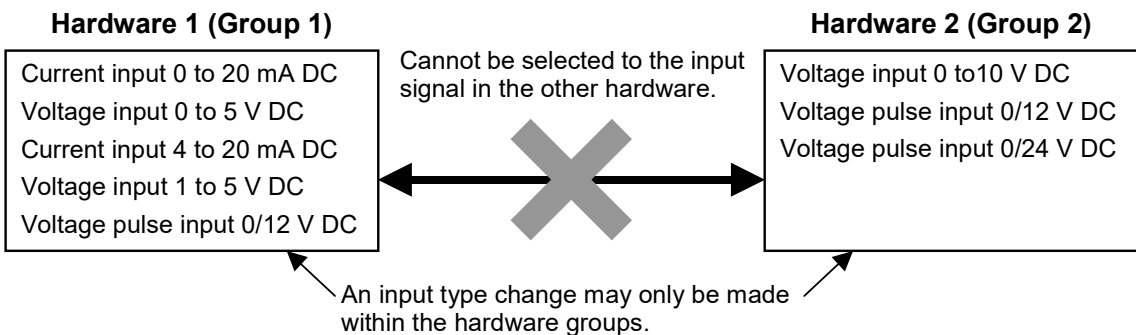
Signal connected to Voltage input and Current input shall be low voltage defined as “SELV” circuit per IEC 60950-1.

■ On input signal change

The input signal is set as specified when ordering at the time of being unpacked. When changing the input signal, conduct the following two settings.

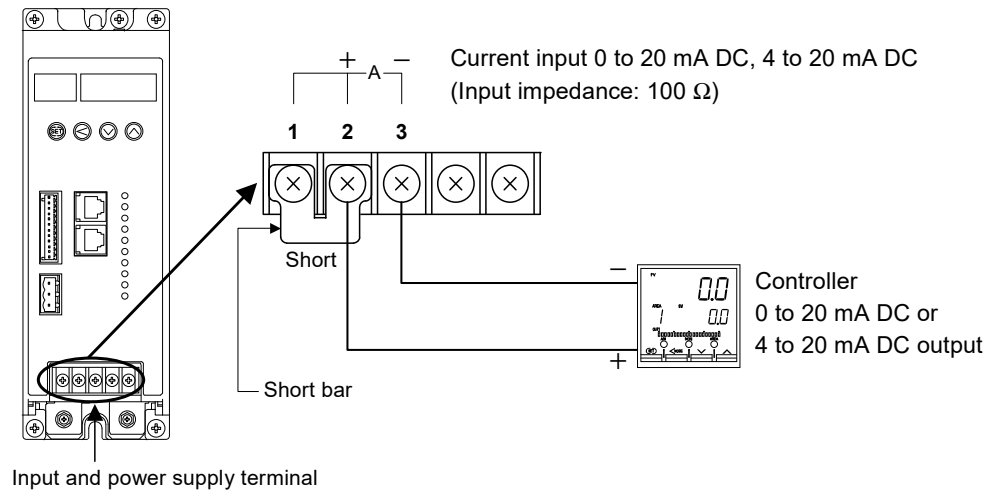
- Set the type of input signal by input signal selection (IS) in Engineering mode. (Refer to **P. 60**)
- Change the position of the short bar as appropriate for the input type. (Refer to **P. 23**)

In addition, the input signal is divided into two pieces of hardware. The input signal in the same hardware is selectable but the input signal in the other hardware cannot be selected.



3.4.1 Wiring of the current input

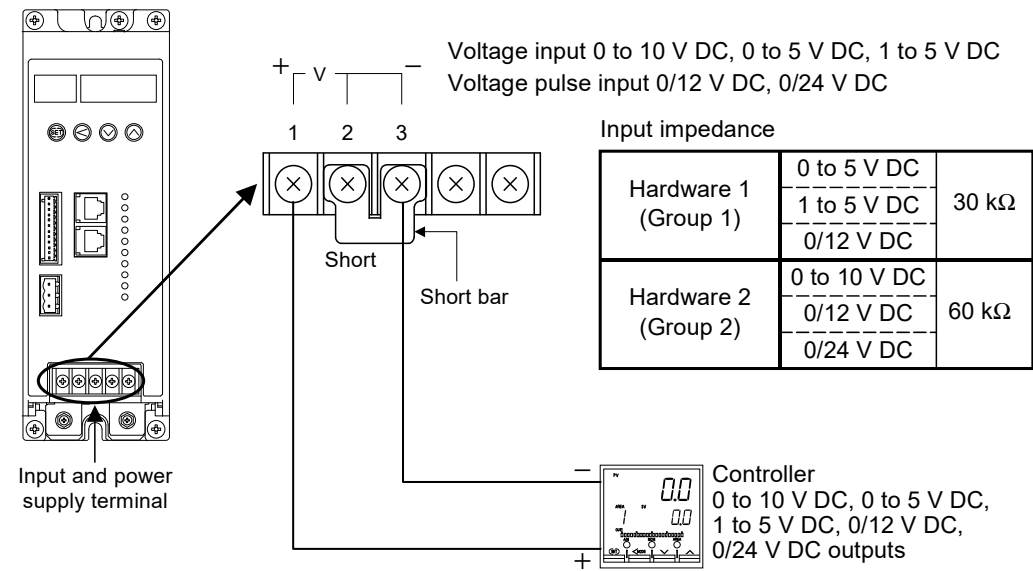
For current input (0 to 20 mA DC, 4 to 20 mA DC), short terminal No.1 with terminal No.2.



The figure shows the type of 20 A/30 A. However, the wiring procedure is the same as for the other types.

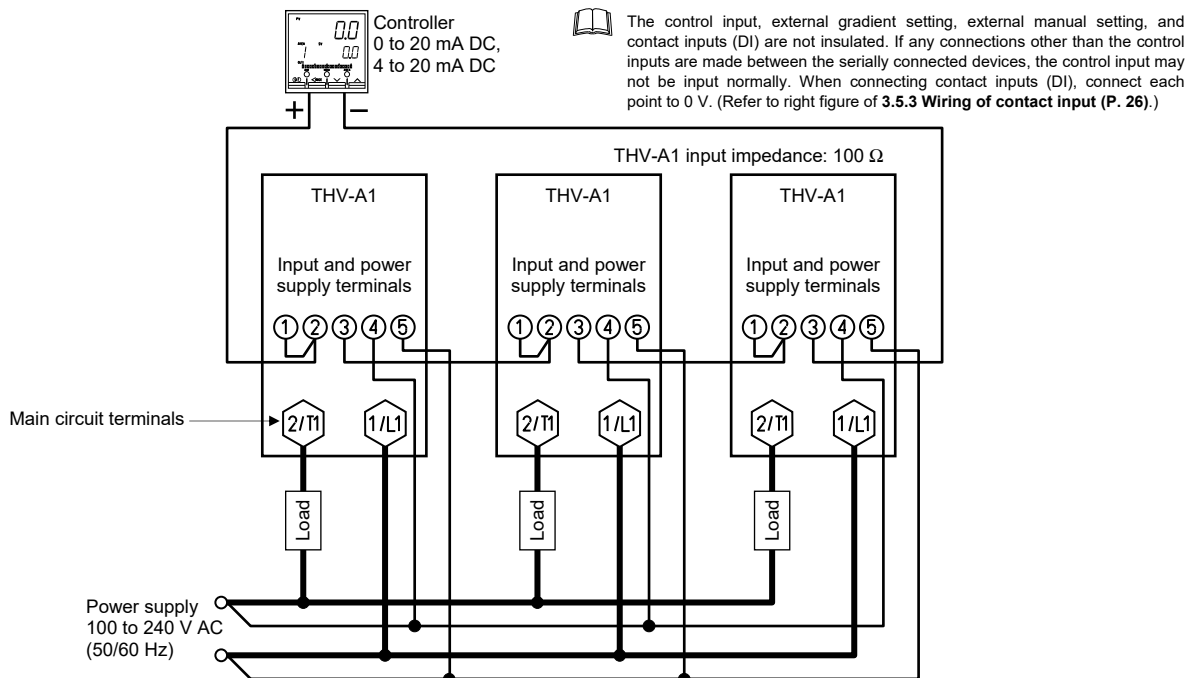
3.4.2 Wiring of the voltage input or voltage pulse input

For voltage input (0 to 5 V DC, 1 to 5 V DC or 0 to 10 V DC) or voltage pulse input (0/12 V DC, 0/24 V DC), short terminal No.2 with terminal No.3.

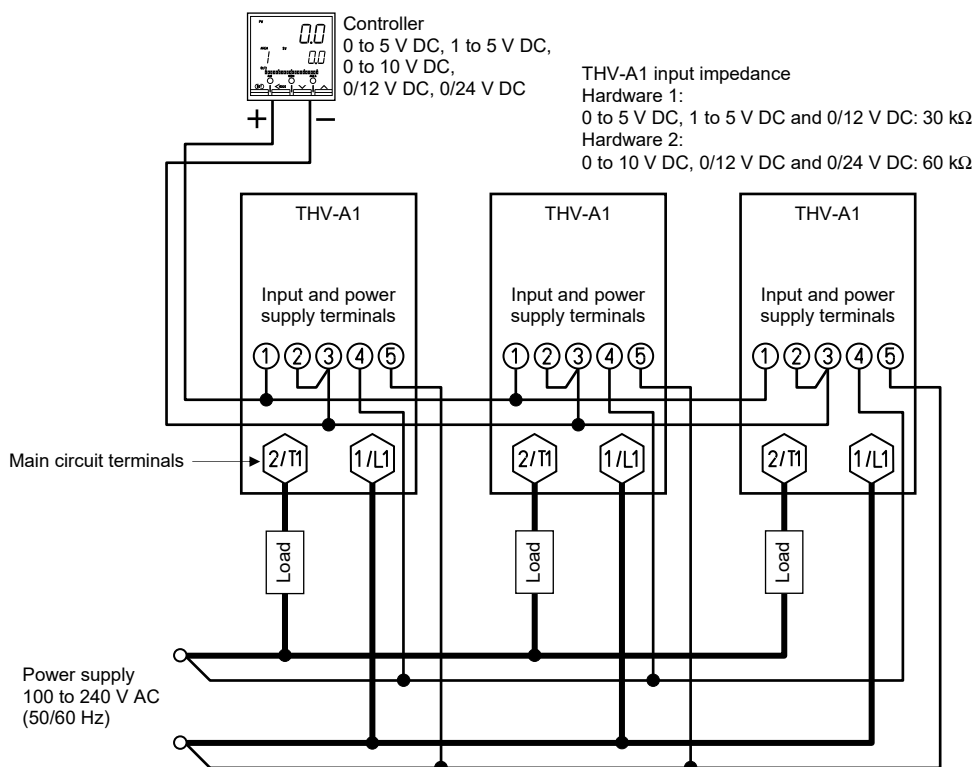


The figure shows the type of 20 A/30 A. However, the wiring procedure is the same as for the other types.

3.4.3 Wiring example of the series connection (For current input) [Built-in fast-blow fuse]



3.4.4 Wiring example of the parallel connection (For voltage input or voltage pulse input) [Built-in fast-blow fuse]

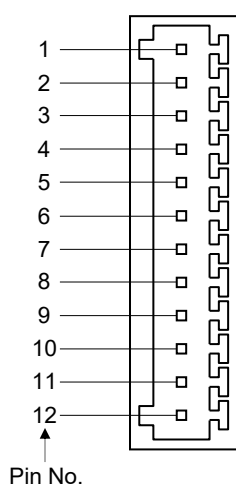


3.5 Wiring for Input Connector

The input connector is used for the following wiring.

- External manual mode
- External gradient setting
- Contact input (DI)

3.5.1 Input connector pin number and details



Pin No.	Details
1	+5 V output (Gradient setting input)
2	0 V (Gradient setting input)
3	Gradient setting input (0 to 5 V input by the gradient setter)
4	+5 V (Manual setting input)
5	0 V (Manual setting input)
6	Manual setting input (0 to 5 V input by the manual setter)
7	Contact input 1 (DI1)
8	Contact input 2 (DI2)
9	Contact input 3 (DI3)
10	0 V (Contact input) *
11	0 V (Contact input) *
12	0 V (Contact input) *

* The circuits of 10 to 12 are connected together internally.



To use the contact inputs, the contact input (DI) functions must be assigned and the action must be selected. Set the following parameters as necessary.

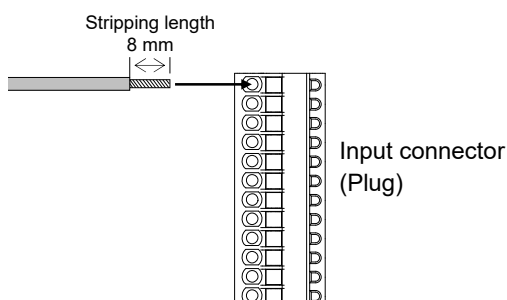
- Contact input 1 (DI1) function assignment (C1).....Refer to **P. 57**, **P. 81**.
- Contact input 2 (DI2) function assignment (C2).....Refer to **P. 57**, **P. 81**.
- Contact input 3 (DI3) function assignment (C3).....Refer to **P. 57**, **P. 81**.
- Contact input action (dA).....Refer to **P. 61**, **P. 81**.

3.5.2 Caution for wiring input connector (plug)

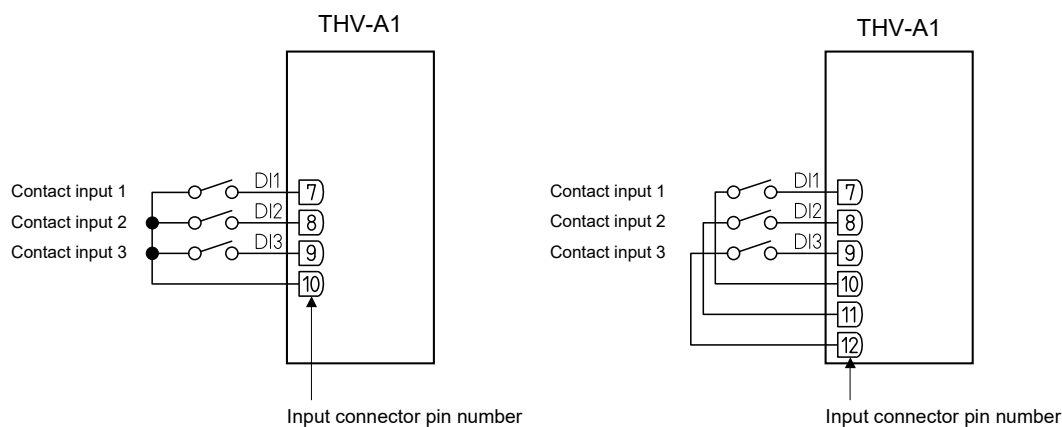
Use the stranded leadwires:

Stranded leadwires: AWG28-20 (cross-section: 0.14 to 0.5 mm²)

Stripping length: 8 mm



3.5.3 Wiring of contact input

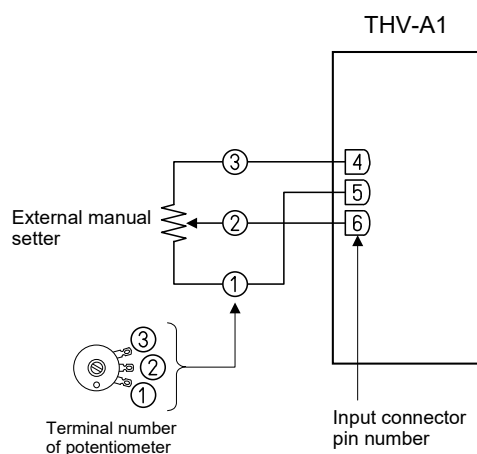


To use the contact inputs, the contact input (DI) functions must be assigned and the action must be selected. Set the following parameters as necessary.

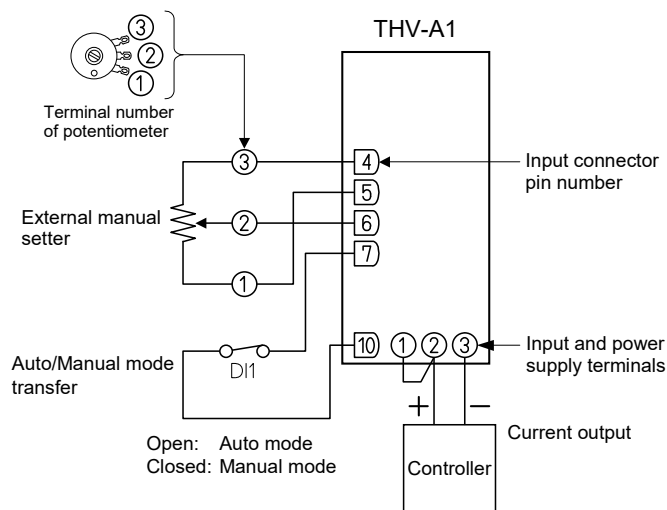
- Contact input 1 (DI1) function assignment (C1)Refer to **P. 57, P. 81**.
- Contact input 2 (DI2) function assignment (C2)Refer to **P. 57, P. 81**.
- Contact input 3 (DI3) function assignment (C3)Refer to **P. 57, P. 81**.
- Contact input action (dA)Refer to **P. 61, P. 81**.

3.5.4 Wiring of external manual setter

■ Only external manual setter

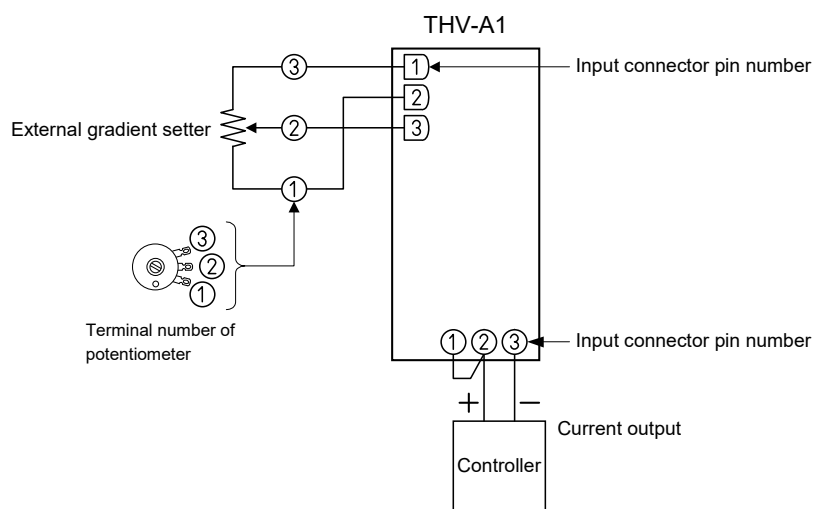


■ External manual setter (With Auto/Manual mode transfer)

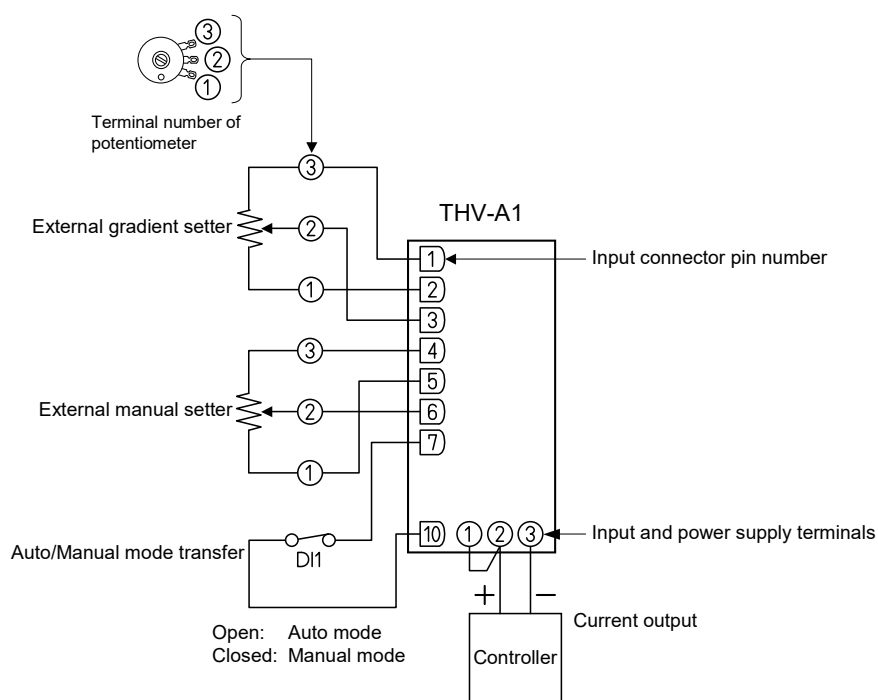


If only external manual mode will be used, set the contact input action (dA) of engineering mode to “3: External manual mode (fixed).” (Refer to **P. 61**)

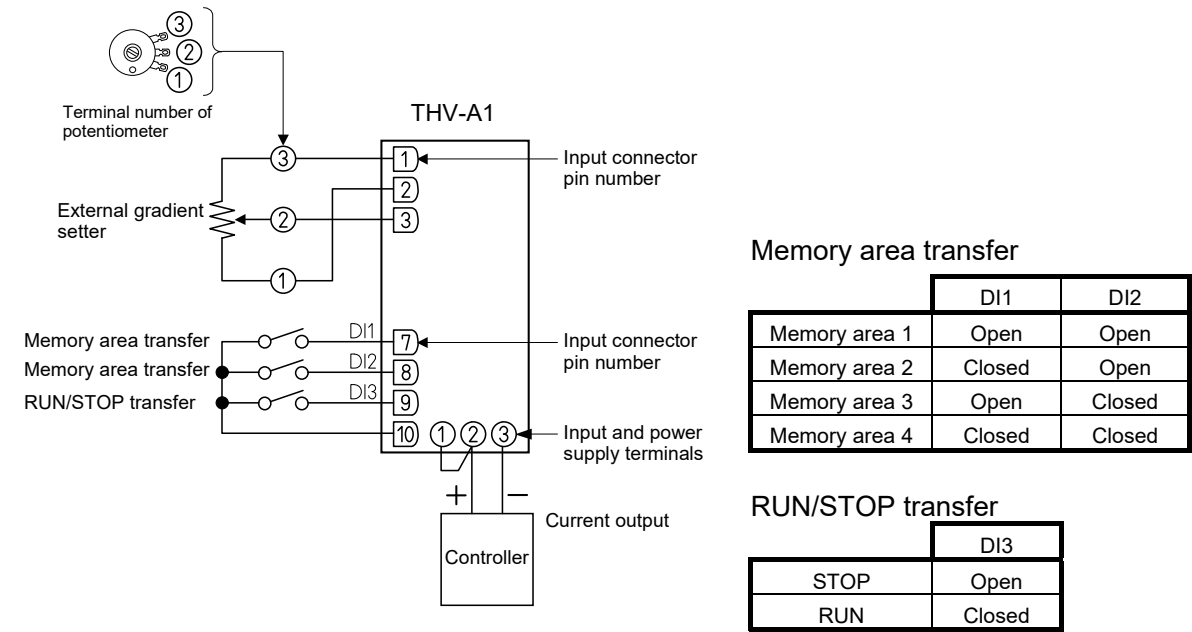
3.5.5 Wiring of external gradient setter



3.5.6 Wiring of Auto/Manual mode transfer (with gradient setter)

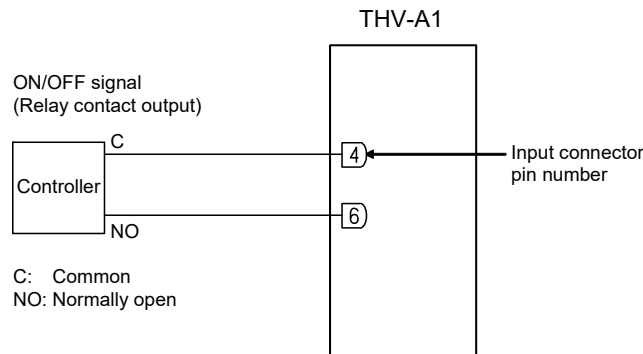


3.5.7 Wiring of auto mode, external gradient setting, memory area transfer and RUN/STOP transfer



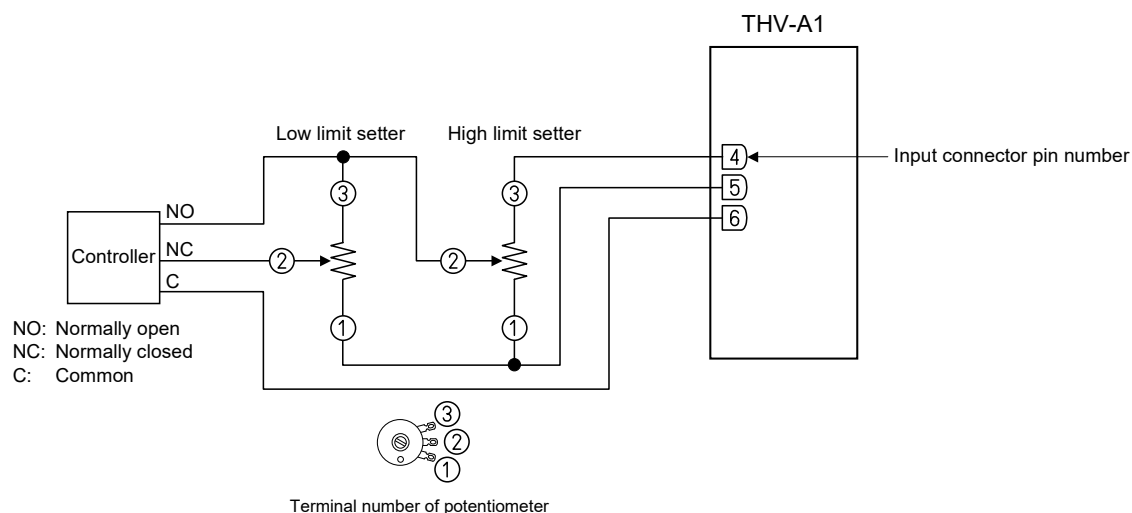
3.5.8 Wiring of contact input

The ON/OFF signal of the controller turns the thyristor output ON and OFF.



- To use the contact input, set the contact input action (dA) of engineering mode to “3: External manual mode (fixed).” (Refer to P. 61)
- After the contact input is connected, the output limiter (high) and output limiter (low) can be set to perform ON/OFF control.
 - Contact closed: Output limiter (high)
 - Contact open: Output limiter (low)

3.5.9 Wiring of ON/OFF control



To perform ON/OFF control, set the contact input action (dA) of engineering mode to “3: External manual mode (fixed).” (Refer to P. 61)



If it is necessary to set or change the output range, begin from high limit setter. The output value (low) depends on the set value of high limit setter.

When performing control using the set value of low limit setter, the output value (low) changes when the set value of high limit setter is changed.

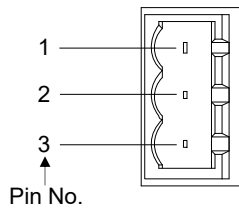
Output value (low) = Set value of high limit setter × Set value of low limit setter

Example: Set value of high limit setter is 80%, set value of low limit setter is 40 %

$$80 \% \times 40 \% = 32 \% \quad \text{Output value (low) } 32 \%$$

3.6 Wiring for Alarm Output Connector

3.6.1 Alarm output connector pin number and details



Pin No.

Pin No.	Details
1	Alarm 1: (ALM1): Digital output 1 (DO1), Relay contact output
2	Alarm 2: (ALM2): Digital output 2 (DO2), Relay contact output
3	Common (COM)

The type of alarm that is output from the alarm output connector must be selected. Select the output alarm type in alarm 1 output logic (L1) and alarm 2 output logic (L2).

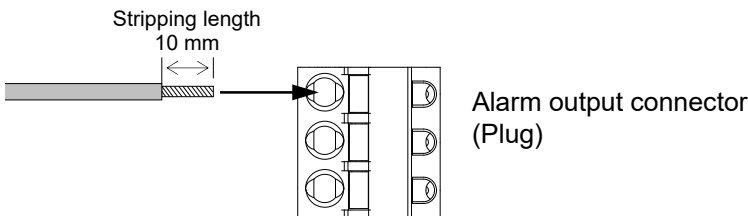
- FAIL alarm (de-energized)
- Power frequency error
- Board error
- Power supply voltage error
- Heater break alarm 1
- Heater break alarm 2
- Thyristor break-down alarm
- Over current
- Fuse break
- Heat sink temperature abnormality

Energized or de-energized can be selected for alarms other than a FAIL alarm.

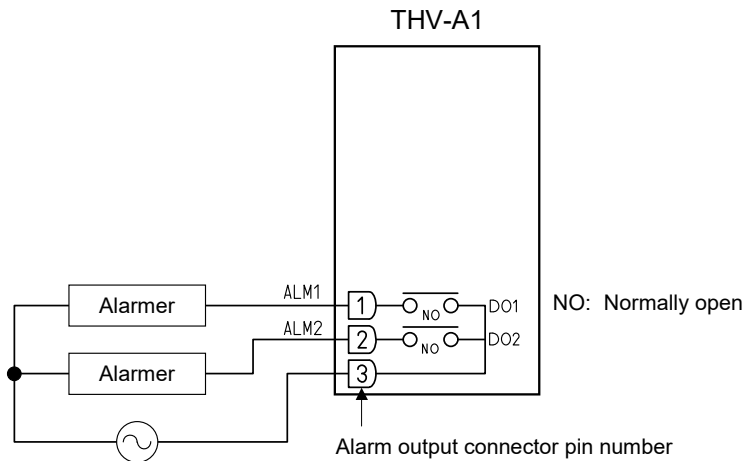
For details of alarm 1 output logic (L1) and alarm 2 output logic (L2), refer to page 67.

3.6.2 Caution for wiring alarm output connector (plug)

Use the stranded leadwires:
Stranded leadwires: AWG24-12 (cross-section: 0.2 to 2.5 mm²)
Stripping length: 10 mm



3.6.3 Wiring of alarm output connector



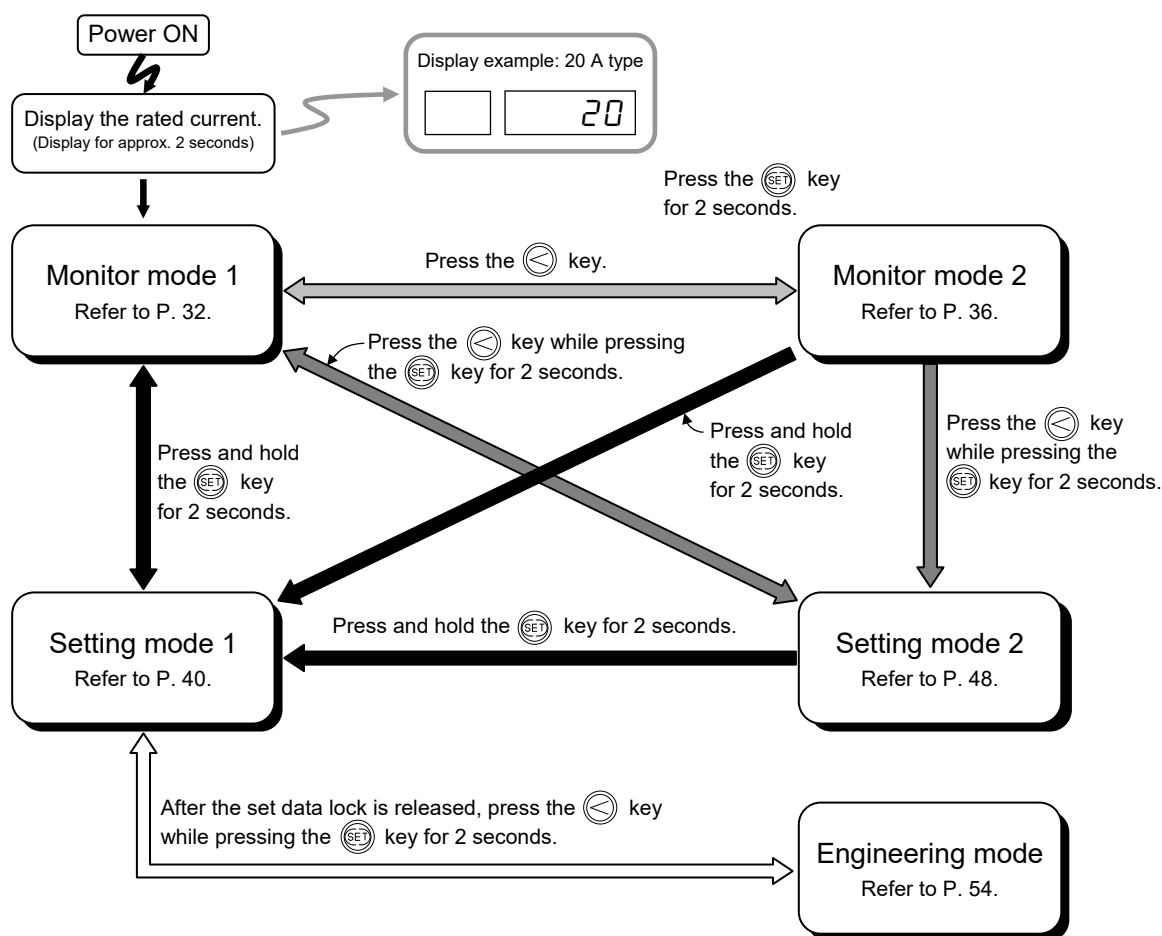
4. SETTING

This chapter describes various monitor screens, parameters or setting method. Set any mode necessary for customer's operation. When setting the mode for the first time, set it in the order of engineering mode and setting mode.

4.1 Mode Menu

THV-A1 has five different modes, and all settable parameters belongs to one of them. The following chart show how to access different mode.

- **Monitor mode 1:** The input signal, phase angle ratio, current and other values can be monitored.
- **Monitor mode 2:** The power frequency, external gradient, external manual and other values can be monitored.
- **Setting mode 1:** The parameters (Soft-start/Soft-down, Internal gradient, Set data lock and others) can be set.
- **Setting mode 2:** Heater break alarm set value, current limit value, etc. can be set. (Displayed when the constant current control function or constant power control function is provided.)
- **Engineering mode:** This is the mode to set parameters which are almost unrequired to be changed hereafter as far as normally used, it set once so as to meet the operating condition.



If the engineering mode is locked, the engineering mode is not displayed.



Setting mode 1, setting mode 2 and engineering mode return to monitor mode 1 if key operation for more than one minute is not performed.

4.2 Monitor Mode 1

When the power is turned on, THV-A1 goes to this mode after self-diagnostics. The following items are displayed in the monitor mode 1.

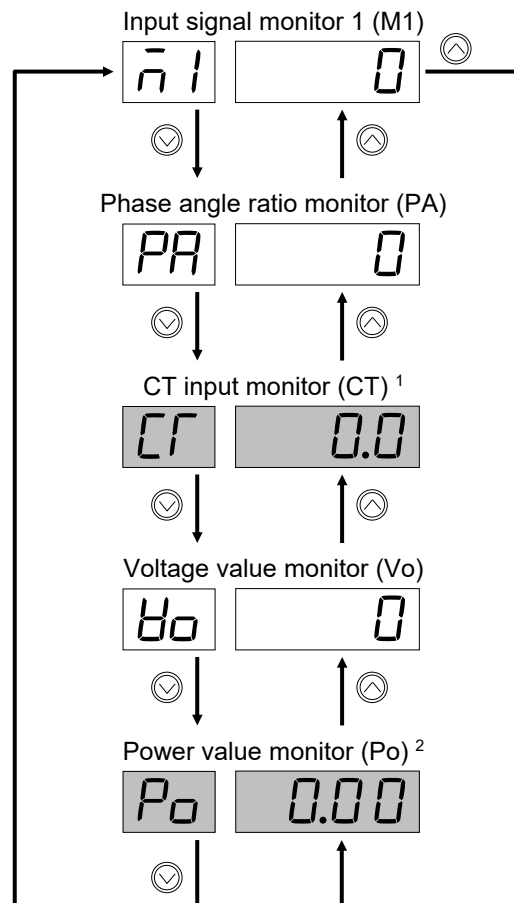
- Input signal value
- Current value
- Power value
- Phase angle ratio value
- Voltage value

4.2.1 Display sequence

To go to the next monitor screen, press UP (⬆) or DOWN (⬇) key.

To go back to the first monitor screen, keep pressing the keys until it is displayed again.

■ Monitor mode 1

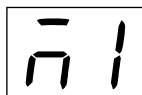


¹ This screen is displayed on the instrument with a constant current control or constant power control.

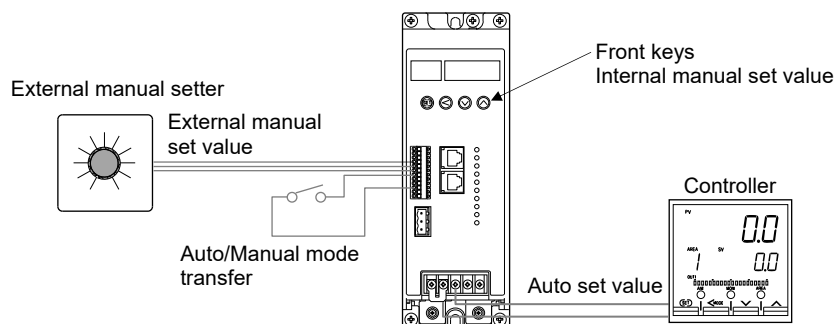
² This screen is displayed on the instrument with a constant power control.

4.2.2 Description of each monitor

Input signal monitor 1 (M1)



Select and then display one input signal value from among three input signal values. If the state at the time of factory set value, display an auto set value. If one point of the contact input (DI) is used for “Auto/Manual mode transfer,” the display can be switched between two types of input signals.



For the selection method of input signal, refer to **4.7 Display Setting of Input Signal Monitor 1 (M1)**. (Refer to page 79.)

Input signal type	Display range
Auto set value (Input signal from controller)	0 to 100 %
External manual set value (Input signal from external manual setter)	
Internal manual set value (Set value set by THV-A1 front keys.)	

The internal manual set value that is set in “Internal manual set value (IM)” is displayed with digits to the right of the decimal point rounded off.

If the input signal type displayed in input signal monitor 1 (M1) is changed, control is immediately performed using the set value of the new input signal.

Phase angle ratio monitor (PA)



Displays the phase angle of the trigger point by percentage.

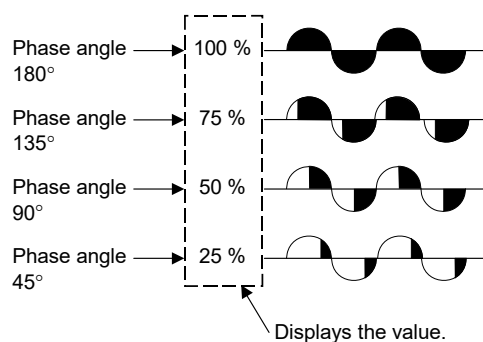
Phase angle is obtained by performing such computation as soft-start/soft-down time, gradient setting, output limiter setting or base up setting to the input signal.

Display range
0 to 100 %



Display the 0 % when the phase angle is 0°.

Display the 100 % when the phase angle is 180°.



CT input monitor (CT)



Displays the captured value of current transformer (CT).

The displayed current value is an effective value.

Display range varies depending on the instrument specification.

Instrument type	Display range
20 A type	0.0 to 27.0 A
30 A type	0.0 to 40.5 A
45 A type	0.0 to 60.8 A
60 A type	0.0 to 81.0 A
80 A type	0.0 to 108.0 A
100 A type	0.0 to 135.0 A
150 A type	0.0 to 202.5 A
200 A type	0.0 to 270.0 A



CT input monitor (CT) screen is displayed when a product with constant current control or constant power control is specified at the time of ordering.




Current Transformer (CT) is built in the THV-A1 when constant current control or constant power control is specified.

Voltage value monitor (Vo)



Displays the output voltage (load voltage) of THV-A1.
The displayed voltage value is an effective value.
(Output voltage is calculated from the instrument power supply).

Display range
0 to 280 V


 90 to 264 V AC [Including power supply voltage variation]
Rated value 100 to 240 V AC


Power value monitor (Po)



Displays the power value.
The power value is calculated from the input value of the current transformer (CT) and the input value of the potential transformer (PT), both of which are incorporated in the THV-A1.

THV-A1 types	Display range
20 A type	0.00 to 7.56 kW
30 A type	0.00 to 11.34 kW
45 A type	0.00 to 17.01 kW
60 A type	0.00 to 22.68 kW
80 A type	0.00 to 30.24 kW
100 A type	0.00 to 37.80 kW
150 A type	0.00 to 56.70 kW
200 A type	0.00 to 75.60 kW

 Power value monitor (Po) screen is displayed when a product with constant power control is specified at the time of ordering.

 Current Transformer (CT) is built in the THV-A1 when constant current control or constant power control is specified.

4.3 Monitor Mode 2

The following items are displayed in the monitor mode 2.

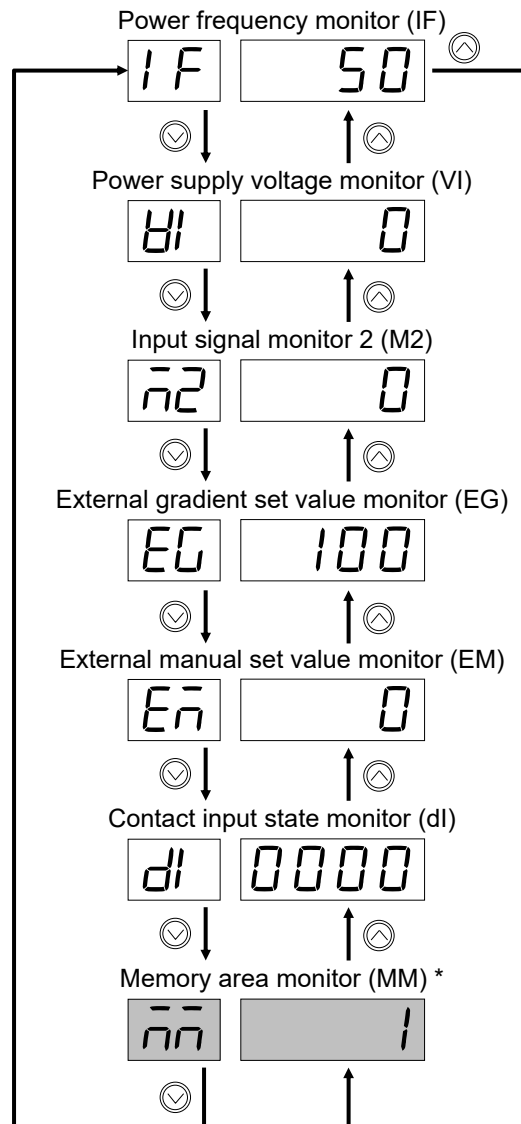
- Power frequency
- Power supply voltage
- Auto set value
- External gradient set value
- External manual set value
- State of contact input (DI) (open/closed state)
- Memory area number

4.3.1 Display sequence

To go to the next monitor screen, press UP (⬆) or DOWN (⬇) key.

To go back to the first monitor screen, keep pressing the keys until it is displayed again.

■ Monitor mode 2



* This screen is displayed on the instrument with a constant current control or constant power control.
If the non-linear resistance heater break alarm is used, memory area function cannot be used.

4.3.2 Description of each monitor

Power frequency monitor (IF)

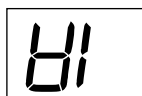


Displays the power frequency.

Display range
40 to 70 Hz

- There is a power frequency monitoring function to this instrument.
For details on function, refer to **5.12 Power Frequency Monitoring Function (P. 146)**.

Power supply voltage monitor (VI)



Displays the power supply voltage.

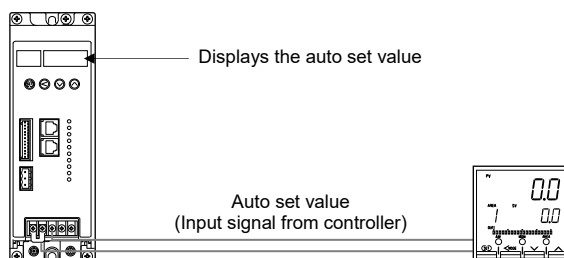
Display range
0 to 280 V

- 90 to 264 V AC [Including power supply voltage variation]
Rated value 100 to 240 V AC

Input signal monitor 2 (M2)



Displays the auto set value (input signal from controller).



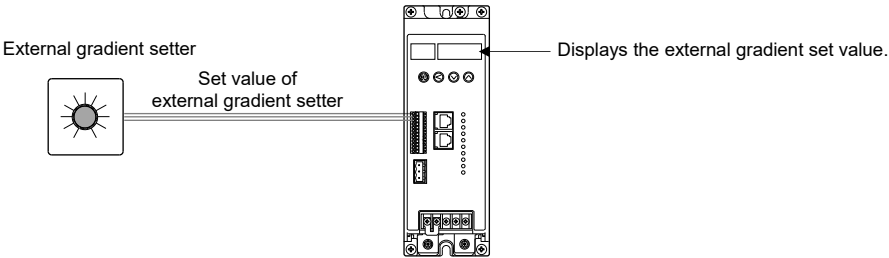
Display range
0 to 100 %

- Displays the "0" to the input signal monitor 2 (M2), if the controller is not connected.


External gradient set value monitor (EG)



Displays the external gradient set value (set value of external gradient setter).



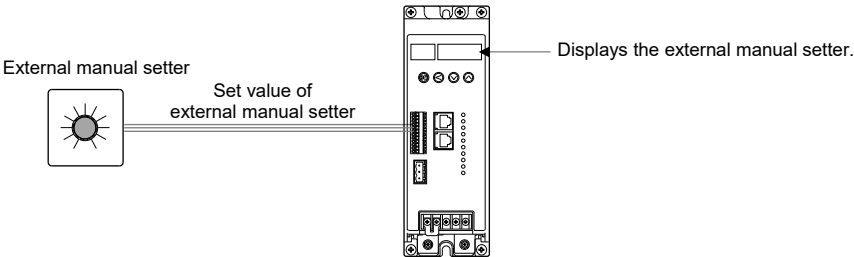
Display range
0 to 100 %

 Displays the “100” to the external gradient set value monitor (EG), if the external gradient setter is not connected.

External manual set value monitor (EM)



Displays the external manual set value (set value of external manual setter).

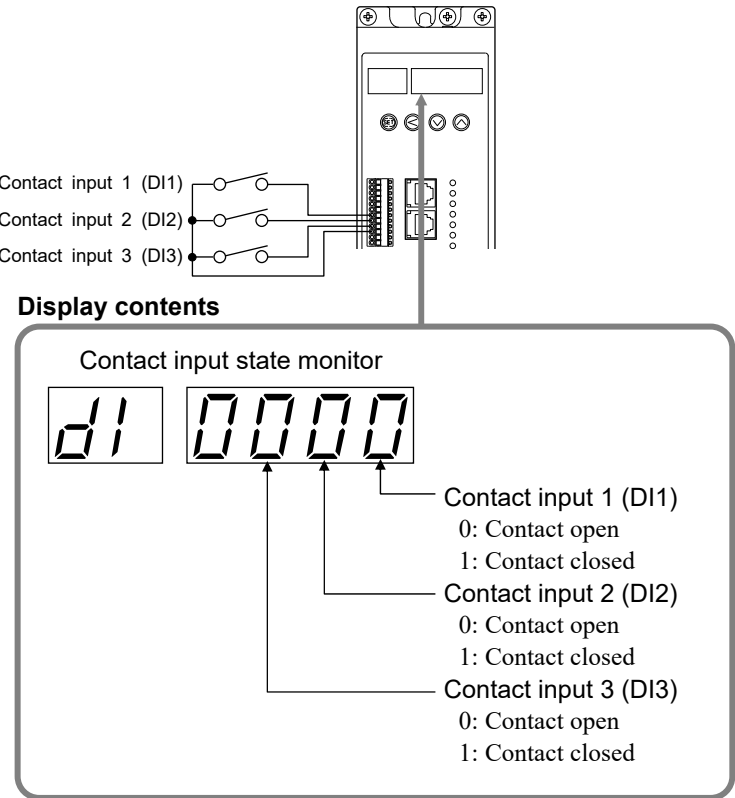


Display range
0 to 100 %

Contact input state monitor (dl)



Displays the open or closed state of contact input.



For users of the THV-1

Please note that the open/close displays of the contact input state monitor in the THV-1 are opposite those in the THV-A1.

	THV-1	THV-A1
Contact open	1	0
Contact closed	0	1

Memory area monitor (MM)



The memory area number now used for alarm monitoring is displayed.

Display range
1 to 4



Memory area monitor (MM) screen is displayed on the instrument with a constant current control or constant power control. In addition, if the non-linear resistance heater break alarm is used, memory area function cannot be used.

4.4 Setting Mode 1

In setting mode 1, the following operations are possible.

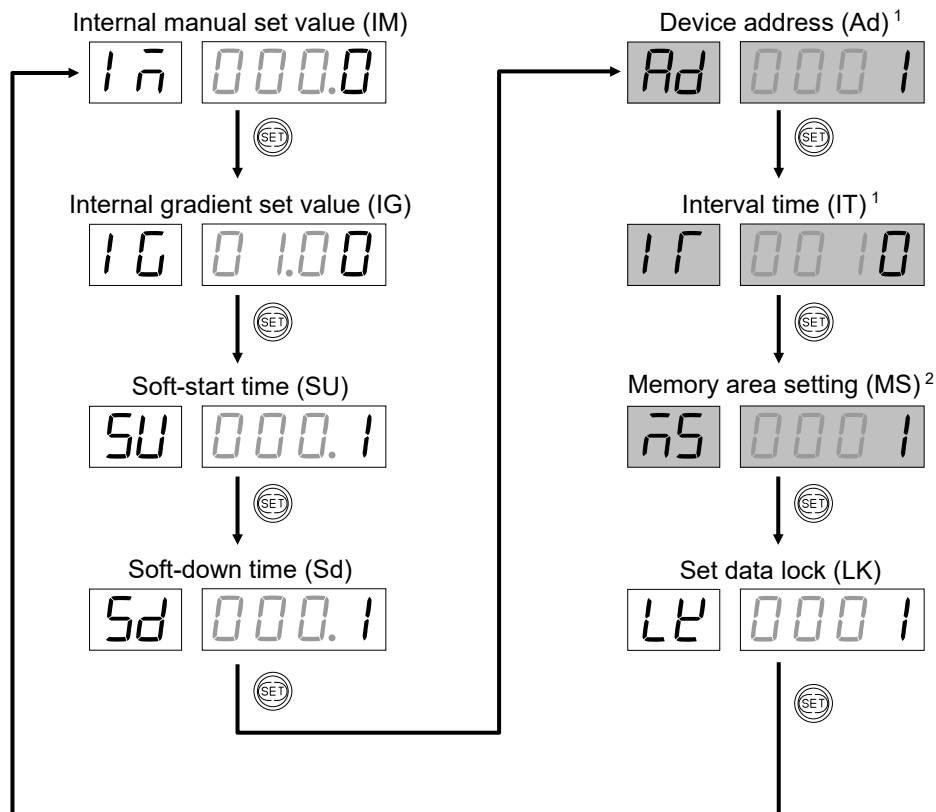
- Internal manual set value
- Internal gradient set value
- Soft-start time
- Soft-down time
- Device address
- Interval time
- Memory area
- Set data lock

4.4.1 Display sequence

To go to the next parameter (setting item), press SET key (Ⓢ). To go back to the first setting item, keep pressing SET keys until it is displayed again.

Setting mode 1 return to monitor mode 1 if key operation for more than one minute is not performed.

■ Setting mode 1



¹ This screen is displayed on the instrument with a communication function (RS-422A or RS-485).

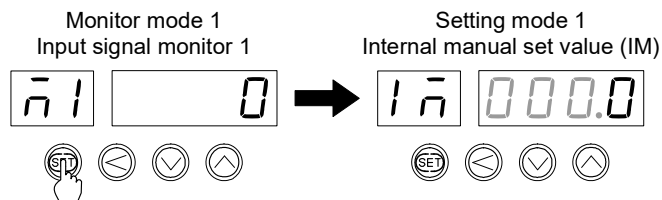
² This screen is displayed on the instrument with a constant current control or constant power control.

In addition, if the non-linear resistance heater break alarm is used, memory area function cannot be used.

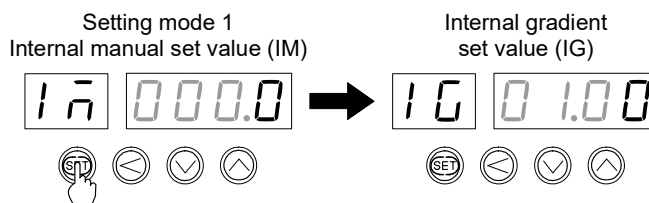
4.4.2 Changing parameter settings

■ When set the internal gradient set value to “0.50”

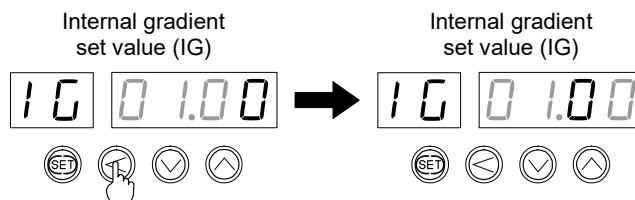
1. Press and hold the SET key for 2 seconds to change to setting mode 1.



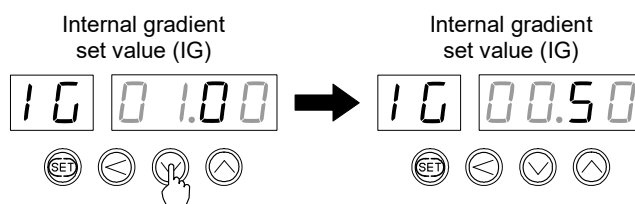
2. To go to the internal gradient set value, press SET key.



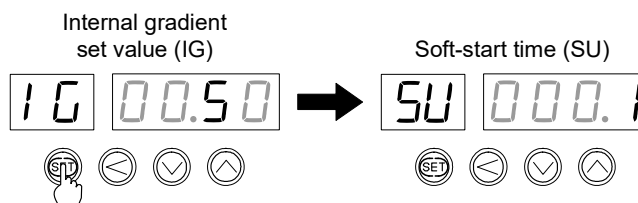
3. Press the shift key to high-light the one decimal place on display (numerical value display).



4. Press the DOWN key to change the number to “5.”



5. Press the SET key to store the new value. The display goes to the next parameter.



Continued on the next page.

Continued from the previous page.



When the value is changed, it will be automatically stored after two seconds without any key operation.

When the device address (Ad) and interval time (IT) are changed, the power must be turned off and then on in order for the new values to take effect.



After changing to setting mode 1, setting mode 2, or engineering mode, if the key is not pressed for more than one minute the display will automatically return to the monitor mode 1.



The same setting procedure applies when other parameters are also set.

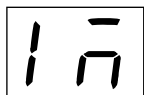


Every time the shift key is pressed, the high-lighted digit moves as follows.



4.4.3 Description of each parameter (setting item)

Internal manual set value (IM)



Use to set the internal manual set value.

Setting range	Factory set value
0.0 to 100.0 %	0.0

If the THV-A1 power is turned off, internal manual set value is reset to “0.0.”

For the function description, refer to page 120.

Internal gradient set value (IG)



Use to set the internal gradient set value.

Setting range	Factory set value
0.00 to 2.00 { Internal gradient is 0 % when set 0.00. Internal gradient is 200 % when set 2.00. }	1.00

Setting for internal gradient set value becomes valid when the control method is the phase control or zero-cross control (continuous).

For the gradient output characteristic, refer to page 122.

Soft-start time (SU)



Use to set the soft-start time. Set the time for the output to go from 0 % to 100 % within the range 0.0 to 100.0 seconds.

CAUTION

If a load generating large rush current is used, thyristor break-down may occur when no soft-start time is appropriately set. In zero-cross control, no rush current can be suppressed even if the soft-start time is set.

Setting range	Factory set value
0.0 to 100.0 seconds (0.0: Soft-start function unused)	0.1



Setting for soft-start function becomes valid when the control method is the phase control.



For the function description, refer to page 123.

■ Caution for using protection function for control of primary side of a transformer

Action of soft-start time (SU) depends on the setting (enable/disable) of protection function for control of primary side of a transformer. When protection function for control of primary side of a transformer is enabled, the action of the soft-start time (SU) becomes as follows.

- When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.
- Even if soft-start, soft-down enable/disable (SF) is selected to “disable,” the action of soft-start time (SU) becomes the same as that for “enable.”
When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.
- Even if soft-start and soft-down functions are selected to “disable” by the contact input (DI), the action of the soft-start time (SU) becomes the same as that for “enable.”
When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.
- When the mode is switched from STOP to RUN by RUN/STOP transfer (rS)
Soft-start function starts working for a period of soft-start time setting (SU).
When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.
- When the mode is switched from STOP to RUN by the contact input (DI)
Soft-start function starts working for a period of soft-start time setting (SU).
When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

Soft-down time (Sd)



Use to set the Soft-down time. Set the time for the output to go from 100 % to 0 % within the range 0.0 to 100.0 seconds.

Setting range	Factory set value
0.0 to 100.0 seconds (0.0: Soft-down function unused)	0.1



When the control method is the zero-cross control, soft-down function is not activated.



For the function description, refer to page 123.

■ Caution for using protection function for control of primary side of a transformer

Action of soft-down time (Sd) depends on the setting (enable/disable) of protection function for control of primary side of a transformer. When protection function for control of primary side of a transformer is enabled, the action of soft-down becomes the same as that for soft-down enable even if soft-start and soft-down functions are disabled by the following setting and operation.

- When soft-down function is disabled by soft-start, soft-down enable/disable (SF).
- When soft-start and soft-down functions are disabled by the contact input (DI).

Device address (Ad)



Use to set the device address of THV-A1.

This address allows the host computer to recognize the THV-A1.

Setting range	Factory set value
0 to 99 THV-A1 with addresses set to “0” will not perform communication.	1



Device address (Ad) is displayed when a product with communication function (RS-422A or RS-485) is specified at the time of ordering.



For the communication function, refer to **THV-A1 Communication Instruction Manual [Detailed version] (IMR02D05-E□)**.

Interval time (IT)



Use to set the interval time. The interval time for the THV-A1 (Slave) should be set to provide a time for host computer (Master) to finish sending all data including stop bit and to switch the line to receive status for the host.

Setting range	Factory set value
0 to 250 ms	10

Interval time (IT) screen is displayed on the instrument with a communication function (RS-422A or RS-485).

For the communication function, refer to **THV-A1 Communication Instruction Manual [Detailed version] (IMR02D05-E□)**.

Memory area setting (MS)



Use to set the memory area used for alarm monitoring.
If the memory area setting (MS) is changed, the memory area selection (AE) changes to the same memory area number.

Setting range	Factory set value
1 to 4	1

Memory area setting (MS) screen is displayed on the instrument with a constant current control or constant power control.

If the non-linear resistance heater break alarm is used, memory area function cannot be used.

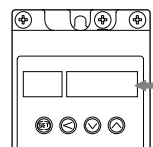
If a contact input (DI) is used for memory area transfer, the contact input (DI) setting is given priority.

For the function description, refer to page 123.

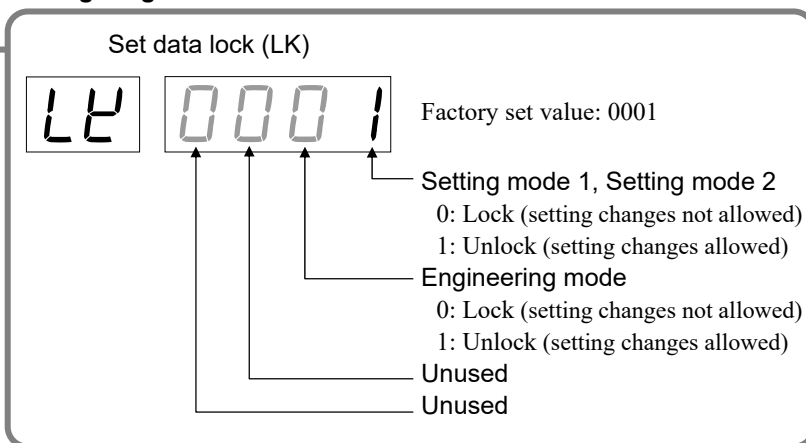
Set data lock (LK)

LE

To prevent operation errors, the parameters of setting mode and engineering mode can be locked.



Setting range




For the function description, refer to page 124.

4.5 Setting Mode 2

In setting mode 2, the following operations are possible. In addition, the following data can be stored in the memory area.

- Maximum load current set value
- Heater break alarm set value
- Thyristor break-down set value
- Current limit value

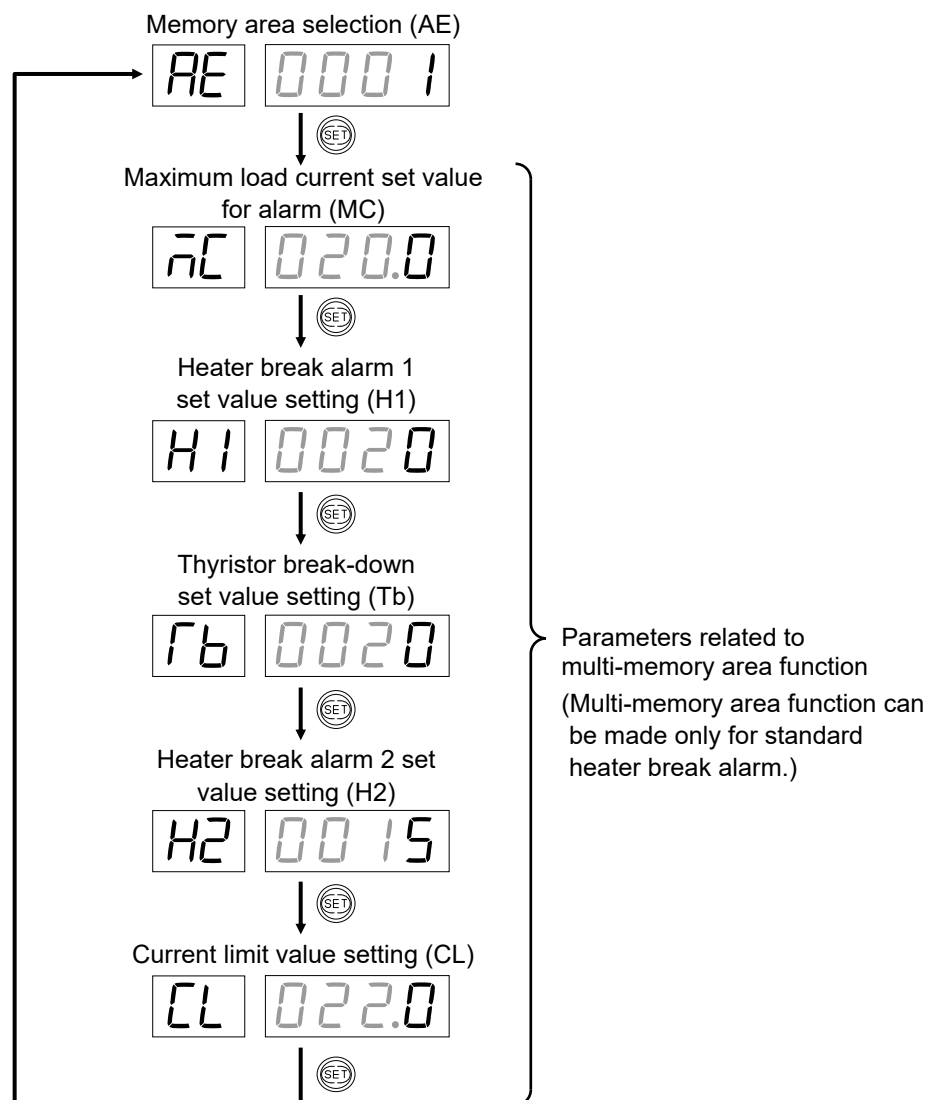
4.5.1 Display sequence

To go to the next parameter (setting item), press SET key (). To go back to the first setting item, keep pressing SET keys until it is displayed again. The monitor mode 2 returns to the monitor mode 1 if no key operation is performed for more than 1 minute.


■ Setting mode 2



Setting mode 2 screen is displayed on the instrument with a constant current control or constant power control.



4.5.2 Description of each parameter (setting item)


 For the setting method of numeric value, refer to **4.2.2 Changing parameter settings (P. 41)**.


Memory area selection (AE)



Select the memory area used to store the set values.
The set values of setting mode 2 are stored in the displayed memory area number.

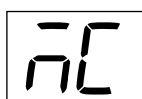
Setting range	Factory set value
1 to 4	1

 If the non-linear resistance heater break alarm is used, memory area function cannot be used. Data of memory area 2 to 4 are invalid.


 For the procedure for configuring settings, refer to **(2) Set each alarm set value (P. 94)**.


 For the function description, refer to page 123.

Maximum load current set value for alarm (MC)





Use to set the maximum heater current value (maximum load current value) for heater break alarm. The maximum load current value means a current value which flows through the heater at an output of 100 % (phase angle: 180°).

 **Be sure to set the maximum load current set value. If this is not set, it will not be possible to make a heater break judgment. In addition, if an incorrect maximum load current set value is set, wrong operation may result.**


 **If the maximum current value which flows through the heater changes due to heater secular change or deterioration, change the maximum load current set value.**

Setting range	Factory set value
0.0 to 22.0 A (20 A type)	20.0
0.0 to 33.0 A (30 A type)	30.0
0.0 to 50.0 A (45 A type)	45.0
0.0 to 66.0 A (60 A type)	60.0
0.0 to 88.0 A (80 A type)	80.0
0.0 to 110.0 A (100 A type)	100.0
0.0 to 165.0 A (150 A type)	150.0
0.0 to 220.0 A (200 A type)	200.0

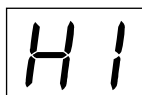
 In the case of non-linear resistance heater break alarm, the maximum load current set value is automatically calculated when automatic calculation of the inflection point is performed. (Refer to **P. 100**)

 If the standard heater break alarm is used, the maximum load current set value can be stored in each memory area.

If the non-linear resistance heater break alarm is used, memory area function cannot be used. Data of memory area 2 to 4 are invalid.

 For the details of maximum load current value calculation method, refer to **4.9 How to Find Maximum Load Current Value (P. 84)**.

Heater break alarm 1 set value setting (H1)



Use to set the heater break alarm 1 setvalue.

Setting range	Factory set value
0 to 100 % of maximum load current set value (0: Heater break alarm 1 unused)	20



If the standard heater break alarm is used, the heater break alarm set value 1 can be stored in each memory area.

If the non-linear resistance heater break alarm is used, memory area function cannot be used. Data of memory area 2 to 4 are invalid.



When “Type 1 (constant resistance type, deviation alarm)” is selected in heater break alarm 1 type, this alarm value becomes a deviation setting.



For the setting procedure, refer to **4.10 Setting Example of Heater Break Alarm (P. 89)**.



For the function description, refer to page 125.

■ Recommended value of heater break alarm 1



Although the following values are recommended, the alarm set value varies depending on the load type and the number of connection. Set the value suited to your system.

When the control method is phase control, RKC recommends:

- Set the heater break alarm set value to approximately 20 % of the maximum load current value for heater break alarm type 1 (constant resistance type, deviation alarm).
This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.
- Set the heater break alarm set value to approximately 10 % of the maximum load current value for heater break alarm Type 2 (linearity resistor type, absolute value alarm).
Do not set the heater break alarm set value to more than 15 %.
This recommended value is a guideline for when there is one connected heater.
- In the case of a non-linear resistance heater break alarm, there is no recommended value because the load characteristics vary depending on the non-linear load type.

When the control method is zero-cross control, RKC recommends:

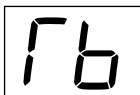
This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.

- Set the heater break alarm set value to approximately 80 % of the reading of current transformer input.
- Set the heater break alarm set value to a slightly smaller value to prevent a false alarm when power supply variation is large.
- Set the heater break alarm set value to a slightly larger value to detect a failure of one heater when more than one heaters are connected in parallel. But the set value should be less than the maximum reading of current transformer input.



If the zero-cross control is used, Type 1 (constant resistance type, deviation alarm), Type 2 (linearity resistor type, absolute value alarm) and non-linear resistance heater break alarm cannot be used. Invalidated even if these function is set.

Thyristor break-down set value setting (Tb)



Use to set the thyristor break-down set value.

Setting range	Factory set value
0 to 100 % of maximum load current set value (0: Thyristor break-down alarm unused)	20

If the standard heater break alarm is used, the thyristor break-down set value can be stored in each memory area. If the non-linear resistance heater break alarm is used, memory area function cannot be used. memory area function cannot be used. Data of memory area 2 to 4 are invalid.

When “Type 1 (constant resistance type, deviation alarm)” is selected in heater break alarm 1 type, this alarm value becomes a deviation setting.

For the setting procedure, refer to **4.10 Setting Example of Heater Break Alarm (P. 89)**.

For the function description, refer to page 125.

■ Recommended value of thyristor break-down set value

Although the following values are recommended, the alarm set value varies depending on the load type and the number of connection. Set the value suited to your system.

When the control method is phase control, RKC recommends:

- Set the thyristor break-down set value to approximately 20 % of the maximum load current value for heater break alarm type 1 (constant resistance type, deviation alarm).
This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.
- Set the thyristor break-down set value to approximately 10 % of the maximum load current value for heater break alarm type 2 (linearity resistor type, absolute value alarm).
Do not set the thyristor break-down set value to more than 15 %.
This recommended value is a guideline for when there is one connected heater.
- In the case of a non-linear resistance heater break alarm, there is no recommended value because the load characteristics vary depending on the non-linear load type.

When the control method is zero-cross control, RKC recommends:

Set the thyristor break-down set value to approximately 80 % of the maximum load current value.
This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.

If the zero-cross control is used, Type 1 (constant resistance type, deviation alarm), Type 2 (linearity resistor type, absolute value alarm) and non-linear resistance heater break alarm cannot be used.

Heater break alarm 2 set value setting (H2)



Use to set the heater break alarm 2 set value.

Setting range	Factory set value
0 to 100 % of maximum load current set value (0: Heater break alarm 2 set value unused)	15



If the standard heater break alarm is used, the heater break alarm set value 2 can be stored in each memory area.

If the non-linear resistance heater break alarm is used, memory area function cannot be used. Data of memory area 2 to 4 are invalid.



When “Type 1 (constant resistance type, deviation alarm)” is selected in heater break alarm 2 type, this alarm value becomes a deviation setting.



For the setting procedure, refer to **4.10 Setting Example of Heater Break Alarm (P. 89)**.



For the function description, refer to page 125.

■ Recommended value of heater break alarm 2 set value



Although the following values are recommended, the alarm set value varies depending on the load type and the number of connection. Set the value suited to your system.

When the control method is phase control and heater break alarm Type 1 (constant resistance type, deviation alarm) is selected, RKC recommends:

- Set this value within the range between the heater break alarm 1 set value and the thyristor break-down set value.
This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.

When the control method is phase control and heater break alarm type 2 (linearity resistor type, absolute value alarm) is selected:

- For the type 2, this item is not available. Set the “0: Heater break alarm 2 unused.”

When the non-linear resistance heater break alarm is used:

- The heater break alarm 2 set value cannot be used as the heater break alarm that supports non-linear resistance. The heater break alarm 2 set value is activated as the standard heater break alarm.

When the control method is zero-cross control, RKC recommends:

This recommended value is a guideline for when changes in the resistance of the load due to temperature are small.

- If the alarm needs to be output before a heater break occurs, set the set value of heater break alarm 2 to any value slightly larger than that of heater break alarm 1.
- If the alarm needs to be output before thyristor break-down occurs, set the set value of heater break alarm 2 to any value slightly smaller than that of heater break alarm 1.

Current limit value setting (CL)



Use to set the current limit value.



If a load through which large rush current flows is used, the current limit function cannot restrict the above current. In this case, use the current limit function together with the soft-start function.

Setting range	Factory set value
0.0 to 22.0 A (20 A type)	22.0
0.0 to 33.0 A (30 A type)	33.0
0.0 to 50.0 A (45 A type)	50.0
0.0 to 66.0 A (60 A type)	66.0
0.0 to 88.0 A (80 A type)	88.0
0.0 to 110.0 A (100 A type)	110.0
0.0 to 165.0 A (150 A type)	165.0
0.0 to 220.0 A (200 A type)	220.0



If the standard heater break alarm is used, the current limit value can be stored in each memory area.

If the non-linear resistance heater break alarm is used, memory area function cannot be used. Data of memory area 2 to 4 are invalid.



If a current limit value is set to its maximum value, the current limit function is deactivated. Factory set value is deactivation state.



If the current limit value is set to 0.0, the output of THV-A1 turns off.



The current limiter function is not available when the zero-cross control is used.



For the function description, refer to page 132.

4.6 Engineering Mode



Parameters in engineering mode should be set according to the application before setting any parameter related to operation. Once the parameters in the engineering mode are set correctly, those parameters are not necessary to be changed for the same application under normal conditions.

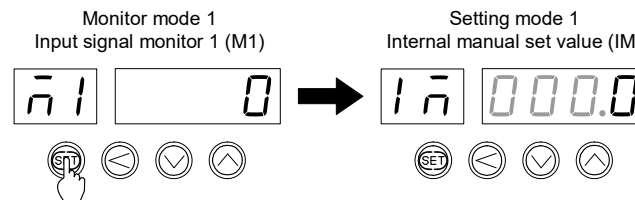


All parameters of the engineering mode are displayed regardless of the instrument specification. Parameters of functions that were not specified when you placed the order will also appear. Even if set, these parameters will not be effective.

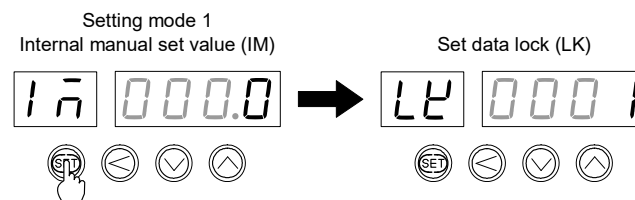
4.6.1 Transfer to engineering mode

When changing to the engineering mode, it is necessary to unlock the engineering mode lock.

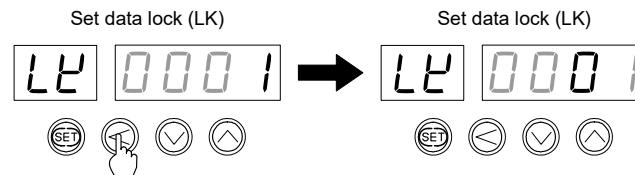
1. Press and hold the SET key for 2 seconds to go to the setting mode 1.



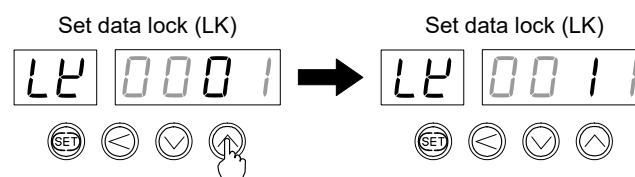
2. Press the SET key several times to go to the set data lock.



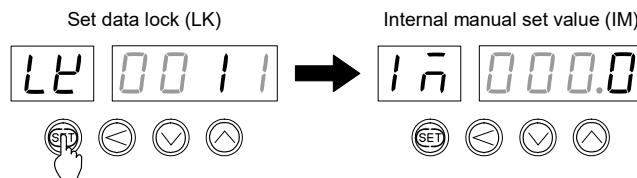
3. Press the shift key to high-light the tens digit of display (numerical value display).



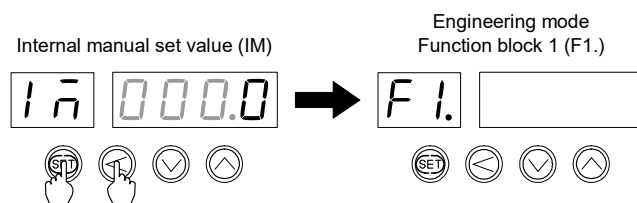
4. Press the UP key to change 0 to 1 in the tens digit.



5. Press the SET key to unlock the engineering mode. The display goes to the first parameter in setting mode 1.



6. Press the shift key while pressing the SET key to change to the engineering mode. The display goes to the function block 1.

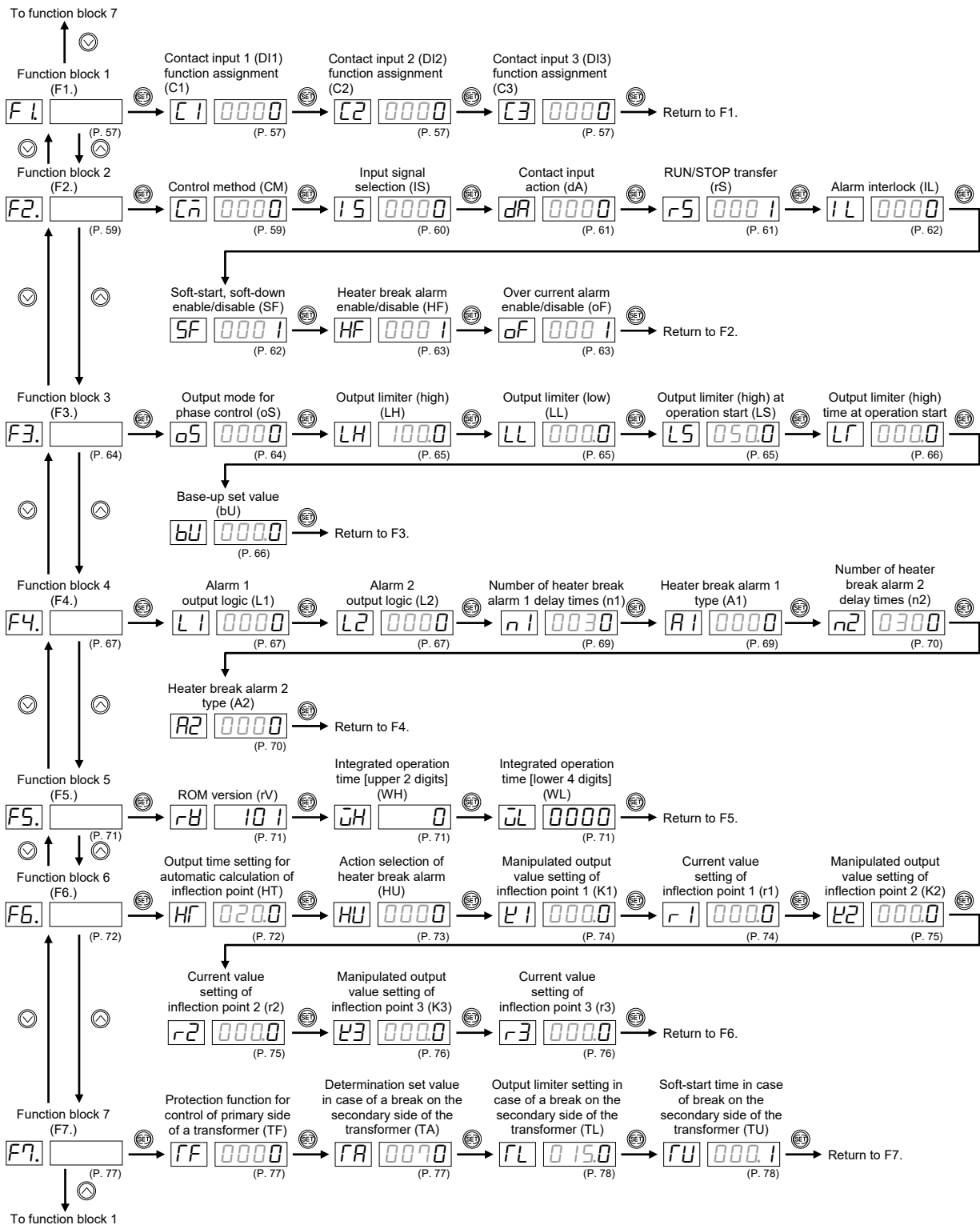


4.6.2 Display sequence


Parameters (setting items) are classified into groups (function block: F□.) within the engineering mode.

Change to the function block (F□.): To go to the next function block, press UP (⬆) or DOWN (⬇) keys.

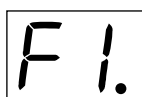
Change to parameter (engineering item): To go to the next parameter, press SET (Ⓢ) key.



4.6.3 Description of each parameter (engineering item)

 For details on changing the numeric value, refer to **4.4.2 Changing parameter settings (P. 41)**.

Function block 1 (F1.)

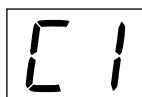


This is first parameter symbol of function block 1 (F1). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Contact input 1 (DI1) function assignment (C1)

Contact input 2 (DI2) function assignment (C2)

Contact input 3 (DI3) function assignment (C3)



Use to assign the function of contact input 1 (DI1), contact input (DI2) or contact input (DI3). The function can be assigned for each contact input (DI). The action of each assigned function can be switched by opening and closing the contact input.

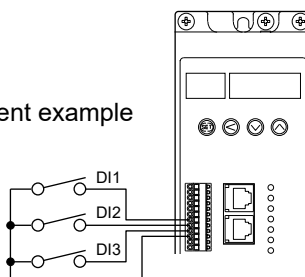


Take care that assignments of following functions are not duplicated.

- Auto mode/Manual mode transfer
- RUN/STOP transfer
- Alarm interlock release
- Soft-start, soft-down enable/disable
- Set data lock/unlock
- Over current alarm enable/disable

A wrong assignment example

DI1: RUN/STOP transfer
DI2: RUN/STOP transfer



Setting range	Factory set value
0: No function 1: Auto mode/Manual mode transfer (Setting type must be selected in contact input action (dA) of function block 2. → Refer to page 61.) 2: RUN/STOP transfer 3: Alarm interlock release 4: Heater break alarm enable/disable 5: Soft-start, soft-down enable/disable 6: Set data lock/unlock 7: Over current alarm enable/disable 8: Memory area transfer	0



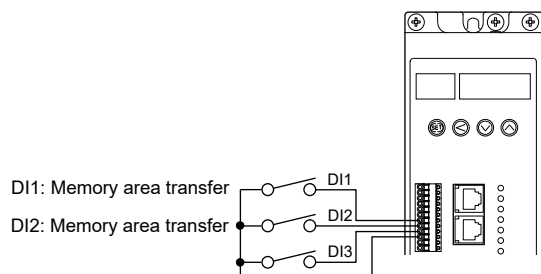
For the setting example, refer to page 81.



For the function description, refer to page 133.

■ Memory area function assignment

Memory area function uses two contact input (DI) points. Assign memory area transfer to contact input 1 (DI1). When assigned to contact input 1 (DI1), memory area transfer is also automatically assigned to contact input 2 (DI2).



Memory area number	DI state	
	DI1	DI2
Memory area 1	Open	Open
Memory area 2	Closed	Open
Memory area 3	Open	Closed
Memory area 4	Closed	Closed

- When “8: Memory area transfer” is assigned to contact input 1 (DI1), even if a value from 1 to 7 is assigned to contact input 2 (DI2), that value will be invalid.
- The set value of “8: Memory area transfer” is not displayed in contact input 2 (DI2) and contact input 3 (DI3).
- If the standard heater break alarm is used, memory area transfer function is available.

■ Settings that become effective based on the contact input (DI) setting

Function name	Settings that become effective based on the DI setting	
	Open	Closed
Auto mode/Manual mode transfer ¹	Auto mode	External manual mode or Internal manual mode
RUN/STOP transfer ²	STOP	RUN
Alarm interlock release		Alarm interlock release
Heater break alarm enable/disable ³	Enable	Disable
Soft-start, soft-down enable/disable ^{4, 5}	Enable	Disable
Set data lock/unlock ⁶	Lock	Unlock
Over current alarm enable/disable ³	Enable	Disable

¹ Selection of the setting type may be necessary using the contact input action (dA) of function block 2.

² When protection function for control of primary side of a transformer is set enabled, switching from STOP to RUN will activate the soft-start function for a period set with the soft-start time (SU). When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

³ This setting becomes valid on the instrument with a constant current control or constant power control.

⁴ When protection function for control of primary side of a transformer is enabled, the action of soft-start and soft-down becomes the same as that for enable even if soft-start and soft-down functions are disabled by the contact input (DI). When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

⁵ This setting becomes valid when the control method is the phase control.

⁶ The mode locked by the contact input (DI) accords with the set data lock (LK) setting. (P. 47)

Function block 2 (F2.)



This is first parameter symbol of function block 2 (F2). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Control method (CM)



Use to select the control method.

Setting range	Factory set value
0: Phase control	0
1: Zero-cross control (continuous)	
2: Zero-cross control (input synchronous type)	



When the phase control is used, the output mode type can be selected.
(Refer to P. 64)

When the zero-cross control is used, the output mode is invalid.



For the function description, refer to page 138.

■ Functions that cannot be used with certain control methods

Some functions cannot be used with certain control methods (refer to the table below).

×: Can be used -: Cannot be used



Function	Phase control	Zero-cross control (continuous)	Zero-cross control (input synchronous type)
Internal gradient setting	×	×	—
Soft-start and Soft-down	×	—	—
Current limit	×	—	—
Output mode	×	—	—
Output limiter (high)	×	×	—
Output limiter (low)	×	×	—
Output limiter (high) at operation start	×	—	—
Base-up set value	×	×	—
Protection function for control of primary side of a transformer	×	—	—

Input signal selection (IS)

15

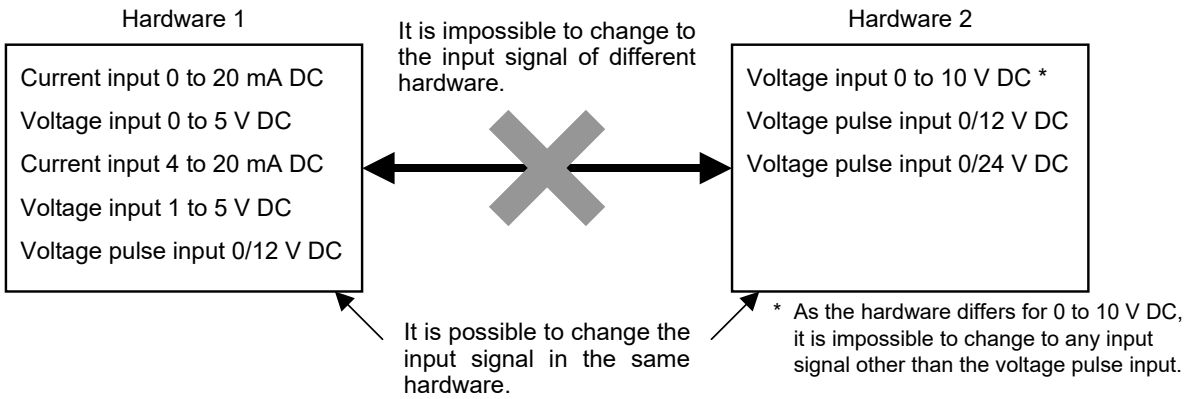
Use to select the input signal type of auto mode.
Select the same input signal type for both the THV-A1 and the controller.

Setting range	Factory set value
0: 0 to 20 mA DC, 0 to 5 V DC, 0 to 10 V DC, 0/12 V DC, 0/24 V DC 1: 4 to 20 mA DC, 1 to 5 V DC, 0/12 V DC, 0/24 V DC	Factory set value varies depending on the instrument specification.

-  For a voltage pulse input of 0/12 V DC or 0/24 V DC, it is not necessary to be changed as the setting is valid even if set to either “0” or “1.”
-  The current or voltage input is selected by a short bar on the input terminals.
(Refer to P. 23)

■ Input signal switching

The input signal can be switched to another input signal of the same hardware type. The hardware type is determined by the input signal that was specified when the order was placed.



Contact input action (dA)



Use to select the contact input action. Set this when “Auto mode/Manual mode transfer” is selected in the function assignments for contact input 1 (DI1) to contact input 3 (DI3). Set this as well to change the display content of input signal monitor 1. The value of the action selected with this item can be checked in input signal monitor 1.

Setting range	Factory set value
0: External manual mode ↔ Auto mode 1: Internal manual mode ↔ Auto mode 2: Internal manual mode (fixed) 3: External manual mode (fixed)	0

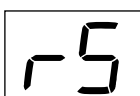
The auto mode set value is continuously displayed in input signal monitor 2 (M2) of monitor mode 2.

For the function description, refer to page 133.

■ Settings that become effective based on the contact input (DI) setting:

Contact input action (dA) setting	Settings that become effective based on the DI setting	
	Closed	Open
0: External manual mode ↔ Auto mode	External manual mode	Auto mode
1: Internal manual mode ↔ Auto mode	Internal manual mode	
2: Internal manual mode (fixed)	Internal manual mode	
3: External manual mode (fixed)	External manual mode	

RUN/STOP transfer (rS)



Use to transfer a RUN or STOP of THV-A1.
If the THV-A1 is transferred to RUN, the thyristor output is turned on.
If the THV-A1 is transferred to STOP, the thyristor output is turned off.

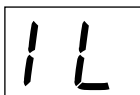
Setting range	Factory set value
0: STOP (THV-A1 output OFF) 1: RUN (THV-A1 output ON)	1

RUN/STOP switching is also possible using a contact input (DI).

When a contact input (DI) is used, the contact input (DI) has priority over the front key setting.





When protection function for control of primary side of a transformer is set enabled, switching from STOP to RUN will activate the soft-start function for a period set with the soft-start time (SU). When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

Alarm interlock (IL)



Select whether or not the alarm interlock function is used. To use the alarm interlock release function in the contact inputs, set this item to “1: Use.”

Setting range	Factory set value
0: Unused 1: Use	0





-  For some contact inputs, the alarm interlock function will not operate while the alarm interlock release state (contacts closed) is held.
-  When this item is set to “0: Unused,” if the alarm interlock release function is assigned to a contact input (DI), the assignment will be invalid.
-  For the function description, refer to page 148.
-  For the alarm interlock release method, refer to page 134.

Soft-start, soft-down enable/disable (SF)



This setting is used to enable or disable the soft-start function and soft-down function. The soft-start function and soft-down function can be disabled without changing the soft-start time and soft-down time.

Setting range	Factory set value
0: Soft-start, soft-down disable 1: Soft-start, soft-down enable	1

-  Enabling/disabling of the soft-start and soft-down functions is also possible by contact input (DI).
-  When a contact input (DI) is used, the contact input (DI) has priority over the front key setting.
-  Setting becomes valid when the control method is the phase control.
-  When protection function for control of primary side of a transformer is enabled, the action of soft-start and soft-down becomes the same as that for enable even if soft-start, soft-down enable/disable (SF) is set to disabled. When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

Heater break alarm enable/disable (HF)



This setting is used to enable or disable the heater break alarm and thyristor break-down alarm.

The heater break alarm and thyristor break-down alarm can be disabled without changing the heater break alarm set value and thyristor break-down set value.

Setting range	Factory set value
0: Heater break alarm disable	1
1: Heater break alarm enable	



Enabling/disabling of the heater break alarm is also possible by contact input (DI).



When a contact input (DI) is used, the contact input (DI) has priority over the front key setting.



Setting for this function becomes valid on the instrument with a constant current control or constant power control.

Over current alarm enable/disable (oF)



This setting is used to enable or disable the over current alarm.

Setting range	Factory set value
0: Over current alarm disable	1
1: Over current alarm enable	



Enabling/disabling of the over current alarm is also possible by contact input (DI).



When a contact input (DI) is used, the contact input (DI) has priority over the front key setting.



Setting for this function becomes valid on the instrument with a constant current control or constant power control.

Function block 3 (F3.)



This is first parameter symbol of function block 3 (F3). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Output mode for phase control (oS)



Use to select the output method for phase control with resistor load.



When constant current control is selected, no normal operation is performed if the rated current of thyristor differs from that maximum load current flowing through the heater. In such a case, set the gradient so that the maximum load current value which flows through the heater is obtained at an input signal of 100 %.

[For the setting method, refer to ■ Caution for using constant current control function (P. 141).]

Setting range	Factory set value
0: Proportional phase angle to input 1: Proportional voltage to input 2: Proportional square voltage (electric power) to input 3: Constant current control 4: Constant voltage control 5: Constant power control 6: Square voltage feedback	Factory set value varies depending on the instrument specification.



The output modes that can be set vary depending on the specifications stipulated when the order was placed.

Model code: THV-A1 PZ□-□*□ □□□□-□
(5)

Contents of "(5) Output mode"	Settable output mode
E: Standard, Constant voltage control and Constant current control (Factory set value: Constant current control)	0: Proportional phase angle to input 1: Proportional voltage to input 2: Proportional square voltage (electric power) to input 3: Constant current control 4: Constant voltage control 6: Square voltage feedback
6: Standard and Constant voltage control (Factory set value: Constant voltage control)	0: Proportional phase angle to input 1: Proportional voltage to input 2: Proportional square voltage (electric power) to input 4: Constant voltage control 6: Square voltage feedback
W: Standard, Constant voltage control and Constant power control (Factory set value: Constant power control)	All of the output mode can be set.



Setting for output mode becomes valid when the control method is the phase control.



For the output characteristic, refer to page 139.

Output limiter (high) (LH)


Output limiter (low) (LL)


LH

LL

Use to set the high limit value or low limit value of output.

Setting range	Factory set value
0.0 to 100.0 %	Output limiter (high): 100.0 Output limiter (low): 0.0

 Output limiter (high) value must be equal or higher than Output limiter (low).
[Output limiter (low) ≤ Output limiter (high)]

 Setting for output limiter (high) and output limiter (low) becomes valid when the control method is the phase control or zero-cross control (continuous).


 For the function description, refer to page 146.


Output limiter (high) at operation start (LS)

LS


Use to set the output limiter (high) at operation start.

Setting range	Factory set value
0.0 to 100.0 %	50.0

 Output limiter (high) value at operation start must be lower than output limiter (high).

 Even if output limiter (high) value at operation start is set to 0.0, the function is enabled.

If output limiter (high) value at operation start is set to 0.0 and output limiter (high) time at operation start is set to 0.1 seconds or more, the output of the THV-A1 will be OFF for that time only.

 Setting for output limiter (high) at operation start becomes valid when the control method is the phase control.

 For the function description, refer to page 147.

Output limiter (high) time at operation start (LT)



Use to set the output limiter (high) time at operation start.

Setting range	Factory set value
0.0 to 600.0 seconds (0.0: Output limiter function at operation start disable)	0.0



Setting for output limiter (high) time at operation start becomes valid when the control method is the phase control.



For the function description, refer to page 147.

Base-up set value (bU)



Use to set the base-up set value (output bias) of output.

Setting range	Factory set value
-10.0 to +100.0 %	0.0



The base-up set value will not exceed the output limiter (high).



The base-up set value is effective only when the output limiter (low) is set to 0.0.



Setting for base-up function becomes valid when the control method is the phase control or zero-cross control (continuous).

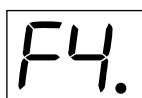


If the THV-A1 is transferred to “STOP (THV-A1 output OFF),” the base-up function becomes invalid.



For the function description, refer to page 148.

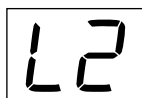
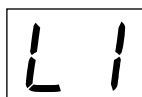
Function block 4 (F4.)



This is first parameter symbol of function block 4 (F4). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Alarm 1 output logic (L1)

Alarm 2 output logic (L2)



Use to select the alarm type of the alarm 1 (ALM1) or alarm 2 (ALM2).

Setting range	Factory set value
0: No output 1: Power frequency error (energized) 2: Board error (energized) 4: Power supply voltage error (energized) 8: Heater break alarm 1 (energized) 16: Heater break alarm 2 (energized) 32: Thyristor break-down alarm (energized) 64: Over current (energized) 128: Fuse break (energized) 256: Heat sink temperature abnormality (energized) 512: FAIL (de-energized)	0
To set the alarm output to “de-energized,” set the thousands digit to “1.” (However, excluding FAIL) For example, to set the alarm output of “2: Board error (energized)” as “de-energized,” set “1002.”	



The following alarms are optional. Any alarm not specified when ordering is not activated even if set.

- Heater break alarm
- Thyristor break-down alarm
- Over current
- Fuse break
- Heat sink temperature abnormality

Continued on the next page.

■ Alarm output setting

From each alarm output, one type of alarm can be output. It is also possible to output multiple alarms by logical *OR*.

Setting example when one type of alarm is output from each alarm output

ALM1 — Heater break alarm 1 (energized) [Set value of alarm 1 output logic: 8]

ALM2—Heater break alarm 2 (energized) [Set value of alarm 2 output logic: 16]

ALM1 — Heater break alarm 1 (energized) [Set value of alarm 1 output logic: 8]

ALM2— Thyristor break-down alarm (de-energized) [Set value of alarm 2 output logic: 1032]

ALM1—FAIL alarm (de-energized) [Set value of alarm 1 output logic: 512]

ALM2—Fuse break (energized) [Set value of alarm 2 output logic: 128]

Setting example when alarms are output by logical OR

To output the alarm output by logical *OR*, set the sum of the set values.

For example, to output “board error (energized)” and “over current (energized)” by logical *OR*, the set value must be $2 + 64 = 66$.


For de-energized, set the thousands place of the set value to “1,” so that the set value is 1066.

ALM1 — Heater break alarm 1 (energized)
 — Thyristor break-down alarm (energized) } [Set value of alarm 1 output logic: 40]


ALM2—Heater break alarm 2 (energized) [Set value of alarm 2 output logic: 16]

ALM1— FAIL alarm (de-energized) [Set value of alarm 1 output logic: 512]

ALM2 {
 Over current alarm (energized)
 Fuse break (energized)
 Heat sink temperature abnormality (energized)
 } [Set value of alarm 2 output logic: 448]

 Mixed output of energized and de-energized from a single alarm output is not possible.

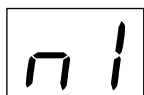
ALM1 { Heater break alarm 1 (energized)
Thyristor break-down alarm (de-energized)
Heater break alarm 2 (energized)

 FAIL alarm (de-energized) cannot be output by logical *OR*, and thus this must be set singly. In addition, FAIL alarm is de-energized only.

ALM1 — FAIL alarm (de-energized)

ALM1 — ~~FAIL alarm (de-energized)~~
~~Over current alarm (de-energized)~~
~~Fuse break (de-energized)~~

Number of heater break alarm 1 delay times (n1)



Use to set the number of delay times of heater break alarm 1 and thyristor break-down alarm. This setting is common to both heater break alarm 1 and thyristor break-down alarm.

Setting range	Factory set value
1 to 100 times	30

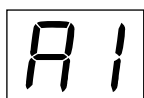


Setting for this function becomes valid on the instrument with a constant current control or constant power control.



For the function description, refer to page 149.

Heater break alarm 1 type (A1)



Use to select the type of heater break alarm 1 in the phase control.

Setting range	Factory set value
0: Type 1 (constant resistance type, deviation alarm)	0
1: Type 2 (linearity resistor type, absolute value alarm)	



Setting for this function becomes valid on the instrument with a constant current control or constant power control.



When the zero-cross control is used, this set value is invalid.



For the function description, refer to page 125.

Number of heater break alarm 2 delay times (n2)



Use to set the number of delay times of heater break alarm 2.

Setting range	Factory set value
1 to 1000 times	300



Setting for this function becomes valid on the instrument with a constant current control or constant power control.



For the function description, refer to page 149.

Heater break alarm 2 type (A2)



Use to select the type of heater break alarm 2 in the phase control.

Setting range	Factory set value
0: Type 1 (constant resistance type, deviation alarm)	0
1: Type 2 (linearity resistor type, absolute value alarm)	



Setting for this function becomes valid on the instrument with a constant current control or constant power control.

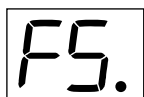


Setting becomes valid when the control method is the phase control.



For the function description, refer to page 125.

Function block 5 (F5.)



This is first parameter symbol of function block 5 (F5). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

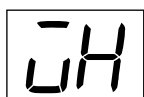
ROM version



Display the version of loading software.

Display example:

Integrated operation time [upper 2 digits] (WH)



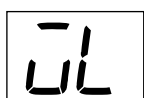
Display the integrated operating time (upper 2 digits).

Display range
0 to 99 (Resolution of display: 10,000 hours)



Up to 999,999 from 0 including the integrated operation time [upper 2 digits] and integrated operation time [lower 4 digits] can be displayed.

Integrated operation time [lower 4 digits] (WL)



Display the integrated operating time (lower 4 digits).

However, as the integral time is increments by 1 when the power is turned on or off. If the total integrated operating time exceeds 9,999 hours, these digits move to the integrated operating time display [upper 2 digits] (WH).

Display range
0 to 9999 (Resolution of display: 1 hour)



Up to 999,999 from 0 including the integrated operation time [upper 2 digits] and integrated operation time [lower 4 digits] can be displayed.

Function block 6 (F6.)



This is first parameter symbol of function block 6 (F6). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Output time setting for automatic calculation of inflection point (HT)

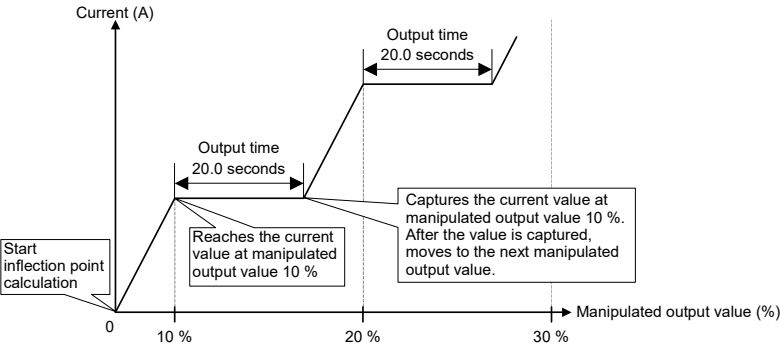


Set the time until the heater stabilizes as the output time.

During automatic calculation of the inflection point, the THV-A1 increases the manipulated output value in increments of 10 % and obtains the current value at each manipulated output value. The heater requires time to stabilize at each manipulated value. The time required until the heater stabilizes at each manipulated value is set as an output time.

When the output time is reached, the THV-A1 captures the input current value and then moves to the next manipulated output value.

When using automatic calculation of the inflection point, set the output time.



Setting range	Factory set value
0.0 to 100.0 seconds (0.0: Inflection point calculation function unused)	20.0

- The automatic calculation function raises the output of the THV-A1 to 100 %. If you do not want to apply an output of 100 % to the heater, use the gradient setting, output limiter, or current limit to limit the output.**
- Setting becomes valid on the instrument with a non-linear resistance heater break alarm.
- The non-linear resistance heater break alarm function is available when the control method is phase control.
- For the setting example, refer to page 98.
- For the function description, refer to page 149.

Action selection of heater break alarm (HU)



Use to select the action of heater break alarm.

If the “0” is selected, the standard heater break alarm is available.

If the “1” is selected, the non-linear resistance heater break alarm is available.

If “2” is selected, calculation of the inflection point begins. When calculation of the inflection point is finished, the display changes to “1: Non-linear resistance heater break alarm.”



- **It may not be possible to use the non-linear resistance heater break alarm function with some heater types.**
- **Use this function in a system with a current capacity of 10 A or more. As the measuring accuracy of the current transformer (CT) is within $\pm 2\%$ of the THV-A1 rated current, no heater break alarm may normally operate if used at a smaller load current value.**

Setting range	Factory set value
0: Standard heater break alarm	0
1: Non-linear resistance heater break alarm	
2: Start inflection point calculation	



If calculation of the inflection point ends abnormally, the display will revert to the values below and the inflection point data will not be updated.

- If action selection of heater break alarm was changed from 0 to 2, it will revert to 0.
- If action selection of heater break alarm was changed from 1 to 2, it will revert to 1.



Setting becomes valid on the instrument with a non-linear resistance heater break alarm.



The non-linear resistance heater break alarm function is available when the control method is phase control.



When “1: Non-linear resistance heater break alarm” is set, the memory area function cannot be used.

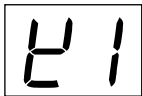


For the setting example, refer to page 98.



For the function description, refer to page 149.

Manipulated output value setting of inflection point 1 (K1)



The position of the inflection point 1 on the horizontal axis (refer to P. 98 to P. 115) is set as a manipulated output value (%). This is used when the inflection point is set manually.

Setting range	Factory set value
0.0 to 100.0 %	0.0

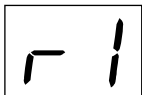
Setting becomes valid on the instrument with a non-linear resistance heater break alarm.

The non-linear resistance heater break alarm function is available when the control method is phase control.

For the setting example, refer to page 98.

For the function description, refer to page 149.

Current value setting of inflection point 1 (r1)



The position of the inflection point 1 on the vertical axis (refer to P. 98 to P. 115) is set as a current value. This is used when the inflection point is set manually.

When setting the current value of the inflection point, set a value that is less than the current value of the maximum load current set value for alarm. If a value greater than the current value of the maximum load current set-value for alarm is set, the alarm function will not operate normally.

Setting range	Factory set value
0.0 to 22.0 A (20 A type)	0.0
0.0 to 33.0 A (30 A type)	
0.0 to 50.0 A (45 A type)	
0.0 to 66.0 A (60 A type)	
0.0 to 88.0 A (80 A type)	
0.0 to 110.0 A (100 A type)	
0.0 to 165.0 A (150 A type)	
0.0 to 220.0 A (200 A type)	

Setting becomes valid on the instrument with a non-linear resistance heater break alarm.

The non-linear resistance heater break alarm function is available when the control method is phase control.

For the setting example, refer to page 98.

For the function description, refer to page 149.

Manipulated output value setting of inflection point 2 (K2)



The position of the inflection point 2 on the horizontal axis (refer to P. 98 to P. 115) is set as a manipulated output value (%). This is used when the inflection point is set manually.

Setting range	Factory set value
0.0 to 100.0 %	0.0

- Setting becomes valid on the instrument with a non-linear resistance heater break alarm.
- The non-linear resistance heater break alarm function is available when the control method is phase control.
- For the setting example, refer to page 98.
- For the function description, refer to page 149.

Current value setting of inflection point 2 (r2)



The position of the inflection point 2 on the vertical axis (refer to P. 98 to P. 115) is set as a current value. This is used when the inflection point is set manually.

- When setting the current value of the inflection point, set a value that is less than the current value of the maximum load current set value for alarm. If a value greater than the current value of the maximum load current set-value for alarm is set, the alarm function will not operate normally.**

Setting range	Factory set value
0.0 to 22.0 A (20 A type)	0.0
0.0 to 33.0 A (30 A type)	
0.0 to 50.0 A (45 A type)	
0.0 to 66.0 A (60 A type)	
0.0 to 88.0 A (80 A type)	
0.0 to 110.0 A (100 A type)	
0.0 to 165.0 A (150 A type)	
0.0 to 220.0 A (200 A type)	

- Setting becomes valid on the instrument with a non-linear resistance heater break alarm.
- The non-linear resistance heater break alarm function is available when the control method is phase control.
- For the setting example, refer to page 98.
- For the function description, refer to page 149.

Manipulated output value setting of inflection point 3 (K3)



The position of the inflection point 3 on the horizontal axis (refer to P. 98 to P. 115) is set as a manipulated output value (%). This is used when the inflection point is set manually.

Setting range	Factory set value
0.0 to 100.0 %	0.0

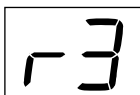
Setting becomes valid on the instrument with a non-linear resistance heater break alarm.

The non-linear resistance heater break alarm function is available when the control method is phase control.

For the setting example, refer to page 98.

For the function description, refer to page 149.

Current value setting of inflection point 3 (r3)



The position of the inflection point 3 on the vertical axis (refer to P. 98 to P. 115) is set as a current value. This is used when the inflection point is set manually.

When setting the current value of the inflection point, set a value that is less than the current value of the maximum load current set value for alarm. If a value greater than the current value of the maximum load current set-value for alarm is set, the alarm function will not operate normally.

Setting range	Factory set value
0.0 to 22.0 A (20 A type)	0.0
0.0 to 33.0 A (30 A type)	
0.0 to 50.0 A (45 A type)	
0.0 to 66.0 A (60 A type)	
0.0 to 88.0 A (80 A type)	
0.0 to 110.0 A (100 A type)	
0.0 to 165.0 A (150 A type)	
0.0 to 220.0 A (200 A type)	

Setting becomes valid on the instrument with a non-linear resistance heater break alarm.

The non-linear resistance heater break alarm function is available when the control method is phase control.

For the setting example, refer to page 98.

For the function description, refer to page 149.

Function block 7 (F7.)



This is first parameter symbol of function block 7 (F7). A parameter symbol will appear in the symbol display. Nothing will appear in the numeric value display.

Protection function for control of primary side of a transformer (TF)



Use to enable/disable protection function for control of primary side of a transformer. This setting must be “1: Protection function for control of primary side of a transformer enable” when protection function for control of primary side of a transformer is used.

Setting range	Factory set value
0: Protection function for control of primary side of a transformer disable	0
1: Protection function for control of primary side of a transformer enable	



This function is available on the instrument with a constant current control or constant power control.



Protection function for control of primary side of a transformer can be used with heater break alarm or non-linear resistance heater break alarm.



For the setting example, refer to page 119.



For the function description, refer to page 150.

Determination set value in case of a break on the secondary side of the transformer (TA)



This is a setting to determine if break (momentary power failure) occurred on the secondary side of the transformer. This parameter is used for protection function for control of primary side of a transformer. When protection function for control of primary side of a transformer is set to “1: Protection function for control of primary side of a transformer enable,” this determination function for break of secondary side of a transformer is enabled.

Setting range	Factory set value
0 to 100 % of computed heater current value	70



This function is available on the instrument with a constant current control or constant power control.



For the setting example, refer to page 116.



For the function description, refer to page 150.

Output limiter setting in case of a break on the secondary side of the transformer (TL)



Use to set output limiter to suppress control output in case of a break (momentary power failure) on the secondary side of the transformer.

This parameter is used for protection function for control of primary side of a transformer. When protection function for control of primary side of a transformer is set to “1: Protection function for control of primary side of a transformer enable,” this output limiter function for break of secondary side of a transformer is enabled.

Setting range	Factory set value
15.0 to 50.0 % of phase angle	15.0



When the instrument is automatically recovered from break on the secondary side of a transformer (momentary power failure), the output limiter for a break of secondary side of a transformer will be released.



This function is available on the instrument with a constant current control or constant power control.



For the setting example, refer to page 116.



For the function description, refer to page 150.

Soft-start time in case of break on the secondary side of the transformer (TU)



Use to set the soft-start time when the instrument is recovered from a break (momentary power failure) on the secondary side of a transformer.

This soft-start function is only activated when the instrument is recovered from a break on the secondary side of a transformer.

This parameter is used for protection function for control of primary side of a transformer. When protection function for control of primary side of a transformer is set to “1: protection function for control of primary side of a transformer enable,” this soft-start function for break of secondary side of a transformer is enabled.

Setting range	Factory set value
0.1 to 100.0 seconds	0.1



This function is available on the instrument with a constant current control or constant power control.



For the setting example, refer to page 116.



For the function description, refer to page 150.

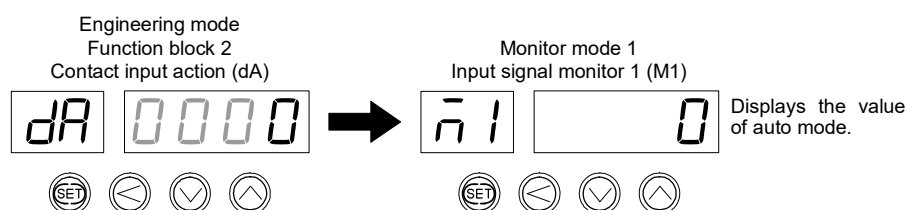
4.7 Display Setting of Input Signal Monitor 1 (M1)

There are two methods for setting the input signal that is displayed. These methods are described below.

- Not using “Auto/Manual mode transfer”
- Using “Auto/Manual mode transfer”

■ Not using “Auto/Manual mode transfer”

The input signal set in contact input action (dA) of function block 2 (F2.) of engineering mode is displayed on input signal monitor 1.



(1) Displaying the automatic set value

Set “0: External manual mode ↔ Auto mode” or “1: Internal manual mode ↔ Auto mode” for the contact input action (dA).



If “Auto/Manual mode transfer” is not assigned to the contact input (DI), the THV-A1 will judge that the contact input (DI) is open. Therefore, if “0” or “1” is set for the contact input action (dA), input signal monitor 1 (M1) will show the automatic set value.

(2) Displaying the internal manual set value

Set “2: Internal manual mode (fixed)” for the contact input action (dA).

(3) Displaying the external manual set value

Set “3: External manual mode (fixed)” for the contact input action (dA).

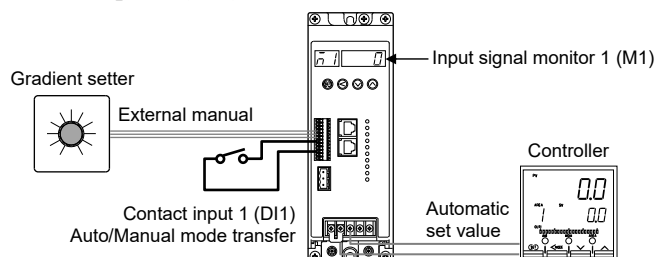
■ Using “Auto/Manual mode transfer”

The displayed input signal is switched by the open/close state of the contact input (DI). An example is given of using contact input 1 (DI1) with “Auto/Manual mode transfer.”

(1) Switching the display between the external manual set value and the automatic set value

Set “0: External manual mode ↔ Auto mode” for the contact input action (dA).

- When the contact of contact input 1 (DI1) is open, the automatic set value is displayed.
- When the contact of contact input 1 (DI1) is closed, the external manual set value is displayed.

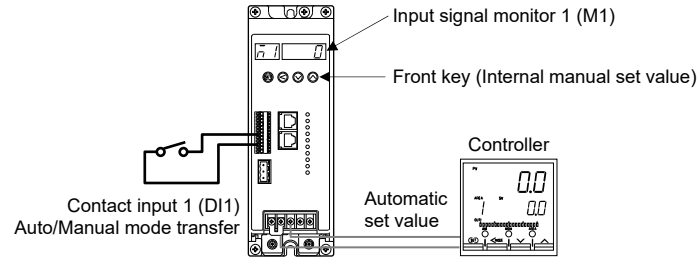


If the input signal is changed, control is performed using the set value of the new input signal.

(2) Switching the display between the internal manual set value and the automatic set value

Set “1: Internal manual mode ↔ Auto mode” for the contact input action (dA).

- When the contact of contact input 1 (DI1) is open, the automatic set value is displayed.
- When the contact of contact input 1 (DI1) is closed, the internal manual set value is displayed.



If the input signal is changed, control is performed using the set value of the new input signal.

(3) Displaying only the internal manual set value

Set “2: Internal manual mode (fixed)” for the contact input action (dA). The state of the contact will be disregarded and the internal manual set value will be displayed.

(4) Displaying only the external manual set value

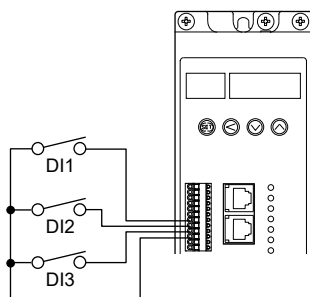
Set “3: External manual mode (fixed)” for the contact input action (dA). The state of the contact will be disregarded and the external manual set value will be displayed.

4.8 Example of Contact Input (DI) Function Assignment

■ Assigning Auto/Manual mode transfer, RUN/STOP transfer, and the alarm interlock release function

Assignment example:

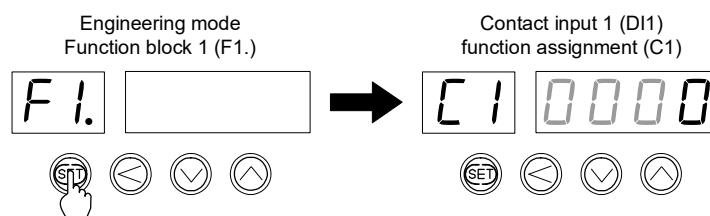
- Contact input 1 (DI1): Auto/Manual mode transfer
(Selection of internal manual set value or automatic set value)
- Contact input 2 (DI2): RUN/STOP transfer
- Contact input 3 (DI3): Alarm interlock release



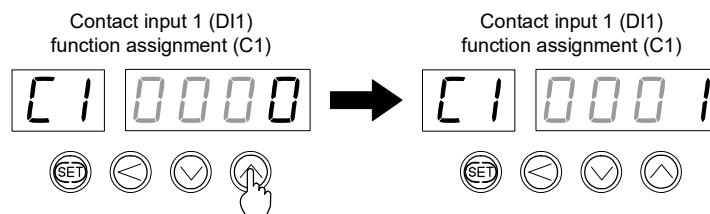
- To assign functions to the contact inputs (DI), the engineering mode lock must be released.

Refer to 4.6.1 Transfer to engineering mode (P. 54).

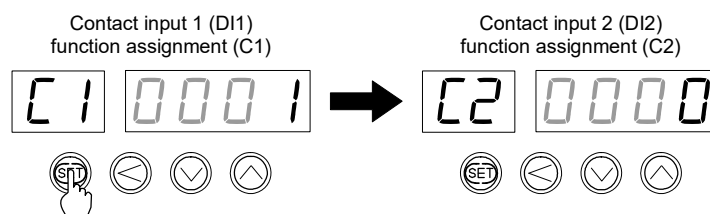
- Press the SET key to change to the contact input 1 (DI1) function assignment (C1).



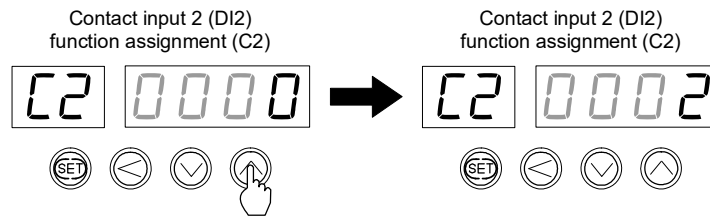
- Press the UP key to set "1: Auto mode/Manual mode transfer."



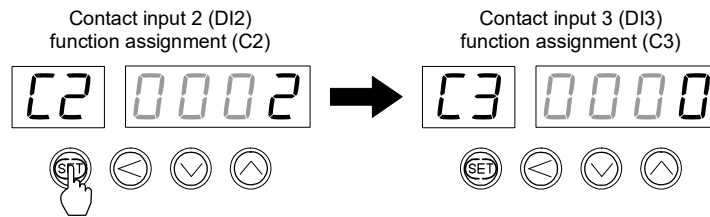
- Press the SET key to change to the contact input 2 (DI2) function assignment (C2).



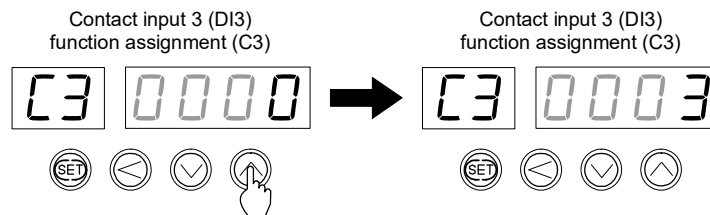
5. Press the UP key to set “2: RUN/STOP transfer.”



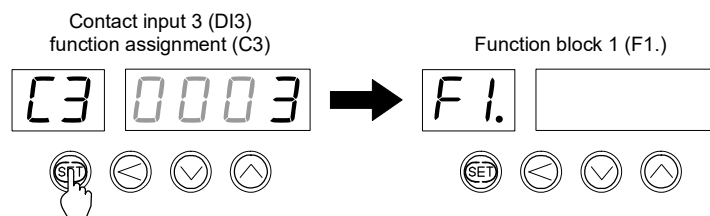
6. Press the SET key to change to the contact input 3 (DI3) function assignment (C3).



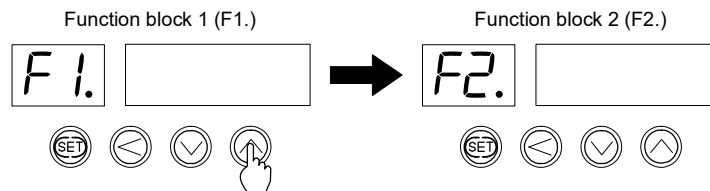
7. Press the UP key to set “3: Alarm interlock release.”



8. Press the SET key.

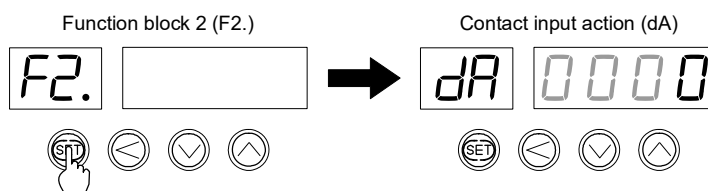


9. Press the UP key to change to the function block 2 (F2.).

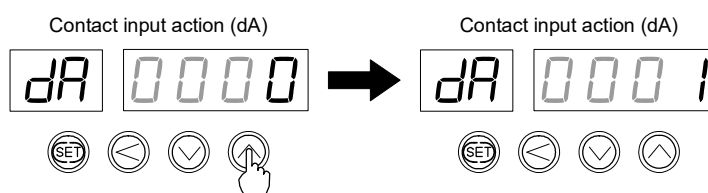


10. Press the SET key three times to change to contact input action (dA).

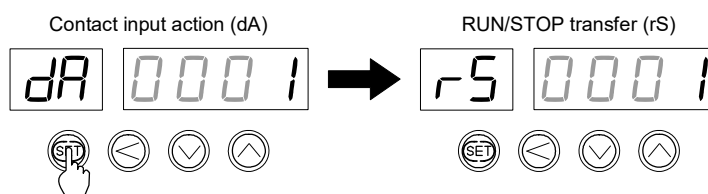
When using an “Auto/Manual mode transfer,” the input signal type must be selected by contact input action (dA).



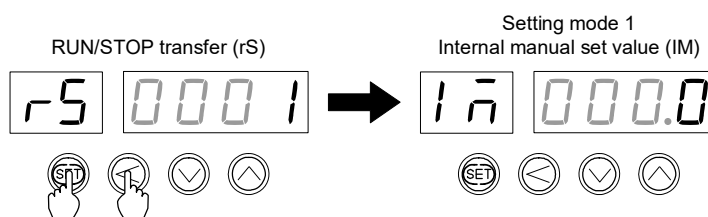
11. Press the UP key to set “1: Internal manual mode ↔ Auto mode.”



12. Press the SET key. The display goes to the next parameter.



13. Press the shift key for 2 seconds while pressing the SET key to change to the setting mode 1.



14. Complete the procedure by locking engineering mode.

To lock engineering mode, refer to the lock release procedure.



Refer to 4.6.1 Transfer to engineering mode (P. 54).

4.9 How to Find Maximum Load Current Value

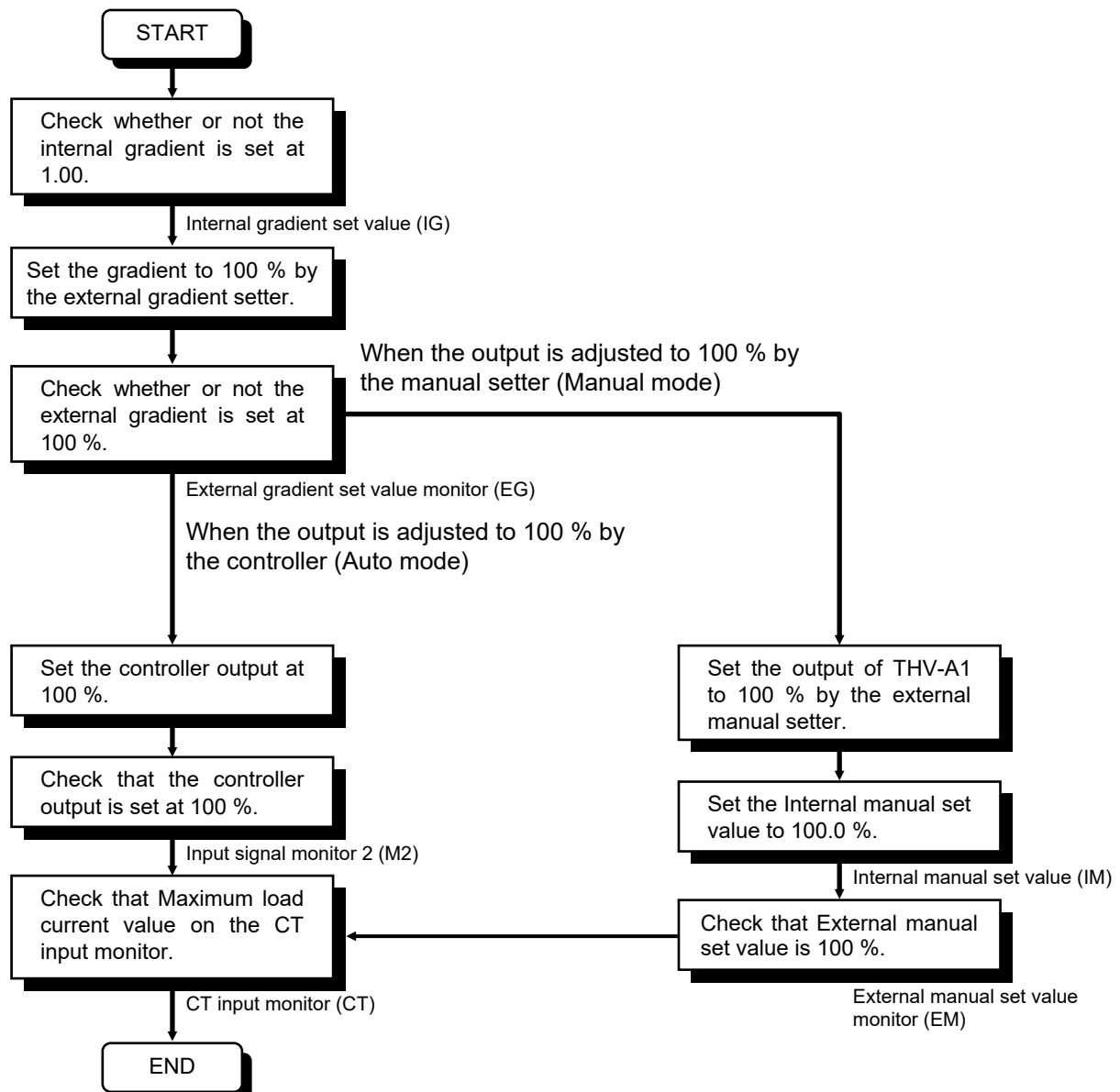
There are two methods for obtaining the maximum load current value. These methods are described below.

- Method of finding the maximum load current by the THV-A1 output
- Method of calculating the rated heater current
(When it is not possible to flow the maximum current through each heater)

4.9.1 Method of finding the maximum load current by the THV-A1 output

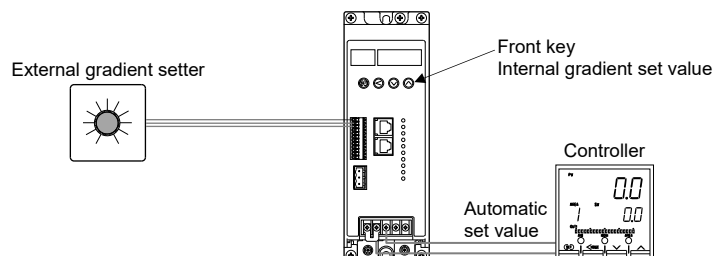
Check the current value by the CT input monitor with the THV-A1 output set at 100 %. The value checked at this time corresponds to the maximum load current value. Set the output at 100 % by the controller (auto mode) or manual setter (manual mode).

■ Procedure



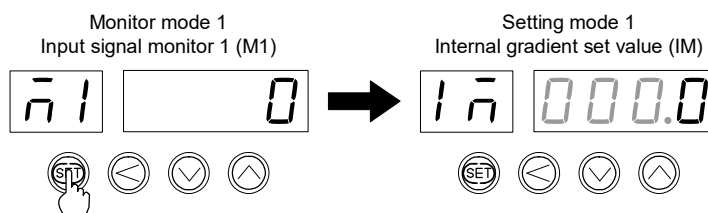
■ Example of finding the maximum load current value with the THV-A1 output set at 100 %

This is how to check the maximum load current value when used together with the controller. After the gradient is adjusted, set the controller output at 100 % and then check for the maximum load current value.

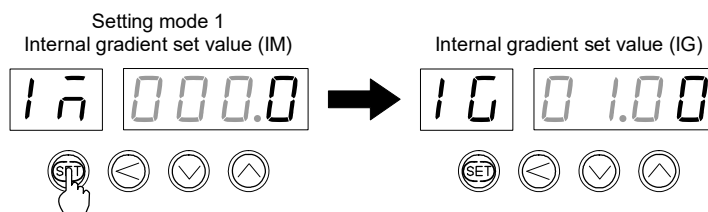


(1) Check whether or not the internal gradient is set at 1.00.

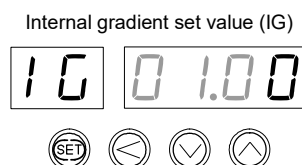
1. Press and hold the SET key for 2 seconds in monitor mode 1. The display goes to the setting mode 1.



2. Press the SET key to go to the internal gradient set value.



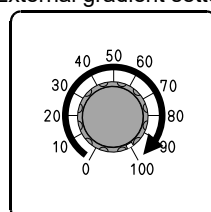
3. Check whether or not the internal gradient is set at “1.00.” (Factory set value: 1.00)



(2) Set the external gradient to 100 %.

Align the arrow on the knob with “100” on the scale plate.

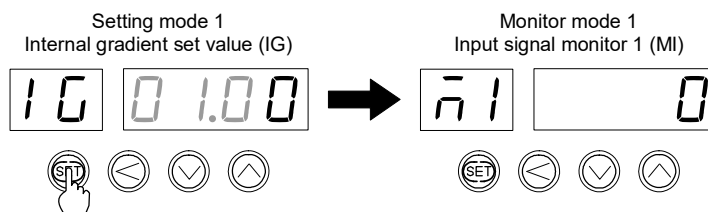
External gradient setter



When an external gradient setter is not used, go to procedure (4). (Refer to the next page.)

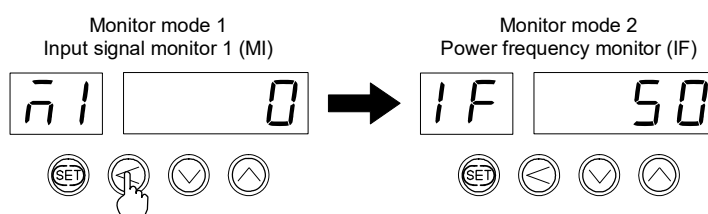
(3) Check whether or not the external gradient is set at 100 %.

1. Press and hold the SET key for 2 seconds. The display goes to the monitor mode 1.

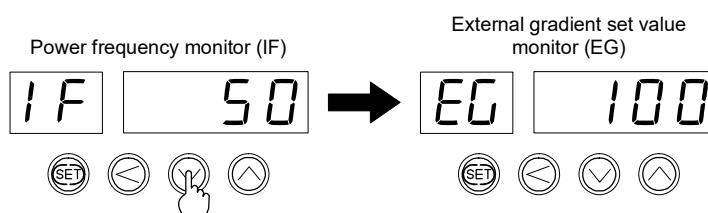


Setting mode 1 returns to the monitor mode 1 if no key operation is performed for more than 1 minute.

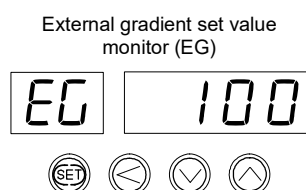
2. Press the shift key. The display goes to the monitor mode 2.



3. Press the DOWN key three times. The display goes to the external gradient set value monitor (EG).



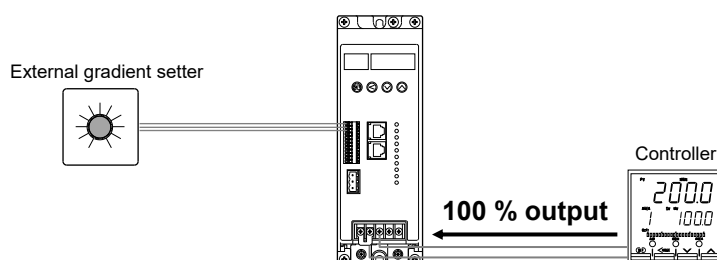
4. Check whether or not the external gradient is set at “100.”



When an external gradient setter is not used, go to procedure (4).

(4) Set the controller output at 100 %.

Make adjustment so that the controller output becomes 100 %.

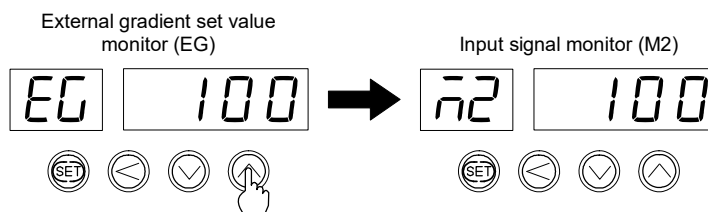


When the output is manually set at 100 %

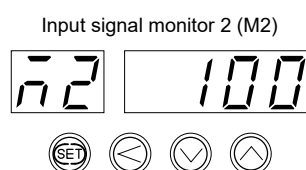
- When set by the manual setter, set the output at 100% with the knob placed in the position of “100.”
(External manual mode must be enabled.)
- When set by the front keys, set the internal manual set value (IM) to “100.0” and the output to “100.0 %.”
(Internal manual mode must be enabled.)

(5) Check that the controller output is set at 100 %.

1. Press the UP key. The display goes to the input signal monitor 2 (M2).



2. Check that the controller output is set at 100 %.



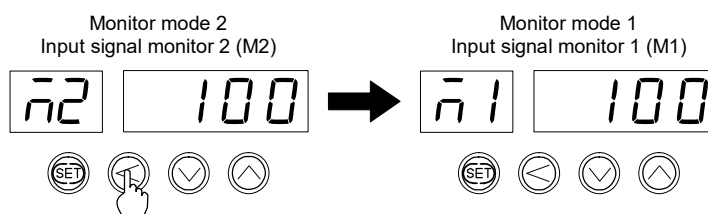
If you omitted steps (2) and (3), switch to monitor mode 2 after switching to monitor mode 1. Next, press the DOWN key to switch to input signal monitor 2 (M2).



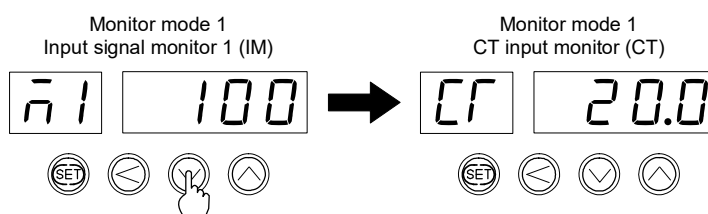
If you set the output to 100 % using the external manual setter, verify that the output is 100 % on the external manual set value monitor (EM).

(6) Check for the current value (maximum load current value) at a controller output of 100 %.

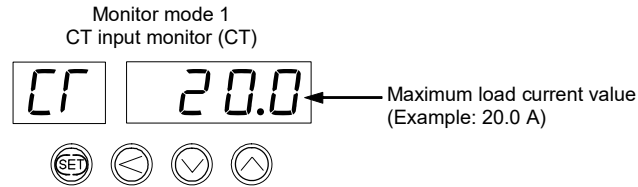
1. Check for the current value at a controller output of 100 %. Press the shift key to go to monitor mode 1.



2. Press the DOWN key two times. The display goes to the CT input monitor (CT).



3. Check the current value displayed on the CT input monitor. At this time, the current value being displayed on the CT input monitor corresponds to the maximum load current value.



4.9.2 Method of calculating the rated heater current (When it is not possible to flow the maximum current through each heater)

This is a method to obtain the maximum current for a heater that may be damaged if maximum current is applied. Obtain the heater current rating from the formula and set the obtained heater current rating as a maximum load current value.



If maximum current of the non-linear resistance heater has changed because of secular change and/or deterioration, the heater current rating cannot be obtained in this formula.

1. Check for heater power supply voltage and capacity.
Refer to the catalog or instruction manual for the heater used to check for the heater power supply voltage and capacity.

2. Calculate the maximum load current value.
Find the maximum load current value by the equation for calculation.

Equation of calculating: Heater capacity / Power supply voltage = Maximum load current value

<Example> For heaters with a capacity of 4 kw and a power supply voltage of 200 V AC
(Power factor is assumed to be 1.)

$$4000 \text{ (heater capacity)} / 200 \text{ (power supply voltage)} = 20 \text{ (maximum load current value)}$$

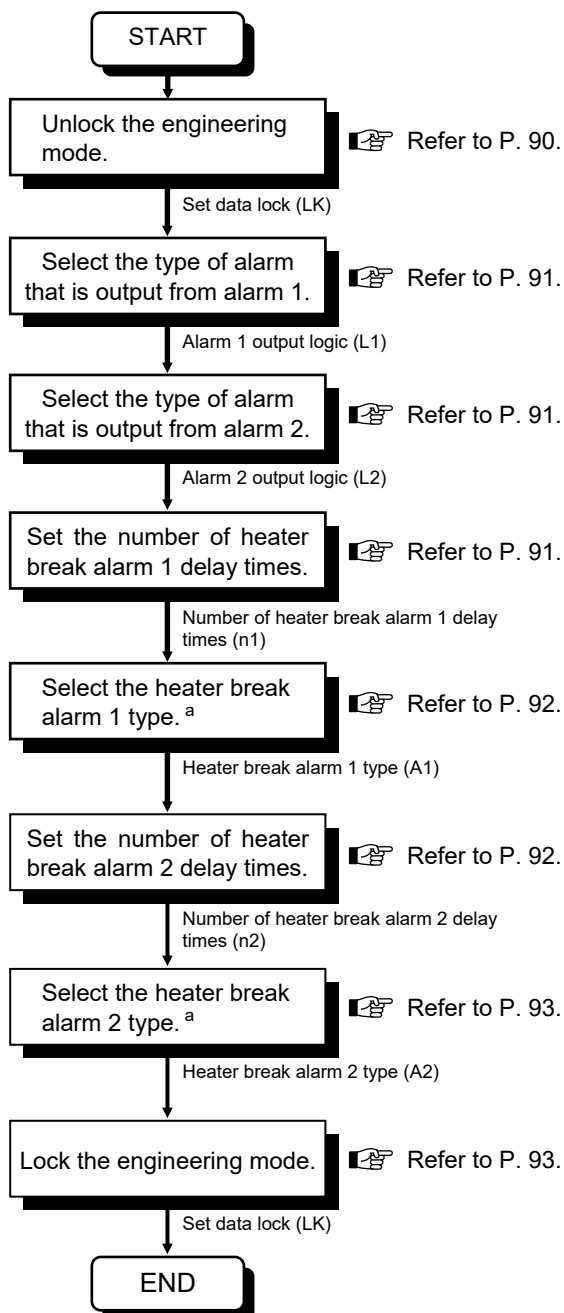
Maximum load current value 20 A

4.10 Setting Example of Heater Break Alarm (HBA)

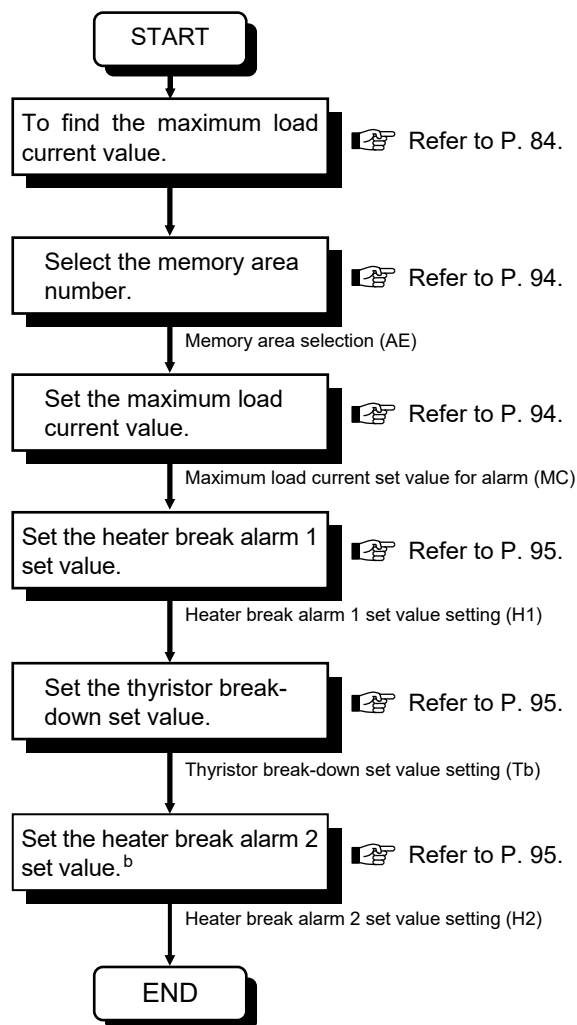
The procedure for setting the heater break alarm is the same as that for any of phase control and zero-cross control.

■ Setting procedure

Step 1: Set the engineering mode.



Step 2: Set each alarm set value.



^a Heater break alarm type is set when in phase control. When the control method is zero-cross control, the heater break alarm type is ignored.

^b When the heater break alarm type is type 2, the heater break alarm 2 is not used. Set the heater break alarm 2 to "Heater break alarm 2 unused."

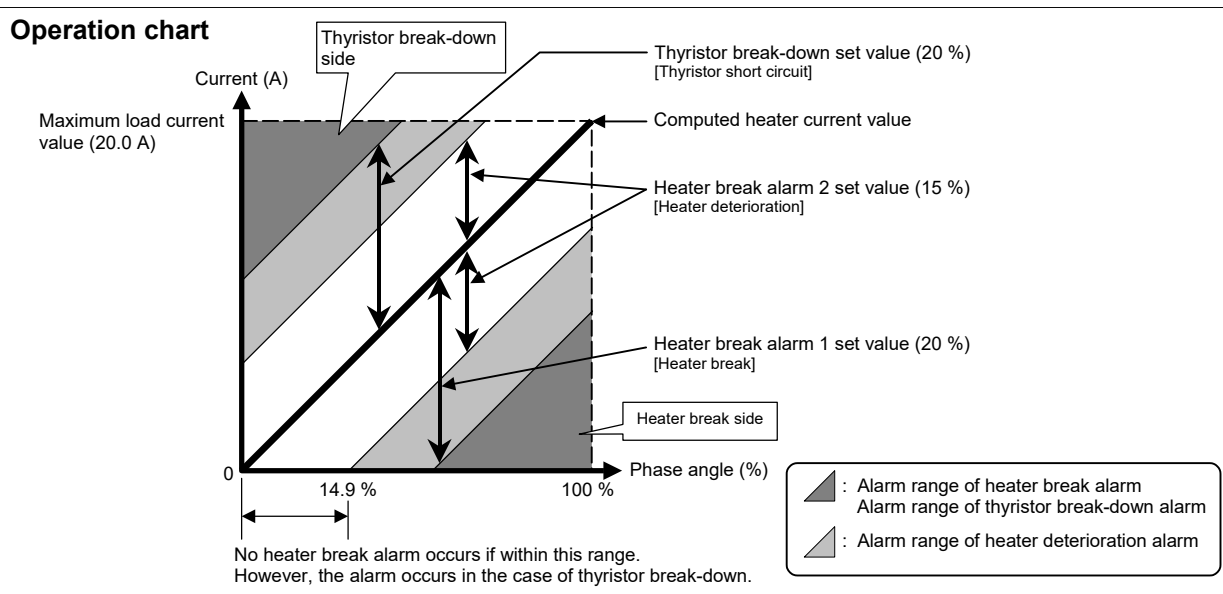
■ Setting Example

The procedure for setting the following conditions is explained as an example.

<Operating condition>

THV-A1:	20 A type
Control method:	Phase control
Output adjustment:	Auto mode
Power supply voltage:	200 V AC
Heater capacity:	4 kW
Maximum load current set value:	20.0 A
Heater break alarm 1 set value:	Use to detect a heater break.
Thyristor break-down set value setting:	Use to detect a thyristor short circuit
Heater break alarm 2 set value setting:	Use to detect a heater deterioration.
Heater break alarm type:	Type 1 (constant resistance type, deviation alarm)
Alarm 1 output logic:	Output as the logical <i>OR</i> of heater break alarm 1 and the thyristor break-down alarm.
Alarm 2 output logic:	Heater break alarm 2 output

Operation chart



(1) Set the engineering mode

1. Unlock the engineering mode.

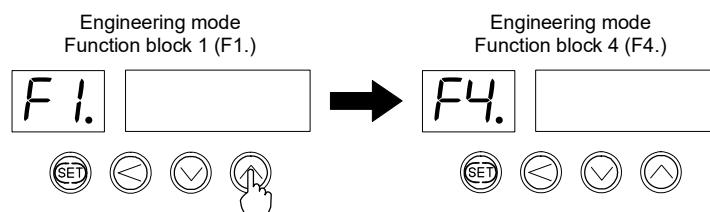


Refer to 4.6.1 Transfer to engineering mode (P. 54).

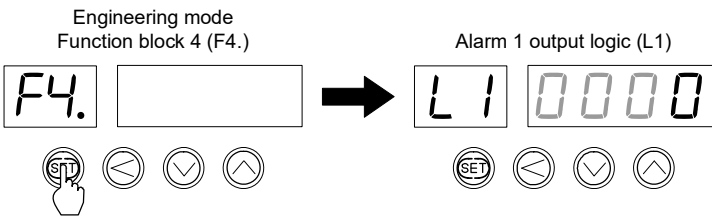


For details on changing the numeric value, refer to 4.4.2 Changing parameter settings (P. 41).

2. Press the UP key to go to the function block 4 (F4.).



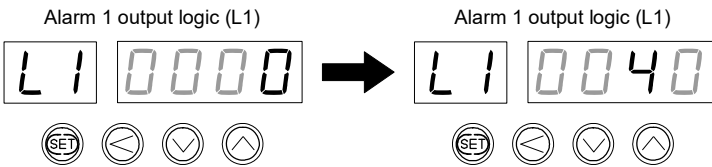
3. Press the SET key to go to the alarm 1 output logic (L1).



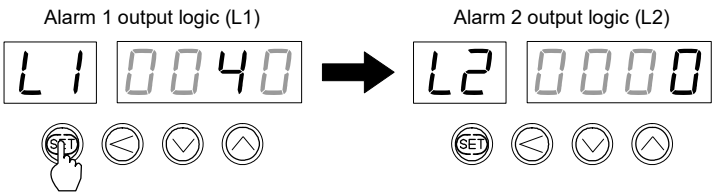
4. Set the set value to “40.”

The logical *OR* of heater break alarm 1 and the thyristor break-down alarm is to be output from alarm 1 (AL1), and thus the sum of the set values “8” and “32” is set.

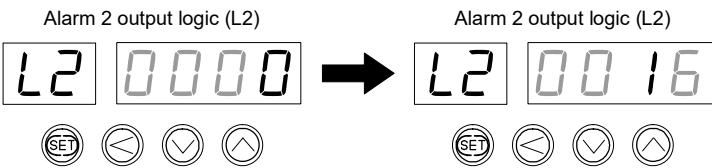
Set value	Alarm type
8	Heater break alarm 1 (energized)
32	Thyristor break-down alarm (energized)



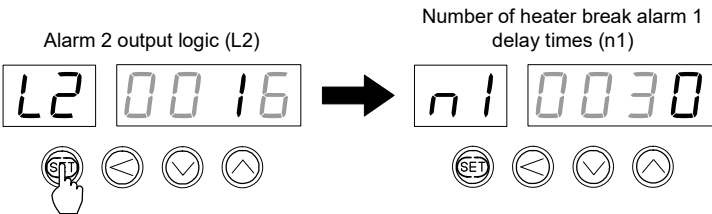
5. Press the SET key to go to the alarm 2 output logic (L2).



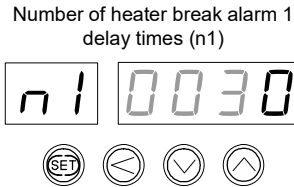
6. Set the set value to “16: Heater break alarm 2 (energized).”



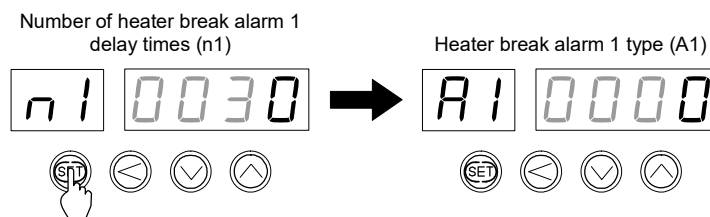
7. Press the SET key to go to the number of heater break alarm 1 delay times (n1).



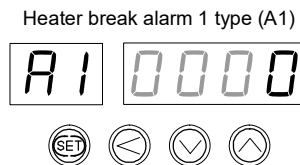
8. Set the number of heater break alarm 1 delay times to “30 times.” (Factory set value: 30)
Here, “30 times” is set. However, set any value meeting the customer’s system.



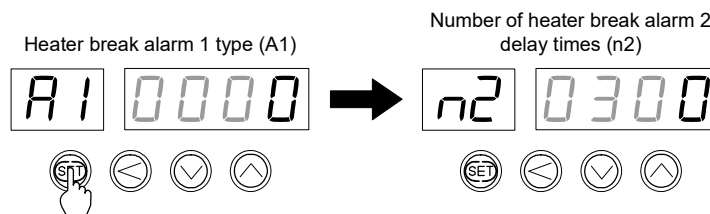
9. Press the SET key to go to the heater break alarm 1 type (A1).



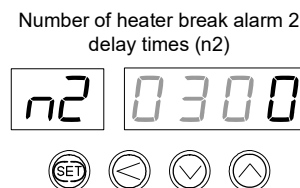
10. Set the heater break alarm 1 type to “0: Type 1 (constant resistance type, deviation alarm).”
(Factory set value: 0)



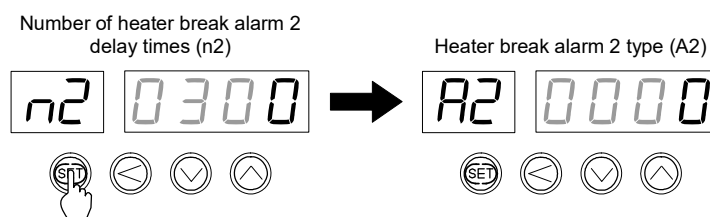
11. Press the SET key to go to the number of heater break alarm 2 delay times (n2).



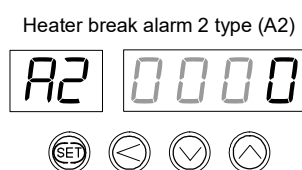
12. Set the number of heater break alarm 2 delay times to “300 times.” (Factory set value: 300)
Here, “300 times” is set. However, set any value meeting the customer’s system.



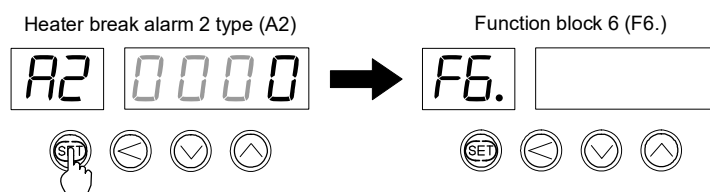
13. Press the SET key to go to the heater break alarm 2 type (A2).



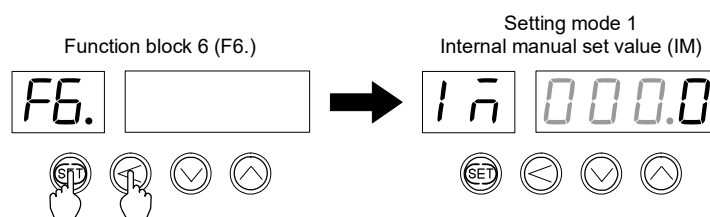
14. Set the heater break alarm 2 type to “0: Type 1 (constant resistance type, deviation alarm).”
(Factory set value: 0)



15. Press the SET key. The display goes to next parameter.



16. Press the shift key for 2 seconds while pressing the SET key to change to the setting mode 1.



17. Complete the procedure by locking engineering mode. To lock engineering mode, refer to the lock release procedure.

 Refer to 4.6.1 Transfer to engineering mode (P. 54).

(2) Set each alarm set value

Before setting the set values of the alarms, check the maximum load current value. If the maximum load current value is not set, a heater break judgment cannot be made, and thus it is important to verify that this has been set. In addition, if the correct maximum load current set value is not set, wrong operation may result.

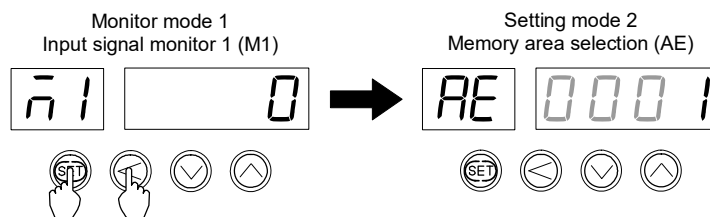


For the maximum load current set value, refer to **4.9 How to Find Maximum Load Current Value (P. 84)**.

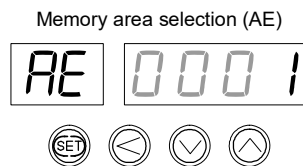


For details on changing the numeric value, refer to **4.4.2 Changing parameter settings (P. 41)**.

1. In monitor mode 1, press the shift key for 2 seconds while pressing the SET key. The display goes to setting mode 2.



2. Select the memory area for storing the set values. Select "1."
(Factory set value: 1)

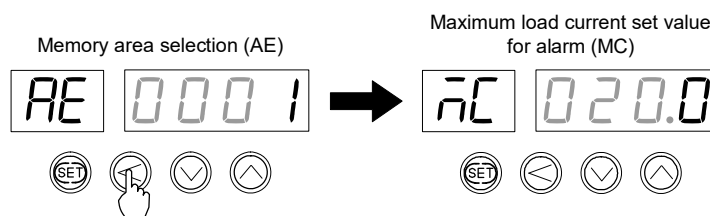


Parameter that can be stored in the memory area:

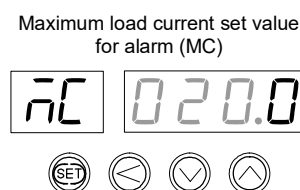
Parameter of setting mode 2 can be stored in the memory area.

- Maximum load current set value for alarm
- Heater break alarm 1 set value
- Thyristor break-down set value
- Heater break alarm 2 set value
- Current limit value

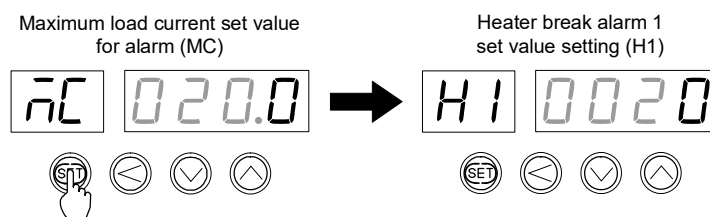
3. Press the SET key to go to the maximum load current set value for alarm (MC).



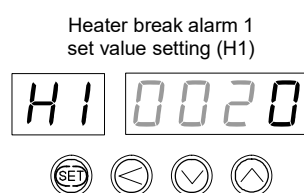
4. Set the maximum load current set value to "20.0 A." (Factory set value: 20.0)



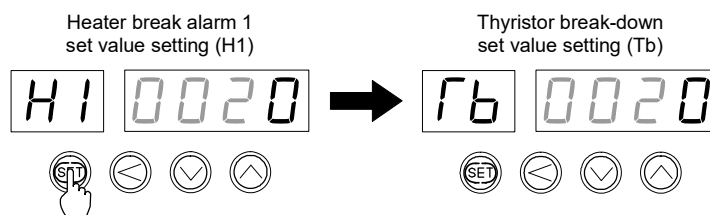
5. Press the SET key to go to the heater break alarm 1 set value setting (H1).



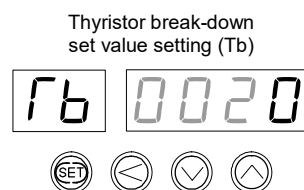
6. Set the heater break alarm 1 set value to "20 %." (Factory set value: 20)
 Converting "20 %" to a current value with a maximum load current set value at "20.0 A" results in a current value of "4 A."



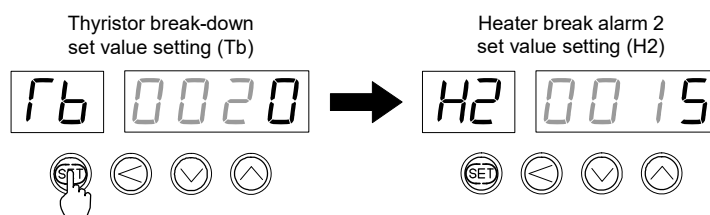
7. Press the SET key to go to the thyristor break-down set value setting (Tb).



8. Set the thyristor break-down set value to "20 %." (Factory set value: 20)
 Converting "20 %" to a current value with a maximum load current set value at "20.0 A" results in a current value of "4 A."

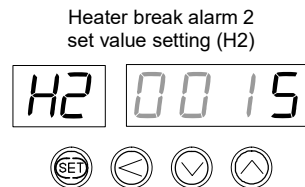
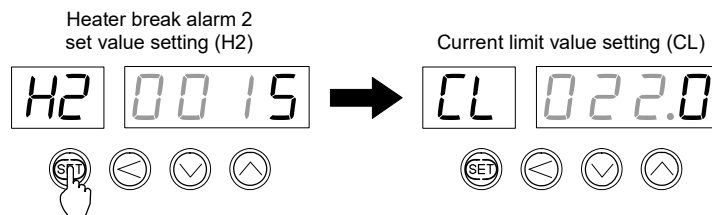


9. Press the SET key to go to the heater break alarm 2 set value setting (H2).



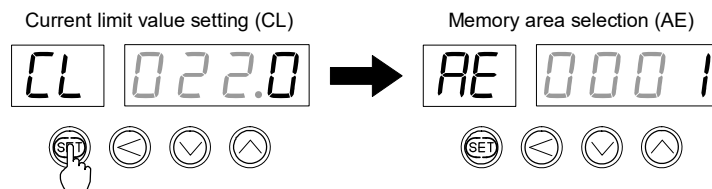
10. Set the heater break alarm 2 set value to “15 %.” (Factory set value: 15)

Converting “15 %” to a current value with a maximum load current set value at “20.0 A” results in a current value of “3 A.”

**11.** Press the SET key. The display goes to current limit value setting (CL).**12.** If the current limiter function is used, set the current limit value.

In this example the function is not used, so press the SET key. The display goes to memory area selection (AE).

(Factory set value: 22.0 A, Current limiter function OFF)

**13.** This completes the settings for memory area 1. The set values have been stored in memory area 1.

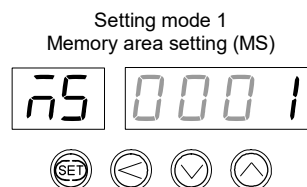
Contents of memory area 1




Parameter name	Set value
Maximum load current set value	20.0 A
Heater break alarm 1 set value	20 %
Thyristor break-down set value	20 %
Heater break alarm 2 set value	15 %
Current limit value	22.0 A

14. To configure settings for other memory areas, use the same procedure beginning from “2.” on page 94.

■ Setting the memory area used during operation

The memory area used for operation is set in memory area setting (MS) of setting mode 1. The memory area can be switched in both the RUN state and the STOP state.



-  If the memory area is switched, alarm monitoring is performed using the new memory area values immediately.
-  When a contact input (DI) is used, the contact input (DI) setting has priority.
-  When the number of memory area setting (MS) is changed, memory area selection (AE) changes to the same memory area number; however, when memory area selection (AE) is changed, the memory number of memory area setting (MS) does not change.

4.11 Setting Example of Non-linear Resistance Heater Break Alarm

4.11.1 Precautions for using the non-linear resistance heater break alarm

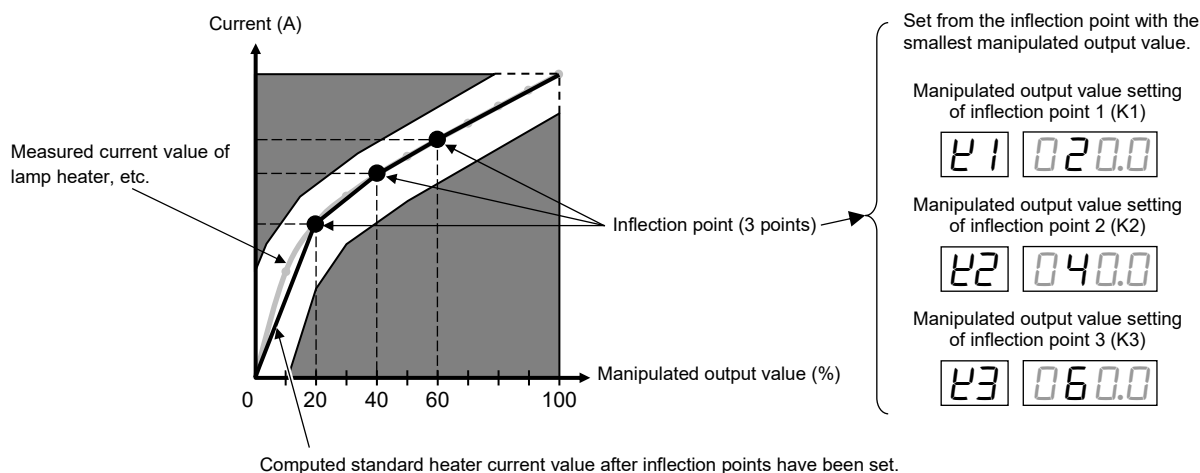
- It may not be possible to use the non-linear resistance heater break alarm function with some heater types.
- Use this function in a system with a current capacity of 10 A or more. As the measuring accuracy of the current transformer (CT) is within ± 2 % of the THV-A1 rated current, no heater break alarm may normally operate if used at a smaller load current value.
- Heater break alarm 2 set value cannot be used as non-linear resistance heater break alarm. If the non-linear resistance heater break alarm is used, heater break alarm 2 set value is activated as standard heater break alarm.
- Use automatic calculation of inflection points when output mode is proportional voltage to input or constant voltage control. If automatic calculation is used in output modes other than proportional voltage to input and constant voltage control, the obtained value may have larger error and false detection may happen.
- The automatic calculation function raises the output of the THV-A1 to 100 %. If you do not want to apply an output of 100% to the heater, use the output limiter or current limit to limit the output.
- If output mode for phase control (oS) is changed after the inflection point was set, the current value characteristics may change. Recalculate the inflection point and set it again.
- The following input signals are disregarded during automatic calculation of the inflection point.
 - Automatic set value (Input signal from controller)
 - External manual set value (Input signal from external manual setter)
 - Internal manual set value (Set by the THV-A1 front keys)
- If the values of the following items are changed during automatic calculation of the inflection point, the inflection point will not be calculated correctly.
Do not change the setting while inflection point is being automatically calculated.

<ul style="list-style-type: none"> – Internal gradient set value (IG) – Maximum load current set value for alarm (MC) – Current limit value setting (CL) – Control method (CM) – Output mode for phase control (oS) – Output limiter (high) (LH) – Output limiter (low) (LL) – Output limiter (high) at operation start (LS) – Output limiter (high) time at operation start (LT) 	<ul style="list-style-type: none"> – Base-up set value (bU) – Output time setting for automatic calculation of inflection point (HT) – Manipulated output value setting of inflection point 1 (K1) – Current value setting of inflection point 1 (r1) – Manipulated output value setting of inflection point 2 (K2) – Current value setting of inflection point 2 (r2) – Manipulated output value setting of inflection point 3 (K3) – Current value setting of inflection point 3 (r3)
--	---
- Action is as follows if an error occurs during automatic calculation of the inflection point.
 - (1) If error number 1, 2, 4, 32, 64 or 128 appears during automatic calculation
Same as normal error action. Refer to **6.2 Error Display (P. 153)**.
 - (2) When a power failure occurred during automatic calculation
The value of the inflection point during automatic calculation is not retained. The value returns to the value before automatic calculation was started.

- When manually setting inflection points, set the “Manipulated output value of inflection point” and “Current value of inflection point” for each inflection point in order from the inflection point with the smallest manipulated output value.
 - Set the inflection point with the smallest manipulated output value by setting “Manipulated output value setting of inflection point 1 (K1)” and “Current value setting of inflection point 1 (r1).”
 - Set the inflection point with the intermediate manipulated output value by setting “Manipulated output value setting of inflection point 2 (K2)” and “Current value setting of inflection point 2 (r2).”
 - Set the inflection point with the largest manipulated output value by setting “Manipulated output value setting of inflection point 3 (K3)” and “Current value setting of inflection point 3 (r3).”



Not compatible with special heaters for which the current decreases when the manipulated output value increases.



- A thyristor break-down alarm may occur if automatic calculation of the inflection point is executed after the inflection points are set. The standard heater break alarms are in effect during automatic calculation of the inflection point, and thus for a lamp heater, the current value will enter the thyristor break-down alarm range due to the load characteristics. If this occurs, the thyristor break-down alarm can be prevented by setting “heater break alarm enable/disable (HF)” to “disable.”

4.11.2 When setting the inflection point automatically (Proportional voltage to input/Constant voltage control)

Use the automatic calculation of the inflection points if output mode is proportional voltage to input or constant voltage control.

(1) Preparation for automatic calculation of inflection points

Before calculating the inflection point, set the external gradient and the parameters in the following table.

- External gradient setting

If an external gradient setter is used, set the external gradient to “100 %.”

- Parameter setting

Mode	Parameter	Name	Description
Setting mode 1	IG	(IG) Internal gradient set value	Set the internal gradient set value to 1.00.
	SU	(SU) Soft-start time	Set the actual values that are used.
Setting mode 2	MC	(MC) Maximum load current set value for alarm	Set the rated current of heater.
	CL	(CL) Current limit value setting	Set the actual values that are used.
Engineering mode Function block 2 (F2.)	CM	(CM) Control method	Set the control method to “0: Phase control.”
Engineering mode Function block 3 (F3.)	oS	(oS) Output mode for phase control *	Set the output mode for phase control to “1: Proportional voltage to input.”
	LH	(LH) Output limiter (high)	Set the actual values that are used.
	LL	(LL) Output limiter (low)	
	LS	(LS) Output limiter (high) at operation start	
	LT	(LT) Output limiter (high) time at operation start	
	bU	(bU) Base-up set value	
Engineering mode Function block 4 (F4.)	A1	(A1) Heater break alarm 1 type	Set the heater break alarm 1 type and heater break alarm 2 type to “0: Type 1 (constant resistance type, deviation alarm).”
	A2	(A2) Heater break alarm 2 type	

* If output mode was changed after the inflection point had been set, calculate the value for the inflection point again.
(Recalculation is not required if output was changed from proportional voltage to input or constant voltage control.)

■ Automatic calculation of the maximum load current set value for alarm (MC)

For the non-linear resistance heater break alarm, automatic calculation of the maximum load current set value is performed together with automatic calculation of the inflection points.

The maximum load current set value is updated if the phase angle exceeds 90 % and the difference between the value and the currently set maximum load current value is ± 1 A or greater during automatic calculation.

(2) How to automatically calculate inflection points

1. Unlock the engineering mode.

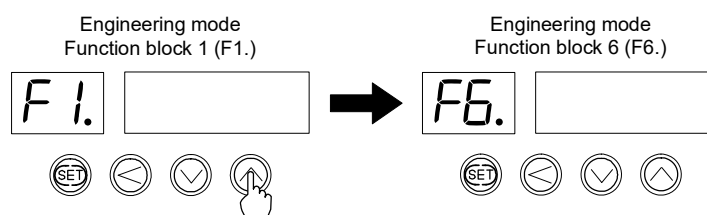


Refer to **4.6.1 Transfer to engineering mode (P. 54)**.

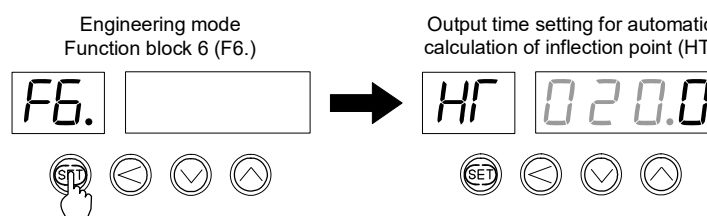


For details on changing the numeric value, refer to **4.4.2 Changing parameter settings (P. 41)**.

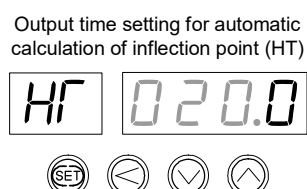
2. Press the UP key to go to the function block 6 (F6.).



3. Press the SET key to go to the output time setting for automatic calculation of inflection point (HT).

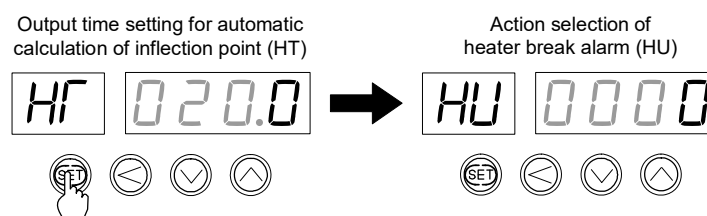


4. Set the output time to “20.0.” (Factory set value: 20.0 seconds)
“20.0 seconds” is the factory set value. However, set any value meeting the customer’s system.

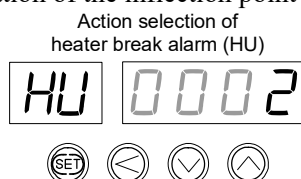


If the heater does not stabilize, lengthen the output time setting.

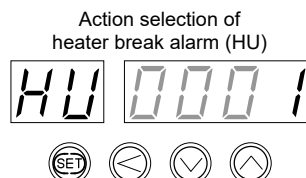
5. Press the SET key to go to the action selection of heater break alarm (HU).



6. Set the action selection of heater break alarm (HU) to “2: Start inflection point calculation.”
When “2” is set, automatic calculation of the inflection point begins.



7. When calculation of the inflection point ends, the display changes from “2” to “1: Non-linear resistance heater break alarm.” When the display is switched to “1,” the manipulated output value and current value of each inflection point are updated and alarm operation based on the non-linear resistance heater break alarm starts.



8. To check the manipulated output values and the current values of the inflection points, press the SET key to switch through the display.
The manipulated output value of inflection point and current value of inflection point have been automatically set for the three inflection points starting from the inflection point with the smallest manipulated output value.

As a result of automatic calculation, the manipulated output values and current values of the three inflection points with the smallest heater current error are automatically set. Setting takes place from the inflection point with the smallest manipulated output value.

Manipulated output value setting
of inflection point 1 (K1)

K1 020.0

Manipulated output value setting
of inflection point 2 (K2)

K2 030.0

Manipulated output value setting
of inflection point 3 (K3)

K3 050.0

Current value setting of
inflection point 1 (r1)

r1 011.8

Current value setting of
inflection point 2 (r2)

r2 013.7

Current value setting of
inflection point 3 (r3)

r3 016.6



The automatically calculated manipulated output value of inflection point and the current value are retained even if the alarm is switched to standard heater break alarm type.

To perform alarm monitoring using the same values again, set action selection of heater break alarm (HU) to “1: Non-linear resistance heater break alarm.”



The output time setting for automatic calculation of inflection point (HT), the action selection of heater break alarm (HU), the manipulated output value of inflection point, and the current value of inflection point are retained even if the power is turned off.

9. The maximum load current set value can be checked in the maximum load current set value for alarm (MC) of setting mode 2.



For selecting mode, refer to **4.1 Mode Menu (P. 31)**.

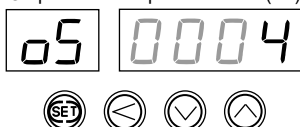
Setting mode 2
Maximum load current set value for alarm (MC)



To use the instrument in constant voltage control

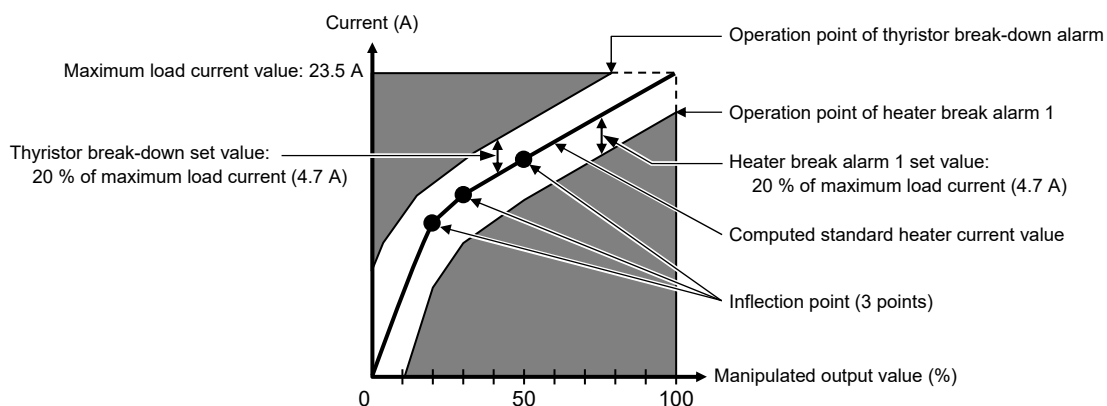
To use the instrument in constant voltage control, calculate the inflection point in proportional voltage to input, then go to “Output mode for phase control” in function block 3 (F3.), and set “Constant voltage control (Set value: 4).”

Function block 3 (F3.)
Output mode for phase control (oS)



4.11.3 Setting the alarm set value for non-linear resistance heater break alarm

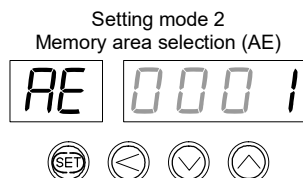
After automatic calculation of the inflection points is completed, set the heater break alarm and the thyristor break-down set value. Set the alarm set value as a deviation from the computed standard heater current value corrected based on the inflection point. Note that heater break alarm 2 set value is not compatible with the non-linear resistance heater break alarm. Heater break alarm 2 set value operates as a standard heater break alarm, and thus if this value will not be used, set to “unused.”



■ Alarm set value setting

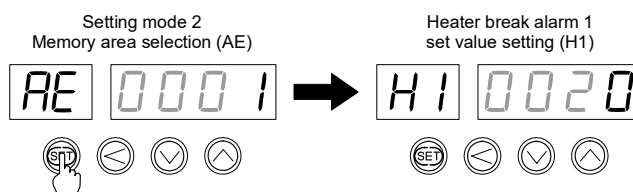
1. Go to the setting mode 2.

For selecting mode, refer to **4.1 Mode Menu (P. 31)**.



2. The non-linear resistance heater break alarm is not compatible with the memory area function, and thus there is no need to select the memory area. Use with memory area 1.

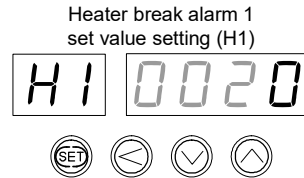
Press the SET key twice to go to the heater break alarm 1 set value setting (H1).



In the case of the non-linear resistance heater break alarm, only the data of memory area 1 is valid.

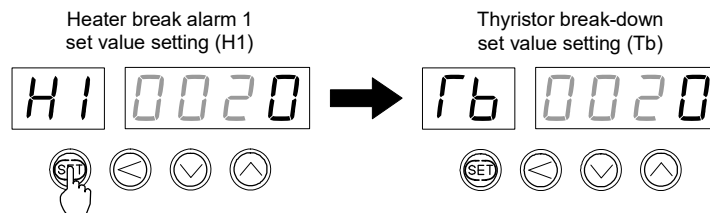
3. Set the heater break alarm 1 set value to “20 %.” (Factory set value: 20)

Converting “20 %” to a current value with a maximum load current set value at “23.5 A” results in a current value of “4.7 A.”



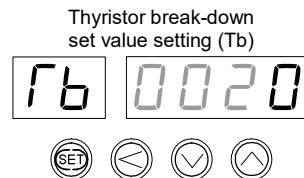
Here, “20 %” is set. However, set any value meeting the customer’s system.

4. Press the SET key to go to the thyristor break-down set value setting (Tb).



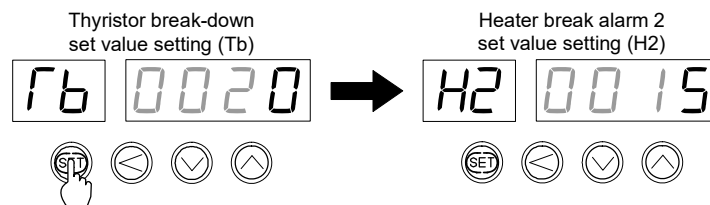
5. Set the thyristor break-down set value to “20 %.” (Factory set value: 20)

Converting “20 %” to a current value with a maximum load current set value at “23.5 A” results in a current value of “4.7 A.”

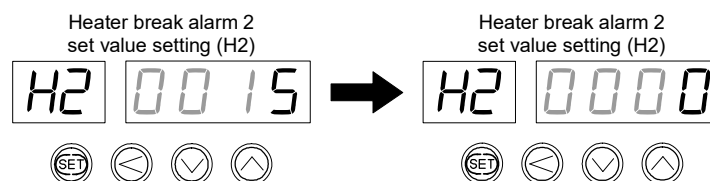


Here, “20 %” is set. However, set any value meeting the customer’s system.

6. Press the SET key to go to the heater break alarm 2 set value setting (H2).



7. Set the heater break alarm 2 set value to “0 % (heater break alarm 2 unused).”



Thus, the setting has been finished.

4.11.4 When setting the inflection point manually (lamp heater)

In case of a lamp heater, use manipulated output values and current values when the phase angle ratio is 20 %, 40 % and 60 % as the values of inflection points. Then, standard heater current calculation values approximated to the lamp heater current characteristics can be obtained. If heater break and thyristor break-down cannot be detected at automatically calculated inflection points, manually set the inflection points. The calculation method of the inflection points depends on the output modes.

Manipulated output values at inflection points are pre-calculated. Only current values need to be measured. (Refer to the following table manipulated output value and current value of inflection point.)

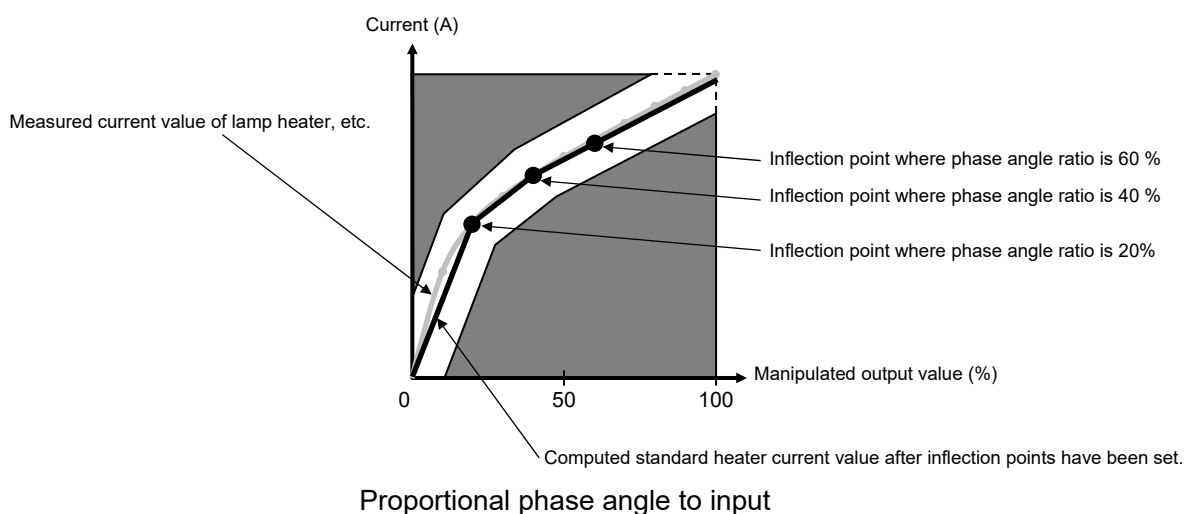


Table: Manipulated output value and current value of inflection point

Output mode for Phase control	Proportional phase angle to input	Proportional square voltage (electric power) to input Square voltage feedback Constant power control	Proportional voltage to input Constant voltage control Constant current control
Inflection point			
Manipulated output value of inflection point 1 *	20.0 %	4.9 %	22.1 %
Manipulated output value of inflection point 2 *	40.0 %	30.6 %	55.4 %
Manipulated output value of inflection point 3 *	60.0 %	69.4 %	83.3 %
Current value of inflection point 1	Measure current value when phase angle ratio is 20 %. (Refer to page 108 for details)		
Current value of inflection point 2	Measure current value when phase angle ratio is 40 %. (Refer to page 108 for details)		
Current value of inflection point 3	Measure current value when phase angle ratio is 60 %. (Refer to page 108 for details)		

* Manipulated output values at inflection points 1 to 3 are those when phase angle ratio is 20, 40, or 60 %. These are obtained by calculation. (Refer to page 110 for formula)

Manipulated output value of inflection point 1: Manipulated output value when phase angle ratio is 20 %

Manipulated output value of inflection point 2: Manipulated output value when phase angle ratio is 40 %

Manipulated output value of inflection point 3: Manipulated output value when phase angle ratio is 60 %











(1) Preparation before manual setting of inflection points

Before calculating the inflection points, set the external gradient and the following parameters.

- External gradient setting

If an external gradient setter is used, set the external gradient set value to “100 %.”

- Parameter setting




Mode	Parameter		Name	Description
Setting mode 1		(IG)	Internal gradient set value	Set the parameters as follows: (Note that the values for constant power control are different from those in other output modes.) Proportional phase angle to input: 1.00 Proportional voltage to input: 1.00 Proportional square voltage (electric power) to input: 1.00 Square voltage feedback: 1.00 Constant current control: 1.00 Constant voltage control: 1.00 Constant power control: 2.00
		(SU)	Soft-start time	Set the actual values that are used.
Setting mode 2		(MC)	Maximum load current set value	Set the rated current of heater.
		(H1)	Heater break alarm 1 set value setting	Set the heater break alarm 1 set value to “0: Heater break alarm 1 unused.”
		(Tb)	Thyristor break-down set value setting	Set the thyristor break-down set value to “0: Thyristor break-down alarm unused.”
		(H2)	Heater break alarm 2 set value setting	Set the heater break alarm 2 set value to “0: Heater break alarm 2 unused.”
		(CL)	Current limit value setting	Set a rated value of the thyristor (with current limiter function OFF). If control system may be influenced when heater rated current flows, enter an appropriate value here.
Engineering mode Function block 2 (F2.)		(CM)	Control method	Set the control method to “0: Phase control.”
		(dA)	Contact input action	Set the contact input action to “2: Internal manual mode (fixed).”
Engineering mode Function block 3 (F3.)		(oS)	Output mode for phase control *	Set an output mode that is actually used

* If output mode has been changed after inflection points had been set, the inflection point needs to be recalculated.

Mode	Parameter		Name	Description
Engineering mode Function block 3 (F3.)	<i>LH</i>	(LH)	Output limiter (high)	In case of manual setting, set this parameter to “100.0” (factory set value). If control system may be influenced when heater rated current flows, enter an appropriate value here.
	<i>LL</i>	(LL)	Output limiter (low)	In case of manual setting, set this parameter to “0.0” (factory set value).
	<i>LT</i>	(LT)	Output limiter (high) time at operation start	
	<i>bU</i>	(bU)	Base-up set value	
Engineering mode Function block 4 (F4.)	<i>A1</i>	(A1)	Heater break alarm 1 type	Set the heater break alarm 1 and heater break alarm 2 types to “0: Type 1 (constant resistance type, deviation alarm).”
	<i>A2</i>	(A2)	Heater break alarm 2 type	

(2) Manually setting inflection points (Example: Constant current control)

On this page constant current control is used for explanation. Setting procedure is the same for other output modes.

-  For selecting mode, refer to **4.1 Mode Menu (P. 31)**.
-  For details on changing the numeric value, refer to **4.4.2 Changing parameter settings (P. 41)**.
-  Refer to **4.6.1 Transfer to engineering mode (P. 54)**.

1. Before setting inflection points, look at “(1) Preparation before manual setting of inflection points (P. 106)” to make sure all necessary conditions are satisfied.
2. Set the following internal manual set values in internal manual set value (IM) and record the measured current values. Check the current value on the CT input monitor (CT).
Set 42.0 %, 70.1 %, 89.6 % and 100.0 % in the internal manual set value (IM) in this order.
(If output mode other than constant current control is used, enter current values referring to the following table in the same way)

Values to be set in internal manual set value (IM)

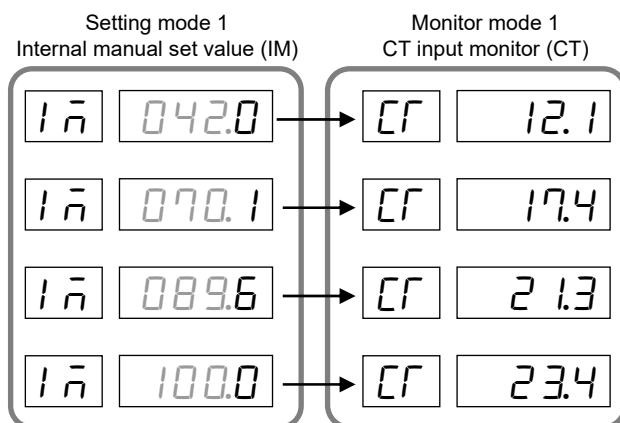
Output mode for phase control	Internal manual set value			
	Phase angle ratio 20 %	Phase angle ratio 40 %	Phase angle ratio 60 %	Phase angle ratio 100 %
Proportional phase angle to input	20.0 %	40.0 %	60.0 %	100.0 %
Proportional square voltage (electric power) to input	4.9 %	30.6 %	69.4 %	100.0 %
Square voltage feedback				
Proportional voltage to input	22.1 %	55.4 %	83.3 %	100.0 %
Constant voltage control				
Constant current control	42.0 %	70.1 %	89.6 %	100.0 %
Constant power control	8.9 % *	37.5 % *	73.9 % *	100.0 % *

* Value when the internal gradient set value (IG) is set to “2.00.”



Setting internal manual set value (IM) to 100.0 % is required to record the maximum load current. If flow of rated heater current provides a bad influence on the control system, do not set 100.0% output setting. If current limiter and output limiter high are set, there is no checking of maximum load current values.

Display example of current value



Record the current value.

Internal manual set value (IM)	Current value
42.0 %	12.1 A
70.1 %	17.4 A
89.6 %	21.3 A
100.0 %	23.4 A



The current values are examples. Actual heater current values will be different.

3. Set the manipulated output value at inflection point and the current value recorded in “2.”

For the manipulated output value, set the value listed in the table “Manipulated output value and current value of inflection point (P. 105).” On this page, constant current control is used for explanation. Set 22.1 %, 55.4 %, and 83.3 % as the manipulated output values at inflection points. Start setting the inflection points with the smallest manipulated output value first and continue setting in the ascending order. Do the same for the current values (from the smallest current value).

Engineering mode Function block 6 (F6.)

<div style="border: 1px solid black; padding: 5px; display: inline-block;">Set the values listed on page 105.</div>	<div style="text-align: center;">Manipulated output value setting of inflection point 1 (K1)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">E1 022.1</div>	<div style="text-align: center;">Current value setting of inflection point 1 (r1)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">r1 012.1</div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Set the current values recorded in “2.”</div>
	<div style="text-align: center;">Manipulated output value setting of inflection point 2 (K2)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">E2 055.4</div>	<div style="text-align: center;">Current value setting of inflection point 2 (r2)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">r2 017.4</div>	
	<div style="text-align: center;">Manipulated output value setting of inflection point 3 (K3)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">E3 083.3</div>	<div style="text-align: center;">Current value setting of inflection point 3 (r3)</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">r3 021.3</div>	

4. Activate the non-linear resistance heater break alarm.

Change to the action selection of heater break alarm (HU), and change the setting from “0: Standard heater break alarm” to “1: Non-linear resistance heater break alarm.”

When “1” is set, the non-linear resistance heater break alarm is activated.

Action selection of
heater break alarm (HU)

HU 0001


5. If maximum load current value is recorded, set the recorded current value at maximum load current set value for alarm (MC) in setting mode 2.


Setting mode 2
Maximum load current set value for alarm (MC)


MC 023.4

6. This completes manual setting of the inflection points.

Next, set the heater break alarm set value and the thyristor break-down set value.

 For the alarm set value setting, refer to **4.11.3 Setting the Alarm Set Value for Non-linear Resistance Heater Break Alarm (P. 103).**

 The manipulated output value of inflection point and the current value are retained even if the alarm is switched to standard heater break alarm type.
To perform alarm monitoring using the same values again, set action selection of heater break alarm (HU) to “1: Non-linear resistance heater break alarm.”

 The output time setting for automatic calculation of inflection point (HT), the action selection of heater break alarm (HU), the manipulated output value of inflection point, and the current value of inflection point are retained even if the power is turned off.

■ Formula to calculate manipulated output value from phase angle ratio

Manipulated output value at inflection point can be calculated from phase angle ratio. Formula depends on the output mode.

- Proportional phase angle to input

This output mode has no formula.

In this mode, input and phase angle are proportional to each other. The value which was viewed at phase angle ratio monitor (PA) can be set as manipulated output value at inflection points.

- Constant voltage control, Constant current control and Proportional voltage to input




$$\text{Manipulated output value of inflection point (\%)} = \sqrt{\frac{\phi}{100} + \frac{1}{2\pi} \sin \left\{ 2\pi \times \left(1 - \frac{\phi}{100} \right) \right\}} \times 100$$

- Constant power control, Proportional square voltage (electric power) to input and Square voltage feedback



$$\text{Manipulated output value of inflection point (\%)} = \left[\frac{\phi}{100} + \frac{1}{2\pi} \sin \left\{ 2\pi \times \left(1 - \frac{\phi}{100} \right) \right\} \right] \times 100$$

4.11.5 When setting the inflection point manually (Other than lamp heater)

If non-linear resistance heater break alarm is used for the load where resistance value changes according to temperature (other than lamp heaters), obtain the manipulated output value and the current value in the following procedure.

-  For selecting mode, refer to **4.1 Mode Menu (P. 31)**.
-  For details on changing the numeric value, refer to **4.4.2 Changing parameter settings (P. 41)**.
-  Refer to **4.6.1 Transfer to engineering mode (P. 54)**.

1. Before setting the inflection point, make sure that the parameters are set.

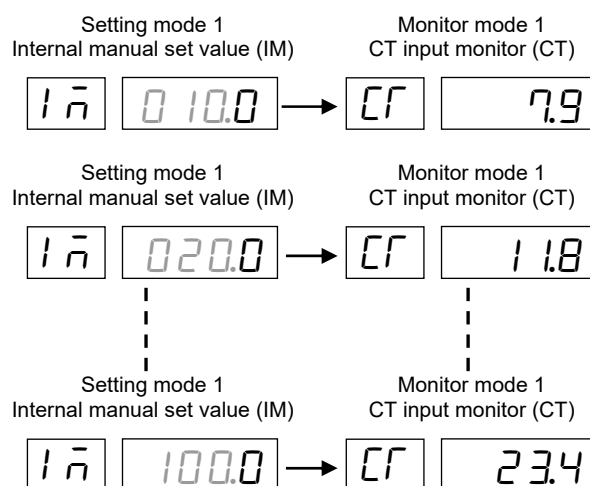
-  Refer to (1) Preparation before manual setting of inflection points (P. 106, P. 107).
-  When external manual setter is used to change the manipulated output value of the heater, set the contact input action (dA) to “3: External manual mode (fixed).”

2. Record the internal manual set value and current value.

Set any manipulated output value in the internal manual set value (IM), and record the internal manual set value and current value at that time.

Check the current value on the CT input monitor (CT).

The example below shows the current values that are recorded when the internal manual set value is increased in increments of 10 %.

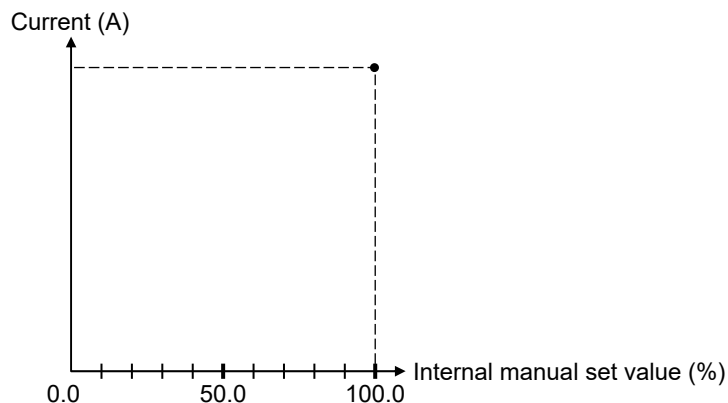


Record example

Internal manual set value	Current value	Internal manual set value	Current value
10.0 %	7.9 A	60.0 %	18.1 A
20.0 %	11.8 A	70.0 %	19.5 A
30.0 %	13.7 A	80.0 %	20.9 A
40.0 %	15.1 A	90.0 %	22.2 A
50.0 %	16.6 A	100.0 %	23.4 A

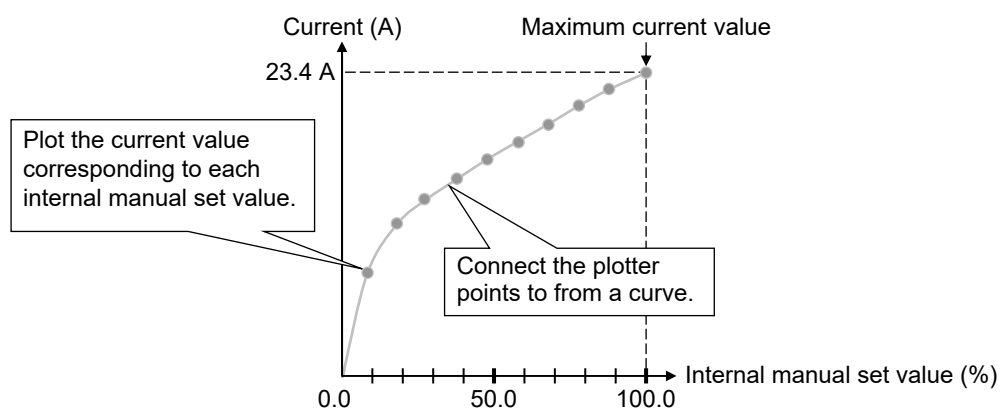
 The values in the table are examples. Actual heater values will be different.

3. Create a graph based on the recorded internal manual set values and current values, with the vertical axis representing current (A) and the horizontal axis representing internal manual set value (%).



4. Plot the recorded curve of current values.

Plot the current value corresponding to each internal manual set value on the graph. Connect the plotted points to form a curve.



Record example

Internal manual set value	Current value	Internal manual set value	Current value
10.0 %	7.9 A	60.0 %	18.1 A
20.0 %	11.8 A	70.0 %	19.5 A
30.0 %	13.7 A	80.0 %	20.9 A
40.0 %	15.1 A	90.0 %	22.2 A
50.0 %	16.6 A	100.0 %	23.4 A



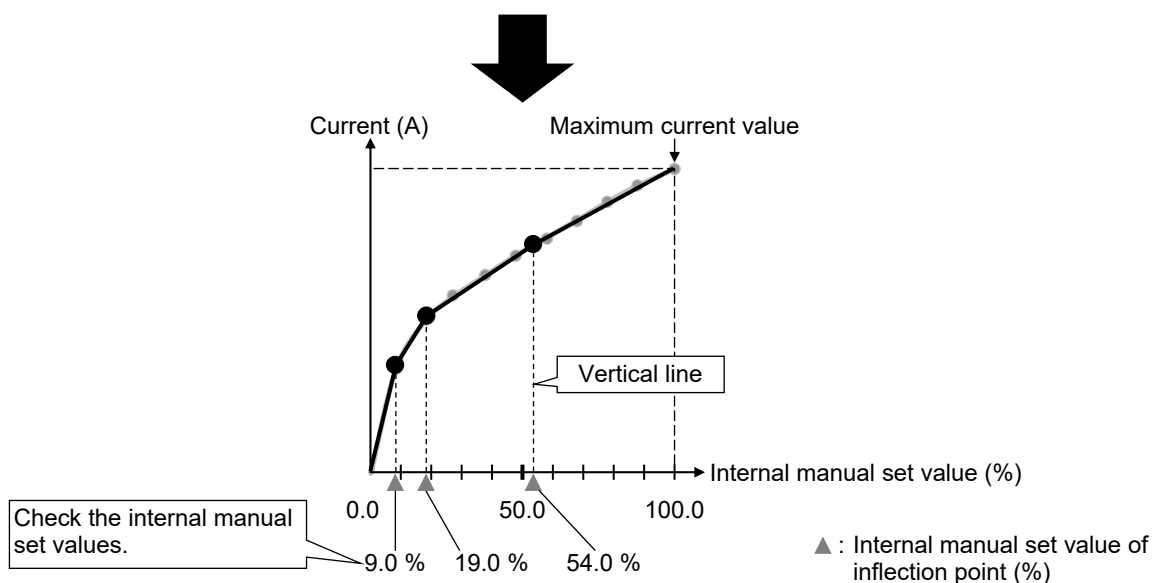
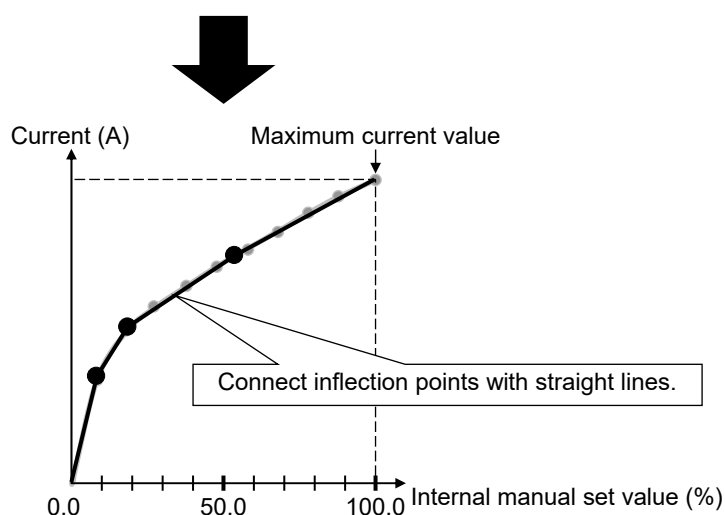
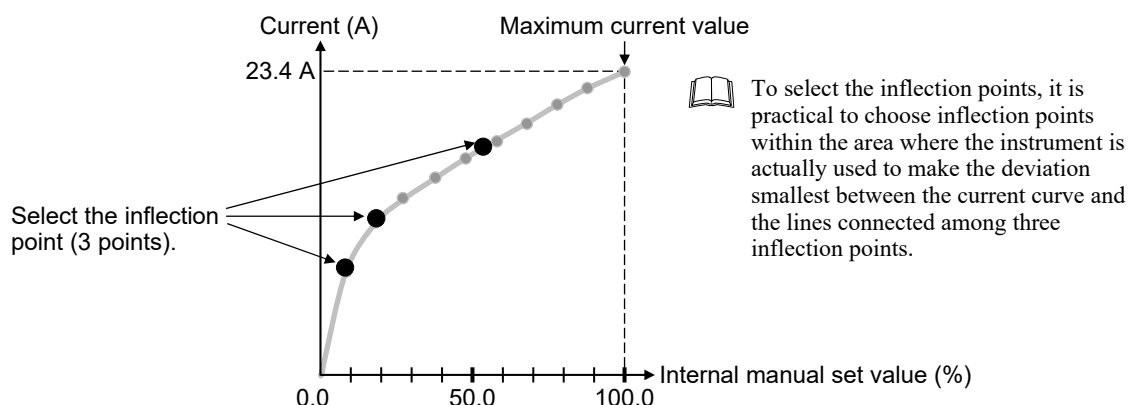
The values in the table are examples. Actual heater values will be different.

5. Obtain 3 inflection points.

When connecting three inflection points (coordinates) with straight lines, select the inflection points that make the deviation from the current value curve smallest.

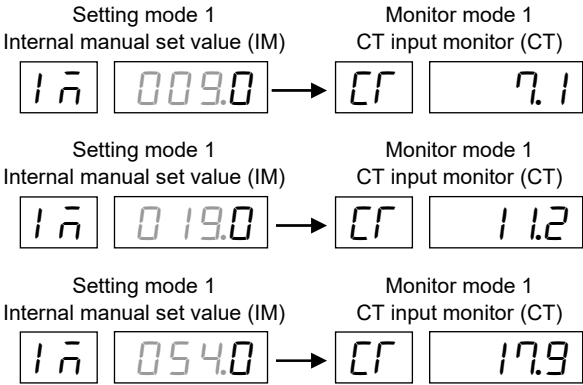
Draw a vertical line through the inflection point and check the internal manual set value of the inflection point on the horizontal axis of the graph.

In this example internal manual set values at inflection points are 9.0 %, 19.0 %, and 54.0 %.



6. Check the current value of the inflection point.
Set the internal manual set value of the inflection point in internal manual set value (IM), and check the current value at that time.
[Internal manual set value: 9.0 %, 19.0 % and 54.0 %]
Check the current value on the CT input monitor (CT).

Display example of current value



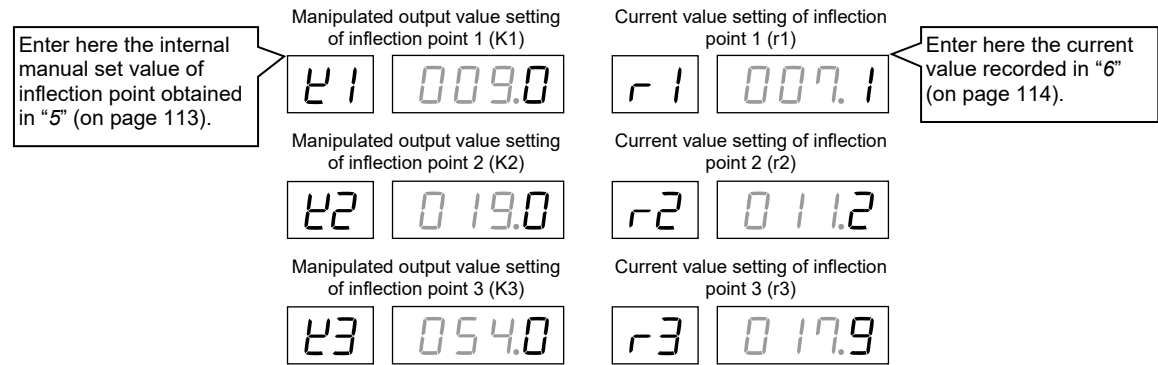
Record the current value.

Internal manual set value (IM)	Current value
9.0 %	7.1 A
19.0 %	11.2 A
54.0 %	17.9 A

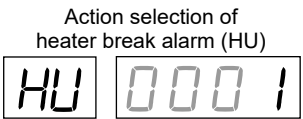
The current values are examples.
Actual heater current values will be different.

7. Set the manipulated output value at inflection point and the current value recorded in “6.”
Set the internal manual set value of inflection point obtained in “5” as manipulated output value for inflection point.
Start setting the inflection points with the smallest internal manual set value first and continue setting in the ascending order. Do the same for the current values (from the smallest current value).

Engineering mode Function block 6 (F6.)



8. Activate the non-linear resistance heater break alarm.
Change to the action selection of heater break alarm (HU), and change the setting from “0: Standard heater break alarm” to “1: Non-linear resistance heater break alarm.”
When “1” is set, the non-linear resistance heater break alarm is activated.



9. If maximum load current value is recorded, set the recorded current value at maximum load current set value for alarm (MC) in setting mode 2.

Setting mode 2
Maximum load current set value for alarm (MC)



10. This completes manual setting of the inflection points.

Next, set the heater break alarm set value and the thyristor break-down set value.



For the alarm set value setting, refer to **4.11.3 Setting the Alarm Set Value for Non-linear Resistance Heater Break Alarm (P. 103)**.



The manipulated output value of inflection point and the current value are retained even if the alarm is switched to standard heater break alarm type.

To perform alarm monitoring using the same values again, set action selection of heater break alarm (HU) to “1: Non-linear resistance heater break alarm.”



The output time setting for automatic calculation of inflection point (HT), the action selection of heater break alarm (HU), the manipulated output value of inflection point, and the current value of inflection point are retained even if the power is turned off.

4.12 Setting Procedure of Protection Function for Control of Primary Side of a Transformer

4.12.1 Setting parameters for protection function for control of primary side of a transformer

The following parameters need to be adjusted to suit your system.

(If the factory set values satisfy the requirements, they can be used as they are)


After having the following parameters properly adjusted, enable the protection function for primary side of a transformer. (P. 116)

- Determination set value in case of a break on the secondary side of the transformer (TA)
[Factory set value: 70 % of computed heater current value]
- Output limiter setting in case of a break on the secondary side of the transformer (TL)
[Factory set value: 15.0 % of phase angle]
- Soft-start time in case of break on the secondary side of the transformer (TU)
[Factory set value: 0.1 seconds]

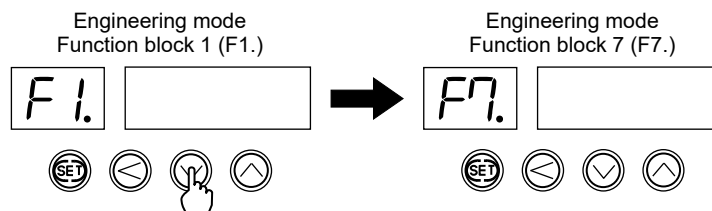
■ Setting procedure

1. Unlock the engineering mode

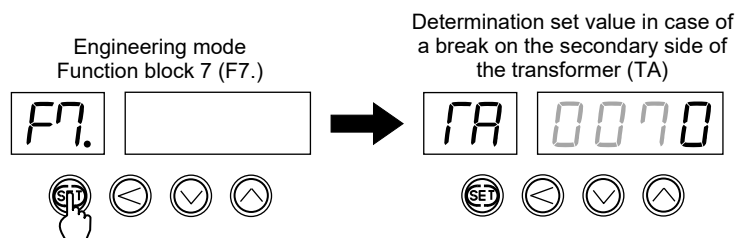
 Refer to 4.6.1 Transfer to engineering mode (P. 54).

 For details on changing the numeric value, refer to 4.4.2 Changing parameter settings (P. 41).

2. Press the Down key to go to the function block 7 (F7.).

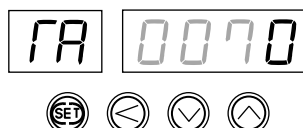


3. Keep pressing the SET key until the determination set value in case of a break on the secondary side of the transformer (TA) screen displays.



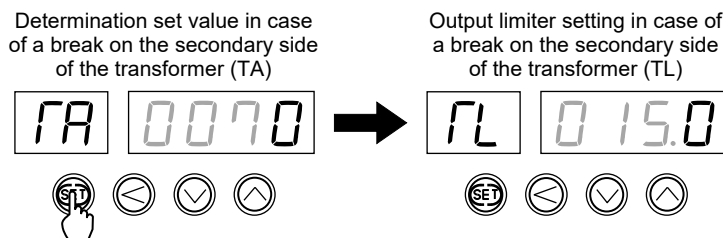
4. Set the determination set value in case of a break on the secondary side of a transformer.
(Factory set value: 70)

Determination set value in case of
a break on the secondary side of
the transformer (TA)

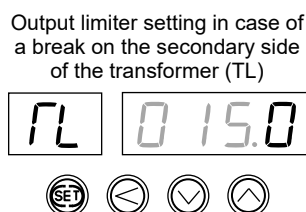


Here, “70 %” is set. However, set any value meeting the customer’s system.

5. Press the SET key to go to the output limiter setting in case of a break on the secondary side of the transformer (TL).

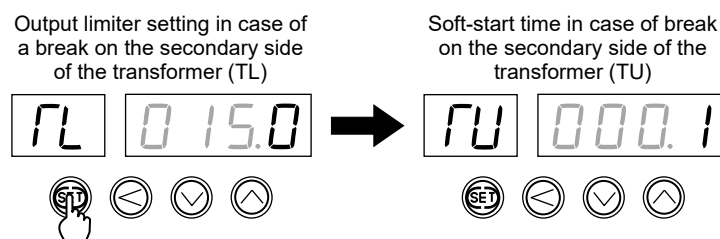


6. Set the output limiter setting in case of a break on the secondary side of the transformer (TL).
(Factory set value: 15.0)

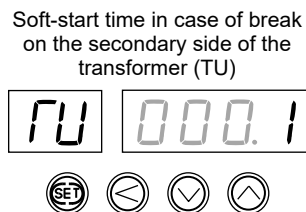


Here, “15.0 %” is set. However, set any value meeting the customer’s system.

7. Press the SET key to go to the soft-start time in case of break on the secondary side of the transformer (TU).

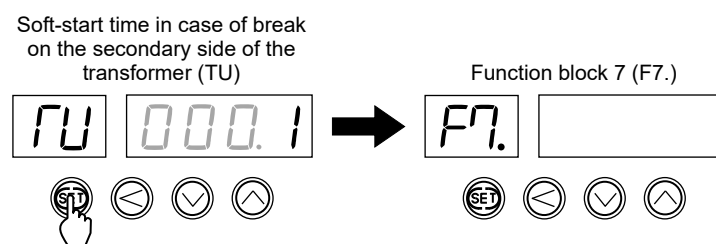


8. Set the soft-start time in case of break on the secondary side of the transformer (TU).
(Factory set value: 0.1)



Here, “0.1 seconds” is set. However, set any value meeting the customer’s system.

9. Press the SET key. The display goes to function block 7 (F7.).



This completes setting of related parameters.

Then, enable the protection function for control of primary side of a transformer. (Refer to next page.)

4.12.2 Enabling protection function for control of primary side of a transformer

1. Unlock the engineering mode

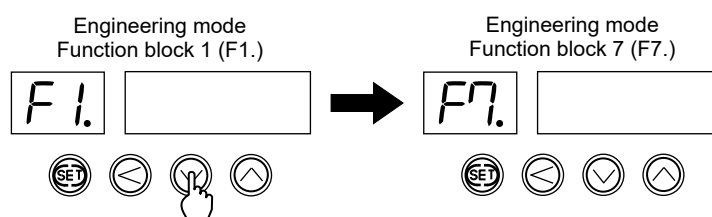


Refer to 4.6.1 Transfer to engineering mode (P. 54).

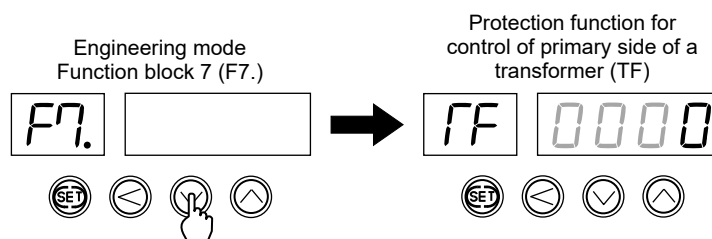


For details on changing the numeric value, refer to 4.4.2 Changing parameter settings (P. 41).

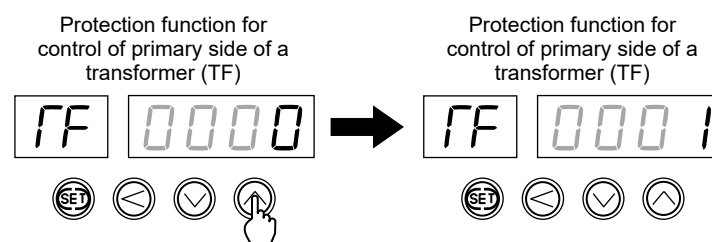
2. Press the Down key to go to the function block 7 (F7.).



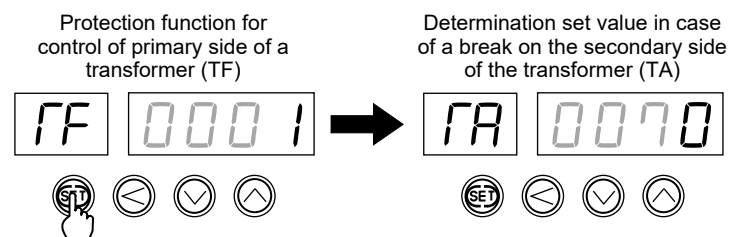
3. Press the SET key to go to the protection function for control of primary side of a transformer (TF).



4. Set the set value to "1: Protection function for control of primary side of a transformer enable."



5. Press the SET key. This completes manual setting of the determination set value in case of a break on the secondary side of the transformer (TA). When the SET key is pressed, the protection function for control of primary side of a transformer is enabled.



Thus, the setting has been finished.

5. FUNCTIONS

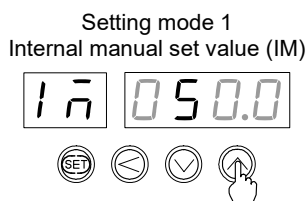
5.1 Manual Mode

The manipulated output value of THV-A1 can be manually set. There are two manual setting methods:

- Set by front keys of THV-A1.
- Set by external manual setter.

■ Set by front keys (Internal manual set value)

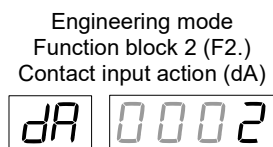
The output value can be set manually using the front keys of the THV-A1. This is done in “internal manual set value (IM)” of setting mode 1.



The internal manual set value reverts to 0.0 when the power of the THV-A1 is turned off.

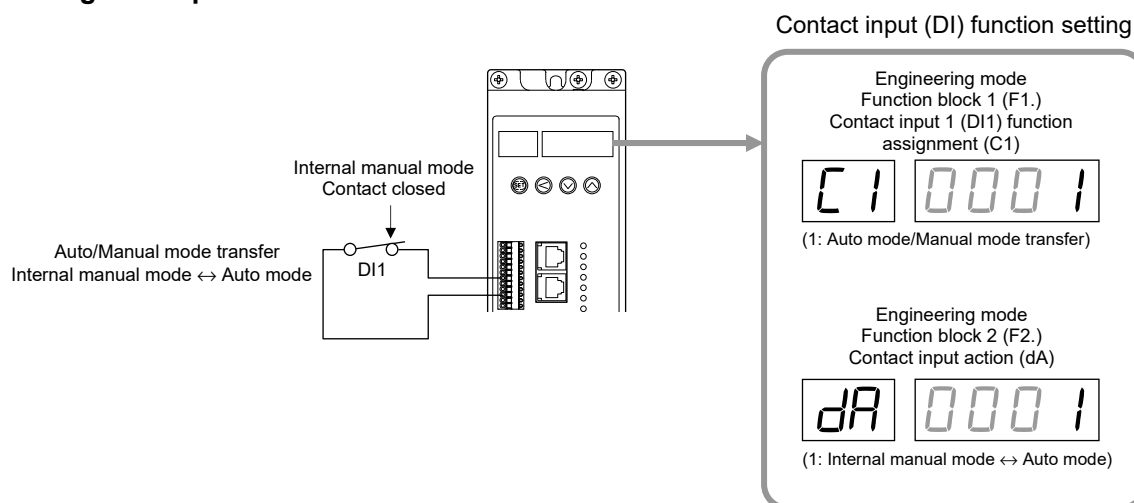
The internal manual set value is valid in either of the following states:

- The contact input action (dA) is set to “2: Internal manual mode (fixed).” (Refer to **P. 61**)



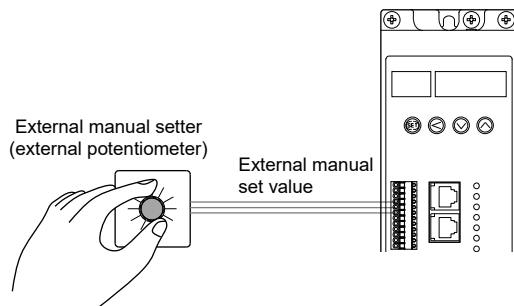
- “Internal manual mode ↔ Auto mode” is used for the contact input (DI) and the contact is closed.

DI usage example:



■ Set by external manual setter (external potentiometer)

The output value of the THV-A1 can be set using the external manual setter.



The external manual set value is valid in either of the following states:

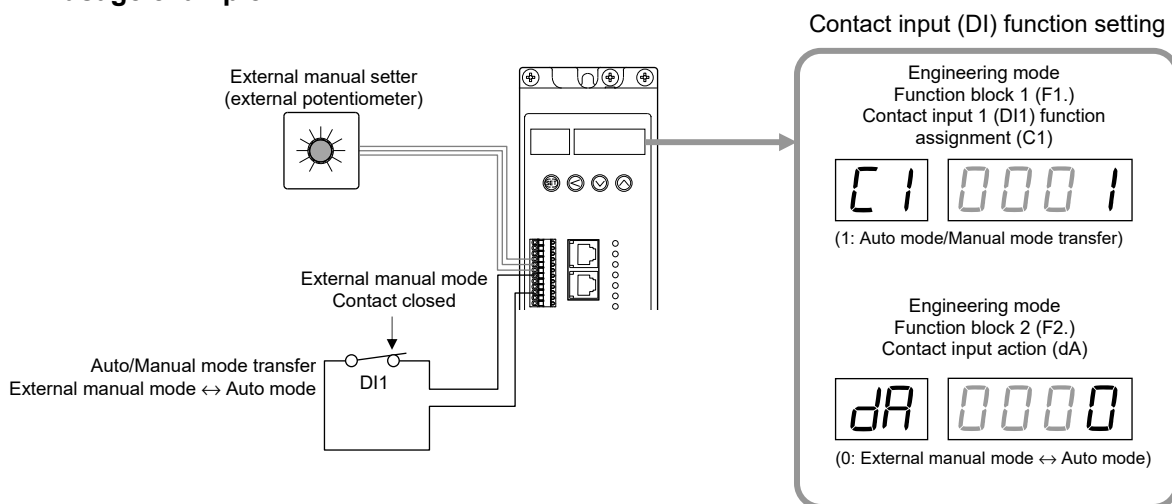
- The contact input action (dA) is set to “3: External manual mode (fixed).” (Refer to **P. 61**)

Engineering mode
Function block 2 (F2.)
Contact input action (dA)

dA 0003

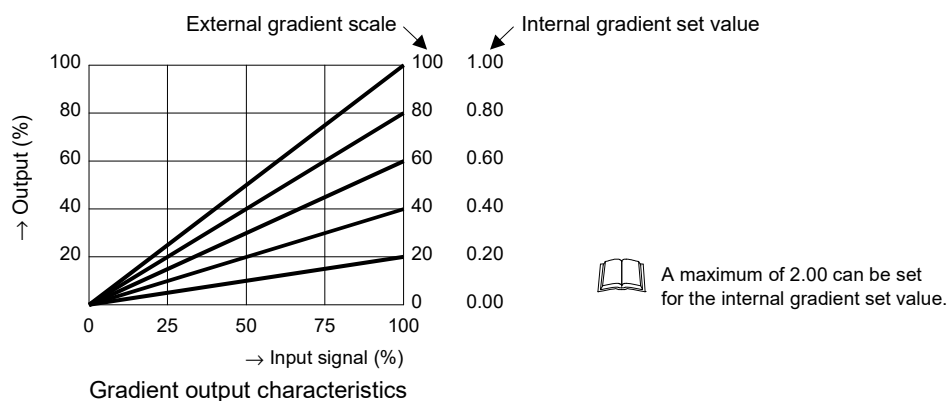
- “External manual mode ↔ Auto mode” is used for the contact input (DI) and the contact is closed.

DI usage example:



5.2 Gradient Setting Function

Gradient setting is a multiplier to be applied to output voltage to the load to adjust the output value depending on an application.



The output value is adjusted by gradient setting function as follows.

- (Output voltage calculated by auto mode [%]) × (Internal gradient set value) × (External gradient set value [%])
- (Output voltage calculated by auto mode [%]) × (Internal gradient set value)
- (Output by manual set value [%]) × (Internal gradient set value) × (External gradient set value [%])

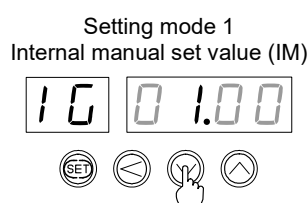


If it is necessary to make only the external gradient set value valid, set the internal gradient set value to 1.00.

The following two types of gradient setting are available.

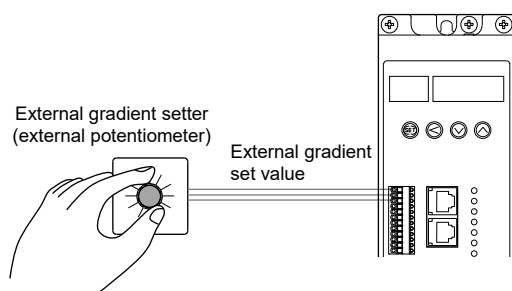
■ Internal gradient setting set by the THV-A1 front keys

The gradient set value can be set manually using the front keys of the THV-A1. This is done in “internal gradient set value (IG)” of setting mode 1.



■ External gradient setting set by the external gradient setter (external potentiometer)

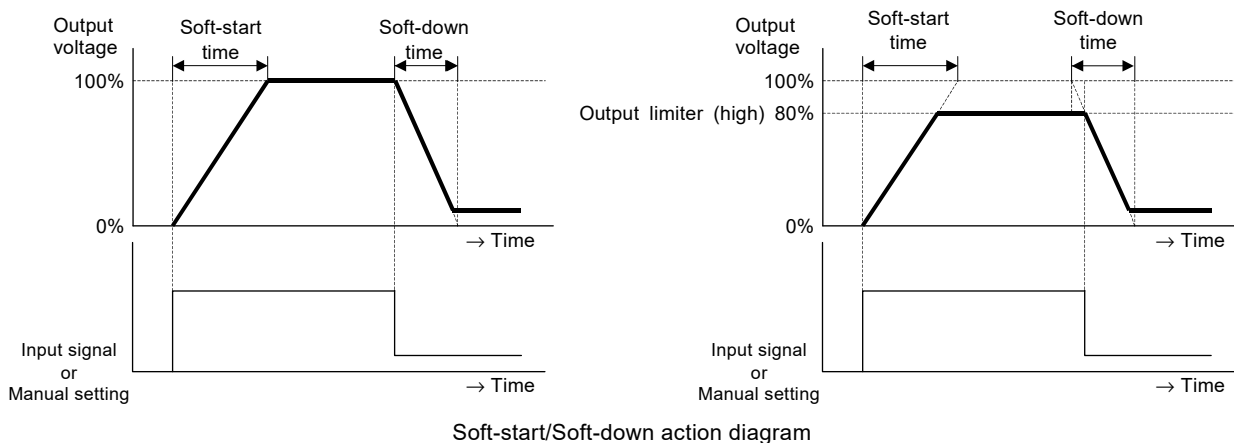
Set the gradient set value by the external gradient setter (external potentiometer)



5.3 Ramp Function (Soft-Start/Soft-Down Function)

Soft-start/soft-down function gradually ramps up/down the output voltage to the demand level over the set time to prevent a sudden change in load or voltage.

The soft-start/soft-down time sets a period of time from 0 % to 100 % or 100 % to 0 %.



If a load generating large rush current is used, thyristor break-down may occur when no soft-start time is appropriately set.

(When the heater break alarm or non-linear resistance heater break alarm is used)



In zero-cross control, no rush current can be suppressed even if the soft-start time is set.

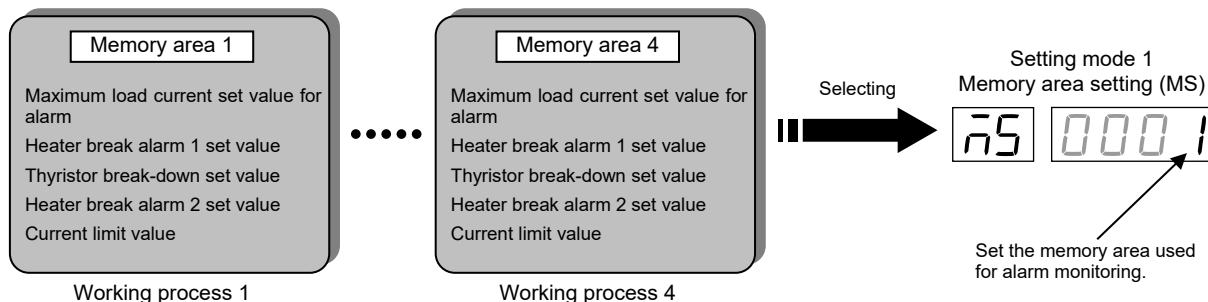
5.4 Multi-Memory Area Function

The multi-memory area function can be used to store heater break alarm set values and other set values in up to 4 areas.

Set values that can be stored in one memory area are the maximum load current set value, heater break alarm 1 set value, thyristor break-down set value, heater break alarm 2 set value, and the current limit value.

One of the 4 areas stored in memory can be called up as necessary and used for alarm monitoring.

If the set values are stored in divided memory areas for each work process, it is possible to collectively call up all of these set values necessary for the process simply by changing the corresponding memory area numbers.



When the standard heater break alarm is used, memory area function can be used.

When the non-linear resistance heater break alarm is used, memory area cannot be used.

5.5 Set Data Lock Function

This function is used to restrict mode changes and parameter setting changes by key operation. This function prevents the operator from making errors during operation. Settings are configured using the front keys or contact inputs (DI).

■ Mode which can be locked

– Setting mode 1, Setting mode 2

When locked, set values cannot be changed. However, the setting mode can be switched to allow set values to be checked.

– Engineering mode

When locked, the mode cannot be changed to engineering mode. Set values cannot be changed or checked.

■ When the data is locked by front keys

The set data lock can be set in set data lock (LK) of setting mode 1.

—: Lock (Unsettable) ×: Unlock (Settable)

Set value of set data lock (LK) *	Setting mode 1	Setting mode 2	Engineering mode
0000	—	—	—
0001	×	×	—
0010	—	—	×
0011	×	×	×

* 0: Lock (Unsettable)

1: Unlock (Settable)

■ When the data is locked by contact input (DI)

To lock data by contact input (DI), select the mode that you wish to lock in “set data lock (LK)” of setting mode 1. The lock will take effect the next time the external contact is opened.

For example, with the set data lock (LK) “0001,” open the external contact. Only the engineering mode will be locked. (Refer to the following table)

—: Lock (Unsettable) ×: Unlock (Settable)

Set value of set data lock (LK) *	DI state	Actual lock state		
		Setting mode 1	Setting mode 2	Engineering mode
0000	Open	—	—	—
	Closed	×	×	×
0001	Open	×	×	—
	Closed	×	×	×
0010	Open	—	—	×
	Closed	×	×	×
0011	Open	×	×	×
	Closed	×	×	×

* 0: Lock (Unsettable)

1: Unlock (Settable)



If the external contact is switched to open (lock) in engineering mode, it is possible to switch from engineering mode to another mode. Once you have switched to another mode, it will not be possible to switch back to engineering mode unless the external contact is closed (unlock).

5.6 Heater Break Alarm

The heater break alarm monitors the current flowing through the load by a dedicated current transformer (CT). The THV-A1 compares the measured value with the set values, and detects a fault in the heating or cooling circuit. In addition, there are several types of heater break alarms depending on control methods and applications of these heater break alarms. Read this chapter carefully to choose a suitable method and set an appropriate set value.



As the measuring accuracy of the current transformer is within ± 2 A of the THV-A1 rated current, no heater break alarm may normally operate if used at a smaller load current value.

5.6.1 Heater break alarm for phase control

There are two alarm types (type 1 or type 2) available for phase control. Select the alarm type (Type 1 or Type 2) suitable for the heater to be connected.

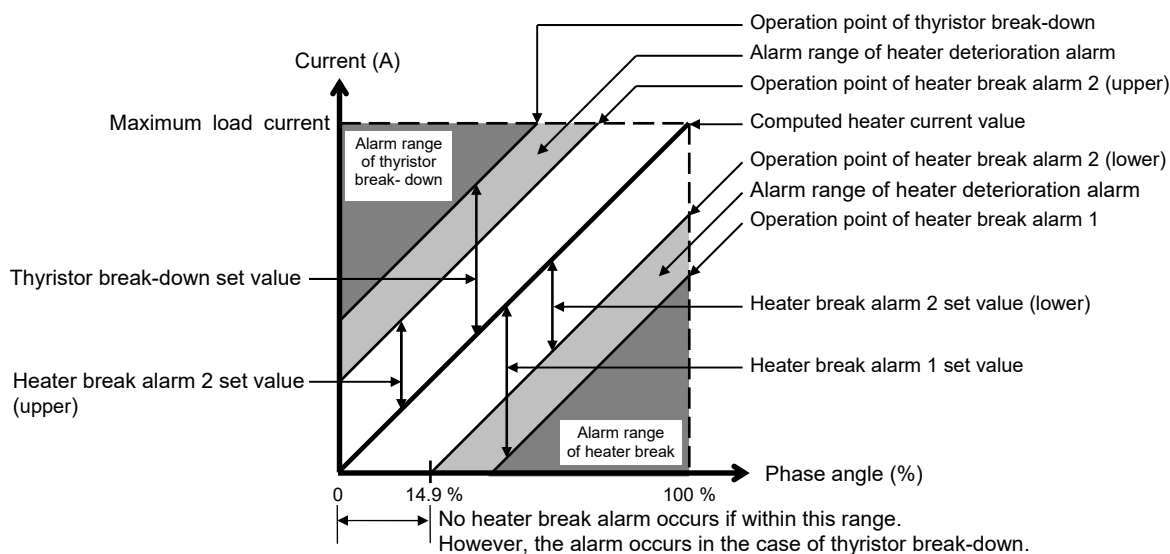
(1) Type 1 (constant resistance type, deviation alarm)

For the Type 1 heater break alarm, the computed heater current value is found for each phase angle to decide the alarm state by deviation from the current transformer input value. Type 1 can be used as follows by using two heater break alarm set values and thyristor break-down set value.

- Heater break alarm 1 set value setting (H1): Used as heater break alarm.
- Thyristor break-down set value setting (Tb): Used as thyristor break-down alarm.
- Heater break alarm 2 set value setting (H2): Used as heater deterioration alarm. If any value smaller than the heater break alarm 1 set value is set, an alarm can be issued prior to a heater break.

Operation chart

- If an alarm is issued above the computed heater current value, a thyristor break-down may result.
- If an alarm is issued below the computed heater current value, a heater break may result.
- If an alarm is issued within the range of the heater break alarm 1 set value and the thyristor break-down set value, heater deterioration will occur.



■ Heater useable for Type 1

The heater break alarm of Type 1 can be used for general heat generation substances making small resistance changes (approx. 10 %) with temperature variations.

(General heat generation substances: Nichrome, ferrochromium, graphite, kanthal A, etc.)



Cannot be used for noble metal or silicon carbide heat generation substances.



Type 1 cannot be used for any power supply waveforms other than a sine waveform.

■ How alarm is activated

- When heater current does not flow (Heater break, malfunction of THV-A1, etc.)

When the phase angle is equal to or more than 15% and the current transformer input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced. **However, in order to prevent malfunctioning, it is so designed that no heater break alarm occurs at an phase angle of less than 15 % (less than 15 % of maximum load current).**

- When heater current can not be turned off (Thyristor break-down or permanent damage)

When the current transformer input value is equal to or greater than the thyristor break-down set value for the preset number of consecutive sampling cycles, an alarm status is produced.



The alarm will be turned off when the current transformer (CT) input value goes in and stays at non-alarm range for five consecutive cycles.

(However, excepting a case where the alarm interlock function is used.)

■ Application

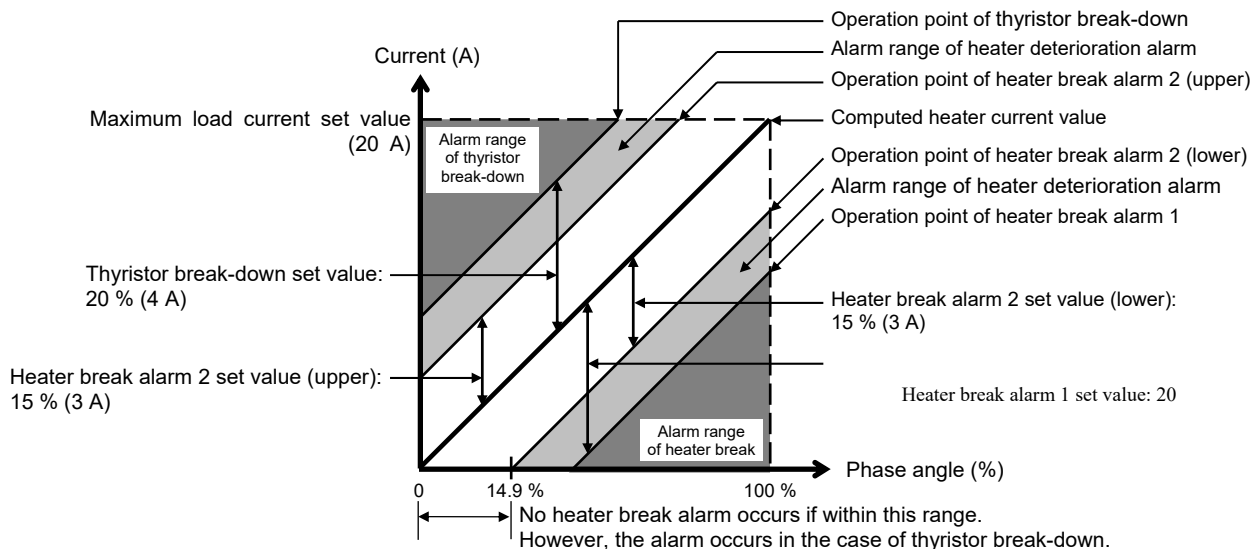
When the parameters are set to the values below, operation takes place as shown in the graph.

Mode	Parameter	Set value
Setting mode 1	Memory area setting (MS)	1 (Memory area 1)
Setting mode 2	Memory area selection (AE)	1 (Memory area 1)
	Maximum load current set value for alarm (MC)	20 A
	Heater break alarm 1 set value setting (H1)	20 % of maximum load current set value ¹
	Thyristor break-down set value setting (Tb)	20 % of maximum load current set value ²
	Heater break alarm 2 set value setting (H2)	15 % of maximum load current set value ³
Engineering mode	Control method (CM)	0 (Phase control)
	Heater break alarm enable/disable (HF)	1 (Heater break alarm enable)
	Alarm 1 output logic (L1)	40 (logical OR of heater break alarm 1 and thyristor break-down alarm [energized])
	Alarm 2 output logic (L2)	16 (Heater break alarm 2 [energized])
	Number of heater break alarm 1 delay times (n1)	1 time
	Heater break alarm 1 type (A1)	0 (Type 1: Constant resistance type, Deviation alarm)
	Number of heater break alarm 2 delay times (n2)	1 time
	Heater break alarm 2 type (A2)	0 (Type 1: Constant resistance type, Deviation alarm)

¹ Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 1 set value (%)

² Equation for conversion to a current value (A): Current value = Maximum load current set value × Thyristor break-down set value (%)

³ Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 2 set value (%)



(2) Type 2 (linearity resistor type, absolute value alarm)

The Type 2 heater break alarm is used for detecting a heater break when one heater is used. The alarm state is decided depending on whether a current transformer (CT) input value is below or above the heater break alarm set value. For Type 2, heater break alarm 1 set value setting (H1) and thyristor break-down set value setting (Tb) is used. Heater break alarm 2 set value setting (H2) is set to “Unused.”



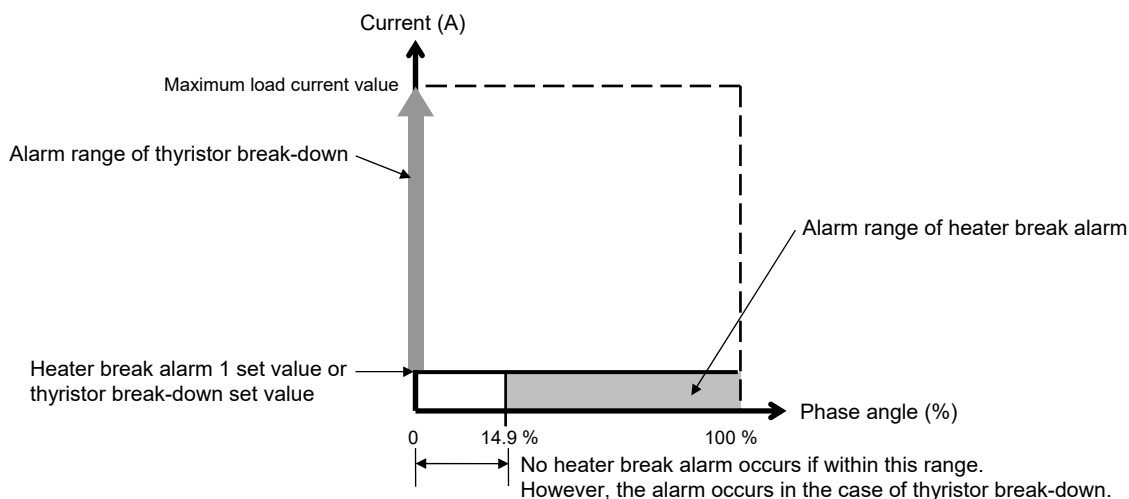
Set the heater break alarm 1 set value setting (H1) or thyristor break-down set value setting (Tb) to approximately 10 % of the maximum load current value. Do not set the heater break alarm set value to more than 15 %.



No type 2 can be used when two or more heaters are used in parallel connection.

Operation chart

- If a current transformer input value exceeds the thyristor break-down set value at an phase angle of 0 %, a thyristor break-down may result.
- If a current transformer input value becomes less than the heater break alarm set value 1 at a phase angle of 15 % or more, a heater break may result.



■ Heater useable for Type 2

The heater break alarm of Type 2 can be used for heat generation substances such as noble metals making large resistance changes with temperature variations.

(Heat generation substances such as noble metals: Platinum, molybdenum, tungsten, superkanthal, tantalum, etc.)

■ How alarm is activated

- When heater current does not flow (Heater break, malfunction of THV-A1, etc.)

When the phase angle is equal to or more than 15 % and the current transformer (CT) input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced. **However, in order to prevent malfunctioning, it is so designed that no heater break alarm occurs at an phase angle of less than 15 % (less than 15 % of maximum load current).**

- When heater current can not be turned off (Thyristor break-down or permanent damage)

When the phase angle is 0 % and the current transformer (CT) input value is equal to or greater than the thyristor break-down set value for the preset number of consecutive sampling cycles, an alarm status is produced.



The alarm will be turned off when the current transformer (CT) input value goes in and stays at non-alarm range for five consecutive cycles.

(However, excepting a case where the alarm interlock function is used.)

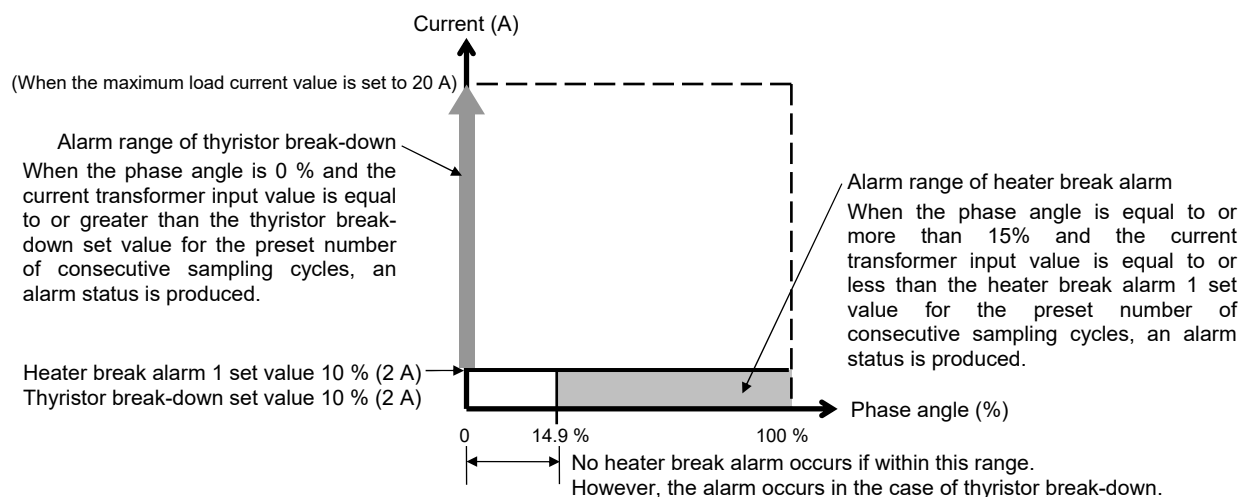
■ Application

When the parameters are set to the values below, operation takes place as shown in the graph.

Mode	Parameter	Set value
Setting mode 1	Memory area setting (MS)	1 (Memory area 1)
Setting mode 2	Memory area selection (AE)	1 (Memory area 1)
	Maximum load current set value for alarm (MC)	20 A
	Heater break alarm 1 set value setting (H1)	10 % of maximum load current set value ¹
	Thyristor break-down set value setting (Tb)	10 % of maximum load current set value ²
	Heater break alarm 2 set value setting (H2)	0 % of maximum load current set value (Heater break alarm 2 unused)
Engineering mode	Control method (CM)	0 (Phase control)
	Heater break alarm enable/disable (HF)	1 (Heater break alarm enable)
	Alarm 1 output logic (L1)	8 (Heater break alarm 1 [energized])
	Alarm 2 output logic (L2)	32 (thyristor break-down alarm [energized])
	Number of heater break alarm 1 delay times (n1)	1 time
	Number of heater break alarm 2 delay times (n2)	1 time

¹ Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 1 set value (%)

² Equation for conversion to a current value (A): Current value = Maximum load current set value × Thyristor break-down set value (%)



5.6.2 Heater break alarm for zero-cross control

The alarm state is judged based on whether the current transformer (CT) input value is below the heater break alarm set value or above the thyristor break-down set value.

The following usage is available in zero-cross control.

- **Heater break alarm 1 set value:** The alarm can be output when a heater break occurs by setting the heater break alarm set value.
- **Thyristor break-down set value:** The alarm can be output when a short-circuit occurs in the thyristor element by setting the thyristor break-down value.
- **Heater break alarm 2 set value:** This alarm set value can be used as an auxiliary alarm.
For example, it can be used as a heater deterioration alarm if set to any value slightly larger than the heater break alarm set value to output the alarm before a heater break alarm occurs when the load current decreases due to heater deterioration, etc.

■ How alarm is activated

- When heater current does not flow (Heater break, malfunction of THV-A1, etc.)

When the control output is ON and the current transformer input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced.

- When heater current can not be turned off (Thyristor break-down or permanent damage)

When the control output is OFF and the current transformer input value is equal to or greater than the thyristor break-down set value for the preset number of consecutive sampling cycles, an alarm status is produced.



The alarm will be turned off when the current transformer input value goes in and stays at non-alarm range for five consecutive cycles.

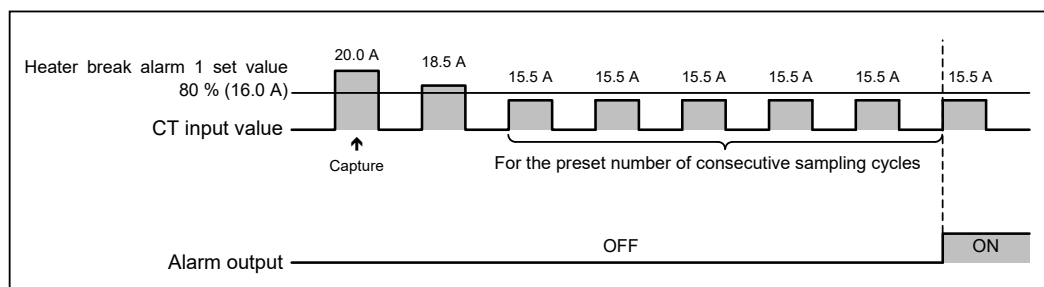
■ Application

(1) Setting example of heater break alarm

When the parameters are set to the values below, operation takes place as shown in the graph.

Mode	Parameter	Set value
Setting mode 1	Memory area setting (MS)	1 (Memory area 1)
Setting mode 2	Memory area selection (AE)	1 (Memory area 1)
	Maximum load current set value for alarm (MC)	20 A
	Heater break alarm 1 set value setting (H1)	80 % of maximum load current set value *
Engineering mode	Control method (CM)	1 (zero-cross control [continuous])
	Heater break alarm enable/disable (HF)	1 (Heater break alarm enable)
	Alarm 1 output logic (L1)	8 (Heater break alarm 1 [energized])
	Number of heater break alarm 1 delay times (n1)	1 time

* Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 1 set value (%)

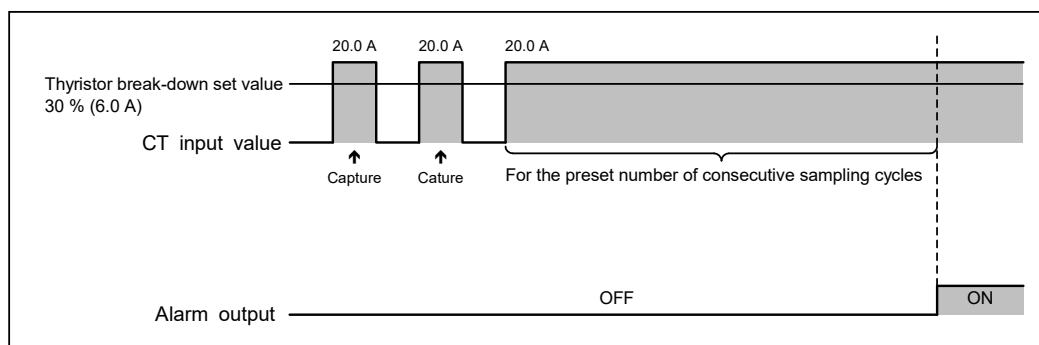


(2) Setting example of thyristor break-down alarm

When the parameters are set to the values below, operation takes place as shown in the graph.

Mode	Parameter	Set value
Setting mode 1	Memory area setting (MS)	1 (Memory area 1)
Setting mode 2	Memory area selection (AE)	1 (Memory area 1)
	Maximum load current set value for alarm (MC)	20 A
	Thyristor break-down set value (Tb)	30 % of maximum load current set value *
Engineering mode	Control method (CM)	1 (zero-cross control [continuous])
	Heater break alarm enable/disable (HF)	1 (Heater break alarm enable)
	Alarm 1 output logic (L1)	32 (Thyristor break-down alarm [energized])
	Number of heater break alarm 1 delay times (n1)	1 time

* Equation for conversion to a current value (A): Current value = Maximum load current set value × Thyristor break-down set value (%)



(3) Setting example of heater deterioration and heater break alarms

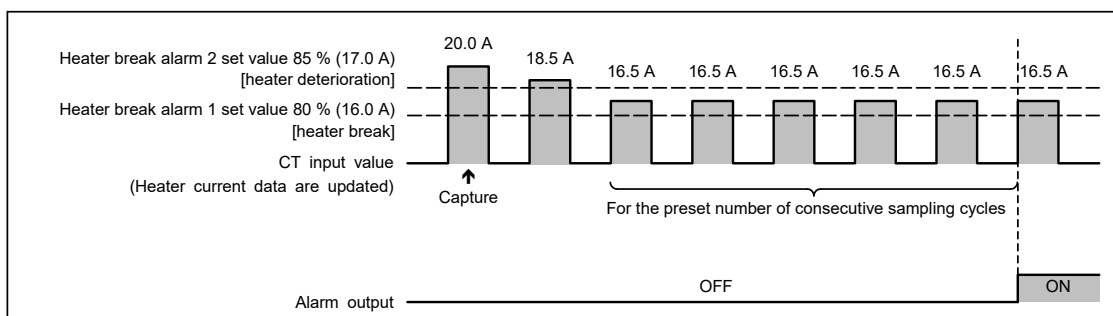
When the parameters are set to the values below, operation takes place as shown in the graph.

Mode	Parameter	Set value
Setting mode 1	Memory area setting (MS)	1 (Memory area 1)
Setting mode 2	Memory area selection (AE)	1 (Memory area 1)
	Maximum load current set value for alarm (MC)	20 A
	Heater break alarm 1 set value setting (H1)	80 % of maximum load current set value ¹
	Heater break alarm 2 set value setting (H2)	85 % of maximum load current set value ²
Engineering mode	Control method (CM)	1 (zero-cross control [continuous])
	Heater break alarm enable/disable (HF)	1 (Heater break alarm enable)
	Alarm 1 output logic (L1)	8 (Heater break alarm 1 [energized])
	Alarm 2 output logic (L2)	16 (Heater break alarm 2 [energized])
	Number of heater break alarm 1 delay times (n1)	1 time
	Number of heater break alarm 2 delay times (n2)	1 time

¹ Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 1 set value (%)

² Equation for conversion to a current value (A): Current value = Maximum load current set value × Heater break alarm 2 set value (%)

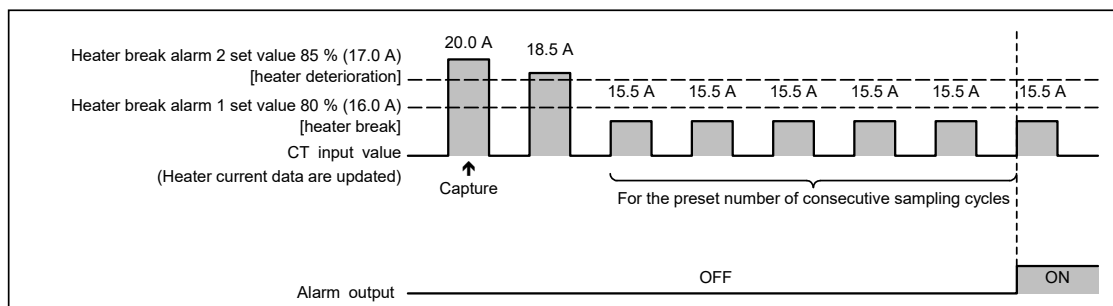
Heater deterioration alarm



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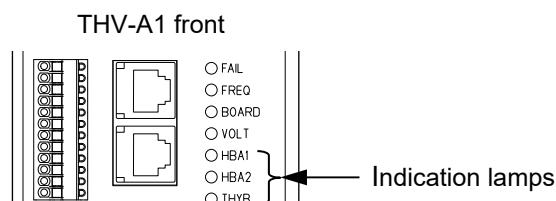
Continued from the previous page.

Heater break alarm



5.6.3 How alarm is checked

When an alarm occurs, the front indication lamps (HBA1, HBA2, THY.B) light up. If the type of alarm to be output is set in “alarm 1 output logic (L1)” or “alarm 2 output logic (L2),” an alarm signal can be output from the alarm output connector.



5.6.4 Alarm delay times

The alarm delay function is that which delays the occurrence of alarm in order to prevent alarm malfunctioning. When an alarm condition becomes ON status, the output is suppressed until the preset number of sampling times elapses. After the preset number of sampling times elapses, if the alarm output is still ON status, the output will be produced. In addition, if the alarm state is released while the alarm delay function is being activated, the alarm output is not turned on.

Number of alarm delay times for heater break alarm 1 and thyristor break-down alarm:

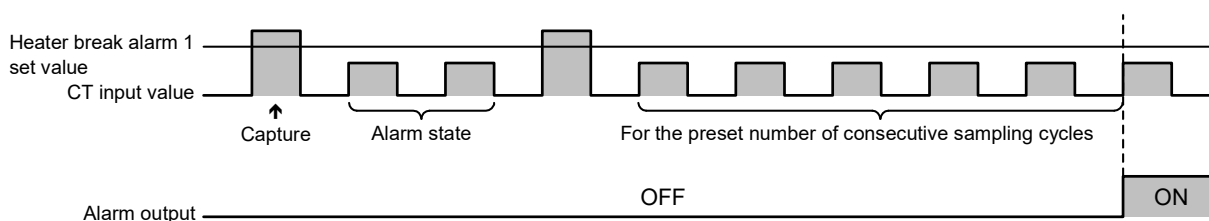
5 sampling cycles* × Number of heater break alarm 1 delay times (1 to 100 times)

Number of alarm delay times for heater break alarm 2:

5 sampling cycles* × Number of heater break alarm 2 delay times (1 to 1000 times)

* It is so designed that the alarm output is turned ON when the alarm state corresponding to five sampling times continues even with the number of alarm delay times not set.

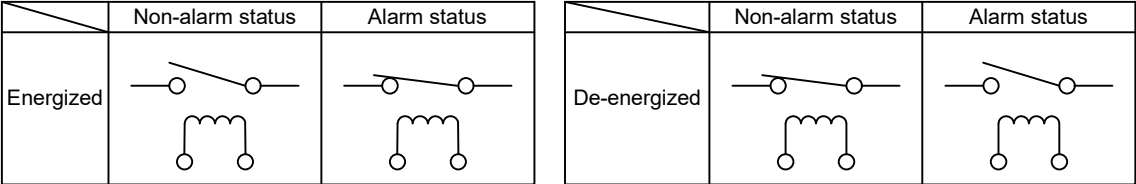
Zero-cross control



5.7 Alarm Energized/De-energized

Energized: Relay contact is closed under the alarm status.
 De-energized: Relay contact opens under the alarm status.

Diagram for explaining operation (At power-ON)

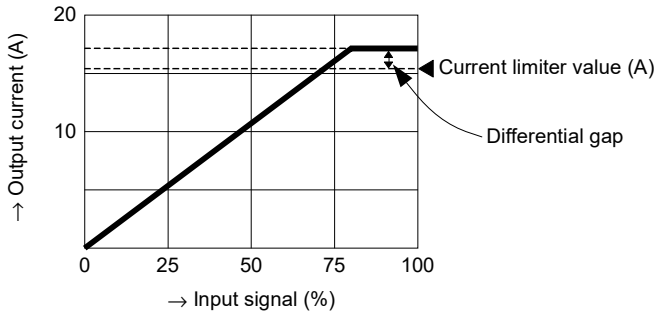


5.8 Current Limiter Function

This is the function of limiting a measured current value to a value not exceeding the preset current limit value. A current value is measured for each constant cycle and then the maximum phase angle not exceeding the current limit value is calculated from the above current value thus measured. If the phase angle at that current output is larger than the maximum phase angle calculated, the current is output at the maximum phase angle to restrict that current.
 The maximum phase angle is calculated during a time period of 0.1 seconds after the power is turned on. The current limit function is activated after the maximum phase angle is calculated.

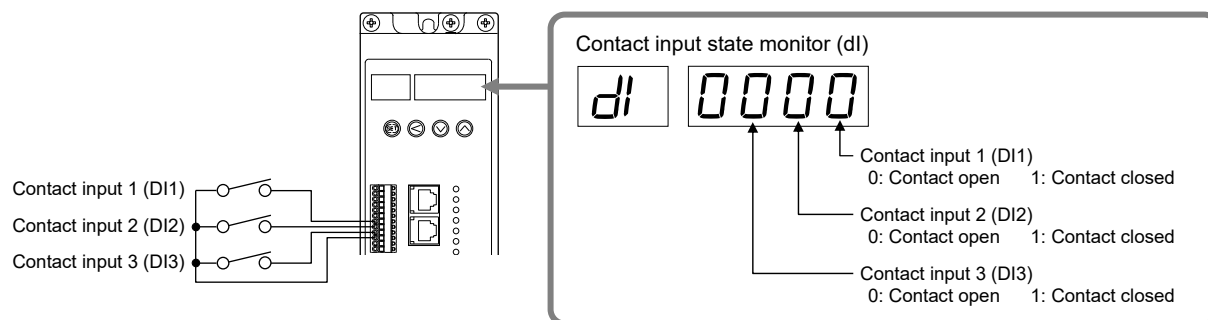
- If a load through which large rush current flows is used, the current limit function cannot restrict the above current. In this case, use the current limit function together with the soft-start function.**
- Even when the soft-up time is 0.0 seconds, the soft-up (soft-start) function operates for 0.1 seconds after the power is turned on because the maximum phase angle is calculated.
- If the current value exceeds “Current limit value + Differential gap” (0.5 A or 1.0 A)* due to voltage or load resistance changes while the current limit function is operating, the maximum phase angle is re-calculated in the next cycle to restrict the current value to within 3 cycles from the point at which it exceeds “Current limit value + Differential gap.”
 - * Differential gap 0.5 A: 20 A and 30 A types
 - Differential gap 1 A: 45 A, 60 A, 80 A, 100 A, 150 A and 200 A types
- If a current limit value is set to its maximum value, the current limit function is deactivated.
- The current limiter function cannot be used when zero-cross control is selected.

Example: 20 A type



5.9 Contact Input (DI) Function

Functions can be selected by external contact signals. There are 3 contact inputs (DI), and a function can be assigned to each. The state of an external contact can be checked on the contact input state monitor (dI).



For users of the THV-1

Please note that the open/close displays of the contact input state monitor in the THV-1 are opposite those in the THV-A1.

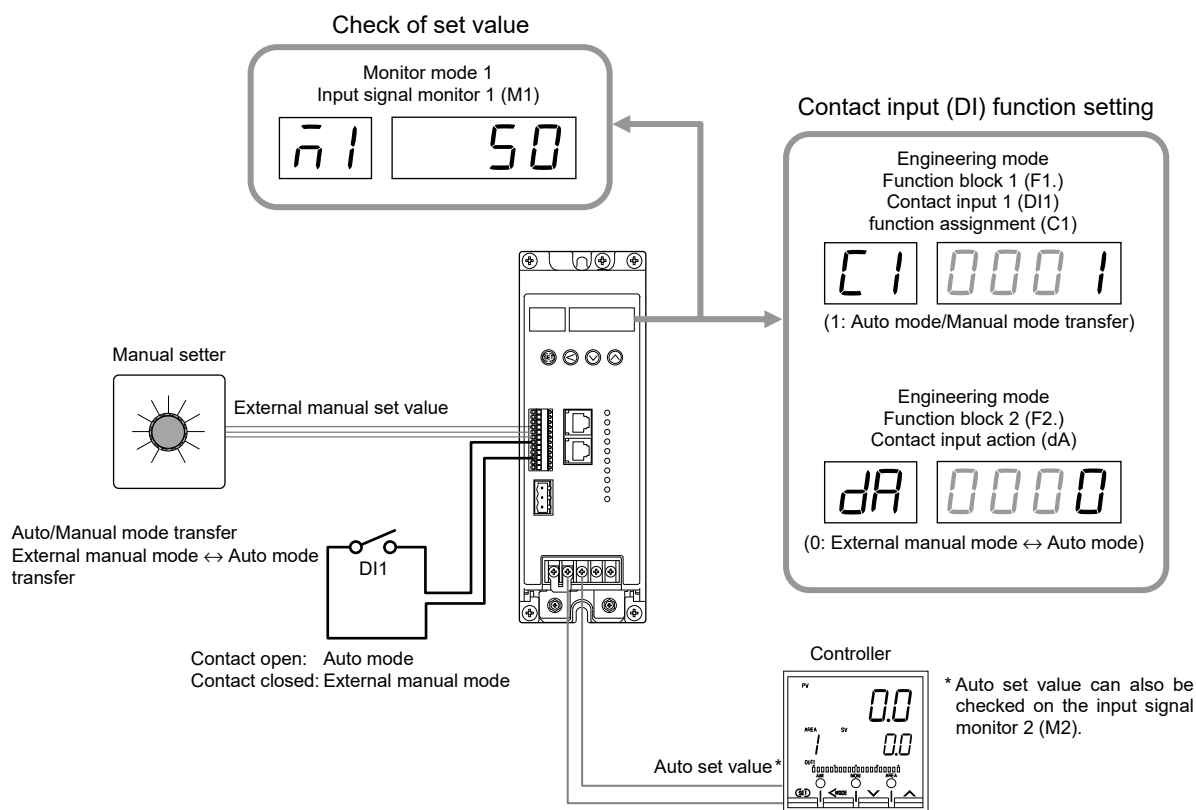
	THV-1	THV-A1
Contact open	1	0
Contact closed	0	1

■ Contact input (DI) function types

(1) Auto/Manual mode transfer (number of DIs used: 1 point)

A contact signal can be used to switch between auto mode and external manual mode, or internal manual mode. The input signal value selected by the contact signal can be checked on input signal monitor 1.

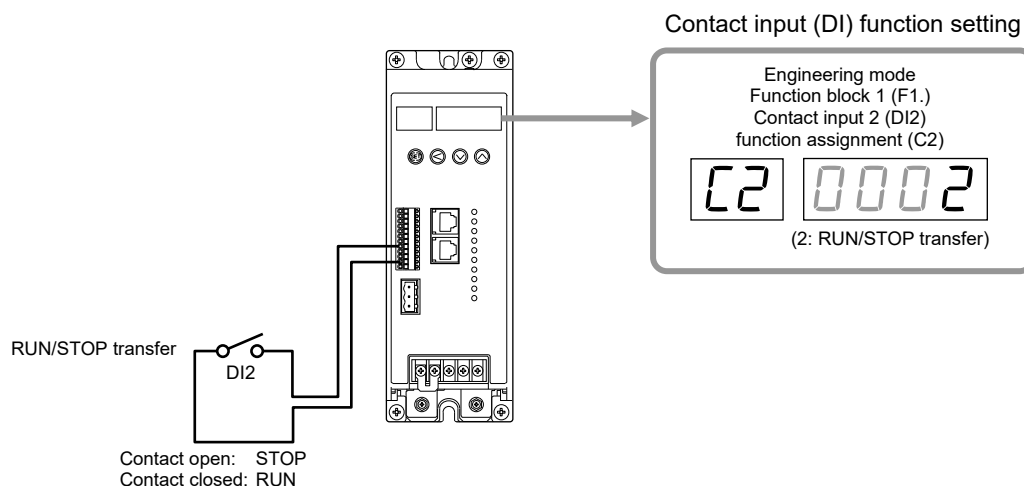
Example: When “External manual mode/Auto mode” transfer is assigned to contact input 1 (DI1)



(2) RUN/STOP transfer (number of DIs used: 1 point)

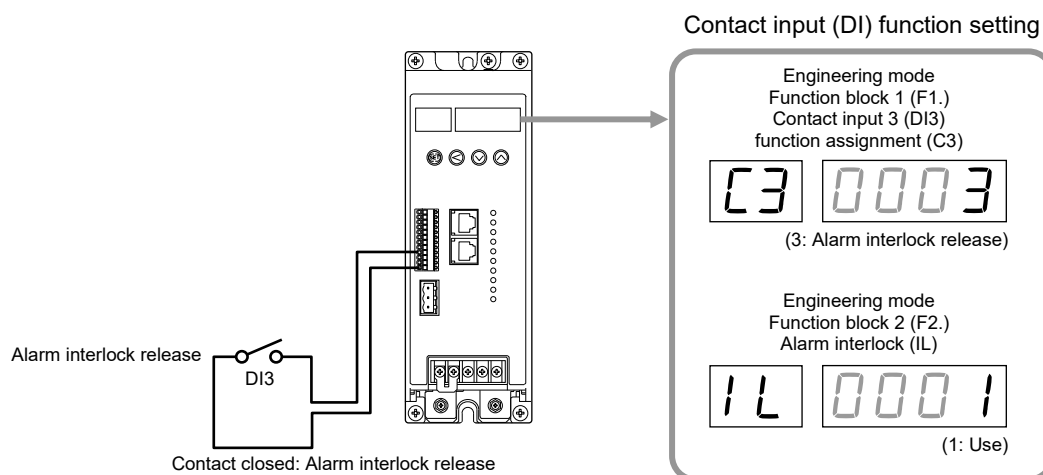
A contact signal can be used to switch between RUN and STOP. When switched to RUN, the output of the THV-A1 turns ON. When switched to STOP, the output of the THV-A1 turns OFF.




Example: When “RUN/STOP transfer” is assigned to contact input 2 (DI2)

**(3) Alarm interlock release (number of DIs used: 1 point)**

A contact signal can be used to release the alarm interlock. When the contact is closed, the alarm interlock state is released.


Example: When “Alarm interlock release” is assigned to contact input 3 (DI3)



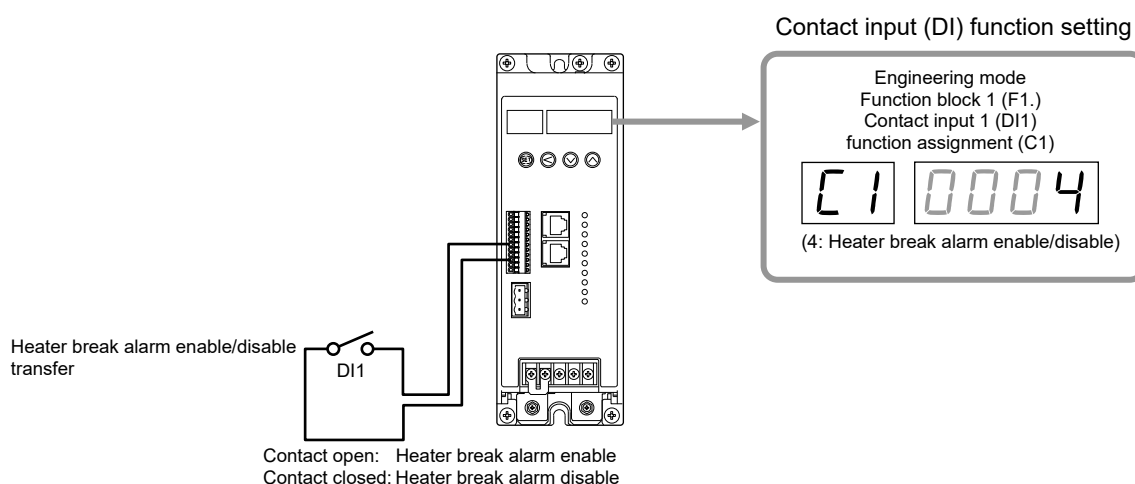
-  No alarm interlock can be released when in the alarm state. Release the alarm interlock after the cause of the alarm is cleared up.
-  When the contact is closed, the alarm interlock function does not operate and the alarm interlock remains in the released state.
-  Use a momentary operation (auto reset) type switch for the alarm interlock release switch.

(4) Heater break alarm enable/disable (number of DIs used: 1 point)

A contact signal can be used to enable or disable the heater break alarm and thyristor break-down alarm. This makes it possible to disable the heater break alarm and thyristor break-down alarm without setting the heater break alarm set value and thyristor break-down alarm set value to “0.”


-  The function can be disabled by setting the heater break alarm set value and thyristor break-down alarm set value to “0.”

Example: When “heater break alarm enable/disable” switching is assigned to contact input 1 (DI1)




(5) Soft-start, soft-down enable/disable (number of DIs used: 1 point)

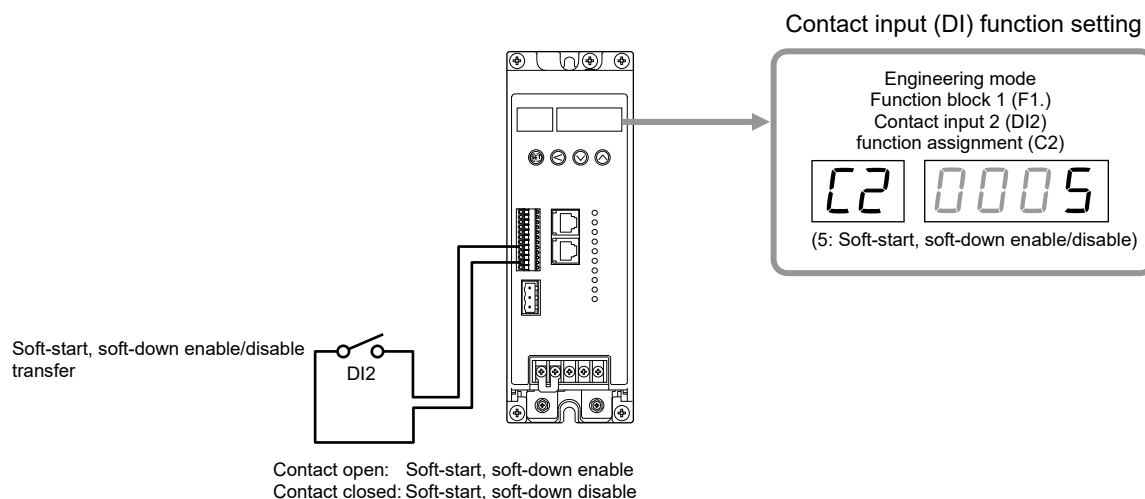
A contact signal can be used to enable or disable the soft-start/soft-down function. This makes it possible to disable the soft-start and soft-down functions without setting the soft-start time and soft-down time to “0.”

-  When protection function for control of primary side of a transformer is enabled, the action of soft-start and soft-down becomes the same as that for enable even if soft-start and soft-down functions are disabled by the contact input (DI).

When soft-start time (SU) is set to 0.0 seconds, soft-start function is operated for 0.1 seconds.

-  The function can be disabled by setting the soft-start time and soft-down time to “0.”

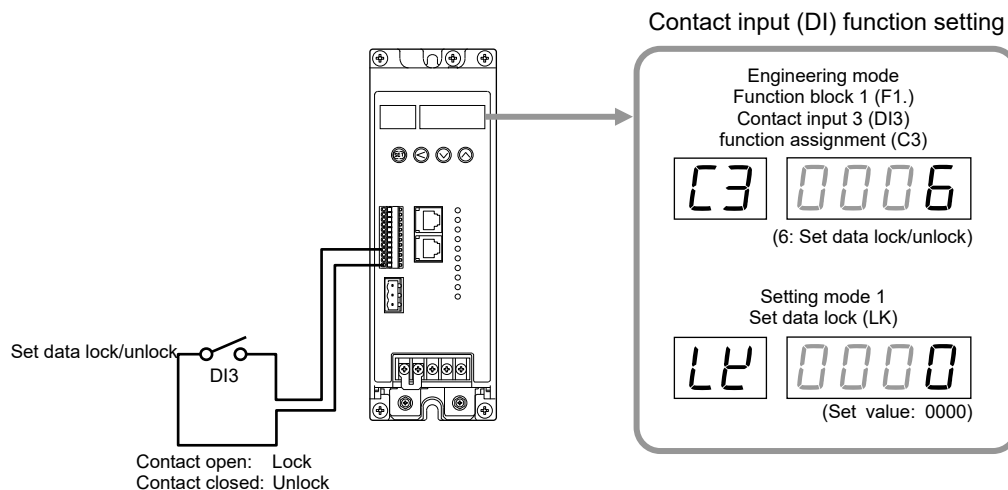
Example: When “soft-start, soft-down enable/disable” switching is assigned to contact input 2 (DI2)



(6) Set data lock/unlock (number of DIs used: 1 point)

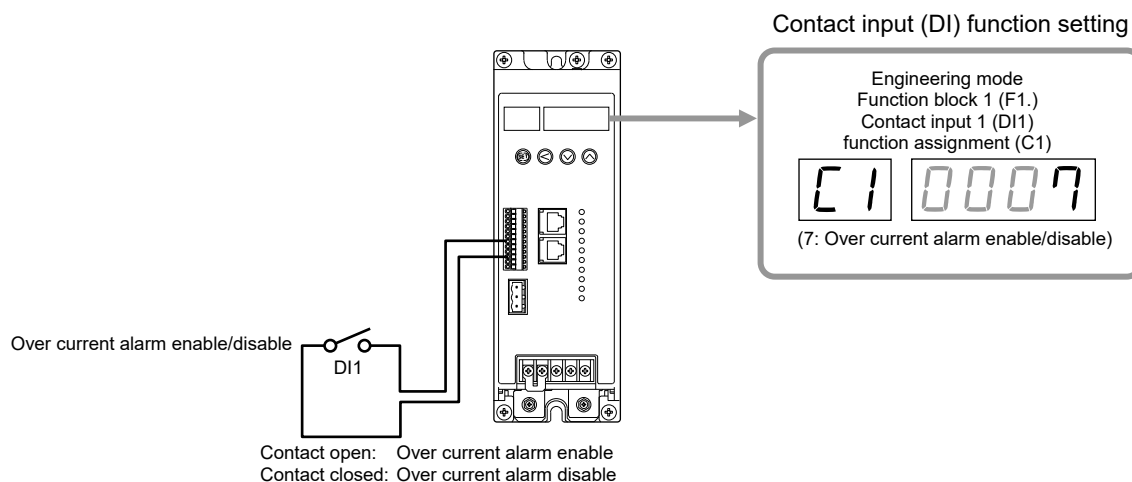
A contact signal can be used to lock or unlock setting data. When set data lock/unlock by contact input (DI) is used, the data is not locked even if the front keys are used to set the locked state (set value = 0000). The locked state must first be set using the front keys (set value = 0000), after which the locked state will take effect when the contact is opened.

Example: When “set data lock/unlock” switching is assigned to contact input 3 (DI3)

**(7) Over current alarm enable/disable (number of DIs used: 1 point)**

A contact signal can be used to enable or disable the over current alarm function.

Example: When “over current alarm enable/disable” switching is assigned to contact input 1 (DI1)



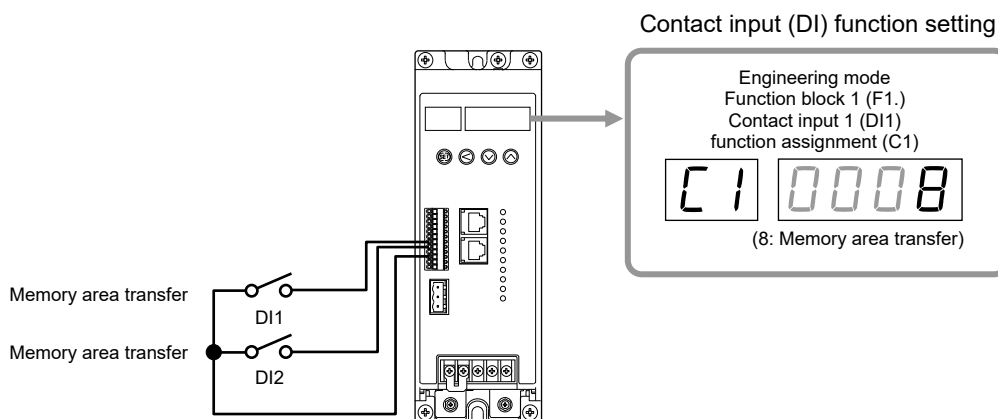
(8) Memory area transfer (number of DIs used: 1 point)

Contact signals can be used to switch between memory areas (memory area 1 to memory area 4).

Assign the memory area transfer function to contact input 1 (DI1). When this is done, contact input 2 (DI2) is also automatically used for the memory area transfer function.*

* If a function other than memory area transfer is assigned by contact input 2 (DI2) function assignment (C2), that function will not be valid.

Example: When “memory area transfer” is assigned to contact input 1 (DI1)



Memory area number	DI state	
	DI1	DI2
Memory area 1	Open	Open
Memory area 2	Closed	Open
Memory area 3	Open	Closed
Memory area 4	Closed	Closed

5.10 Control Method

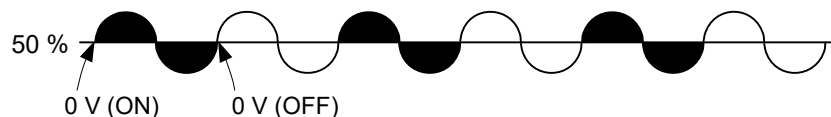
■ Phase control

Phase control is to continuously control electric power supplied to a load by changing phase angle θ of AC voltage applied to the load. Each half-cycle has ON and OFF time.



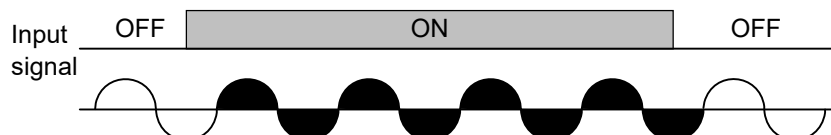
■ Zero-cross control (Continuous)

Continuous zero-cross control is to control electric power supplied to a load by turning the power supply voltage ON and OFF at the point of 0 V AC so that the high frequency noise can be suppressed compared with phase control. This on and off time is typically measured in milliseconds.



■ Zero-cross control (Input synchronous type)

Input synchronous type zero-cross control is to turn the power supply ON and OFF synchronously with the pulse signal from a controller.



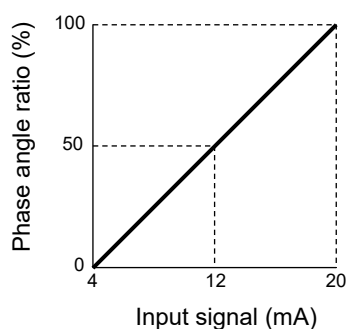
5.11 Output Mode for Phase Control

When phase control is selected for a resistance load, one of the following seven output types can be selected. (The output mode setting is invalid when the control method is zero-cross control.)

(1) Proportional phase angle to input

This is the output mode to manipulate the trigger point (phase angle) of the AC voltage applied to the load in proportion to the input signal change.

Proportional phase angle to input



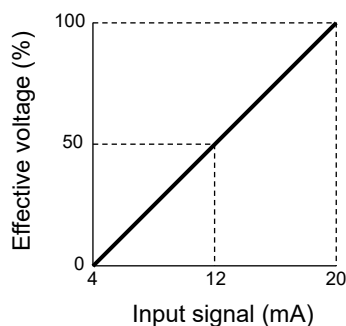
For example, in case of input signal 4 to 20 mA DC, the trigger point (phase angle) becomes as follows:

- Input signal 4 mA DC:
Phase angle 0° (phase angle ratio: 0 %)
- Input signal 12 mA DC:
Phase angle 90° (phase angle ratio: 50 %)
- Input signal 20 mA DC:
Phase angle 180° (phase angle ratio: 100 %)

(2) Proportional voltage to input

This is the output mode to manipulate the trigger point (phase angle) so that the change of the AC voltage applied to the load is proportional to the input signal change. This is effective when voltage linear to the input from a temperature controller needs to be output.

Proportional voltage to input



Action for proportional voltage to input

If the AC voltage applied to the load is 200 V AC, when 50 % of the input signal is received, the output voltage of the thyristor becomes 100 V AC ($200 \text{ V AC} \times 50 \%$).

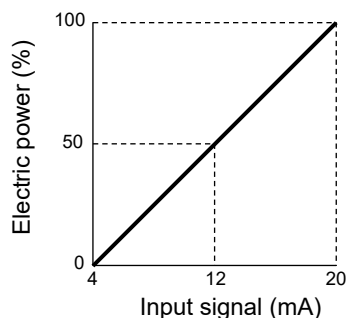
When the AC voltage applied to the load changes to 180 V AC, receiving 50 % of the input signal changes the output from the thyristor to 90 V AC ($180 \text{ V AC} \times 50 \%$).

In proportional voltage to input, change of the AC voltage applied to the load changes the output voltage of the thyristor.

(3) Proportional square voltage (electric power) to input

Proportional square voltage is the output mode to manipulate the trigger point (phase angle) so that the input signal change will be proportional to the power also as well as the AC voltage applied to the load.

Proportional square voltage
(electric power) to input

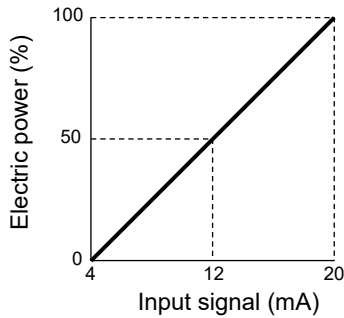


Different from the constant power control, proportional square voltage is not the mode which maintains constant power against load change against the load change.

(4) Square voltage feedback

This is the output mode which consists of constant voltage control and proportional square voltage (electric power) to input. This mode is effective when supply voltage fluctuation may exist.

Square voltage feedback



Different from constant power control, square voltage feedback is not the mode to maintain the constant power against the load change.

■ Caution for using square voltage feedback

In square voltage feedback, the output voltage is 200 V AC for the input signal 100 %. This is used as a standard. As the standard is set to 200 V AC, when the maximum AC voltage applied to the load is 100 V AC, the output voltage is 100 V AC for 25 % of the input signal.

To produce the output voltage 100 V AC against the input signal 100 %, use and adjust the gradient setting.

Example: When used in the following condition

- Maximum AC voltage applied to the load is 100 V AC
- Input signal from controller: 4 to 20 mA DC
- Output voltage is 100 V AC for input signal 100 % (20 mA DC)

If the instrument is used without setting the gradient, output voltage becomes 100 V AC for 8 mA input signal. Calculate the gradient value with the following formula, and set it with the internal gradient setting or the external gradient setter.

Formula for calculating the gradient:

$$\text{Power supply voltage}^2 = 200 \text{ V} \times 200 \text{ V} \times \text{Gradient setting}$$

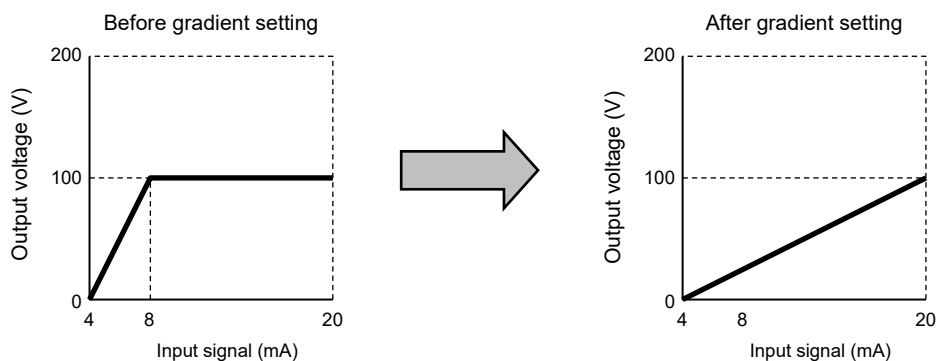
$$(\text{Gradient setting} = \text{External gradient set value} \times \text{Internal gradient set value})$$

$$100 \text{ V} \times 100 \text{ V} = 200 \text{ V} \times 200 \text{ V} \times \text{Gradient setting}$$

$$\text{Gradient setting} = 0.25$$

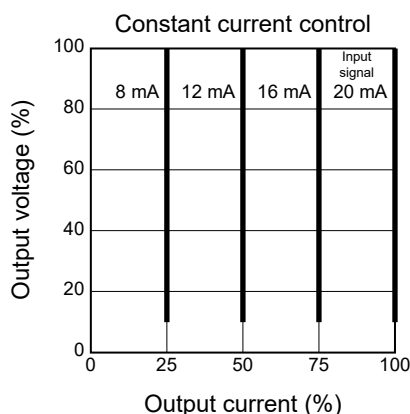
Use the obtained value for the internal gradient setting or the external gradient setter.

- Setting with internal gradient setting: Set 0.25 at internal gradient set value (IG).
- Setting with external gradient setter: Set 25 % (0.25 × 100) with the external gradient setter.



(5) Constant current control

This is the function used to keep the output current constant in proportion to the input signal. This function is effective when a heater with large resistance changes caused by temperature variations is used (such as tantalum, superkanthal, tungsten, platinum, or molybdenum). The maximum output current when the constant current control function is used coincides with the rated current in the THV-A1 specification.



Operating condition	Stability
Power supply voltage variation: 10 % or less of input voltage	$\pm (2 \% \text{ of rated current})$
Load variation: Within 2 times	



Constant current control is optional.

■ Caution for using constant current control function

In constant current control, the output voltage becomes the rated current of THV-A1 when the input signal is 100 %. This is used as a standard.

If the rated current of THV-A1 differs from that maximum load current flowing through the heater, compensate for the difference by setting the gradient. If there is the difference, a section where control is disabled may come into existence.

A compensation example when there is a difference between the currents flowing through the THV-A1 and the heater is shown in the following.

Example: When used in the following condition

- Rated current of THV-A1: 30 A
- Maximum load current of heater: 15 A
- Input signal from controller: 4 to 20 mA DC
- Soft-start time setting: 0.0 seconds

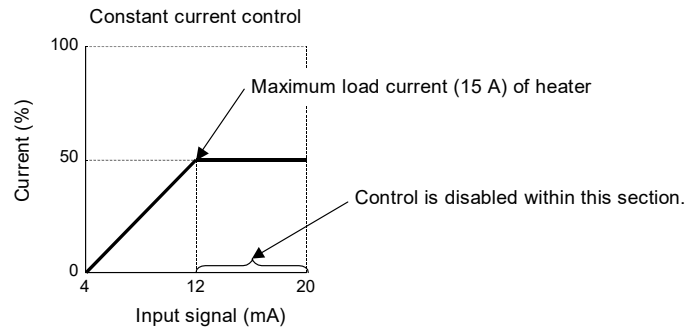


When constant current control is used, the soft-start function operates for 4 cycles after the power is turned on, even if the soft-start time is set to 0.0 seconds.

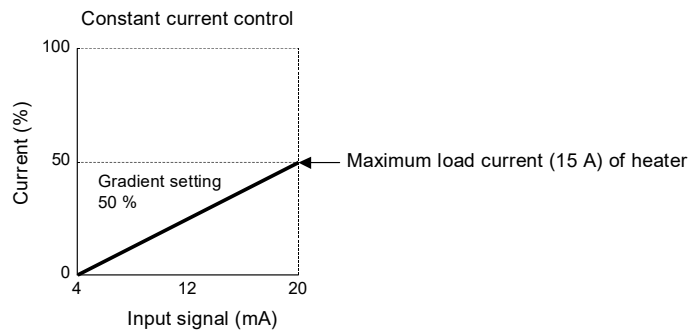
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When used without setting the gradient, the maximum heater load current becomes 15 A at an input signal of 12 mA. In this case, control is disabled if the input signal exceeds 12 mA.

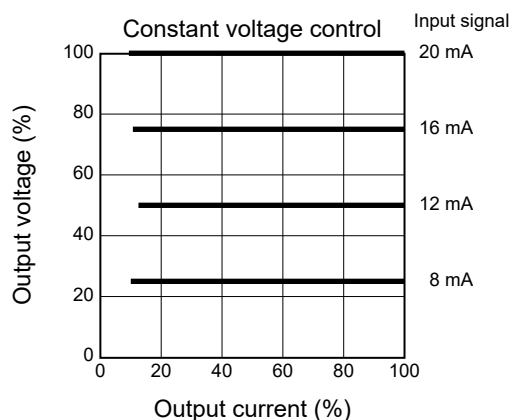


In this case, set the gradient to 50 % so that the maximum heater load current will become 15 A at an input signal of 20 mA. The gradient is valid even if internally set or set by the external gradient setter.



(6) Constant voltage control

This is a control method of compensating power supply voltage and load variations so that no output voltage changes while in control.



Operating condition	Stability
Power supply voltage variation: ±10 % or less of input voltage	± (2 % of rated voltage)
Load variation: Within 2 times	

■ Caution for using constant voltage control function

In constant voltage control, the output voltage is 200 V AC for the input signal 100 %. This is used as a standard. As the standard is set to 200 V AC, when the maximum AC voltage applied to the load is 100 V AC, the output voltage is 100 V AC for 50 % of the input signal.

To provide 100 V AC for the input signal 100 %, adjust the gradient setting.

Example: When used in the following condition

- Maximum AC voltage applied to the load is 100 V AC
- Input signal from controller: 4 to 20 mA DC
- Output voltage is 100 V AC for input signal 100 % (20 mA DC)

If the instrument is used without setting the gradient, output voltage becomes 100 V AC for 12 mA input signal. Calculate the gradient value with the following formula, and set it with the internal gradient setting or the external gradient setter.

Formula for calculating the gradient:

Power supply voltage = 200 V × Gradient setting

(Gradient setting = External gradient set value × Internal gradient set value)

100 V = 200 V × Gradient setting

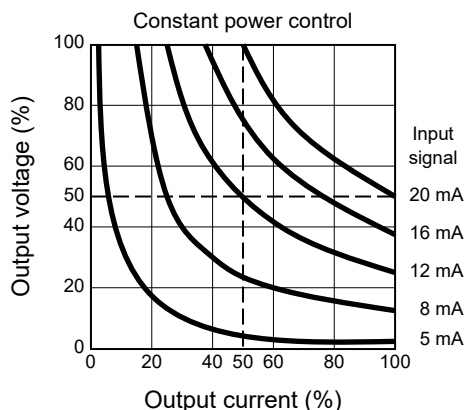
Gradient setting = 0.5

Use the obtained value for the internal gradient setting or the external gradient setter.

- Setting with internal gradient setting: Set 0.50 at Internal gradient set value (IG)
- Setting with external gradient setter: Set 50 % (0.5 × 100) with the external gradient setter

(7) Constant power control

This is a control method of outputting the root mean square power value proportional to the input signal even if there are power supply voltage and load variations while in control. This is suitable for heater control such as by silicon carbide or silicon unit which increases its resistance value due to temperature and secular changes.



Operating condition	Stability
Power supply voltage variation: ±10 % or less of input voltage	± (4 % of rated power*)
Load variation: Within 2 times	

* Rated power = Rated voltage × Rated current × 0.5



When constant power control is used, the soft-start function operates for 4 cycles after the power is turned on, even if the soft-start time is set to 0.0 seconds.



Constant power control is optional.

■ Caution for using constant power control function

In case of constant power control, the standard power against input signal 100 % depends on the rated current of THV-A1. Power can be calculated with the following formula.

Formula for calculating:

Power (W) = Input (%) × 200 V × THV-A1 rated current (A) × 0.5 × Internal manual set value × External gradient set value (%)

Example: Applied power of the 20 A rated current type against the input signal 100 %

The standard power can be calculated with internal gradient setting “1.00” and external gradient setting “100 %.”

Power (W) = Input (%) × 200 V × THV-A1 rated current (A) × 0.5 × Internal manual set value × External gradient set value (%)
 = 100 % × 200 V × 20 A × 0.5 × 1.00 × 100 %
 = 2000 [W] (2.00 kW)

Power of other than 20A type is as follows:

Rated current	Power when the input signal is 100 %
30 A type	3.00 kW
45 A type	4.50 kW
60 A type	6.00 kW
80 A type	8.00 kW
100 A type	10.00 kW
150 A type	15.00 kW
200 A type	20.00 kW

To change the power when the input signal is 100 %, use internal gradient setting or external gradient setting for correction.

Example 1: To produce 3 kW against the input signal 100 % on the 20 A rated current type

The standard power is 2 kW on the 20 A type when input signal is 100 %, but it can be 3 kW by adjusting the internal gradient setting set to “1.50.”

$$\begin{aligned}\text{Power (W)} &= \text{Input (\%)} \times 200 \text{ V} \times \text{THV-A1 rated current (A)} \times 0.5 \times \text{Internal manual set value} \times \text{External} \\ &\quad \text{gradient set value (\%)} \\ &= 100 \% \times 200 \text{ V} \times 20 \text{ A} \times 0.5 \times 1.50 \times 100 \% \\ &= 3000 \text{ [W]} (3 \text{ kW})\end{aligned}$$

Example 2: To produce 100 W against the input signal 100 % on the 20 A rated current type

For 20 A type, the standard power is 2 kW when the input signal is 100 %. Adjusting the gradient set value can reduce it to 100 W. The gradient is valid even if internally set or set by the external gradient setter.

- Set “0.05” to make correction with internal gradient setting.

$$\begin{aligned}\text{Power (W)} &= \text{Input (\%)} \times 200 \text{ V} \times \text{THV-A1 rated current (A)} \times 0.5 \times \text{Internal manual set value} \times \text{External} \\ &\quad \text{gradient set value (\%)} \\ &= 100 \% \times 200 \text{ V} \times 20 \text{ A} \times 0.5 \times 0.05 \times 100 \% \\ &= 100 \text{ [W]}\end{aligned}$$

- Set “5 %” to make correction with external gradient setter.

$$\begin{aligned}\text{Power (W)} &= \text{Input (\%)} \times 200 \text{ V} \times \text{THV-A1 rated current (A)} \times 0.5 \times \text{Internal manual set value} \times \text{External} \\ &\quad \text{gradient set value (\%)} \\ &= 100 \% \times 200 \text{ V} \times 20 \text{ A} \times 0.5 \times 1.00 \times 5 \% \\ &= 100 \text{ [W]}\end{aligned}$$

5.12 Power Frequency Monitoring Function

This function monitors the power supply frequency and when it goes out of the detection range, the error message display appears.

Detection range: 45.0 to 64.9 Hz

Action on occurrence of error: FREQ lamp is lit.
THV-A1 output is turned off.
(The output can be turned ON when the error is canceled.)



For users of the THV-1 and THW-3

The detection range of the THV-A1 differs from the detection ranges of the THV-1 and THW-3. The detection ranges of the THV-1 and THW-3 are different for 50 Hz and 60 Hz power.

Power supply frequency	Detection range		
	THV-A1	THV-1	THW-3
50 Hz	45.0 to 64.9 Hz	45.0 to 54.9 Hz	45.0 to 54.9 Hz
60 Hz		55.0 to 64.9 Hz	55.0 to 64.9 Hz

5.13 Output Limiter (High and Low)

This function limits the output range. Output limiter function is related to other functions.

- Output limiter (high) and (low) have priority to the output value¹ calculated with gradient setting function. The maximum output from the instrument will not exceed the output limiter (high) and the minimum output will not go below the output limiter (low).
- Output limiter (high) has priority to the output value² calculated with gradient setting and base-up setting function. The maximum output from the instrument will not exceed the output limiter (high).
- When output limiter (low) is not set to zero (0.0), the base-up setting function is invalid.

¹ Proportional phase angle to input, Proportional voltage to input or Proportional square voltage (electric power) to input:

$$\text{Output value} = (\text{Input signal}) \times (\text{Internal gradient setting}) \times (\text{External gradient setting})$$

Constant voltage control, Constant current control, Constant power control or Square voltage feedback:

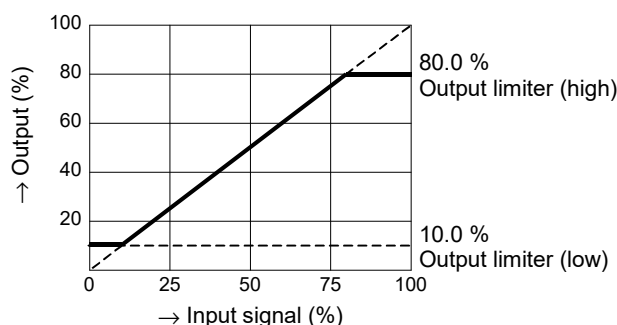
$$\text{Output value} = \text{Input signal}$$

² Proportional phase angle to input, Proportional voltage to input or Proportional square voltage (electric power) to input:

$$\text{Output value} = (\text{Input signal}) \times (\text{Internal gradient setting}) \times (\text{External gradient setting}) + (\text{Base-up set value})$$

Constant voltage control, Constant current control, Constant power control or Square voltage feedback:

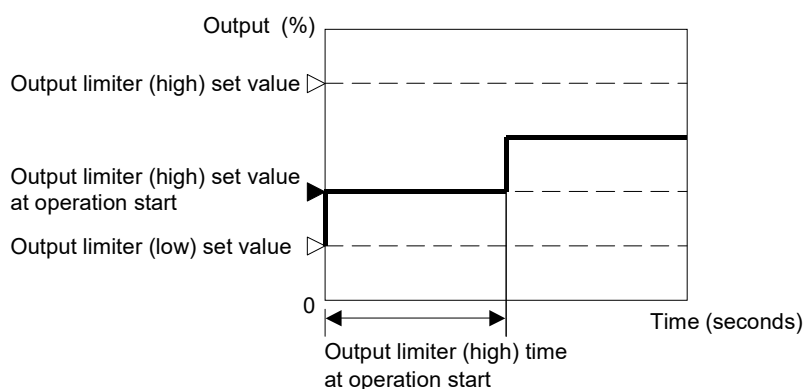
$$\text{Output value} = (\text{Input signal}) + (\text{Base-up set value})$$



5.14 Output Limiter (High) at Operation Start

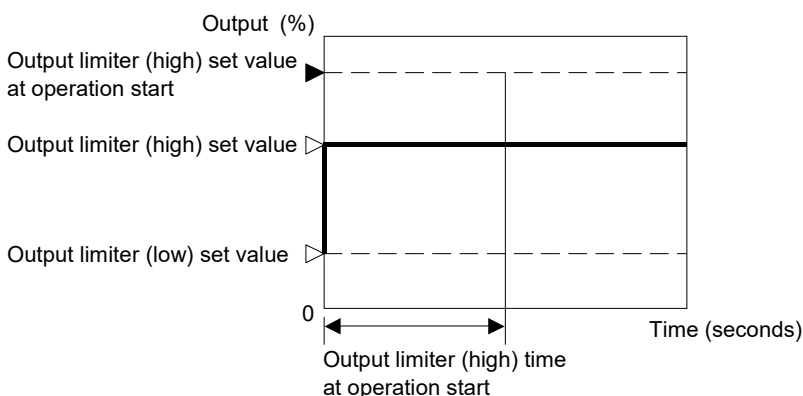
This is the function used to restrict the output for any preset time [output limiter (high) time at the time of start] when power is turned on. It is possible to lessen rush current by using this function.

The use of this function is effective for any heater (halogen lamp, platinum, tungsten, molybdenum, etc.) through which rush current flows.

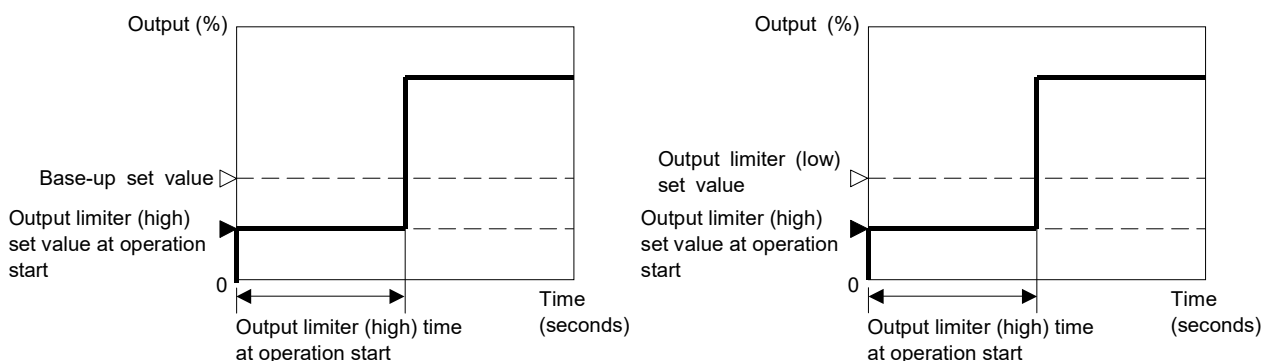


■ Priority order of output limiter

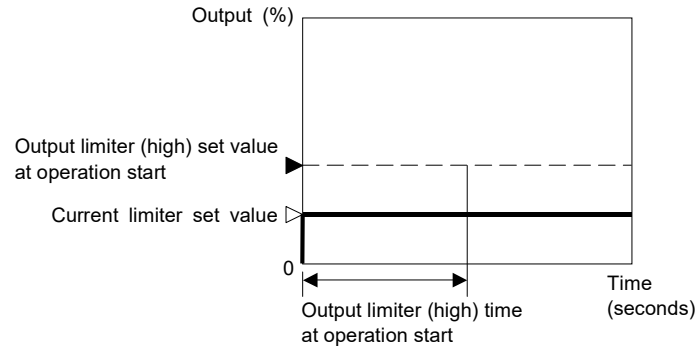
If the output limiter (high) at the time of start is set to any value larger than the output limiter (high), the latter has priority over the former.



If the output limiter (high) at the time of start is set to any value smaller than the base-up set value or output limiter (low), the former has priority over the latter.



If the output limiter (high) at the time of start is set to any value larger than the current limiter value, the latter has priority over the former.

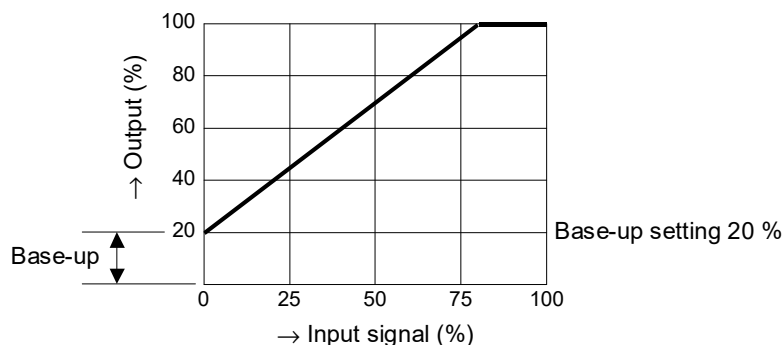


5.15 Base-Up Setting Function

Base-up setting function adds positive bias to the output value calculated with gradient setting function.

- Base-up setting is valid only when output limiter (low) is set to zero (0.0).
- Output limiter (high) has priority to the output value * calculated with gradient setting and base-up setting function. The maximum output from the instrument will not exceed the output limiter (high).

* Output value = (Input signal) × (Gradient set value) + (Base-up set value)



The base-up set value is effective only when the output limiter (low) is set to 0.0.

5.16 Alarm Interlock Function

The alarm interlock function is used to hold the alarm state even if the power frequency or CT input value is out of the alarm zone after its entry into the alarm zone once.

The following parameter can be interlocked.

- | | |
|-------------------------------------|--|
| • Power frequency error (FREQ) | • Thyristor break-down alarm (THY.B) |
| • Board error (BOARD) | • Over current (OCR) |
| • Power supply voltage error (VOLT) | • Fuse break (FUSE) |
| • Heater break alarm 1 (HBA1) | • Heat sink temperature abnormality (HEAT) |
| • Heater break alarm 2 (HBA2) | |

Indication lamp: This lamp continues lighting until the alarm is released.

Alarm output: The alarm output continues being output until the alarm is released.

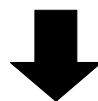
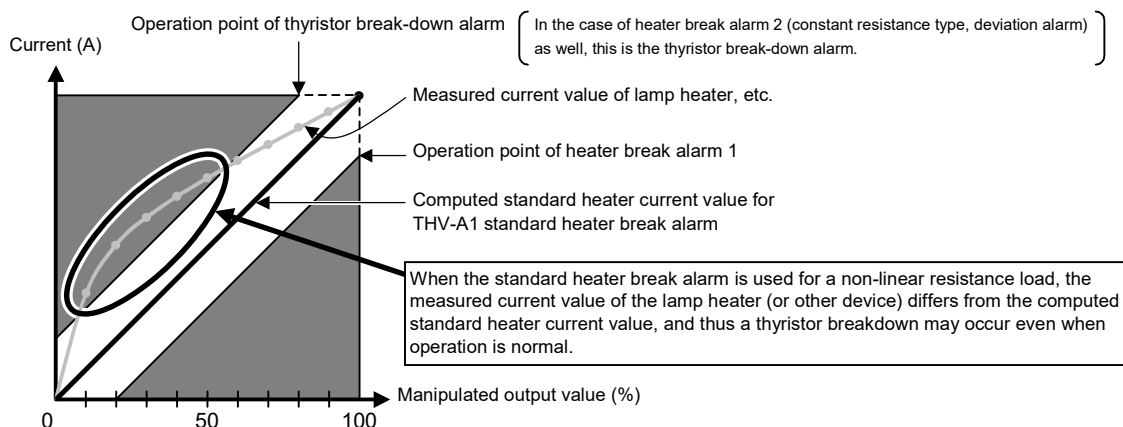
Alarm interlock release: The alarm interlock can be released by the external contact signal.

5.17 Non-linear Resistance Heater Break Alarm

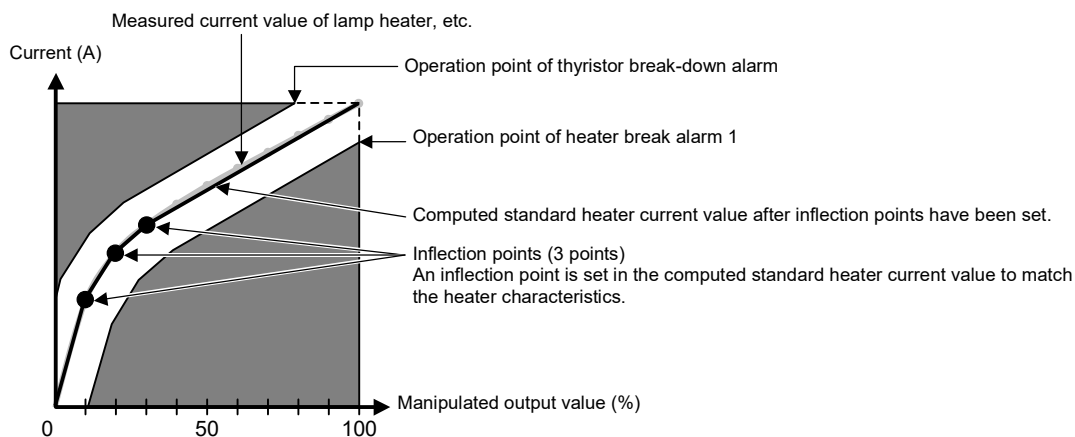
The non-linear resistance heater break alarm is used to detect breaks in loads with large changes in resistance due to temperature (lamp heaters, etc.).

Adjustment is made for the properties of non-linear resistance loads by adding 3 inflection points to the computed standard heater current value of the THV-A1.

■ Load characteristic (Proportional voltage to input)



Set the inflection point.
(Non-linear resistance heater break alarm)



Inflection points can be set either automatically (when the proportional voltage to input or the constant voltage control is used) or manually. When set automatically, the maximum load current set value is calculated in addition to the inflection points.



For the setting example of inflection point, refer to **4.11 Setting Example of Non-linear Resistance Heater Break Alarm (P. 98)**.



It may not be possible to use the non-linear resistance heater break alarm function with some heater types.




Use this function in a system with a current capacity of 10 A or more. As the measuring accuracy of the current transformer (CT) is within $\pm 2\%$ of the THV-A1 rated current, no heater break alarm may normally operate if used at a smaller load current value.


5.18 Protection Function for Control of Primary Side of a Transformer

If momentary power failure occurs during execution of the control of primary side of a transformer, inrush current is generated. Protection function for control of primary side of a transformer is to protect the thyristor from the inrush current. With this protection function enabled, when momentary power failure occurs, the instrument determines that the secondary side of a transformer was disconnected and suppresses the output. When the instrument is automatically reset from the breakdown (momentary power failure), the soft-start function suppresses the inrush current.

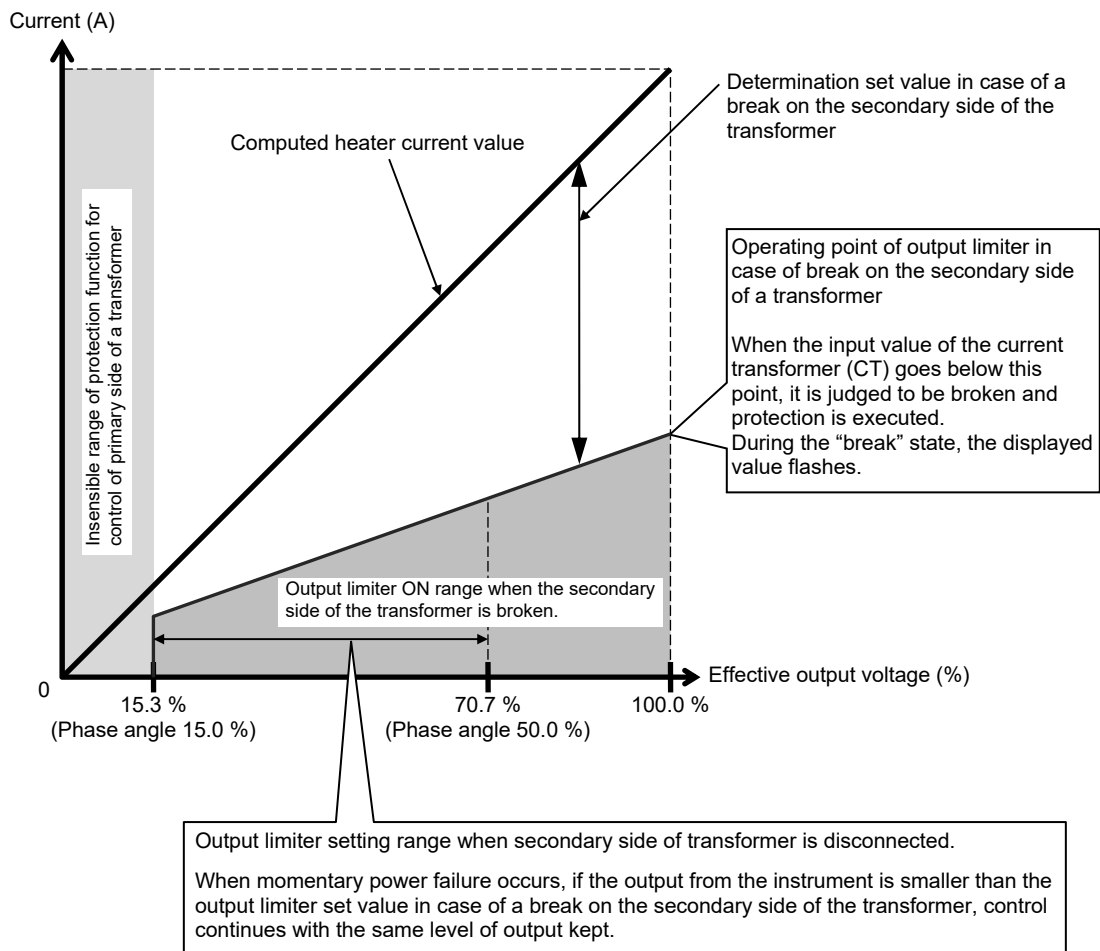
To use this protection, the following parameters need to be set.

- Protection function for control of primary side of a transformer (TF)
- Determination set value in case of a break on the secondary side of the transformer (TA)
- Output limiter setting in case of a break on the secondary side of the transformer (TL)
- Soft-start time in case of break on the secondary side of the transformer (TU)

 For the setting range of parameter, refer to page 77, 78.

 For the setting procedure, refer to page 116 to 119.

■ Operation chart



■ Determination of break and release of secondary side of transformer

• Determination of break

While control of primary side of a transformer is executed, if the current transformer (CT) value goes below the determination set value in case of a break on the secondary side of the transformer, it is judged to be a break (momentary power failure). Below is a formula to convert the determination set value in case of a break on the secondary side of the transformer (TA) into the current value (A).

$$\text{Current value [A]} = \text{Maximum load current set value [A]} \times \text{Effective output voltage [\%]} \times (100 \% - \text{Determination set value in case of a break on the secondary side of the transformer [\%]})$$

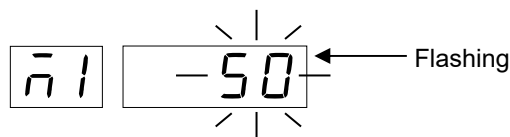
• Determination of release

While the phase angle is 15 % or more, when the current goes over the determination set value in case of a break on the secondary side of the transformer by 0.3 A, it is judged to be a release from a break (momentary power failure).

■ Display in case of break of secondary side of a transformer

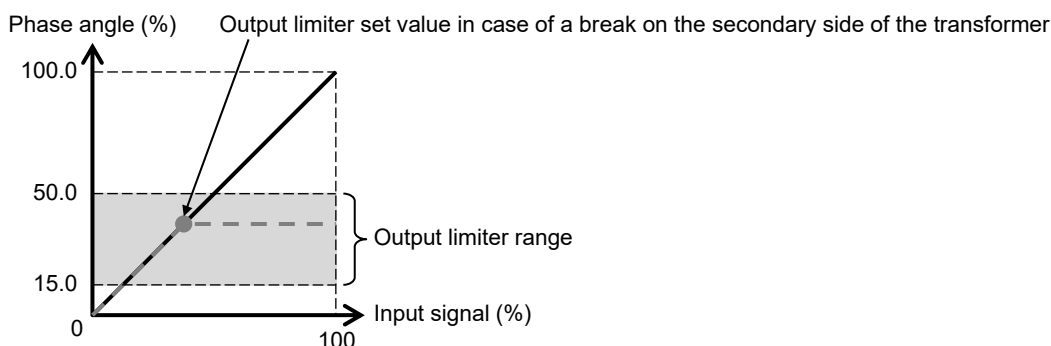
When the signal level goes below the determination set value in case of a break on the secondary side of the transformer, the displayed value flashes. (Parameters of monitor mode 1 and monitor mode 2 flash)

When the instrument is automatically released from the break (momentary power failure), the display stops flashing and remains lit.



■ Output limiter setting in case of a break on the secondary side of the transformer

This is a function to limit the phase angle between 15.0 % and 50.0 % when the signal goes below the determination set-value in case of a break on the secondary side of the transformer.



■ Soft-start function in case of break on the secondary side of the transformer

This is a soft-start function which is activated when the instrument is automatically released from the break (momentary power failure) of the secondary side of the transformer. This function suppresses the inrush current at the time of automatic release from the break (momentary power failure).



While the soft-start function of the soft-start time (SU) is working, if break (momentary power failure) of secondary side of a transformer occurs, protection function for control of primary side of a transformer starts working to suppress the output. When released from the break (momentary power failure), the instrument changes the output according to the soft-start time in case of break on the secondary side of the transformer (TU). After elapse of the soft-start time in case of break on the secondary side of the transformer (TU), the soft-start time (SU) takes over, and output is changed in the remaining time of the soft-start time (SU).

6. MAINTENANCE



WARNING

- In order to prevent electric shock or instrument failure, always conduct necessary work after power supplied to the entire system is turned off.
- Conduct work after this instrument is cooled. As the temperature of this instrument is very high just after the power is turned off, never touch the instrument while heated.

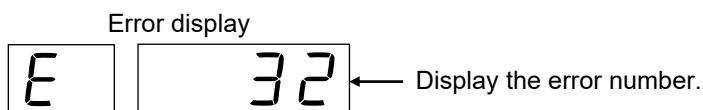
6.1 Daily Inspection

In order to prevent accident and instrument failure, inspect the instrument periodically.

Check item	Details
Inspecting main circuit terminal tightening torque	<p>As the large current flows through each hexagon headed bolt used for the main circuit terminal, the loosened bolt may generate heat to cause ignition.</p> <p>Inspect the tightening torque of the bolt periodically. If loosened, tighten it with adequate torque.</p> <p>Recommended tightening torque:</p> <ul style="list-style-type: none">1.6 N·m [16 kgf·cm] (20 A/30 A types)3.8 N·m [38 kgf·cm] (45 A/60 A types)9.0 N·m [90 kgf·cm] (80 A/100 A types)18.0 N·m [180 kgf·cm] (150 A/200 A types)
Cleaning of thyristor	<p>The attachment of dust to the heat radiation fins may worsen the cooling effect. Therefore, remove the dust attached using a cleaner.</p>

6.2 Error Displays

When the error occurs, the display changes to the error display. When two or more errors occur simultaneously, the error code numbers are totaled and displayed as one number.



Error number	Description	Indication lamp	Action	Solution
1	Adjusted data error	BOARD lamp: ON	THV-A1 output OFF	Turn off the power at once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
2	Back-up error	BOARD lamp: ON	THV-A1 output OFF	
4	A/D conversion error	BOARD lamp: ON	THV-A1 output OFF	
32	Power frequency error	FREQ lamp: ON	THV-A1 output OFF	Check the value of power supply frequency, and turn off the power at once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
64	Power supply voltage error	VOLT lamp: ON	THV-A1 output OFF	Turn off the power at once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
128	Watchdog timer	FAIL lamp: ON	THV-A1 operation stop*	

* When the operation of THV-A1 stopped, the output of THV-A1 turns OFF.

6.3 Troubleshooting

General causes to be assumed and measures to be taken when an error occurs in this instrument are described in the following. For any inquiries, please contact RKC sales office or the agent, to confirm the specifications of the product.

Problem	Possible cause	Solution
The FAIL lamp lights	Error of this instrument	Please contact RKC sales office or the agent.
The FREQ lamp lights	Power frequency is out of the allowable range (detection range) when power is turned on or during operation.	Check the value of power supply frequency, and turn off the power at once. If a lamp lights after the power is turned on again, please contact RKC sales office or the agent.
The BOARD lamp lights	Error of board inside this instrument	Turn off the power once. If a lamp lights after the power is turned on again, please contact RKC sales office or the agent.
The VOLT lamp lights	The power supply voltage exceeded 264 V	Verify whether or not the normal power supply voltage is being supplied. Turn off the power and then turn it back on.
	The power supply voltage has fallen to less than 90 V*. (150 A/200 A types)	If a lamp lights after the power is turned on again, please contact RKC sales office or the agent.
Not to be output	The power supply voltage is not being supplied	Supply the power.
	No gradient is set	Set the external gradient or internal gradient.
	There is no automatic setting input	Check whether or not wiring is conducted by mistaking the output signal of the controller and the type of thyristor input signal. Check that the temperature controller normally operates.
		If switching between auto mode and manual mode is performed by contact input (DI), open the contact (auto mode).
		Set the “0: External manual mode ↔ Auto mode” or “1: Internal manual mode ↔ Auto mode” by contact input (DI).
	The fast-blow fuse is broken.	Replace the fast-blow fuse.
	The output limiter (low) is set to 100.0%	Set the set value of the output limiter (low) (LL) to a proper value.
	This instrument is not set to RUN	If switching between RUN and STOP is performed by contact input (DI), close the contact (RUN).
		Set the “1: RUN” by RUN/STOP transfer (rS) of engineering mode.

* However, note that this includes measurement error. [Measurement error: \pm (3 % of input voltage) or ± 5 V]

Continued on the next page.

Continued from the previous page.

Problem	Possible cause	Solution
Not to be output	The current limit value is set to 0.0 %	Set the set value of the current limit value setting (CL) to a proper value.
No output is turned off.	The automatic set value is set to the maximum value.	Check the output signal of temperature controller.
	A thyristor element is shorted.	Please contact RKC sales office or the agent.
The HBA1 lamp lights	A heater is broken.	Turn off the power, and check or replace the heater, etc.
	An incorrect memory area number is selected (when the standard heater break alarm is used).	Switch to the correct memory area.
The HBA2 lamp lights	A heater is broken.	Turn off the power, and check or replace the heater, etc.
	A thyristor element is shorted.	Please contact RKC sales office or the agent.
	An incorrect memory area number is selected (when the standard heater break alarm is used).	Switch to the correct memory area.
The THY.B lamp lights	No soft-start time is appropriately set.	If a load generating large rush current is used, thyristor break-down may occur when no soft-start time is appropriately set. In such a case, make the soft-start time longer.
	An incorrect memory area number is selected (when the standard heater break alarm is used).	Switch to the correct memory area.
	The thyristor break-down set value is set to a value smaller than the base-up set value.	Set the base-up set value or the thyristor break-down set value to the correct value.
	A thyristor element is shorted.	Please contact RKC sales office or the agent.
The OCR lamp lights	A current of more than 1.2 times the rating of this instrument flowed.	Turn off the power, and check or replace the heater, etc.
The FUSE lamp lights	The fast-blow fuse is broken.	Replace the fast-blow fuse.
The HEAT lamp lights	The temperature of the thyristor element (SCR) exceeded 120 °C.	Turn off the power and let the heat sink (radiator fins) cool. If a lamp lights after the power is turned on again, please contact RKC sales office or the agent.
The cooling fan has stopped	Dust, oil, or other substance has collected.	Turn off the power and contact an RKC sales office or agent.
	The cooling fan has failed.	
	The cooling fan has reached the end of its service life.	

6.4 Replacement of the Fast-Blow Fuse

CAUTION

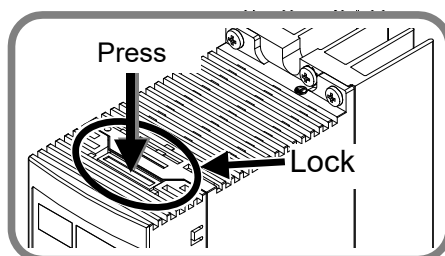
- Use a torque wrench for removing or tightening each hexagon headed nut which fixes the fuse.
- Tighten the hexagon headed nut at an appropriate torque value.

Recommended tightening torque:

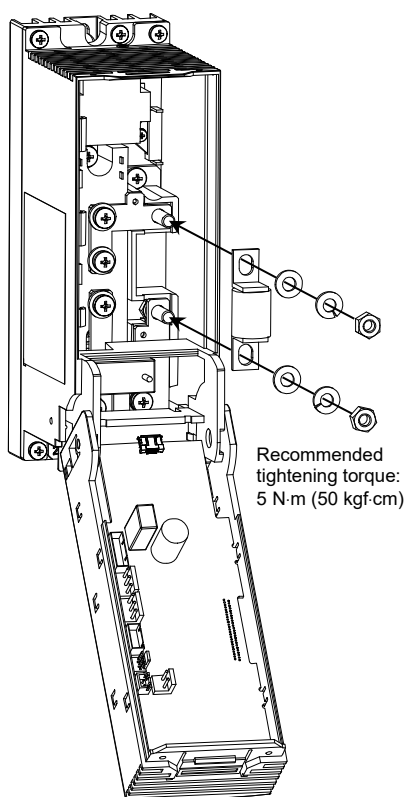
5 N·m [50 kgf·cm] (20 A/30 A/45 A/60 A/80 A/100 A types)

12 N·m [122 kgf·cm] (150 A/200 A types)

Press the lock on top of the unit, open the front toward you, and replace the fuse.



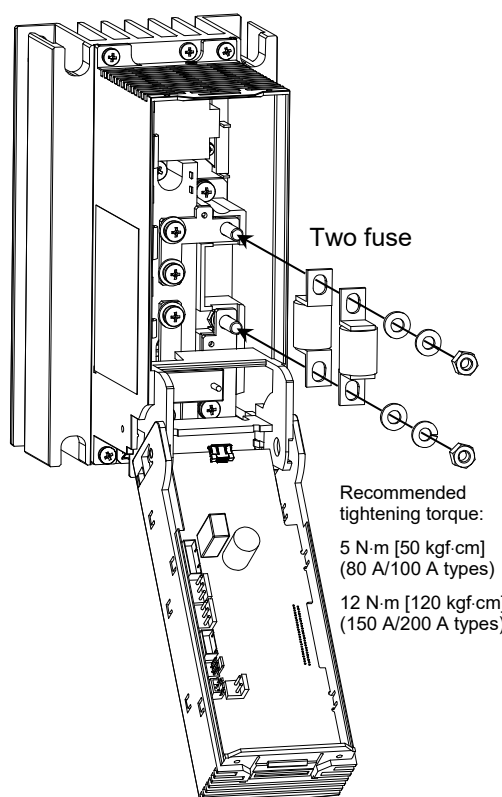
20 A/ 30 A/ 45 A/ 60 A types



Recommended
tightening torque:
5 N·m (50 kgf·cm)

The figure shows the type of 20 A/30 A.

80 A/ 100 A/150 A/200 A types



Recommended
tightening torque:
5 N·m [50 kgf·cm]
(80 A/100 A types)
12 N·m [120 kgf·cm]
(150 A/200 A types)

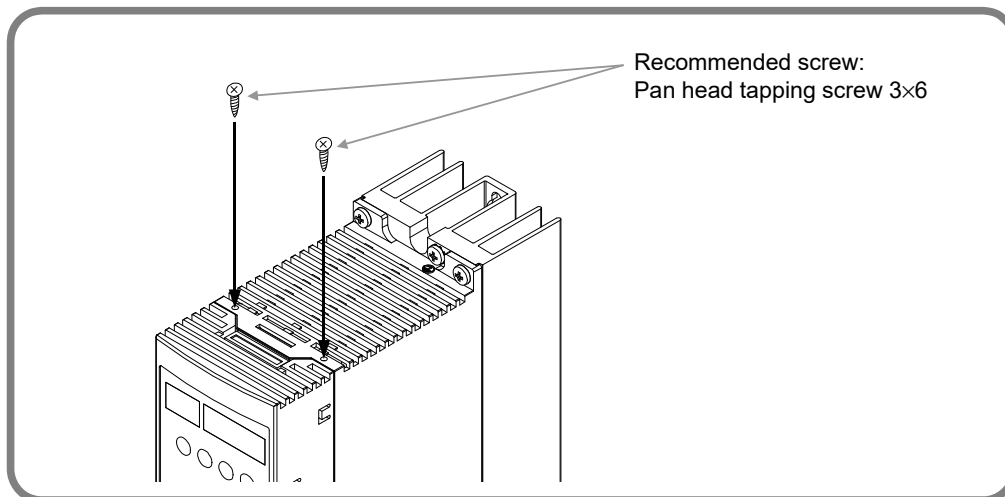
The figure shows the type of 80 A/100 A.



For details of fast-blow fuse for replacement, refer to ■ **Accessories (Order Separately)** on page 3.

6.5 Securing the Front with Screws

The front of the THV-A1 (20 A/30 A/45 A/60 A/80 A/100 A types) can be secured with screws.
Please obtain the screws separately.



7. SPECIFICATIONS

Number of phase:	Single-phase		
Rated current:	20 A AC, 30 A AC, 45 A AC, 60 A AC, 80 A AC, 100 A AC, 150 A AC and 200 A AC (Specify either type when ordering.) 20 A, 30 A, 45 A, 80 A, 100 A, 150 A and 200 A types: The rated current drops when the ambient temperature exceeds 50 °C. 60 A type: The rated current drops when the ambient temperature exceeds 45 °C.		
Minimum load current:	0.5 A (at 98 % output of rated voltage)		
Power supply voltage:	90 to 264 V AC [Including power supply voltage variation] (Rating: 100 to 240 V AC)		
Power frequency:	50/60 Hz		
Allowable power frequency variations:	50 Hz ± 1 Hz, 60 Hz ± 1 Hz (Performance guarantee) 50 Hz: 45.0 to 54.9 Hz (Operation guarantee) 60 Hz: 55.0 to 64.9 Hz (Operation guarantee)		
Output voltage range:	0 to 98 % of rating voltage (excluding voltage drops due to fuse effects)		
Applicable load:	Phase control:	Resistor load (Corresponding utilization category: AC-51) Control of primary side of a transformer The magnetic flux density must be 1.25 T [12,500 Gauss] or less when the protection function for control of primary side of a transformer is not provided.	
	Zero-cross control:	Resistor load (Corresponding utilization category: AC-51)	
Control method:	Phase control, Zero-cross control		
Output setting range:	Internal manual set value:	0.0 to 100.0 %	(Set by the THV-A1 front keys)
	External manual set value:	0 to 100 %	(Set by the setter [optional])
	Internal gradient set value:	0.00 to 2.00 (0 to 200 %)	(Set by the THV-A1 front keys)
	External gradient set value:	0 to 100 %	(Set by the setter [optional])
	Output limiter (high) set value:	0.0 to 100.0 %	(Set by the THV-A1 front keys)
	Output limiter (low) set value:	0.0 to 100.0 %	(Set by the THV-A1 front keys)
	Base-up set value:	-10.0 to +100.0 %	(Set by the THV-A1 front keys)
Output mode for phase control:	Standard ¹ and Constant voltage control ² Standard and Constant voltage control and Constant current control ^{3, 4} Standard and Constant voltage control and Constant power control ^{3, 4, 5} ¹ Proportional phase angle to input, Proportional voltage to input and Proportional square voltage (electric power) to input ² Square voltage feedback can be selected. ³ With heater break alarm, thyristor break-down alarm, memory area, current limiter, over current alarm and Protection function for control of primary side of a transformer ⁴ Constant current control or constant power control is optional. ⁵ Constant current control is available.		
Power off leakage current:	20 A, 30 A, 45 A, 60 A, 80 A and 100 A types: 27 mA AC rms or less (load voltage 200 V rms, 60 Hz, Ta = 25 °C) 150 A and 200 A types: 90 mA AC rms or less (load voltage 200 V rms, 60 Hz, Ta = 25 °C)		

Output accuracy, stability:

Proportional phase angle to input:	$\pm (3 \% \text{ of input voltage})$ or $\pm 5 \text{ V}$ (whichever is larger)
Proportional voltage to input:	$\pm (3 \% \text{ of input voltage})$ or $\pm 5 \text{ V}$ (whichever is larger)
Proportional square voltage (electric power) to input:	$\pm (3 \% \text{ of input voltage})$ or $\pm 5 \text{ V}$ (whichever is larger)
Constant voltage control:	$\pm (2 \% \text{ of input voltage})$
Power supply voltage variation:	Within $\pm 10 \%$ of input voltage
Load variation:	Within 2 times
Square voltage feedback:	$\pm (4 \% \text{ of input voltage})$
Power supply voltage variation:	Within $\pm 10 \%$ of input voltage
Load variation:	Within 2 times
Constant current control:	$\pm (2 \% \text{ of rated current})$
Power supply voltage variation:	Within $\pm 10 \%$ of input voltage
Load variation:	Within 2 times
Constant power control:	$\pm (4 \% \text{ of rated power}^*)$
Power supply voltage variation:	Within $\pm 10 \%$ of input voltage
Load variation:	Within 2 times

* Rated power = Rated voltage \times Rated current \times 0.5

Input signal:

Number of input point:	1 point
Hardware 1 (Group 1):	Current input: 0 to 20 mA DC, 4 to 20 mA DC Voltage input: 0 to 5 V DC, 1 to 5 V DC Voltage pulse input: 0/12 V DC Dry contact input
Hardware 2 (Group 2):	Voltage input: 0 to 10 V DC Voltage pulse input: 0/12 V DC, 0/24 V DC Dry contact input (Specify either one of them when ordering. However, it is possible to change if it is the input signal within the same hardware.)

Input impedance:

Hardware 1 (Group 1):	Current input 0 to 20 mA DC: 100 Ω Current input 4 to 20 mA DC: 100 Ω Voltage input 0 to 5 V DC: 30 k Ω Voltage input 1 to 5 V DC: 30 k Ω Voltage pulse input 0/12 V DC: 30 k Ω
Hardware 2 (Group 2):	Voltage input 0 to 10 V DC: 60 k Ω Voltage pulse input 0/12 V DC, 0/24 V DC: 60 k Ω
Setting range:	0 to 100 %
Sampling cycle:	0.5 of power cycle
Action at input break:	Indicates the value near 0 %
Allowable input range:	Hardware 1 (Group 1) current: -55 to $+55 \text{ mA}$ Hardware 1 (Group 1) voltage: -10 to $+15 \text{ V}$ Hardware 2 (Group 2) voltage: -10 to $+30 \text{ V}$

External contact input (DI):

Number of input point: 3 points
 Input method: Dry contact input
 Dry contact: Open state: 500 k Ω or more
 Closed state: 250 Ω or less
 Contact current: 1 mA or less
 Voltage when opened: Approx. 5 V DC
 Function: Auto/Manual mode transfer
 Open state: Auto mode
 Closed state: Manual mode
 RUN/STOP transfer
 Open state: STOP
 Closed state: RUN
 Alarm interlock release
 Closed state: Alarm interlock release
 Heater break alarm enable/disable
 Open state: Enable
 Closed state: Disable
 Soft-start, soft-down enable/disable
 Open state: Enable
 Closed state: Disable
 Set data lock/unlock
 Open state: Lock
 Closed state: Unlock
 Over current alarm enable/disable
 Open state: Enable
 Closed state: Disable
 Memory area transfer
 Memory area 1: DI1: Open state
 DI2: Open state
 Memory area 2: DI1: Closed state
 DI2: Open state
 Memory area 3: DI1: Open state
 DI2: Closed state
 Memory area 4: DI1: Closed state
 DI2: Closed state
 Capture judgment time:
 5 of power cycle

Current transformer (CT) input (optional):

Input: Current transformer (CT): Incorporated in unit
 Input range: 0.0 to rated current \times 1.35 A

Potential transformer (PT) input:

Input: Potential transformer (PT): Incorporated in unit
 Input range: 80 to 280 V

Power measurement (optional):

The current is calculated from the input values of CT and PT in the THV-A1.
 Measurement range: 0.00 to 37.80 kW (20 A/30 A/45 A/60 A/80 A/100 A types)
 0.00 to 63.36 kW (150 A/200 A types)

Indication lamp:	Parameter display:	2 digits, 7-segments LED (Orange)
	Data display:	4 digits, 7-segments LED (Orange)
	State display:	FAIL: LED (Red)
		Lights when CPU error or operation failure occurs
	Power frequency error:	LED (Red)
		Lights when power frequency error occurs
	Board error:	LED (Red)
		Lights when a data error, back-up error, or A/D conversion error occurs
	Power supply voltage error:	LED (Red)
		Lights when the allowed power supply voltage is exceeded
	Heater break alarm 1*:	LED (Red)
		Lights when heater break alarm 1 occurs
	Heater break alarm 2*:	LED (Red)
		Lights when heater break alarm 2 occurs
	Thyristor break-down*:	LED (Red)
		Lights when thyristor break-down occurs
Monitor items:	Over current alarm*:	LED (Red)
		Lights when over current alarm occurs
	Fuse break*:	LED (Red)
		Lights when a fuse break occurs
	Heat sink temperature abnormality*:	LED (Red)
		Lights when a heat sink temperature abnormality occurs
	Protection function for control of primary side of a transformer*:	4 digits, 7-segments LED flashes (Orange)

* Optional

Multi-memory area (Standard heater break alarm):

Number of memory areas: 4

Applicable items: Maximum load current set value, Heater break alarm 1 set value, Thyristor break-down set value, Heater break alarm 2 set value and Current limit value

Method of memory area transfer:

Front key
Contact input (DI)
Communication

Monitor items:	Load current:	Display range 0.0 to rated current \times 1.35 A
		0.0 to 27.0 (20 A type) 0.0 to 108.0 (80 A type)
		0.0 to 40.5 (30 A type) 0.0 to 135.0 (100 A type)
		0.0 to 60.8 (45 A type) 0.0 to 202.5 (150 A type)
		0.0 to 81.0 (60 A type) 0.0 to 270.0 (200 A type)
	Load voltage:	Display range 0 to 280 V
		(calculated based on the measured value of PT and the output phase angle)
	Load power:	Display range:
		0.00 to 7.56 kW (20 A type) 0.00 to 30.24 kW (80 A type)
		0.00 to 11.34 kW (30 A type) 0.00 to 37.80 kW (100 A type)
		0.00 to 17.01 kW (45 A type) 0.00 to 56.70 kW (150 A type)
		0.00 to 22.68 kW (60 A type) 0.00 to 75.60 kW (200 A type)

Output phase angle: Display range 0 to 100 %
(0° to 180° displayed as a percentage)
Input value: Display range 0 to 100 %
Memory area: Display range 1 to 4
Power frequency: 40 to 70 Hz

External manual setting:

Number of inputs: 1 point
Input type: Variable resistor 5 k Ω (B)
Setting range: 0 to 100 %
Setting accuracy: \pm (15 % of span + 1 digit)
Input impedance: Approx. 62 k Ω
Capture judgment time:
5 of power cycle
Action at input break: +5 V output: Near the 0%
0 V: Near the 100%
Setting input: Near the 0%

External gradient setting:

Number of inputs: 1 point
Input type: Variable resistor 5 k Ω (B)
Setting range: 0 to 100 %
Setting accuracy: \pm (15 % of span + 1 digit)
Input impedance: Approx. 62 k Ω
Capture judgment time:
5 of power cycle
Action at input break: +5 V output: Near the 0 %
0 V: Near the 100 %
Setting input: Near the 100 %

Output limiter at operation start:

High limit setting: 0.0 to 100.0 % (Function is enabled even if set to 0.0 %)
Time setting: 0.0 to 600.0 seconds (Function is disabled when set to 0.0 seconds)

Ramp (Soft-start/Soft-down) function:

Soft-start setting: 0.0 to 100.0 seconds
(0.0 seconds: Soft-start function disabled)
Soft-down setting: 0.0 to 100.0 seconds
(0.0 seconds: Soft-down function disabled)

Current limiter function (optional):

20 A type: 0.0 to 22.0 A
30 A type: 0.0 to 33.0 A
45 A type: 0.0 to 50.0 A
60 A type: 0.0 to 66.0 A
80 A type: 0.0 to 88.0 A
100 A type: 0.0 to 110.0 A
150 A type: 0.0 to 165.0 A
200 A type: 0.0 to 220.0 A



The current limit function is activated only during phase control.
If a current limit value is set to its maximum value, the current limit function is deactivated.

ON/OFF control:

An external setter (variable resistor 5 k Ω (B)) is used to set the high limit value and low limit value
Input type: Variable resistor 5 k Ω (B)

Alarm function:	Power frequency error: Outside allowed power frequency range
	Board error: Data error during self-diagnostic, Back-up (circuit) error or A/D conversion error
	Power supply voltage error: Outside allowed power supply voltage range (Note that this includes measurement error.)
	Over current: When load current equal to 1.2 times the rated current is detected
	Fuse break (optional): When fuse break is detected (load resistance of 1 k Ω or less, detection not possible for heater break)
	Heat sink temperature abnormality (optional): SCR temperature abnormality (temperature setting is fixed)
	Standard heater break alarm (optional):
	Heater break alarm 1 [Low alarm of heater current]:
	Type 1 (constant resistance type, deviation alarm):
	Applicable control method: Phase control
	Setting range: 0 to 100 % of the maximum load current set value
	Alarm detection conditions: Phase angle 15 % or more
	Load current characteristic: Linear approximation
	Sampling cycle: One cycle of power supply frequency
	Number of alarm delay times: 1 to 100 (one time is five power cycles)
	Type 2 (linearity resistor type, absolute value alarm):
	Applicable control method: Phase control
	Setting range: 0 to 100 % of the maximum load current set value
	Alarm detection conditions: Phase angle 15 % or more
	Load current characteristic: Linear approximation
	Sampling cycle: One cycle of power supply frequency
	Number of alarm delay times: 1 to 100 (one time is five power cycles)
	Thyristor break-down [High alarm of heater current]:
	Type 1 (constant resistance type, deviation alarm):
	Applicable control method: Phase control
	Setting range: 0 to 100 % of the maximum load current set value
	Alarm detection conditions: Phase angle 0 to 100 %
	Load current characteristic: Linear approximation
	Sampling cycle: One cycle of power supply frequency
	Number of alarm delay times: 1 to 100 (one time is five power cycles)
	Type 2 (linearity resistor type, absolute value alarm):
	Applicable control method: Phase control
	Setting range: 0 to 100 % of the maximum load current set value
	Alarm detection conditions: Phase angle 0 to 100 %
	Load current characteristic: Linear approximation
	Sampling cycle: One cycle of power supply frequency
	Number of alarm delay times: 1 to 100 (one time is five power cycles)
	Heater break alarm 2:
	Type 1 (constant resistance type, deviation alarm)
	[High/Low alarm of heater current]:
	Applicable control method: Phase control
	Setting range: 0 to 100 % of the maximum load current set value
	Alarm detection conditions: Heater break: Phase angle 15 % or more Thyristor break-down: Phase angle 0 to 100 %
	Load current characteristic: Linear approximation
	Sampling cycle: One cycle of power supply frequency
	Number of alarm delay times: 1 to 1000 (one time is five power cycles)

Heater break alarm for zero-cross control (linearity resistor type, absolute value alarm):	
Heater break alarm 1 [Low alarm of heater current]:	
Setting range:	0 to 100 % of the maximum load current set value
Alarm detection conditions:	Phase angle 100 %
Load current characteristic:	Linear approximation
Sampling cycle:	One cycle of power supply frequency
Number of alarm delay times:	1 to 100 (one time is five power cycles)
Thyristor break-down [High alarm of heater current]:	
Setting range:	0 to 100 % of the maximum load current set value
Alarm detection conditions:	Phase angle 0 %
Load current characteristic:	Linear approximation
Sampling cycle:	One cycle of power supply frequency
Number of alarm delay times:	1 to 100 (one time is five power cycles)
Heater break alarm 2 [auxiliary alarm]:	
Setting range:	0 to 100 % of the maximum load current set value
Alarm detection conditions:	Heater break: Phase angle 100 % Thyristor break-down: Phase angle 0 %
Load current characteristic:	Linear approximation
Sampling cycle:	One cycle of power supply frequency
Number of alarm delay times:	1 to 1000 (one time is five power cycles)
Non-linear resistance heater break alarm (optional):	
Applicable control method:	Phase control
Heater break alarm type:	Type 1 (constant resistance type, deviation alarm)
Supported loads:	Load whose resistance varies widely depending on the voltage (lamp heaters, etc.)
Action:	Alarm value is set at the deviation from the set load curve, and alarm monitoring is performed
Inflection point (3 points):	
Manipulated output value of inflection point: 0 to 100 %	
Current value of inflection point:	
0.0 to 22.0 A (20 A type)	
0.0 to 33.0 A (30 A type)	
0.0 to 50.0 A (45 A type)	
0.0 to 66.0 A (60 A type)	
0.0 to 88.0 A (80 A type)	
0.0 to 110.0 A (100 A type)	
0.0 to 165.0 A (150 A type)	
0.0 to 220.0 A (200 A type)	
Setting of inflection point: Automatically calculated or manually set	
Heater break alarm 1 [Low alarm of heater current]:	
Setting range:	0 to 100 % of the maximum load current set value
Alarm detection conditions:	Phase angle 15 % or more
Load current characteristic:	Broken line approximation (Inflection point: 3 points)
Sampling cycle:	One cycle of power supply frequency
Number of alarm delay times:	1 to 100 (one time is five power cycles)
Thyristor break-down [High alarm of heater current]:	
Setting range:	0 to 100 % of the maximum load current set value
Alarm detection conditions:	Phase angle 0 to 100 %
Load current characteristic:	Broken line approximation (Inflection point: 3 points)
Sampling cycle:	One cycle of power supply frequency
Number of alarm delay times:	1 to 100 (one time is five power cycles)

Alarm output (optional):	Number of output points: 2 points
	Output type: Relay contact output
	Contact type: 1a contact
	Contact capacity: 250 V AC, 1 A or less (resistor load) 30 V DC, 1 A or less (resistor load)
	Electrical life: 300,000 times or more (250 V AC, 1 A, DC 30 A 1 A Switching: 10 times/min)
	Mechanical life: 2 million times or more (No-load, Switching 300 times/min)
	Energized/De-energized: Selectable
	Alarm type:
	FAIL alarm (Only de-energized)
	Power frequency error
	Board error
	Power supply voltage error
	Heater break alarm 1 (optional)
	Heater break alarm 2 (optional)
	Thyristor break-down alarm (optional)
	Over current alarm (optional)
	Fuse break (optional)
	Heat sink temperature abnormality (optional)
Self-diagnostic function:	Control stop (notification of error condition possible):
	Calibration data error (Err code 1) Back-up error (Err code 2) A/D conversion error (Err code 4) Power frequency error (Err code 32) Power supply voltage error (Err code 64)
	Action stop (Error number is not displayed):
	Power supply voltage monitoring Watchdog timer (Err code 128)
	Instrument status:
	When a self-diagnostic error occurs: All output OFF
	Display: Fail LED lights (action stop) Board LED lights (control stop)
	Error recovery: Recovery by device power restart after cause of error is removed
Communication function (optional):	
	Interface:
	Based on RS-485 EIA standard
	Based on RS-422A EIA standard (Specify when ordering)
	Synchronous method: Start/Stop synchronous type
	Communication speed: 9600 bps
	Data format:
	Start bit: 1
	Data bit: 8
	Parity bit: None
	Stop bit: 1
	Communication method:
	2-wire system, half-duplex (RS-485)
	4-wire system, half-duplex (RS-422A)
	Protocol: Modbus-RTU
	Maximum connections: Up to 31 instruments (RS-422A, RS-485)
	Connection method: Modular connector
	Termination resistors: External installation (120 Ω 1/2 W)

Protection function for control of primary side of a transformer:

Applicable control method:

Phase control

Setting range: Protection function for control of primary side of a transformer:

0 (disable)/1 (enable)

Determination set value in case of a break on the secondary side of the transformer:

0 to 100 % of computed heater current value

(Deviation setting against the computed heater current value.)

Output limiter setting in case of a break on the secondary side of the transformer:

15.0 to 50.0 % of phase angle

Soft-start time in case of break on the secondary side of the transformer:

0.1 to 100.0 seconds

Abnormality judgment conditions:

Phase angle 15 % or more

Sampling cycle: 0.5 of power cycle

Action at the time of automatic release from the break (momentary power failure) of secondary side of the transformer:

Output by soft-start function at the time of the break (momentary power failure) of secondary side of transformer.

Power consumption (at maximum control circuit load):

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

6 VA MAX. (at 100 V AC) rush current 10 A or less

8 VA MAX. (at 240 V AC) rush current 24 A or less

150 A/200 A types:

14 VA MAX. (at 100 V AC) rush current 22 A or less

22 VA MAX. (at 240 V AC) rush current 52 A or less

Insulation resistance: 500 V DC, 20 MΩ or more (indicated by ○)

Time: 1 min.	Protective earth (PE) terminals	Power terminals, Main circuit terminals	Input terminals	Alarm terminals	Communication terminals
Protective earth (PE) terminals					
Power terminals, Main circuit terminals	○				
Input terminals	○	○			
Alarm terminals	○	○	○		
Communication terminals	○	○	○	○	

Withstand voltage: 50/60 Hz, 1 minute

Time: 1 min.	Protective earth (PE) terminals	Power terminals Main circuit terminals	Input terminals	Alarm terminals	Communication terminals
Protective earth (PE) terminals					
Power terminals, Main circuit terminals	2000 V				
Input terminals	1000 V	2000 V			
Alarm terminals	2000 V	2000 V	2000 V		
Communication terminals	1000 V	1000 V	1000 V	2000 V	

Power failure: A power failure of Approx. 50 ms or less will not affect the control action. (Control circuit)

Memory backup: Backed up by non-volatile memory

Number of writing: Approx. One million times

Data storage period: Approx. 10 years

Recovery operation when power fails:

Same as operation before power failure. After recovery, the state is the same as at power on, and thus if the soft-start function or output limiter at operation start function is set enabled, operation takes place.

However, the internal manual set value changes to 0.0 % after recovery.

Vibration:

Amplitude: < 1.5 mm (2 to 9 Hz)

Acceleration: < 5 m/s² (9 to 150 Hz)

Each direction of XYZ axes

Shock:

Height 50 mm or less (de-energized state)

Each direction of XYZ axes

Ambient temperature: 0 to 45 °C (Performance guarantee range): 60 A type

0 to 50 °C (Performance guarantee range): 20 A, 30 A, 45 A, 80 A, 100 A, 150 A and 200 A types

–15 to +55 °C (Operation guarantee range): 20 A, 30 A, 45 A, 60 A, 80 A and 100 A types

–10 to +55 °C (Operation guarantee range): 150 A and 200 A types

Ambient humidity:

5 to 95 %RH (Non-condensing)

(Absolute humidity MAX. W. C 29.3 g/m³ dry air at 101.3 kPa)

Operating environments:

A location without:

Rapid changes in ambient temperature which may cause condensation.

Corrosive or inflammable gases.

Water, oil, chemicals, vapor or steam splashes.

Direct air flow from an air conditioner.

Exposure to direct sunlight.

Excessive heat accumulation.

Dust and vibration

Calorific values:

23 W (20 A type) 95 W (80 A type)

34 W (30 A type) 116 W (100 A type)

56 W (45 A type) 190 W (150 A type)

72 W (60 A type) 245 W (200 A type)

Transportation and Storage environment conditions:

Vibration:

- Amplitude: < 7.5 mm (2 to 9 Hz)

- Acceleration: < 20 m/s² (9 to 150 Hz)

Each direction of XYZ axes

Shock: Height 800 mm or less

Temperature:

- At storage: –25 to +55 °C

- At transport: –40 to +70 °C

Humidity: 5 to 95 %RH (Non condensing)

Ambient atmosphere:

A location without:

- Rapid changes in ambient temperature which may cause condensation.

- Corrosive or inflammable gases.

- Water, oil, chemicals, vapor or steam splashes.

- Direct air flow from an air conditioner.

- Exposure to direct sunlight.

- Excessive heat accumulation.

- Dust and vibration

Standard:	20 A/45 A/60 A/80 A/100 A types:	
	Safety standards: UL:	UL61010-1 OVERVOLTAGE CATEGORYII, POLLUTION DEGREE 2, Class I
	cUL:	CAN/CSA-C22.2 No. 61010-1 OVERVOLTAGE CATEGORYII, POLLUTION DEGREE 2, Class I
	CE marking:	LVD: EN61010-1 OVERVOLTAGE CATEGORYII, POLLUTION DEGREE 2, Class I
	EMC:	EN60947-4-3 THV-A1 conforms to CE marking by using the noise filter. The noise filter specified: (SOSHIN ELECTRIC CO., LTD.)
		<ul style="list-style-type: none"> • 20 A/30 A: HF2030A-UP • 45 A: HF2050A-UP • 60 A: HF2060A-UP • 80 A: HF2080A-UP • 100 A: HF2100A-UP
	150 A/200 A types:	
	Safety standards: UL:	UL508 (file No. E177758) POLLUTION DEGREE 2
	cUL:	C22.2 No.14 (file No. E177758) POLLUTION DEGREE 2
Mounting and Structure:		
	Mounting method:	Vertical mounting
	Mounting orientation:	Vertical direction
	Case color:	Resin parts: Bluish white
		Metal plate parts: Stainless steel color (150 A/200 A type)
	Case material:	Resin parts: PPE-GF20 (Flame retardancy: UL94 V-1) (20 A/30 A/45 A/80 A/100 A types) PPE (Flame retardancy: UL94 V-1)
		Metal plate parts: SUS430 (150 A/200 A types)
	Panel sheet material:	Polyester
Weight:	Approx. 1.4 kg (20 A/30 A types)	Approx. 2.4 kg (80 A/100 A types)
	Approx. 1.6 kg (45 A/60 A types)	Approx. 4.5 kg (150 A/200 A types)
Dimensions:	20 A/30 A types:	68 × 198 × 143.9 mm (W × H × D)
	45 A/60 A types:	68 × 198 × 168.9 mm (W × H × D)
	80 A/100 A types:	110 × 198 × 178.9 mm (W × H × D)
	150 A/200 A types:	125.4 × 240 × 190 mm (W × H × D)



RKC INSTRUMENT INC.

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

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

E-mail: info@rkcinstrument.co.jp

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

