



Three-phase Thyristor Unit
200 VAC Type

THW-A1

Instruction Manual

- 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 your new instrument, carefully read all the instructions in this manual. Please place the manual in a convenient location for easy reference.

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.



WARNING

- An external protection device must be installed if failure of this instrument could result in damage to the instrument, equipment or injury to personnel.
- 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 the high-voltage sections such as power supply terminals, power supply lines and input/output terminals. If touched, electric shock or injury may result.
- 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.
- Do not enter the hand into the opening of this instrument. If entered, electric shock or injury 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 Class A instrument. In a domestic environment, this instrument may cause radio interference, in which case the user may be required to take additional measures.
- Be sure to provide an appropriate surge control circuit respectively for the following:
 - If input/output or signal lines within the building are longer than 30 meters.
 - If input/output or signal lines leave the building, regardless the length.
- This instrument is 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 or failure, protect the power line and the input/output lines with a protection device such as fuse, etc.
- If this product is used for phase control, higher harmonic noise may be generated. Therefore in this case, take such measures as installing an isolation transformer and 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 dispensation.
- 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.

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.
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CONTENTS

	Page
1. OUTLINE	1
1.1 Checking the Product	2
1.2 Parts Description	4
2. MOUNTING	6
2.1 Mounting Environment.....	6
2.2 Mounting Cautions.....	7
2.3 Dimensions.....	8
2.4 Mounting Procedures	11
2.5 How to Fix the Terminal Cover	12
3. WIRING	13
3.1 Circuit Block Diagram	13
3.2 Wiring of Main Circuit	14
3.3 Wiring of Controller (Auto Mode)	17
3.3.1 Wiring of the current input	18
3.3.2 Wiring of the voltage input or voltage pulse input	18
3.3.3 Wiring of the series connection (For current input)	19
3.3.4 Wiring of the parallel connection (For voltage input or voltage pulse input).....	19
3.4 Wiring for Input/Output Connector	20
3.4.1 Input/Output connector pin number and details	20
3.4.2 Caution for wiring input/output connector (plug)	21
3.4.3 Wiring of external manual setter	21
3.4.4 Wiring of external gradient setter	21
3.4.5 Wiring of external contact input.....	22
3.4.6 Wiring of Auto mode (with gradient setter).....	22
3.4.7 Wiring of Auto/Manual mode selection.....	23
3.4.8 Wiring of Auto/Manual mode selection (with gradient setter).....	23
3.4.9 Wiring of alarm output	24
3.4.10 Wiring of contact input.....	24
3.4.11 Wiring of ON/OFF control.....	25

	Page
4. SETTING	26
4.1 Mode Menu.....	26
4.2 Monitor Mode 1.....	28
4.2.1 Display sequence.....	28
4.2.2 Description of each monitor item.....	29
(1) Input signal monitor 1 (InS1).....	29
(2) Phase angle ratio monitor (PHAr).....	31
(3) Current value monitor (CT).....	31
(4) Voltage value monitor (Vo).....	31
(5) Power value monitor (PoW).....	31
4.3 Monitor Mode 2.....	32
4.3.1 Display sequence.....	32
4.3.2 Description of each monitor item.....	33
(1) Power frequency monitor (IFrq).....	33
(2) Input signal monitor 2 (InS2).....	33
(3) External gradient set value monitor (EGr).....	33
(4) External manual set value monitor (EMAn).....	33
(5) Contact input state monitor (dIST).....	33
4.4 Setting Mode	34
4.4.1 Display sequence.....	34
4.4.2 Changing parameter settings.....	35
4.4.3 Description of each parameter.....	37
(1) Internal manual set value (IMAn).....	37
(2) Internal gradient set value (IGr).....	37
(3) Soft-start time (SoFS).....	37
(4) Soft-down time (SoFd).....	37
(5) Maximum load current set value for alarm (MAXC).....	38
(6) Heater break alarm 1 set value setting (HbA1).....	38
(7) Thyristor break-down set value setting (THb).....	39
(8) Heater break alarm 2 set value setting (HbA2).....	39
(9) Current limiter value setting (CL).....	40
(10) Set data lock setting (LCK).....	40
4.5 Engineering Mode	41
4.5.1 Transfer to engineering mode.....	41
4.5.2 Display sequence.....	43

	Page
4.5.3 Description of each parameter	44
(1) Function block 24 (F24.)	44
■ Contact input action (dISL)	44
(2) Function block 30 (F30.)	44
■ Output mode for phase control (oS)	44
■ Alarm 1 output logic (LGA1), Alarm 2 output logic (LGA2)	45
(3) Function block 45 (F45.)	45
■ Number of heater break alarm 1 delay times (HbC1)	45
■ Heater break alarm 1 type (AS1)	46
■ Alarm interlock (ILS)	46
(4) Function block 46 (F46.)	46
■ Number of heater break alarm 2 delay times (HbC2)	46
■ Heater break alarm 2 type (AS2)	46
(5) Function block 51 (F51.)	47
■ Control method (ConT)	47
■ RUN/STOP action (rSA)	47
■ Input signal (InSS)	47
(6) Function block 52 (F52.)	48
■ Output limiter (high) (oLH)	48
■ Output limiter (low) (oLL)	48
■ Output limiter (high) at operation start (SoLH)	48
■ Output limiter (high) time at operation start (SoLT)	48
■ Base-up set value (bAUP)	48
(7) Function block 60 (F60.)	49
(8) Function block 91 (F91.)	49
■ ROM version	49
■ Integrated operating time [upper 2 digits] (WTH)	49
■ Integrated operating time [lower 4 digits] (WTL)	49

5. FUNCTIONS

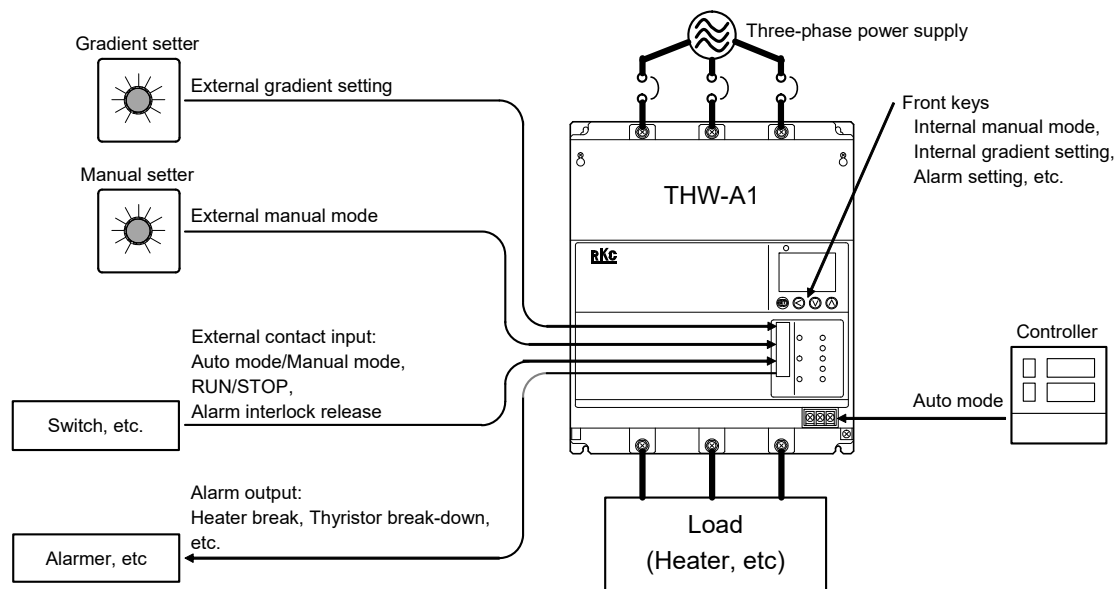
5.1 Control Method	50
5.2 Ramp Function (Soft-Start/Soft-Down Function)	50
5.3 Gradient Setting Function	51
5.4 Output Limiter (High and Low)	51
5.5 Output Limiter (High) at Operation Start	52
5.6 Base-Up Setting Function	53
5.7 Output Mode for Phase Control	54

	Page
5.8 Current Limiter Function (optional)	57
5.9 Automatic Power Frequency Detection and Power Frequency Monitoring Function	57
5.10 Alarm Interlock Function	58
5.11 Heater Break Alarm 1 (HBA1), Heater Break Alarm 2 (HBA2) and Thyristor Break-Down Alarm Functions (optional)	58
5.11.1 Number of alarm delay times	58
5.11.2 Heater break alarm for phase control (Type 1)	59
5.11.3 Heater break alarm for phase control (Type 2)	65
5.11.4 Heater break alarm for zero-cross control.....	66
5.12 FAIL Alarm.....	69
5.13 Negative Phase Sequence Alarm.....	69
5.14 Over Current Alarm (optional).....	69
5.15 Fuse Break Alarm (optional).....	69
5.16 Set Data Lock Function	69
5.17 External Contact Input (DI) Function	70
6. MAINTENANCE	71
6.1 Daily Inspection	71
6.2 Troubleshooting.....	72
6.3 Replacement of the Fast-Blow Fuse.....	73
6.3.1 Replacement of the fast-blow fuse (without microswitch)	73
6.3.2 Replacement of the fast-blow fuse (with microswitch)	76
7. SPECIFICATIONS	78
APPENDIX	82
■ Description of terms	83
■ Character symbols	83

1. OUTLINE

This instrument is a three-phase thyristor unit for power supply voltage 200 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.



 This is a thyristor unit designed for three-phase 3-wire system.

■ The rated currents of six types are available.

Power supply voltage	200 V AC					
Rated current	20 A	30 A	45 A	60 A	80 A	100 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 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.

■ Automatic power frequency detection

The instrument automatically detects a power supply frequency (50/60 Hz) when the power is turned on.

■ 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).

1.1 Checking the Product

Before using this product, check each of the following:

- Model code
- Check that there is 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)

THW - A 1 PZ □ - □ * □ □ □ - □
 (1) (2) (3) (4) (5) (6) (7) (8)*

* The code shown in (8) is printed on the nameplate when the relevant accessory is specified as an optional.

(1) Power supply

1: Three-phase 200 to 240 V AC

(2) Control method

PZ: Phase control/Zero-cross control (configurable)

(3) Rated current

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

(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

N: Standard (Proportional phase angle to input, Proportional voltage to input, Proportional square voltage (electric power) to input)

6: Standard and Constant voltage control (No heater break alarm)

V: Standard and Constant voltage control (With heater break alarm and current limiter function ¹)

E: Standard and Constant current control (With heater break alarm and current limiter function ¹)

W: Standard and Constant power control (With heater break alarm and current limiter function ^{1,2})

¹ When the Heater break alarm and Current limiter are provided, the Over current and Thyristor break-down alarm are available.

² The Constant current control is available. The Constant voltage control is not available.

(6) Fuse

- N: No fast-blow fuse is provided
- F: Built-in fast-blow fuse
- S: Built-in fast-blow fuse (With microswitch)

(7) Optional function

- N: No function

(8) Accessories

- 1: Setter (potentiometer, knob and scale plate) [1 set] and Input/Output connector (plug)
- 2: Setter (potentiometer, knob and scale plate) [2 sets] and Input/Output connector (plug)
- 9: Input/Output connector (plug)
- N: Without terminal cover (For main circuit terminal)

■ Accessories (Order Separately)

- THV1P-S01: Setter (potentiometer, knob and scale plate)
- THWP-C01: Input/Output connector (plug)
- THWP-F20: Fast-blow fuse for 20 A
- THWP-F30: Fast-blow fuse for 30 A
- THWP-F40: Fast-blow fuse for 45 A and 60 A
- THWP-F80: Fast-blow fuse for 80 A
- THWP-FA0: Fast-blow fuse for 100 A
- THWP-F21: Fast-blow fuse for 20 A (With microswitch)
- THWP-F31: Fast-blow fuse for 30 A (With microswitch)
- THWP-F41: Fast-blow fuse for 45 A and 60 A (With microswitch)
- THWP-F81: Fast-blow fuse for 80 A (With microswitch)
- THWP-FA1: Fast-blow fuse for 100 A (With microswitch)
- THWP-A11: Terminal cover for 20 A, 30 A, 45 A and 60 A (For main circuit terminal)
- THWP-A12: Terminal cover for 80 A and 100 A (For main circuit terminal)

The accessories attached to product

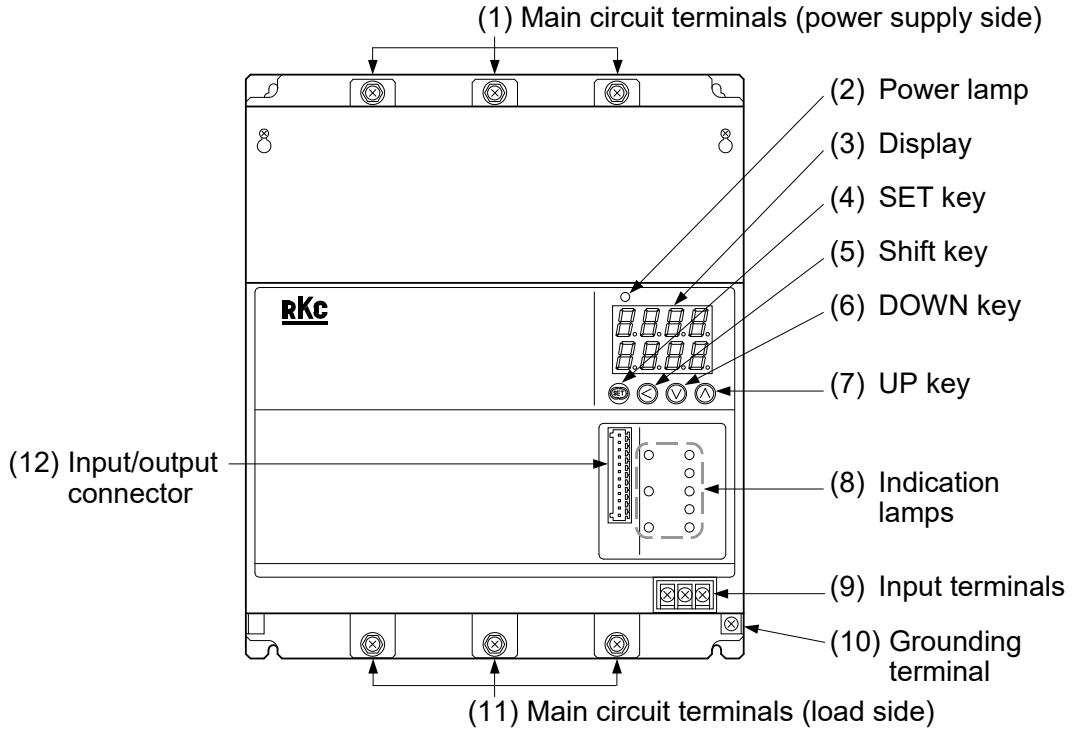
Instruction Manual (IMR02R01-E3).....	1
Short bar (The short bar is connected to the “input terminals.”).....	1
Terminal cover (For main circuit terminal) *.....	2

* With provided 4 screws for fixing the terminal covers







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

1.2 Parts Description



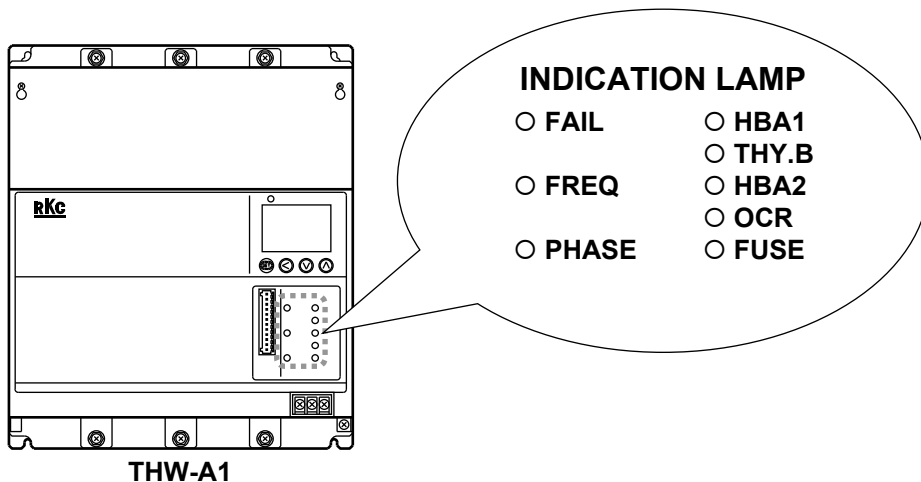
THW-A1

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

No.	Name	Description	No.	Name	Description
(1)	Main circuit terminals (power supply side) (1/L1, 3/L2, 5/L3)	Used to connect three-phase power supply.	(7)	 (UP key)	<ul style="list-style-type: none"> Used to select the monitor item and function block (F□□). Increase numerals.
(2)	Power lamp (green)	Lit when the power is turned on.	(8)	Indication lamps (red)	Lights when any error occurs. For details, refer to the Description of Indication lamp (P. 5).
(3)	Display	<ul style="list-style-type: none"> Display (upper): Display the parameters symbols and numeric value. Display (lower): Display the input signal value and each set value. 	(9)	Input terminals	Used to connect input signal wires (controller, etc.).
(4)	 (SET key)	Used for parameter calling up and set value registration.	(10)	Grounding terminal	Used to connect the grounding terminal.
(5)	 (Shift key)	<ul style="list-style-type: none"> Used to select the mode. Shift digits when settings are changed. 	(11)	Main circuit terminals (load side) (2/T1, 4/T2, 6/T3)	Used to connect the load.
(6)	 (DOWN key)	<ul style="list-style-type: none"> Used to select the monitor item and function block (F□□). Decrease numerals. 	(12)	Input/Output connector (socket) [Optional]	Used to connect with a setter (potentiometer), external contact or controller. In addition, used to alarm output.

■ **Description of indication lamp**

If an error occurs, the indication lamp lights.



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

Symbol	Description	Action taken when an error occurs
FAIL (Board error)	This lamp lights if a board error of this instrument is detected by the self-diagnosis function.	Thyristor output OFF
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.	Thyristor output OFF The output can be turned ON when the error is canceled.
PHASE (Negative phase sequence)	This lamp lights if negative phase sequence or the open phase is detected.	Thyristor output OFF
HBA1 (Heater break alarm 1)	Lights when Heater break alarm 1 output is turned on. HBA1 is not available when heater break alarm is not provided.	Control is continued. *
THY.B (Thyristor break-down alarm)	Lights when thyristor break-down alarm output is turned on. Thyristor break-down alarm is not available when heater break alarm is not provided.	Control is continued. When shorted: Thyristor output continues to be turned ON When broken: Thyristor output OFF
HBA2 (Heater break alarm 2)	Lights when Heater break alarm 2 output is turned on. HBA2 is not available when heater break alarm is not provided.	Control is continued. *
OCR (Over current)	This lamp lights if the current of more than 1.2 times the rating of this instrument flows. The over current alarm is not available when heater break alarm is not provided.	Thyristor output OFF
FUSE (Fuse break)	This lamp lights if the fast-blow fuse in this instrument blew. Fuse break alarm is not available when the fast-blow fuse (with microswitch) is not provided.	Thyristor output OFF

* When this instrument is switched to STOP by the RUN/STOP transfer during alarm state, the action of the instrument is as follows.

- Thyristor output OFF
- Heater bareak alarm (HBA) output remains on.

☞ When an abnormality occurs, refer to **6.2 Troubleshooting (P. 72)**.

2. MOUNTING



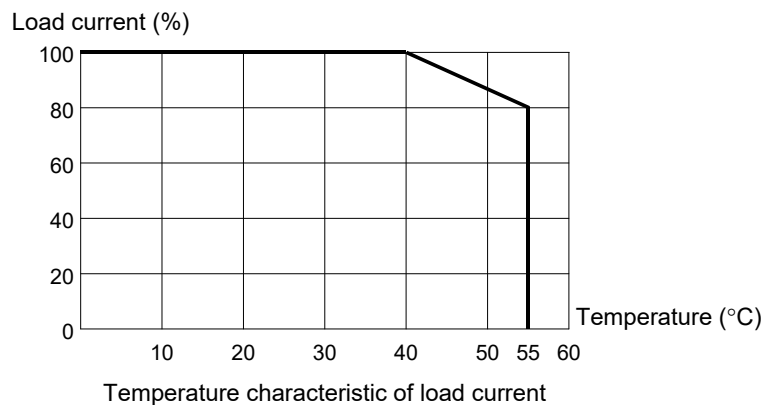
WARNING

- 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.

2.1 Mounting Environment

Avoid the following conditions when selecting the mounting location:

- Ambient temperature of less than 0 °C or more than 40 °C.
(The rated current drops when the ambient temperature exceeds 40 °C.)

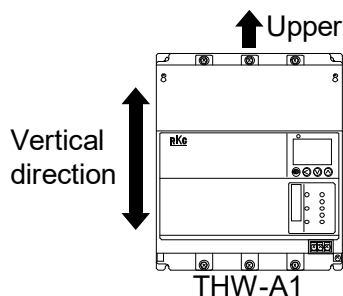


- Ambient humidity of less than 5 % or more than 95 %RH.
(Absolute humidity: MAX. W. C 29 g/m³ dry air at 101.3 kPa)
- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Such a place where there are inflammable materials near this instrument.
- Direct 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.

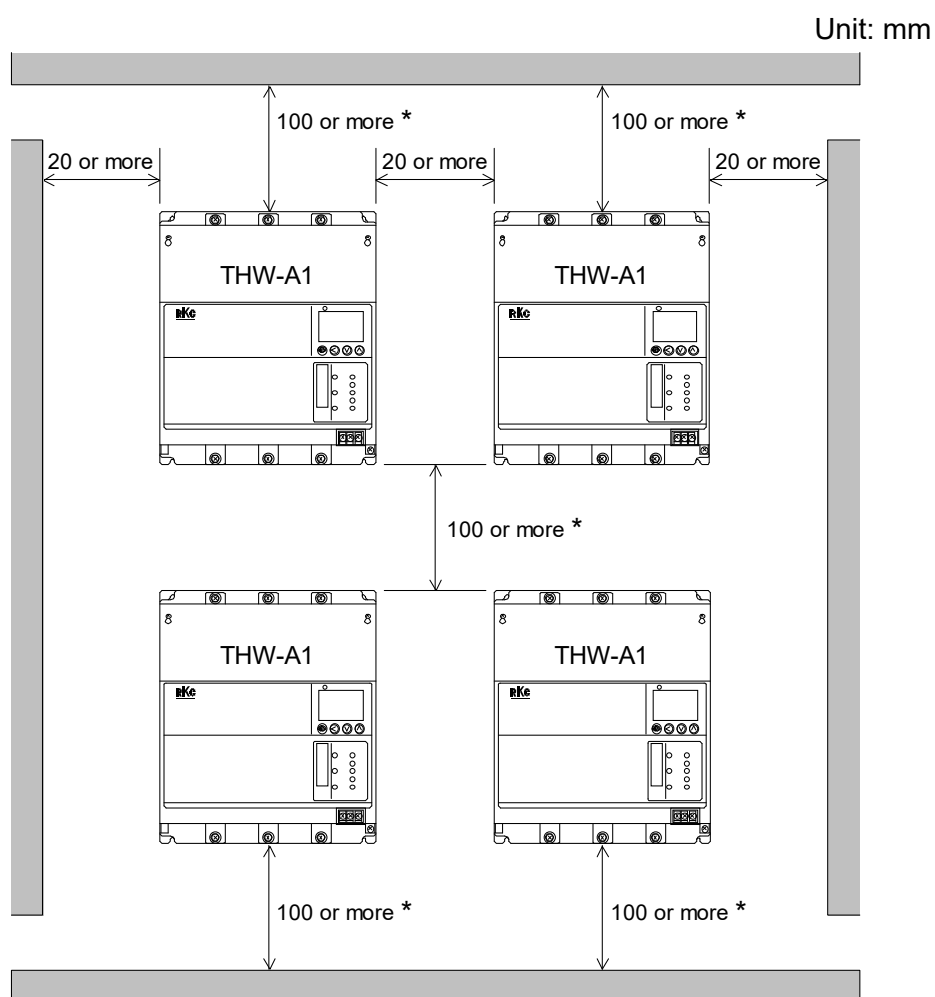
2.2 Mounting Cautions

Take the following points into consideration when mounting this instrument.

- Mount this instrument in the direction shown below.



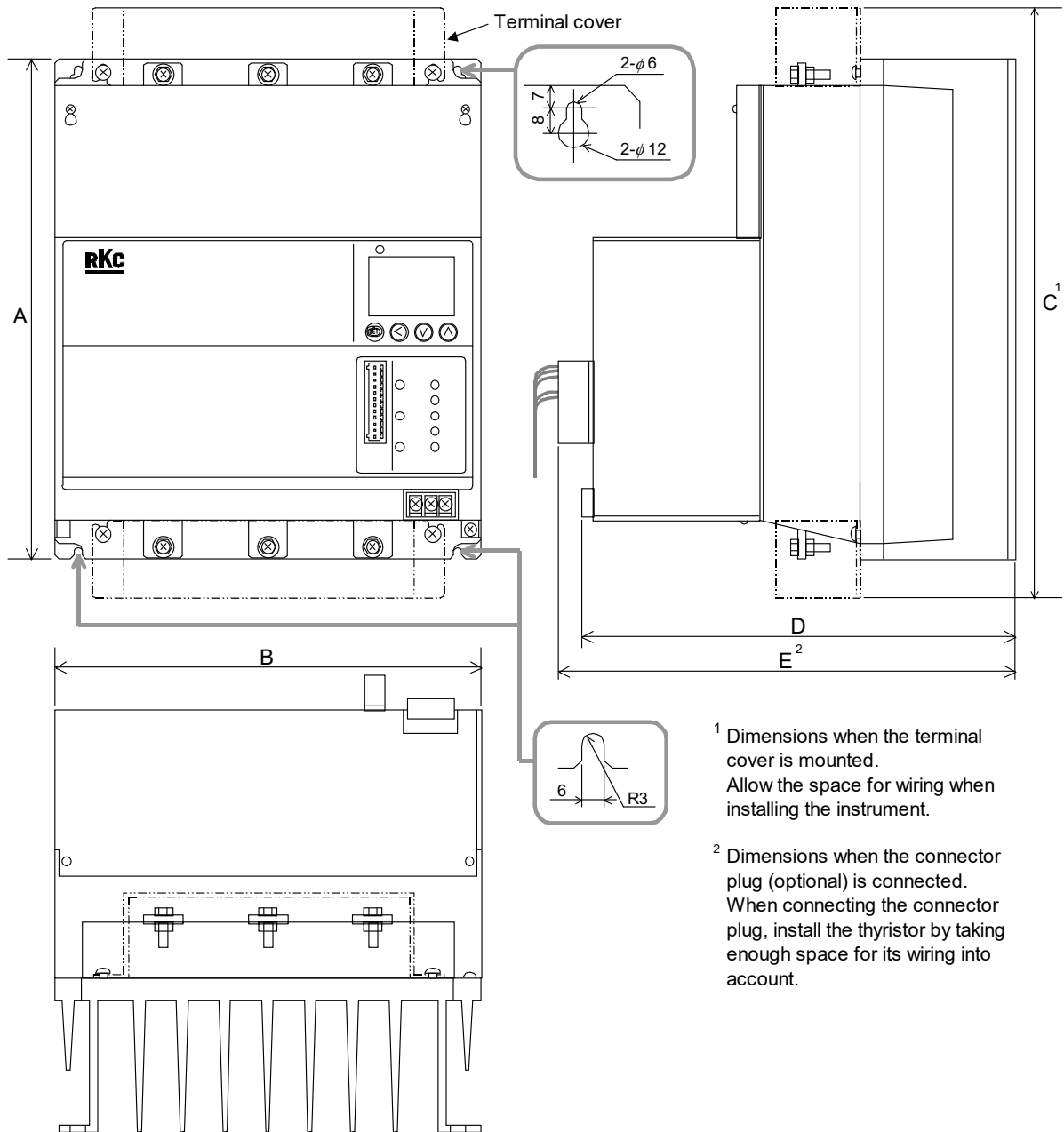
- Provide adequate heat radiation space so that heat does not build up.
- At least 20 mm is necessary on the left and right and at least 100 mm on the top and bottom.
- If the panel inside temperature rises due to self-generation of heat, install a forced circulation fan so that the panel inside is fully ventilated with the open air.



* For standard mounting size, refer to Dimensions A at 2.3 Dimensions (P. 8).

2.3 Dimensions

■ Dimensions



Unit: mm

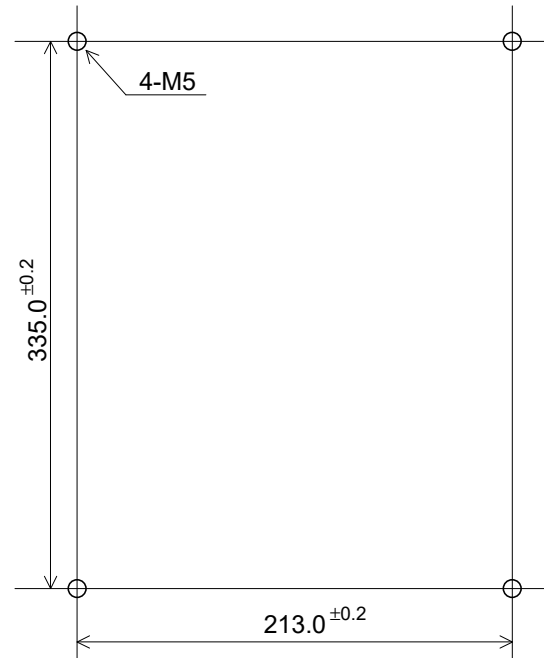
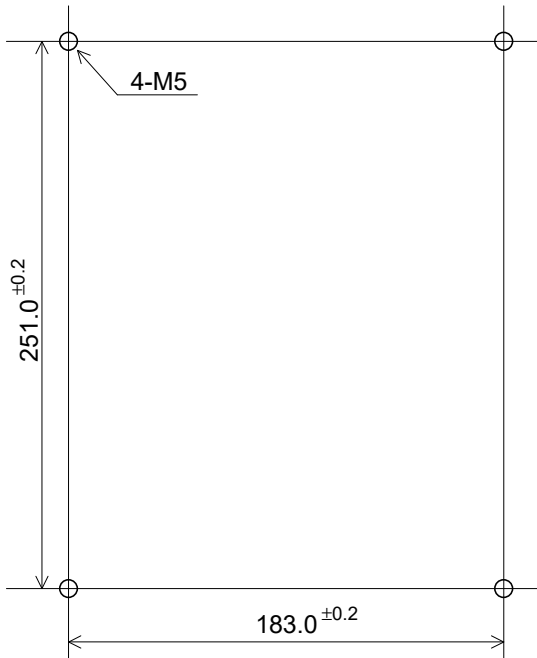
Types \ Dimensions	A	B	C	D	E
20 A, 30 A, 45 A and 60 A types	263.0	200.0	318.0	203.0	212.0
80 A and 100 A types	347.0	230.0	401.0	231.0	244.0

■ Mounting dimensions

20 A, 30 A, 45 A and 60 A types

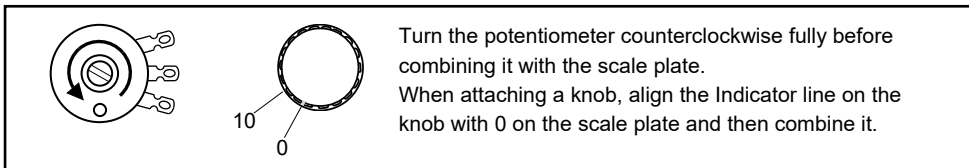
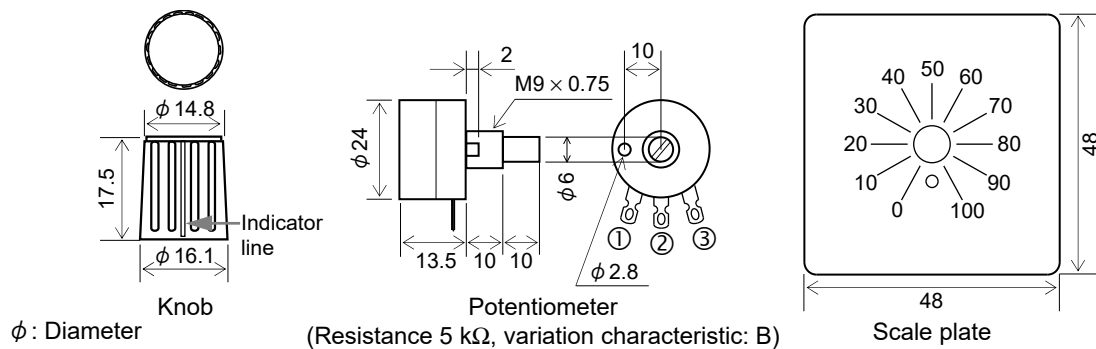
80 A and 100 A types

Unit: mm



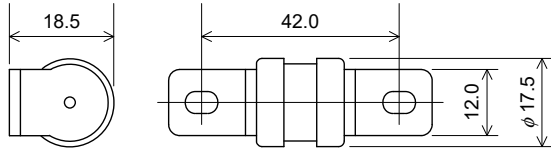
■ Setter (Potentiometer, Knob and Scale plate)

Unit: mm

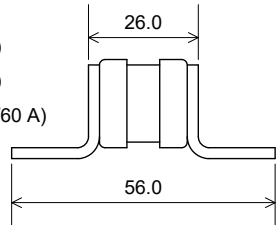


■ Fast-blow fuse (For 20 A, 30 A, 45 A and 60 A)

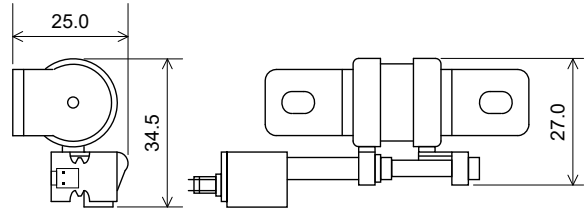
Unit: mm



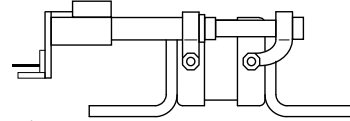
Code:
 THWP-F20 (20 A)
 THWP-F30 (30 A)
 THWP-F40 (45 A/60 A)



Without microswitch



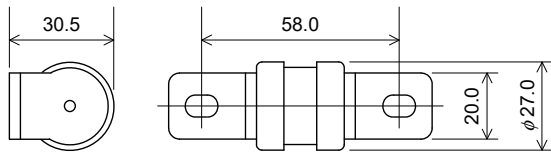
Code:
 THWP-F21 (20 A)
 THWP-F31 (30 A)
 THWP-F41 (45 A/60 A)



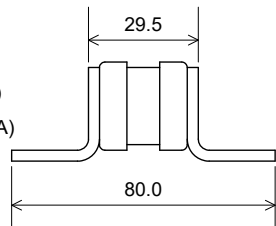
With microswitch

■ Fast-blow fuse (For 80 A and 100 A)

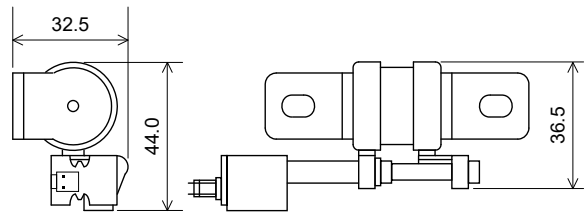
Unit: mm



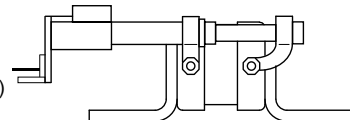
Code:
 THWP-F80 (80 A)
 THWP-FA0 (100 A)



Without microswitch



Code:
 THWP-F81 (80 A)
 THWP-FA1 (100 A)

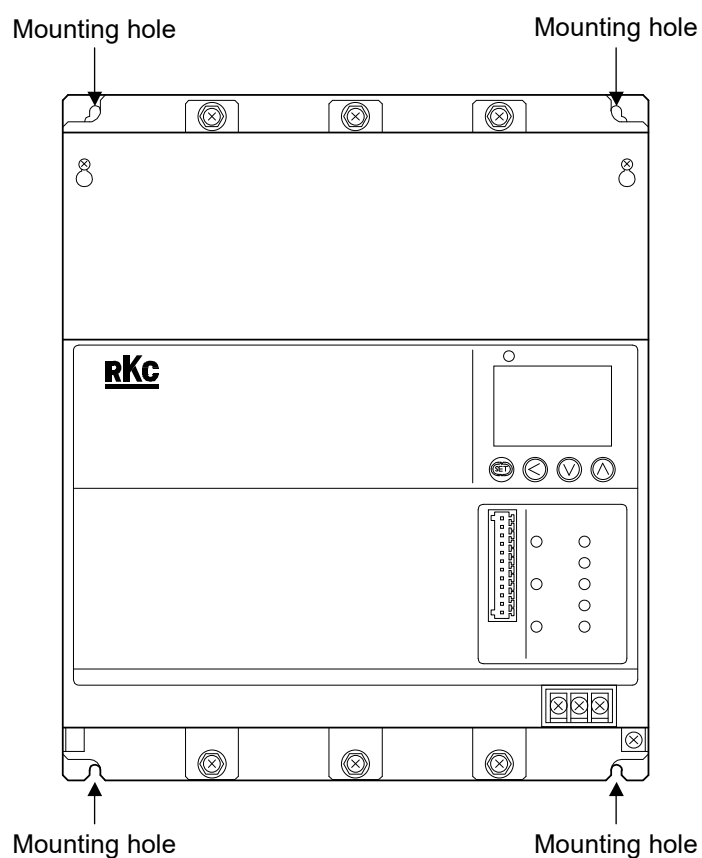


With microswitch

2.4 Mounting Procedures

1. Prepare the holes as specified in ■ **Mounting dimensions (P. 9)**.
2. Place the instrument in mounting position.
3. Insert the mounting screws into the holes, and then tighten them with a Phillips screwdriver.
Customer must provide the set of screws.

Screw size	Recommended tighten torque
M5	3.6 N·m (36 kgf·cm)



The Figure shows the type of 20 A to 60 A. However, the mounting procedure is the same as for the type of 80 A/100 A.

2.5 How to Fix the Terminal Cover



WARNING

In order to prevent electric shock or instrument failure, always fix or remove the terminal cover after power supplied to the entire system is turned off.

(1) Checking the product

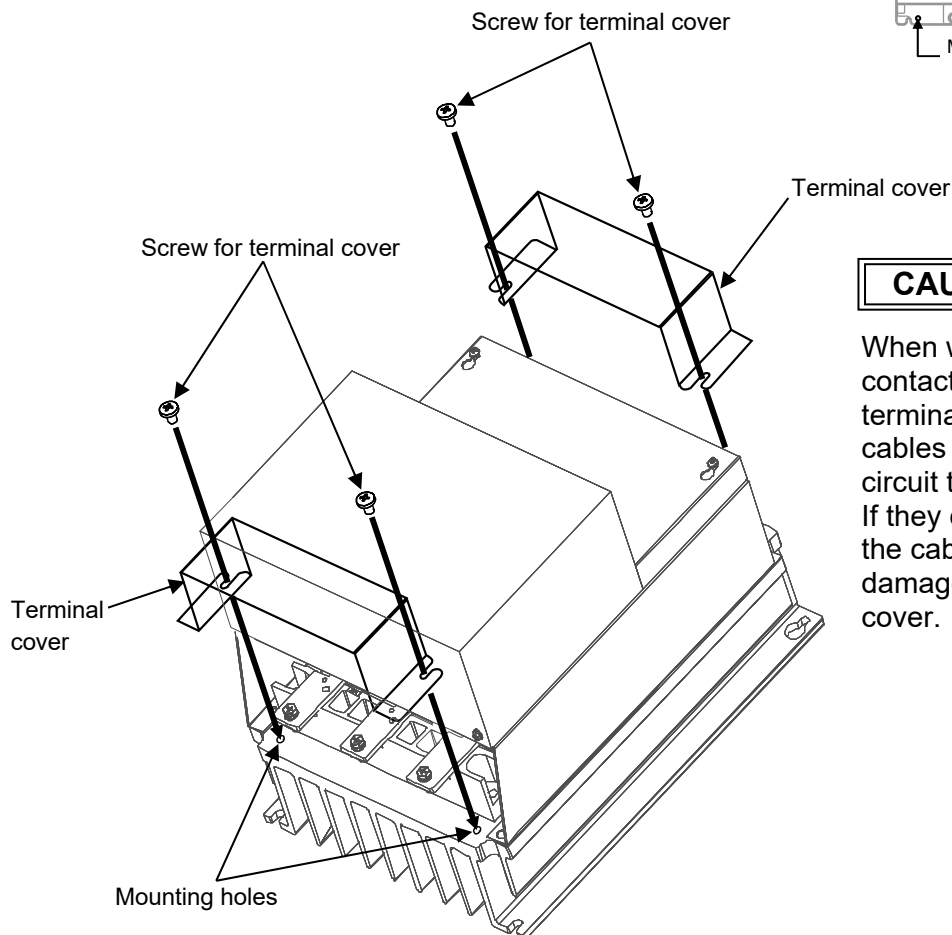
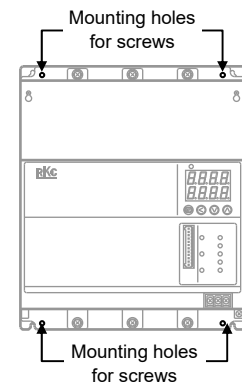
If there is any shortage of accessories, contact the RKC sales office or your nearest RKC sales agent.

- Terminal cover (For main circuit terminal): 2 pieces
- Screw for terminal cover: 4 pieces

(2) Mounting procedures

Tools necessary for mounting: Phillips screwdriver

- ① Place the terminal covers at the mounting locations.
- ② Tighten each screw using the Phillips screwdriver to fix the terminal cover.
(Recommended tightening torque: 0.4 N·m [4.1 kgf·cm])



CAUTION

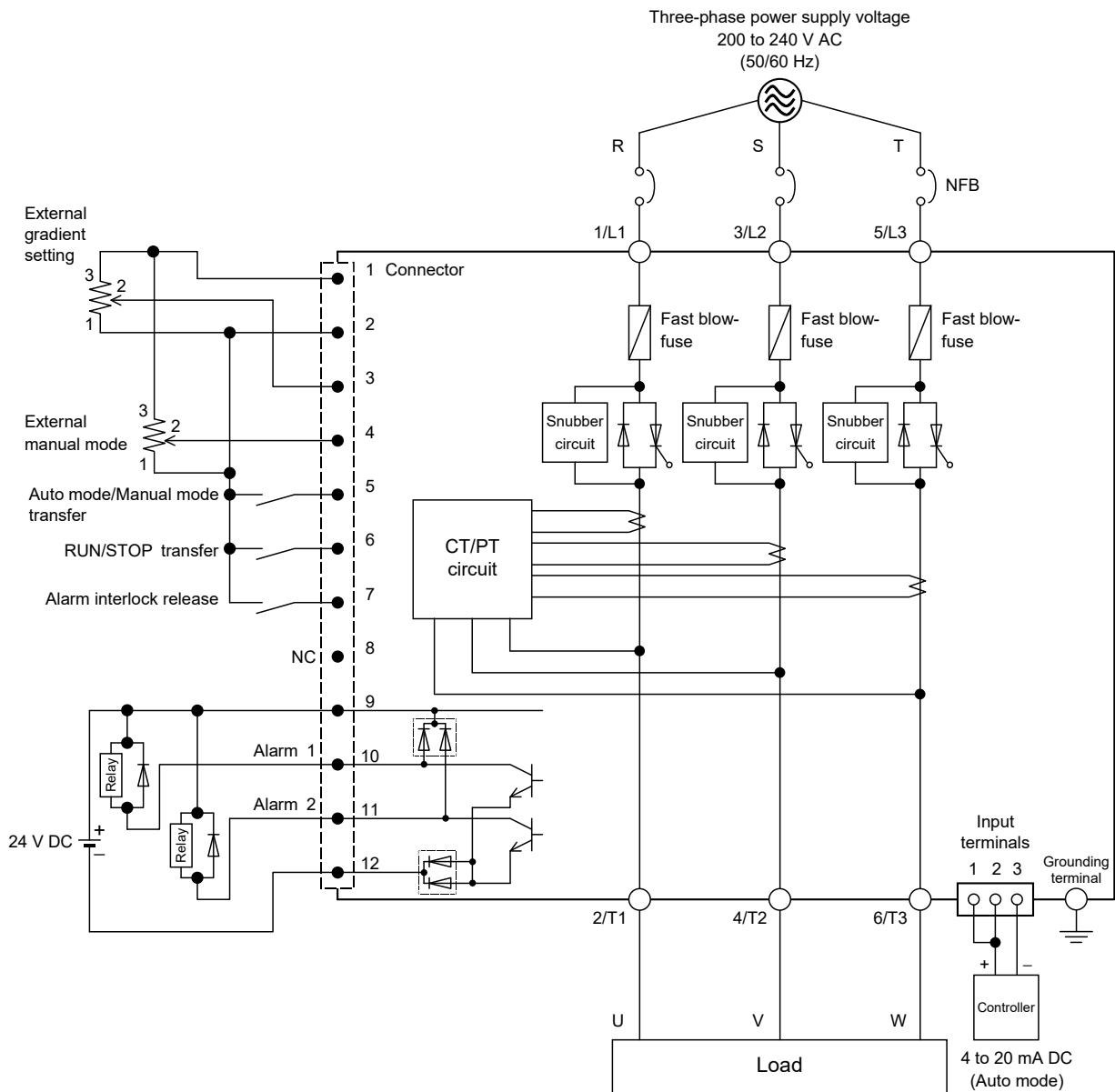
When wiring, avoid contact between the terminal cover and the cables for the main circuit terminals. If they contact, pulling the cables forcibly may damage the terminal cover.

3. WIRING



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, CT and PT are optional.



No instrument power supply wiring is required. Its wiring is already conducted within the instrument.

3.2 Wiring of Main Circuit

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

CAUTION

- Always conduct wiring so that the R, S and T phases of 3-phase power coincide with the main circuit terminals (power side), 1/L1, 3/L2 and 5/L3 on this instrument, respectively. Otherwise the instrument may not function properly or the load may be damaged.
R → Connect to the 1/L1 terminal.
S → Connect to the 3/L2 terminal.
T → Connect to the 5/L3 terminal.
- Always coincide the main circuit terminals (load side), 2/T1, 4/T2 and 6/T3 on this instrument with the U, V and W phases of the load, respectively. Otherwise the instrument may not function properly or the load may be damaged.
2/T1 terminal → Connect to the U.
4/T2 terminal → Connect to the V.
6/T3 terminal → Connect to the W.
- When controlling the primary side of the transformer, do not open its secondary side of circuit during operation. In addition, do not operate the instrument below the minimum load current.
- When controlling the primary side of the transformer, set magnetic field density of the transformer to about 0.8T (8,000-gauss). If the transformer is saturated, overcurrent flows through it to cause the thyristor to be damaged.
- Imbalance between each phase of the load may result in a large error of the input/output characteristic.
- No power switch is provided in this instrument. Therefore install the switches near the instrument, if necessary.
- 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 grounding terminal.
- 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.

Recommended tool: Manufactured by TOHNICHI MFG. CO., LTD.

	Model code of adjustable type torque wrench with ratchet head	Socket size
20 A/30 A	QL3N	M4
45 A/60 A	QL6N	M6
80 A/100 A	QL12N	M8

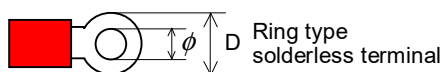
- Use wires satisfying the rated current capacity.
- Firmly tighten each terminal hexagon headed bolt with the tightening torque specified below. Otherwise, electric shock, fire or heat generation may result.

Terminal hexagon bolt size and tightening torque list

	Main circuit terminal (1/L1 to 5/L3 and 2/T1 to 6/T3)		
	20 A/30 A	45 A/60 A	80 A/100 A
Hexagon bolt size	M4	M6	M8
Recommended tightening torque	1.6 N·m (16.31 kgf·cm)	3.8 N·m (38.74 kgf·cm)	9.0 N·m (91.77 kgf·cm)

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

Ring type solderless terminal size



	Main circuit terminal (1/L1 to 5/L3 and 2/T1 to 6/T3)		
	20 A/30 A	45 A/60 A	80 A/100 A
φ dimension	4.3 mm or more	6.4 mm or more	8.4 mm or more
D dimension	9.5 mm or less	12.0 mm or less	22.0 mm or less

■ Wiring of the main circuit

CAUTION

This is a thyristor unit designed for three-phase 3-wire system. The instrument must be used in the three-phase 3-wire system.

Three-phase power supply voltage
200 to 240 V AC
(50/60 Hz)

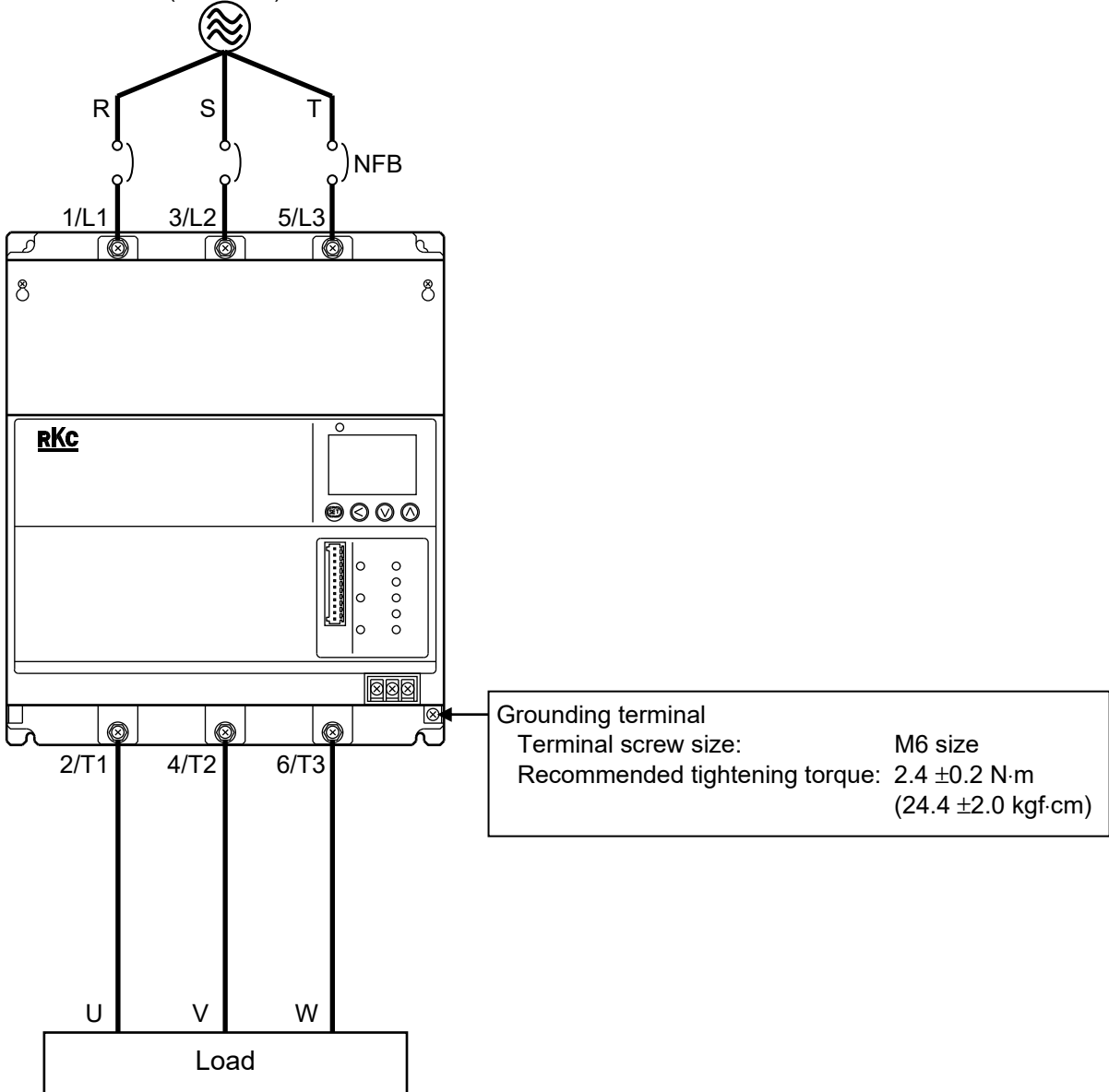


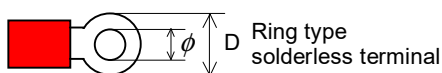
Table of calorific values

	Rating current					
	20 A	30 A	45 A	60 A	80 A	100 A
200 to 240 V AC	82 W	118 W	172 W	226 W	298 W	370 W

3.3 Wiring of Controller (Auto Mode)

When using a solderless terminal lug, use ring type.

Ring type solderless terminal size



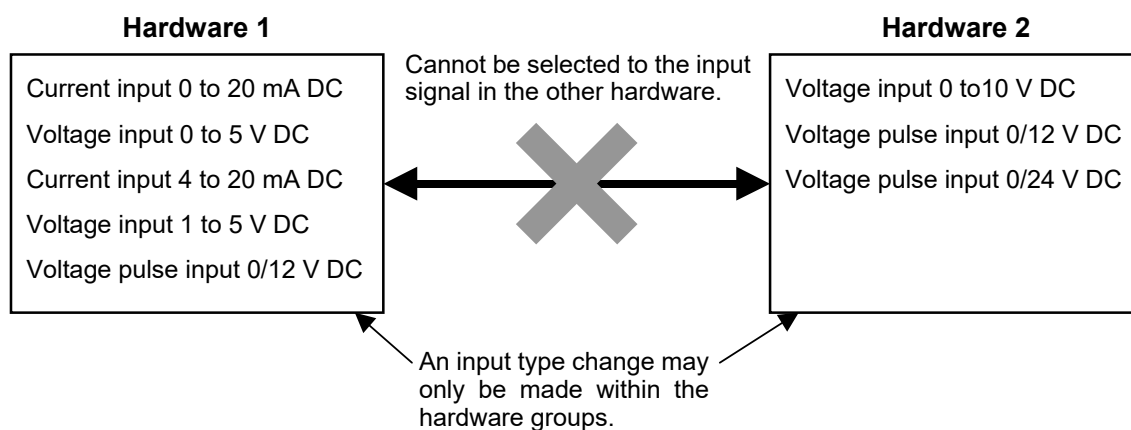
	Input terminal (1, 2 and 3)
ϕ dimension	3.2 mm or more
D dimension	5.5 mm or less
Recommended tightening torque	0.4 N·m (4 kgf·cm)

■ 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.

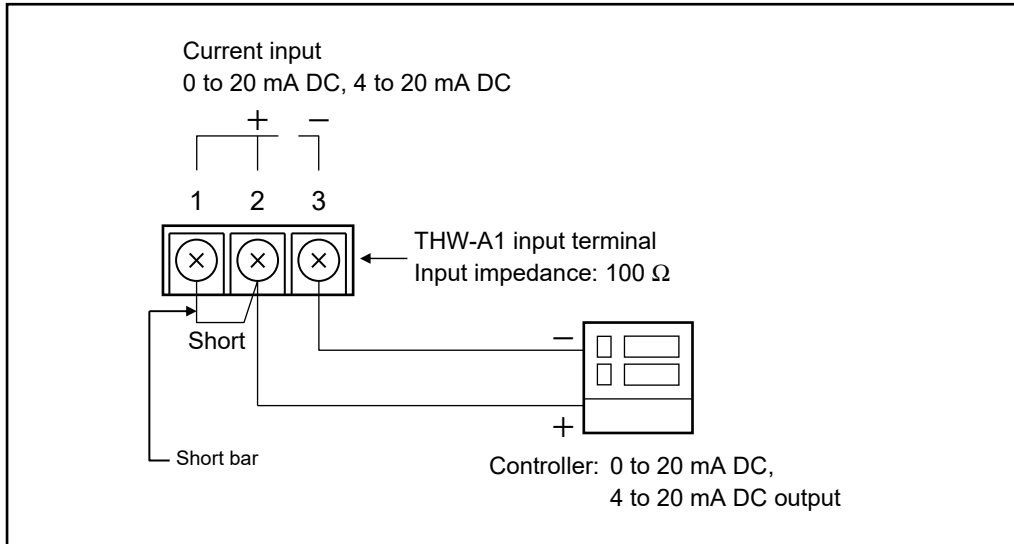
- Set the type of input signal by Input signal (InSS) in Engineering mode. (Refer to P. 47)
- Change the position of the short bar to match the input type. (Refer to the next page.)

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.



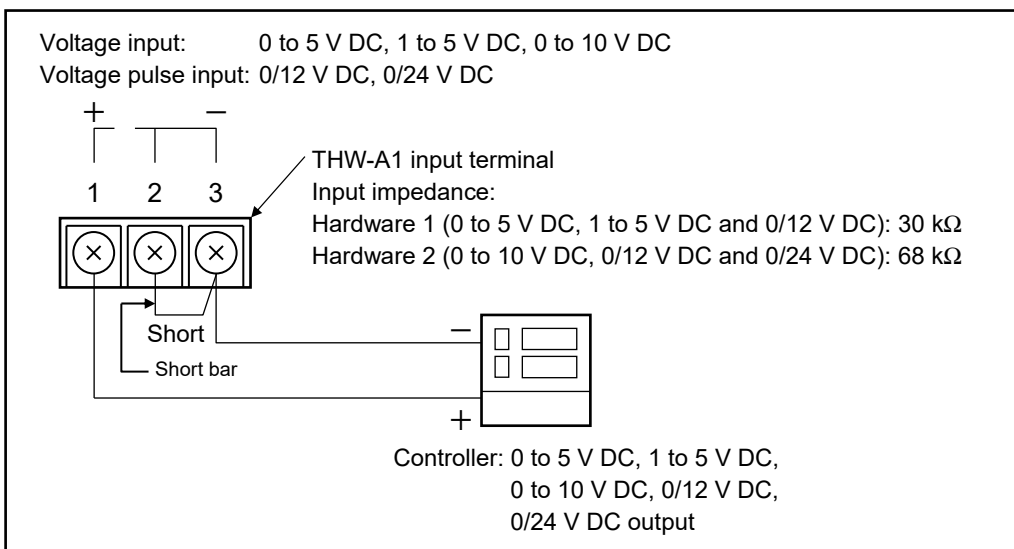
3.3.1 Wiring of the current input

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

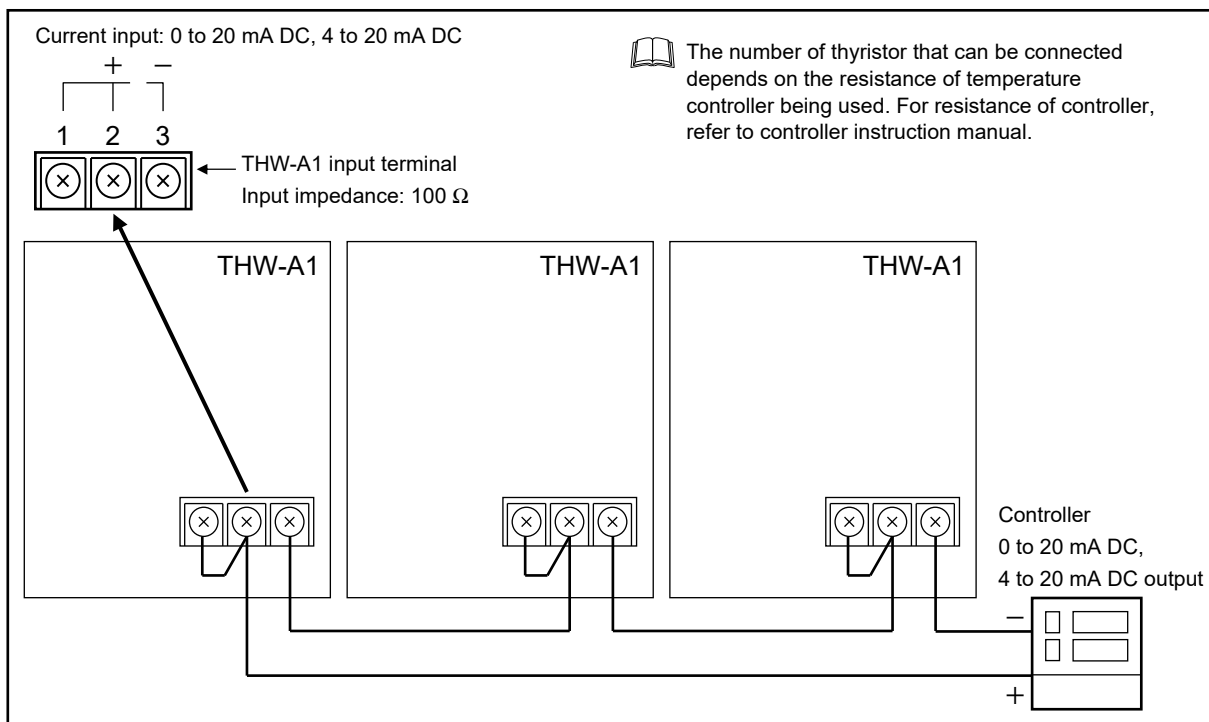


3.3.2 Wiring of the voltage input or voltage pulse input

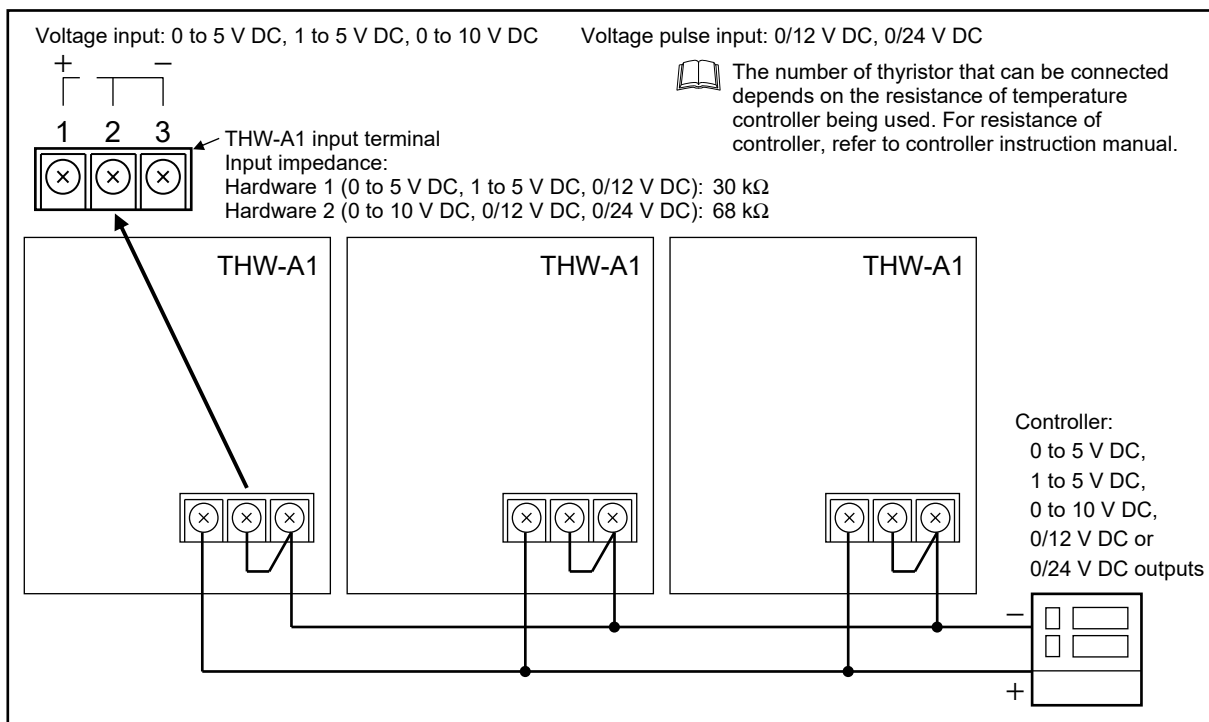
For voltage input (0 to 5 V DC, 1 to 5 V DC or 0 to 10 V DC) or voltage pulse input (0/12 V DC, 0/24 V DC), short terminal No.2 with terminal No.3.



3.3.3 Wiring of the series connection (For current input)



3.3.4 Wiring of the parallel connection (For voltage input or voltage pulse input)



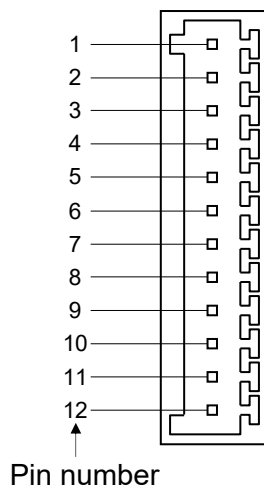
3.4 Wiring for Input/Output Connector

To use the following functions, prepare the Input/Output connector for wiring.

(Plug side: THWP-C01 [sold separately])

- External manual setting
- External gradient setting
- External contact input (Auto/Manual mode transfer, RUN/STOP transfer, alarm interlock release)
- Alarm output

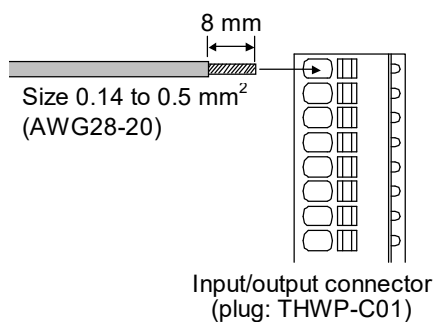
3.4.1 Input/Output connector pin number and details



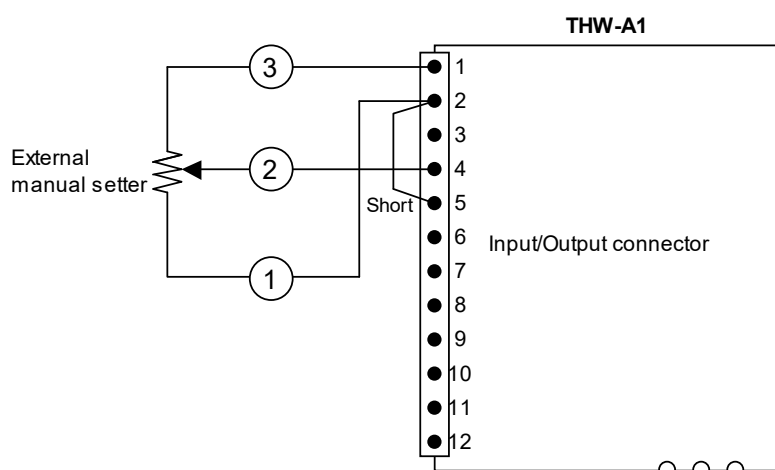
Pin No.	Details
1	+5 V output
2	0 V
3	External gradient setting input (0 to 5 V input by the gradient setter)
4	External manual setting input (0 to 5 V input by the manual setter)
5	External contact input (DI) Auto/Manual mode transfer: Contact closed: Manual mode Contact open: Auto mode
6	External contact input (DI) RUN/STOP transfer: Contact closed: RUN Contact open: STOP When using RUN/STOP transfer, it is necessary to set RUN/STOP action (rSA) to "1: Used." (Refer to P. 47)
7	External contact input (DI) Alarm interlock release: Closing the contact releases the alarm interlock
8	Unused
9	24 V DC (+)
10	Alarm 1: Open collector output In order to output an alarm, it is necessary to select the type of alarm by Alarm 1 output logic (LGA1). (Refer to P. 45)
11	Alarm 2: Open collector output In order to output an alarm, it is necessary to select the type of alarm by Alarm 2 output logic (LGA2). (Refer to P. 45)
12	0 V

3.4.2 Caution for wiring input/output connector (plug)

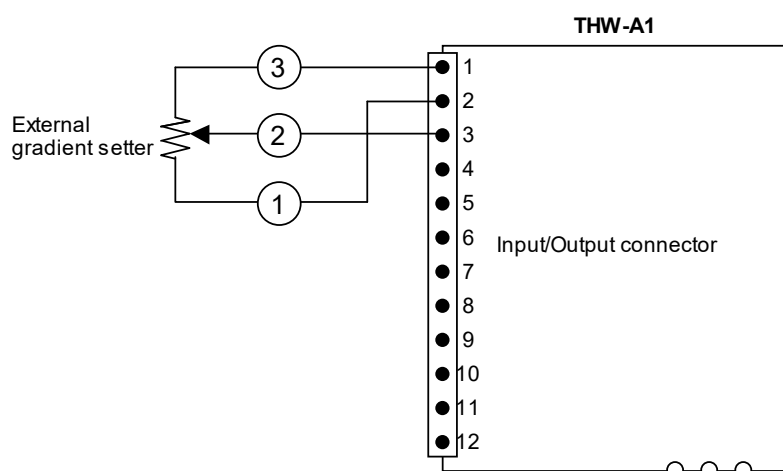
- Use stranded wire of size 0.14 to 0.5 mm² for the leadwires.
- Strip off the sheath from 8 mm from the leadwire end.



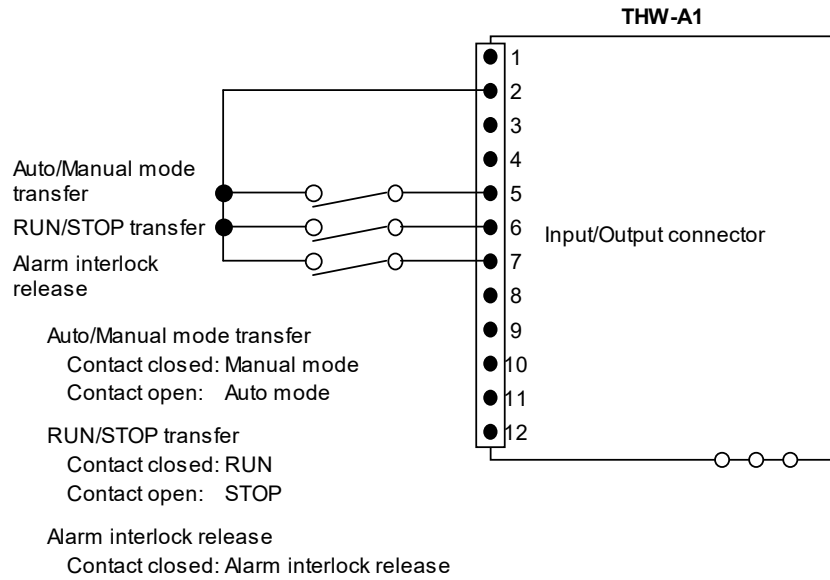
3.4.3 Wiring of external manual setter



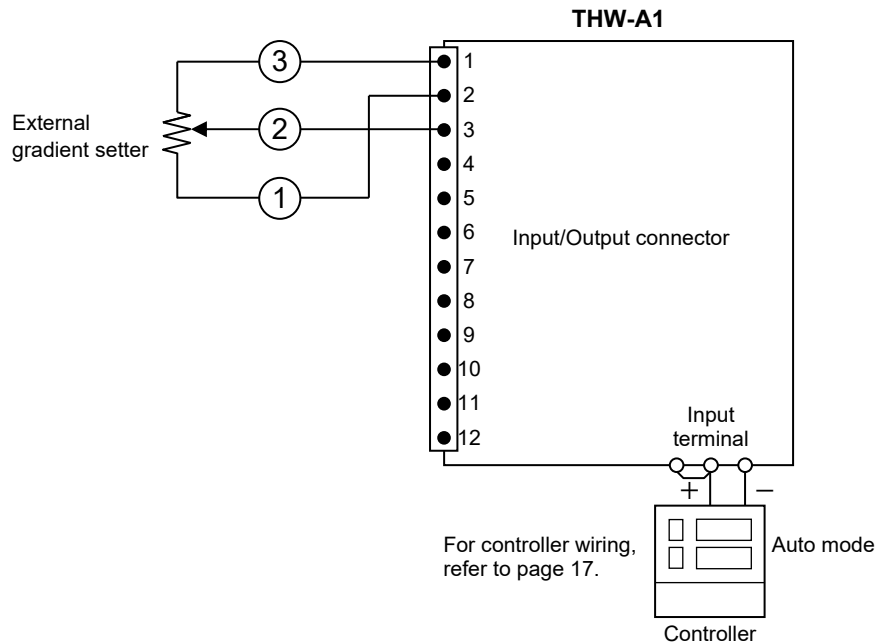
3.4.4 Wiring of external gradient setter



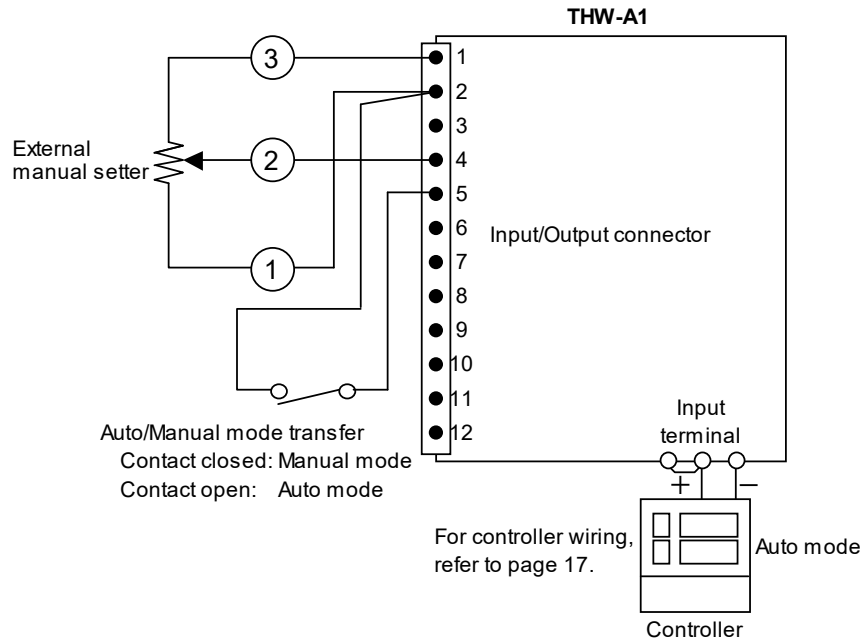
3.4.5 Wiring of external contact input



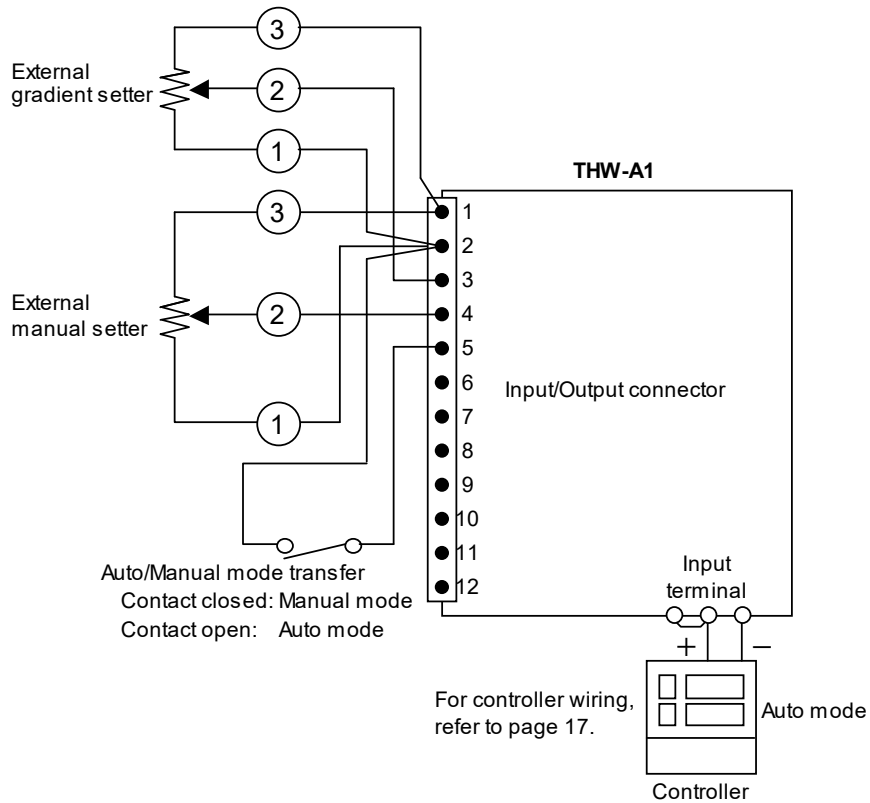
3.4.6 Wiring of Auto mode (with gradient setter)



3.4.7 Wiring of Auto/Manual mode selection



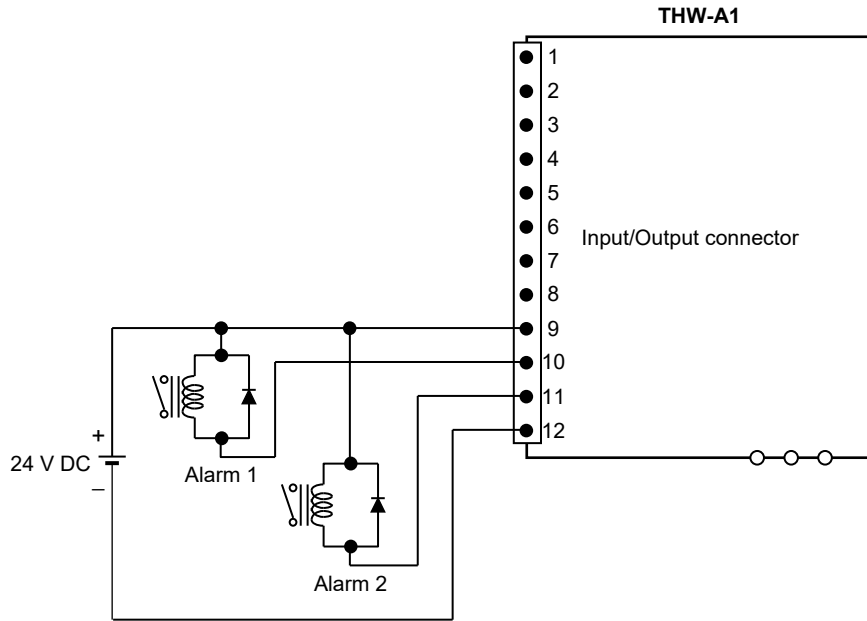
3.4.8 Wiring of Auto/Manual mode selection (with gradient setter)



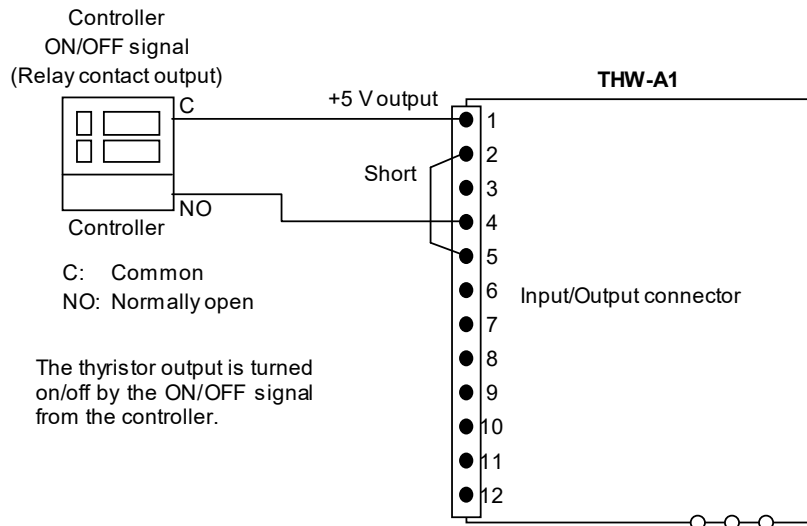
3.4.9 Wiring of alarm output



A diode should be used and connected as show in the diagram, when using a relay.



3.4.10 Wiring of contact input



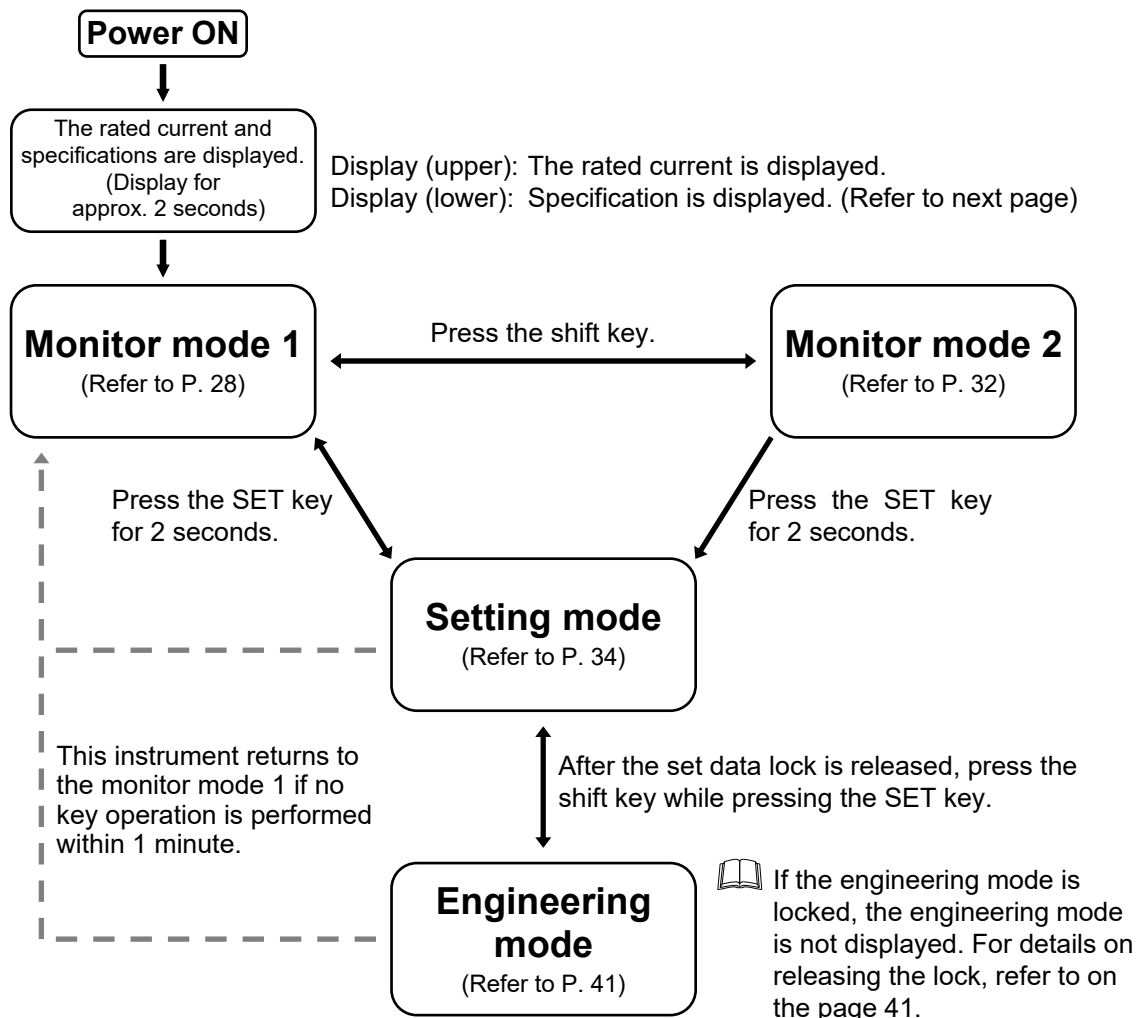
4. SETTING

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

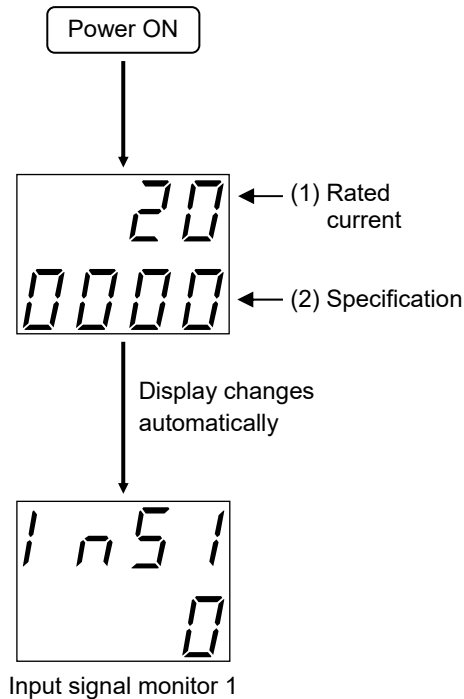
THW-A1 has four different modes, and all settable parameters belongs to one of them. The following chart show how to access different mode.

- **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:** The parameters (Soft-start/Soft-down, Internal gradient, Set data lock and others) can be set.
- **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.



■ The rated current and specification display

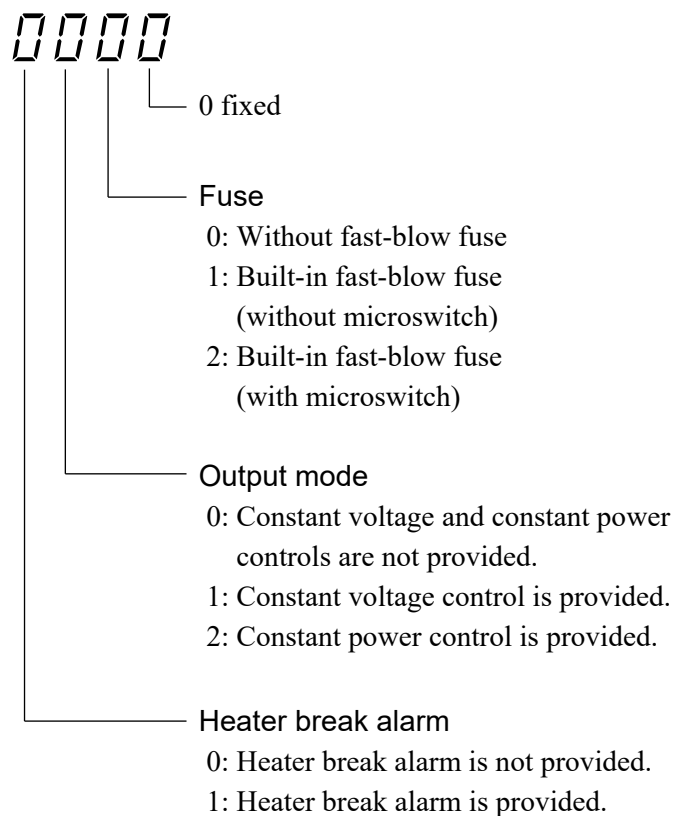
THW-A1 immediately confirms the rated current and specification following power ON.



(1) The rated current display

Parameter	Rated current
20	20 A
30	30 A
45	45 A
60	60 A
80	80 A
100	100 A

(2) Specification display



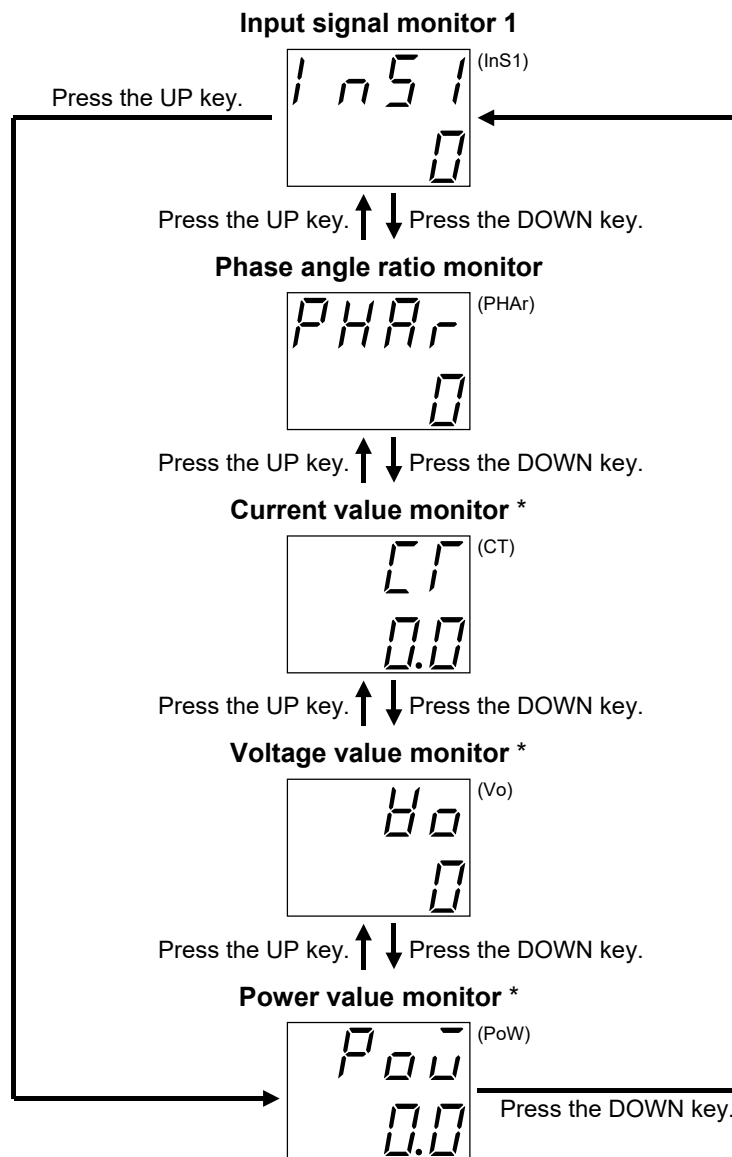
4.2 Monitor Mode 1

When the power is turned on, THW-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
- 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.



* These parameters may not be displayed depending on the specification.

4.2.2 Description of each monitor item

(1) Input signal monitor 1 (1 n 5 1)

Select and then display one input signal value from among three input signal values. The type of input signal to be displayed can be selected by the external contact input.

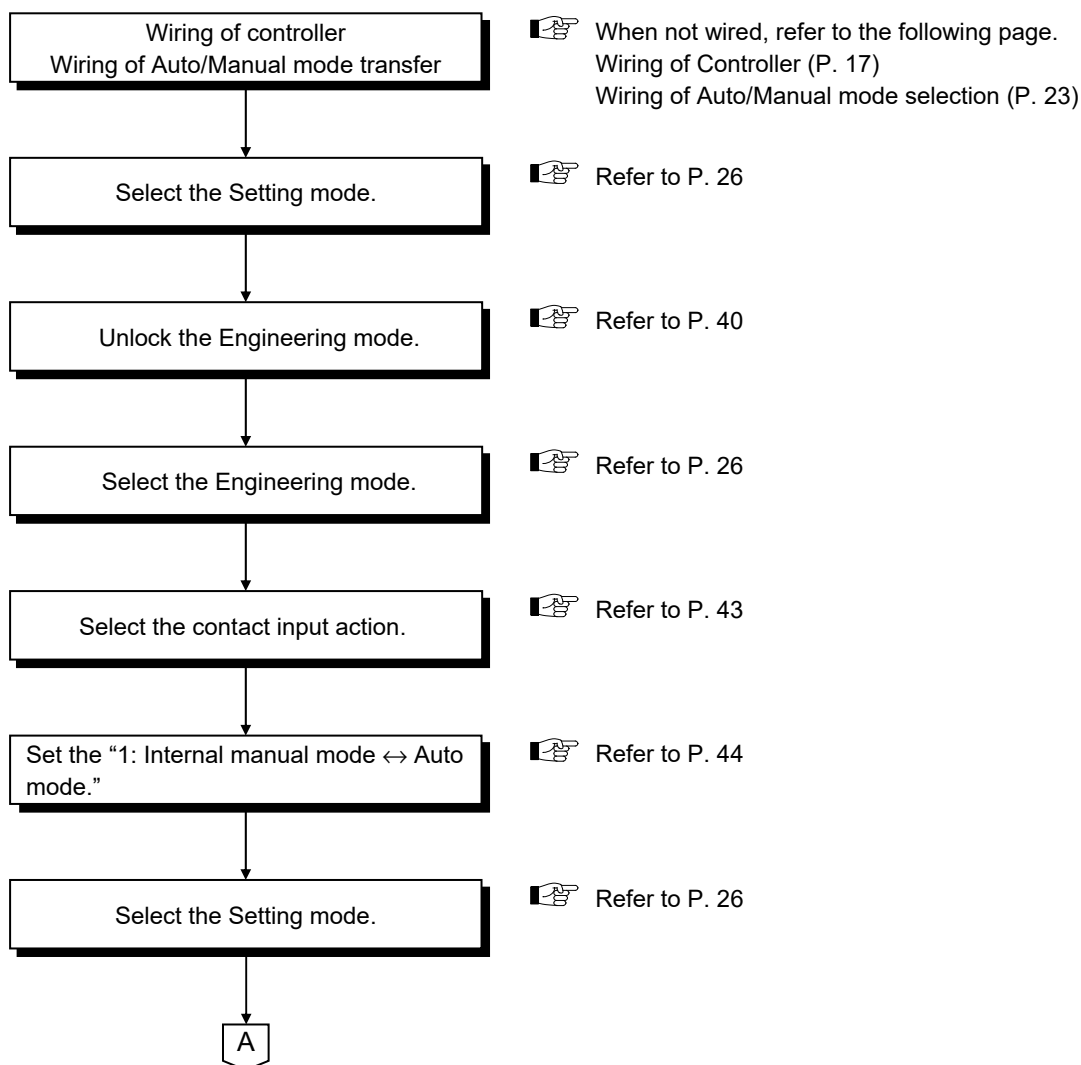
Input signal type: Auto set value (Value of Auto mode)
 External manual set value
 Internal manual set value

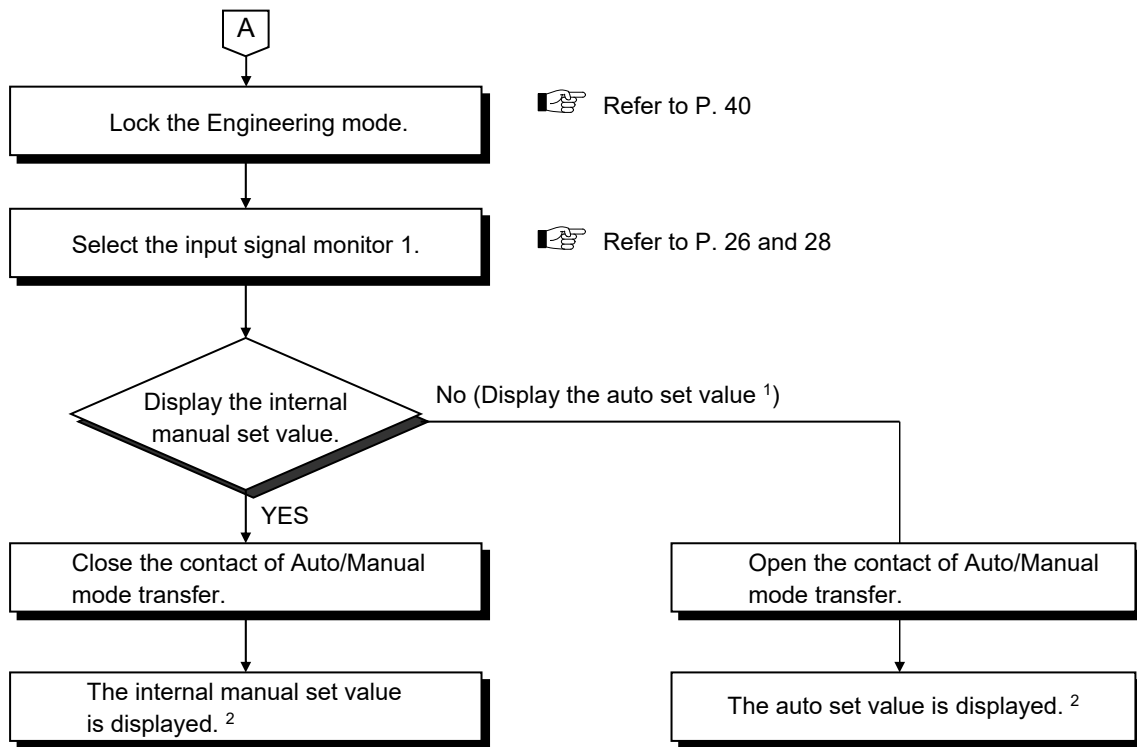
Display range: 0 to 100 %



The internal manual set value displayed on Input signal monitor 1 is that whose digits following the decimal point are truncated.

■ Application (Procedure required until the internal manual set value is displayed)





¹ Auto set value: Input signal from controller

² If the internal manual set value or auto set value display is selected, control is also performed at the set value thus selected.

When necessary to display any other input signal, first select the external contact action by referring to the following table and then select the external contact.

Contact input action	State of External contact	
	Contact closed (Manual mode)	Contact open (Auto mode)
0: External manual mode ↔ Auto mode	Displays the External manual set value.	Displays the Auto set value.
1: Internal manual mode ↔ Auto mode	Displays the Internal manual set value.	
2: Internal manual mode (fixed)	Displays the Internal manual set value.	

When no wiring of “Auto/Manual mode transfer” is conducted, the contact keeps opening and as a result Input signal monitor 1 displays the input signal value in the following table.

Contact input action	State of contact (Contact open: Auto mode)
0: External manual mode ↔ Auto mode	Displays the Auto set value.
1: Internal manual mode ↔ Auto mode	
2: Internal manual mode (fixed)	Displays the Internal manual set value.

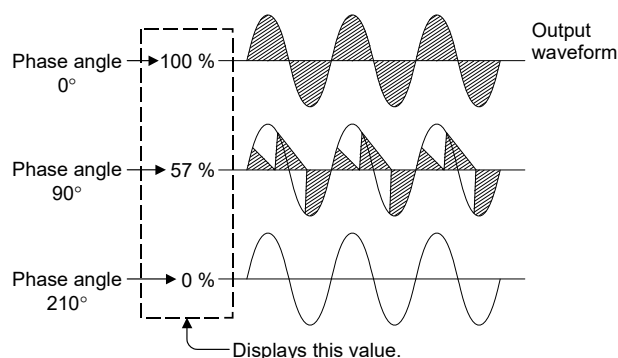
(2) Phase angle ratio monitor ($\overline{P H A r}$)

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 210°.

Display the 100 % when the phase angle is 0°.



(3) Current value monitor (\overline{I})

Displays the current value (Input value of CT). The display range varies depending on the instrument specification.

Display range: 20 A type: 0.0 to 26.0 A
 30 A type: 0.0 to 39.0 A
 45 A type: 0 to 58 A
 60 A type: 0 to 78 A
 80 A type: 0 to 104 A
 100 A type: 0 to 130 A



The current value monitor is not displayed when the heater break alarm function is not provided.

(4) Voltage value monitor (\overline{V})

Displays the voltage value (Input value of PT).

Display range: 0 to 300 V



The voltage value monitor is not displayed when the constant voltage control is not provided.

(5) Power value monitor (\overline{P})

Displays the power value.

Display range: 0.0 to 46.0 kW



The power value monitor is not displayed when the constant power control is not provided.

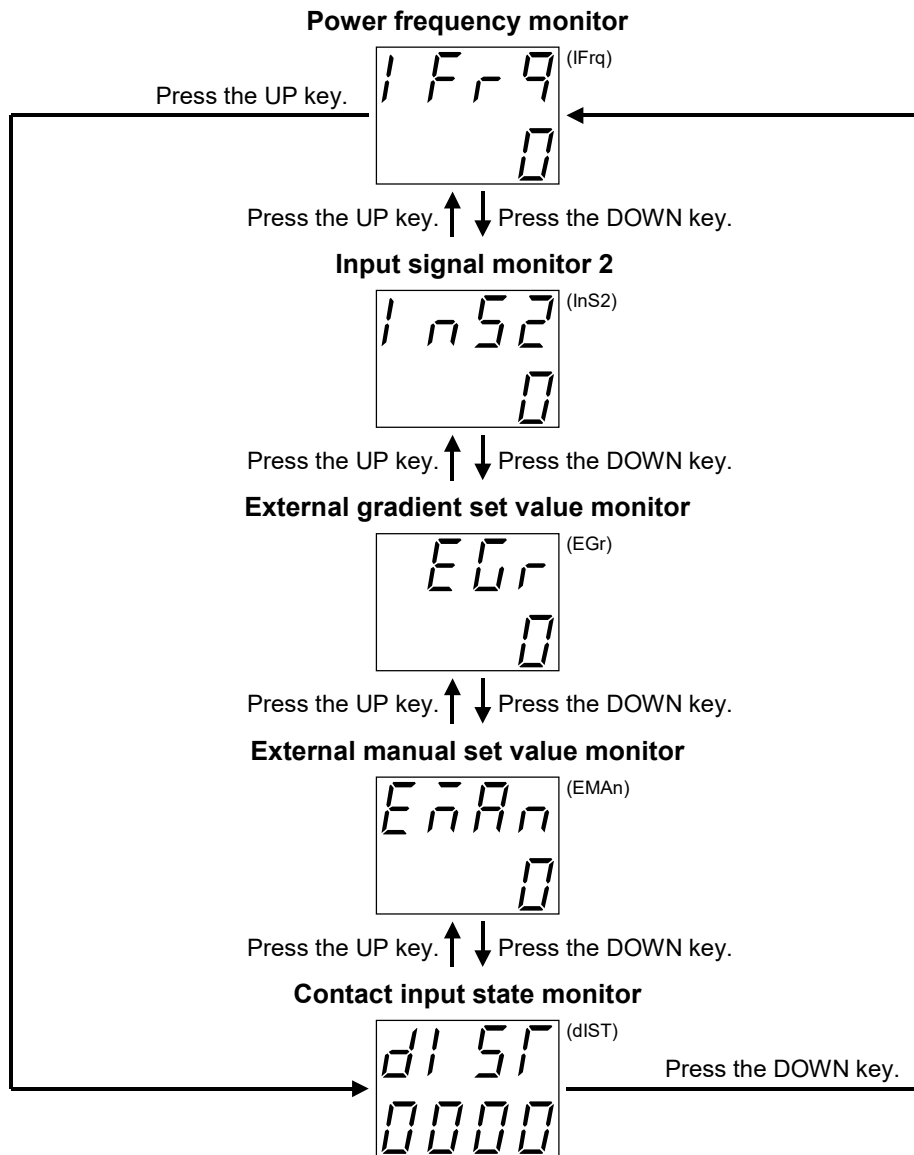
4.3 Monitor Mode 2

The following items are displayed in the monitor mode 2.

- Power frequency
- External gradient set value
- State of contact (open/closed state)
- Auto set value (value of auto mode)
- External manual set value

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.



4.3.2 Description of each monitor item

(1) Power frequency monitor (*f r q*)

Displays the power frequency.

Display range: 0 to 70 Hz



The automatic power frequency detection and power frequency monitoring function is available with the THW-A1. For details, refer to the function description (P. 57).

(2) Input signal monitor 2 (*i n s 2*)

Displays the Auto set value (value of auto mode).

Display range: 0 to 100 %

(3) External gradient set value monitor (*E G r*)

Displays the external gradient set value.

Display range: 0 to 100 %

(4) External manual set value monitor (*E n A n*)

Displays the external manual set value.

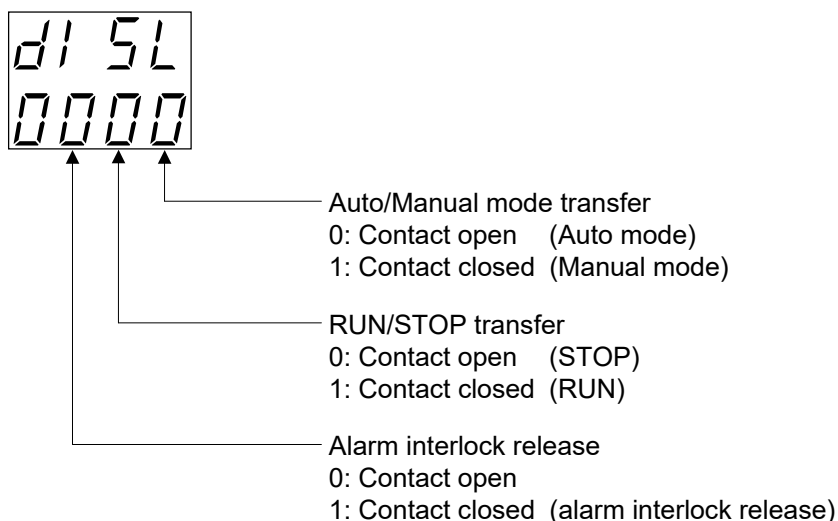
Display range: 0 to 100 %

(5) Contact input state monitor (*d i S r*)

Displays the state of the contact input.

Display item: 0: Contact open
1: Contact closed

Contact input state monitor



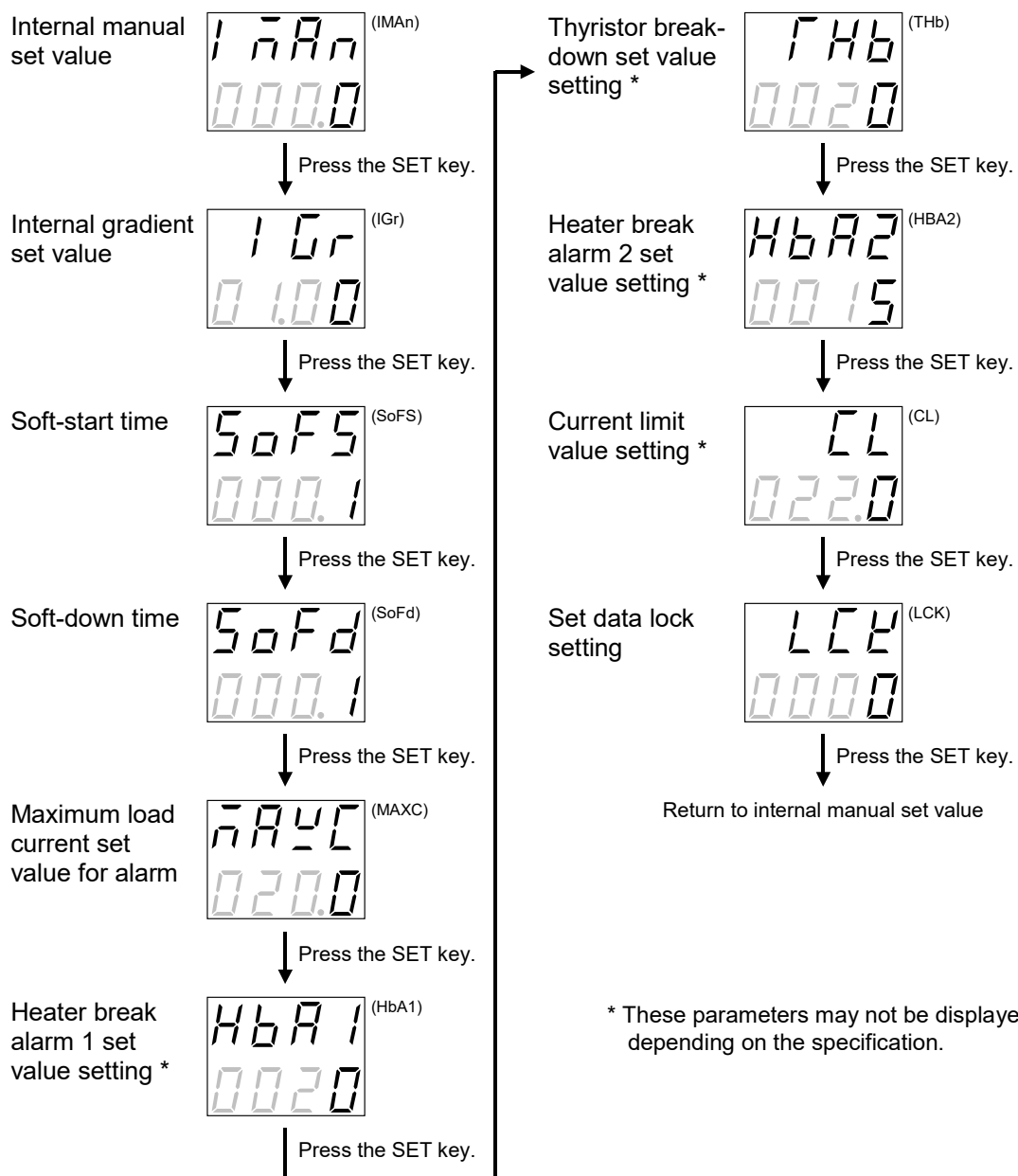
4.4 Setting Mode

In Setting mode, the following operations are possible.

- Internal gradient can be set.
- Heater break alarm set value can be set.
- Maximum load current set value for alarm, etc.
- Soft-start time and Soft-down time can be set.
- Current limit value can be set.

4.4.1 Display sequence

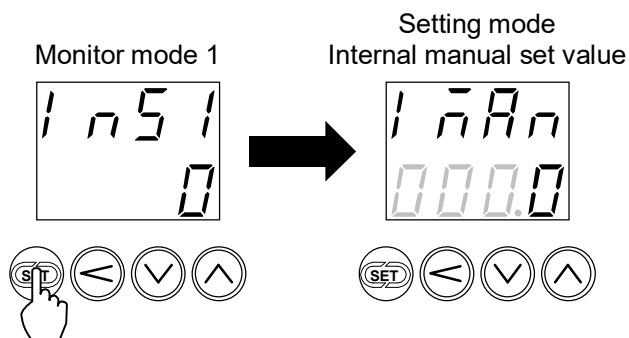
To go to the next parameter (setting item), press the SET key. To go back to the first setting item, keep pressing the SET keys until it is displayed again.



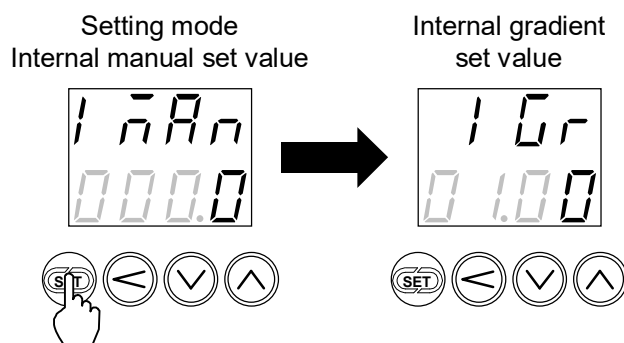
4.4.2 Changing parameter settings

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

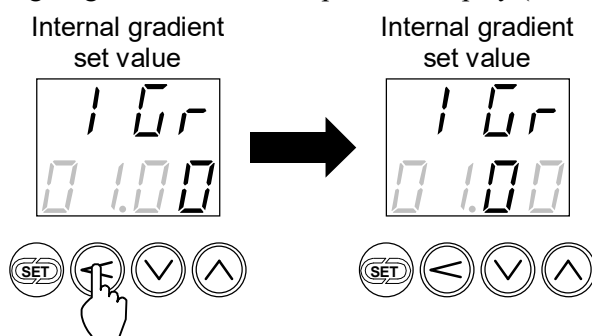
1. Press the SET key for 2 seconds to change to Setting mode.



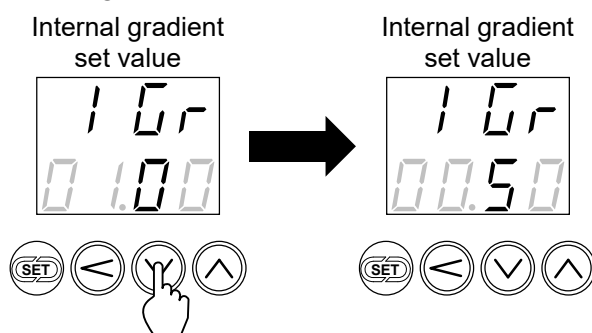
2. Press the SET key to enter the Internal gradient set value.



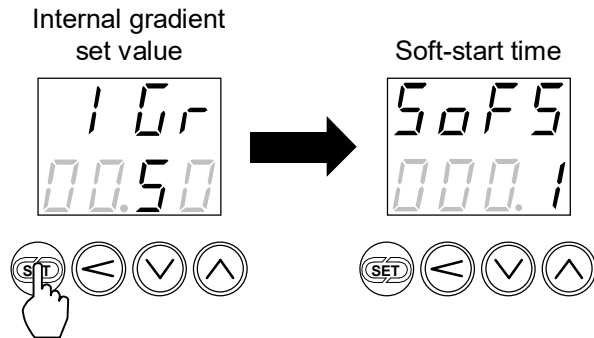
3. Press the shift key to high-light the one decimal place on display (lower).








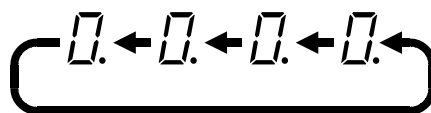
4. Press the DOWN key to change the number to “0.5.”



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



-  To store a new value for the parameter, always press the SET key. A new value will not be stored without pressing the SET key after the new value is displayed on the display.
-  After a new value has been displayed by using the UP and DOWN keys, the SET key must be pressed within 1 minute, or the new value is not stored and the display will return to the monitor mode 1.
-  If the following setting is tried to be set, no set value is registered even if the SET key is pressed. In addition, it does not go to the next parameters.
 - When in zero-cross control, it is tried to set constant current control, constant voltage control or constant power control.
 - When in constant current control, constant voltage control or constant power control, it is tried to set zero-cross control.
-  Other parameters can be set in the same way as the example above.
-  Every time the shift key is pressed, the high-lighted digit moves as follows.



4.4.3 Description of each parameter

(1) Internal manual set value (| $\bar{A}n$)

Use to set the Internal set value.

Setting range: 0.0 to 100.0 %


Factory set value: 0.0

(2) Internal gradient set value (| $\bar{G}r$)

Use to set the Internal gradient set value.

Setting range: 0.00 to 1.00 Internal gradient is 0 % when set 0.00.
Internal gradient is 100 % when set 1.00

Factory set value: 1.00

 For the gradient output characteristic, refer to page 51.

(3) Soft-start time ($\bar{S}oF\bar{S}$)

Use to set the Soft-start time.

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: 0.0 to 99.9 seconds

Factory set value: 0.1


 For the function description, refer to page 50.

(4) Soft-down time ($\bar{S}oF\bar{d}$)

Use to set the Soft-down time.

Setting range: 0.0 to 99.9 seconds

Factory set value: 0.1

 For the function description, refer to page 50.

(5) Maximum load current set value for alarm ($\bar{A}UL$)

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: 0°). After the wiring is complete, check a current value which flows through the heater at an output of 100 % (phase angle: 0°) on the current monitor (refer to P. 31).

Phase angle can be checked on the Phase angle ratio monitor (refer to P. 31).



Always set the maximum load current value if the heater break alarm function is provided.



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

Setting range:	20 A type: 0.0 to 22.0 A	Factory set value:	20 A type: 20.0
	30 A type: 0.0 to 33.0 A		30 A type: 30.0
	45 A type: 0 to 50 A		45 A type: 45
	60 A type: 0 to 66 A		60 A type: 60
	80 A type: 0 to 88 A		80 A type: 80
	100 A type: 0 to 110 A		100 A type: 100



This parameter is not displayed when the heater break alarm function is not provided.



For the application, refer to **5.11 Heater Break Alarm 1 (HBA1), Heater Break Alarm (HBA2) and Thyristor Break-down Alarm** (refer to P. 58).

(6) Heater break alarm 1 set value setting ($HbA1$)

Use to set the heater break alarm 1 set value. For the heater break alarm 1 set value, make the setting as follows.

When the control method is Phase Control, RKC recommends:

Set the heater break set value to approximately 20 % of the maximum load current value for heater break alarm Type 1.

Set the heater break set value to approximately 5 % of the maximum load current value for heater break alarm Type 2.

When the control method is Zero-cross Control, RKC recommends:

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.

Setting range: 0 to 100 % (0: Heater break alarm 1 unused)

Factory set value: 20



This alarm value is the deviation setting when the heater break alarm 1 type is Type 1.



This parameter is not displayed when the heater break alarm function is not provided.



For the function description, refer to P. 58.

(7) Thyristor break-down set value setting (ΓHb)

Use to set the thyristor break-down set value. For the thyristor break-down set value, make the setting as follows.

When the control method is Phase Control, RKC recommends:

Set the heater break set value to approximately 20 % of the maximum load current value for heater break alarm Type 1.

Set the heater break set value to approximately 5 % of the maximum load current value for heater break alarm Type 2.

When the control method is Zero-cross Control, RKC recommends:

Set the heater break set value to approximately 30 % of the maximum load current value.

Setting range: 0 to 100 % (0: Thyristor break-down alarm unused)

Factory set value: 20



This alarm value is the deviation setting when the heater break alarm 1 type is Type 1.



This parameter is not displayed when the heater break alarm function is not provided.



For the function description, refer to P. 58.

(8) Heater break alarm 2 set value setting ($HbA2$)

Use to set the heater break alarm 2 set value. For the heater break alarm 2 set value, make the setting as follows.

When the control method is Phase Control and heater break alarm Type 1 is selected, RKC recommends:

Set the value must be equal or less than the heater break alarm 1 set value.

When the control method is Phase Control and heater break alarm Type 2 is selected:

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

When the control method is Zero-cross Control is selected:

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

Setting range: 0 to 100 % (0: Heater break alarm 2 unused)

Factory set value: 15



This alarm value is the deviation setting when the heater break alarm 2 type is Type 1.



This parameter is not displayed when the heater break alarm function is not provided.




For the function description, refer to P. 58.


(9) Current limiter value setting (\overline{L})


Use to set the current limiter value.

Setting range: 20 A type: 0.0 to 22.0 A
 30 A type: 0.0 to 33.0 A
 45 A type: 0 to 50 A
 60 A type: 0 to 66 A
 80 A type: 0 to 88 A
 100 A type: 0 to 110 A

Factory set value: 20 A type: 22.0
 30 A type: 33.0
 45 A type: 50
 60 A type: 66
 80 A type: 88
 100 A type: 110

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

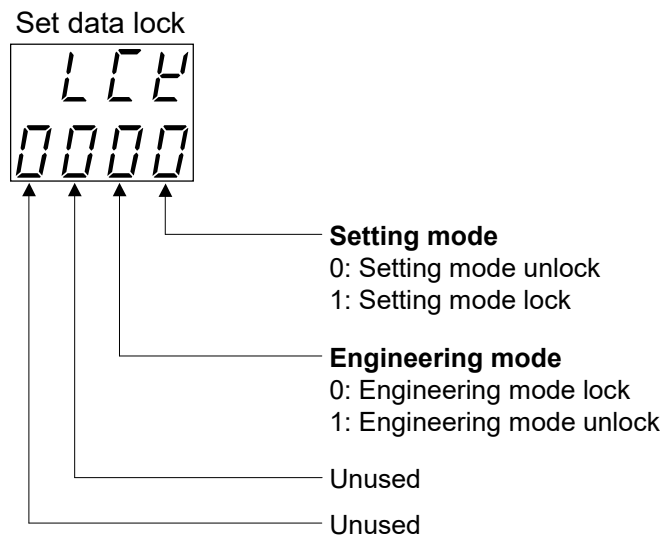
 This parameter is not displayed when the heater break alarm function is not provided.

 For the function description, refer to P. 57.


(10) Set data lock setting (\overline{L} \overline{L} \overline{L})

The Set Lock Function limits access of unauthorized personnel to the parameter and prevents parameter change by mistake. Parameters of Setting mode and Engineering mode can be locked.



Setting range:



Factory set value: 0000

 If the parameters of Engineering mode are locked, those parameters are not displayed.

4.5 Engineering Mode

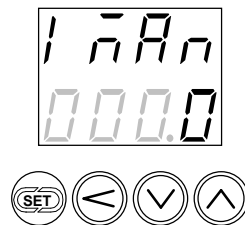
-  Parameters in Engineering mode should be set according to the application before setting any parameter related to operation. Once the Parameters in the Engineering mode are set correctly, those parameters are not necessary to be changed for the same application under normal conditions.
-  All parameters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

4.5.1 Transfer to engineering mode

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

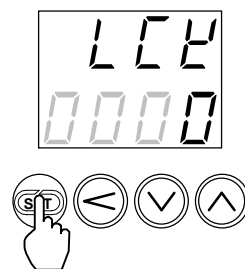
1. Change to setting mode.

Setting mode (Internal manual set value)



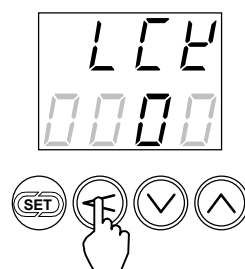
2. Press the SET key several times to change to the set data lock setting.

Set data lock setting



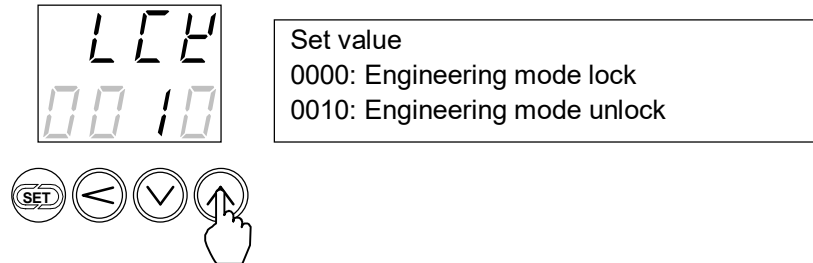
3. Press the shift key to high-light the tens digit of display (lower).

Set data lock setting

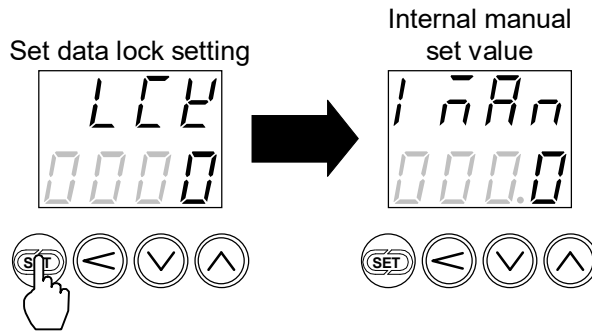


4. Press the UP key to change 0 to 1 in the tens digit.

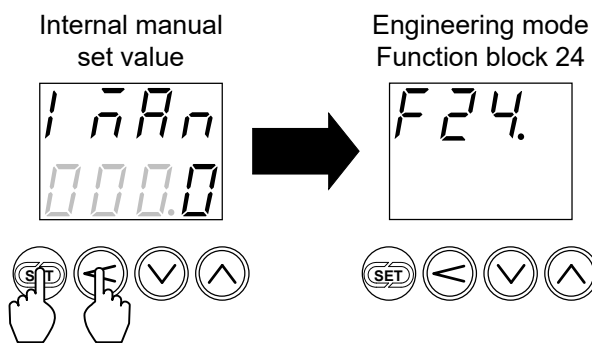
Set data lock setting



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



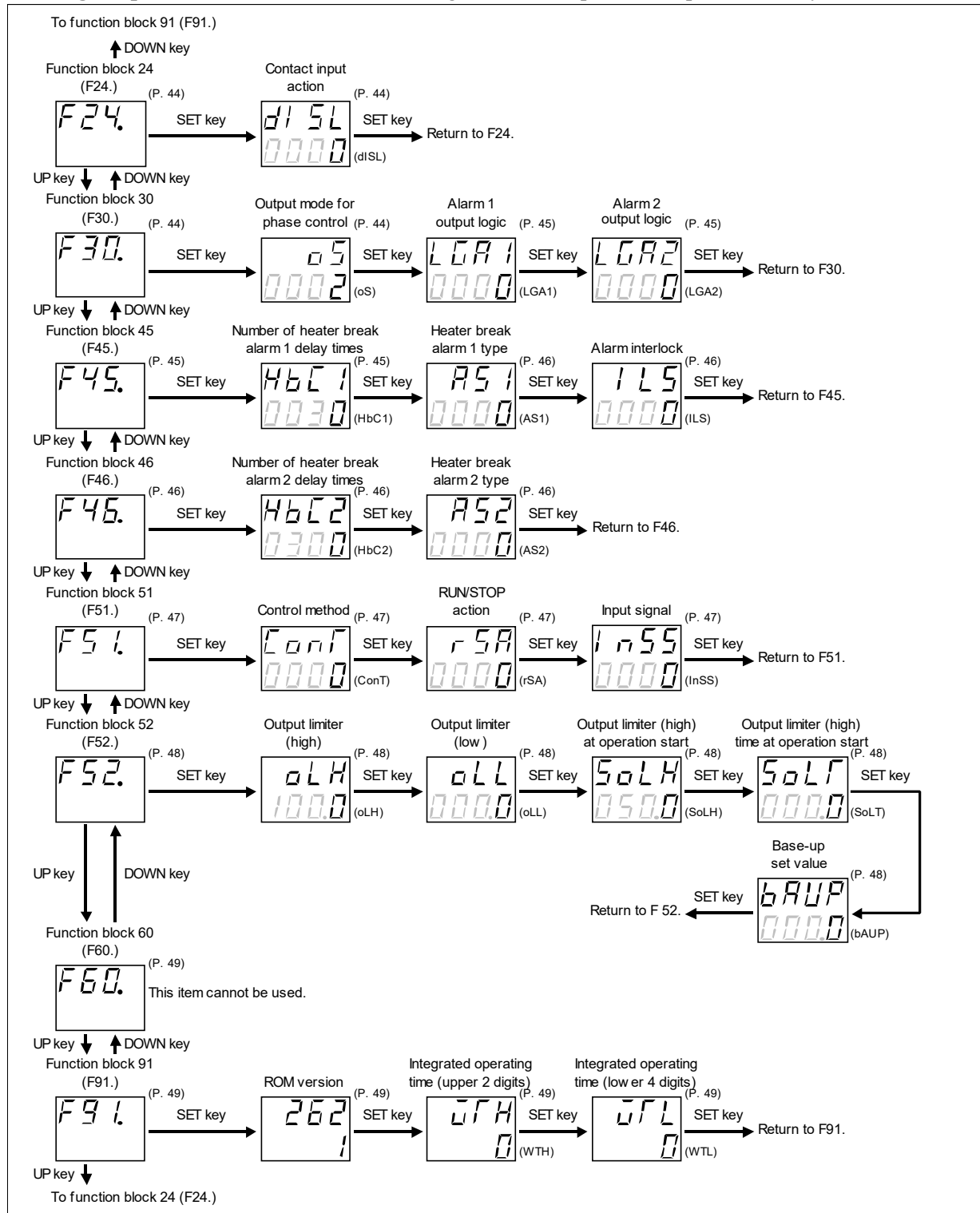
6. Press the shift key while pressing the SET key to change to the engineering mode. The display goes to the function block 24.



4.5.2 Display sequence

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:** To go to the next parameter, press SET key.



4.5.3 Description of each parameter



For details on changing the numeric value, refer to **4.2.2 Procedure for changing numerical value (P. 35)**.

(1) Function block 24 (F24.)

■ Contact input action (dl 5L)

Use to select the contact input action of auto/manual mode transfer. This selection also affects the display of the input signal monitor 1.

Setting item: 0: External manual mode ↔ Auto mode
1: Internal manual mode ↔ Auto mode
2: Internal manual mode (fixed)

Factory set value: 0



Relationship between Contact input action and Contact input

Contact input action	Contact input state	
	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	

(2) Function block 30 (F30.)

■ Output mode for phase control (o 5)

Use to select the output method for phase control with linearity load (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 P. 55.)



Setting is invalidated if the output mode is not specified at ordering.



Output mode setting is invalidated for zero-cross control.



To go to the next parameter, set 0, 1 or 2 at Output mode.
(Output mode setting is invalidated for zero-cross control.)

Setting item: 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

Factory set value: Factory set value varies depending on the instrument specification.



For the output characteristic, refer to P. 54.

■ Alarm 1 output logic ($L O A 1$) Alarm 2 output logic ($L O A 2$)

Use to select the output logic of the alarm 1 or alarm 2. (open-collector output)

Setting item:	0: No output
	1: Heater break alarm 1 (ON at alarm output)
	2: Thyristor break-down alarm (ON at alarm output)
	3: Heater break alarm 2 (ON at alarm output)
	4: Logical <i>OR</i> of Heater break alarm 1 and Thyristor break-down alarm (ON at alarm output)
	5: Logical <i>OR</i> of Heater break alarm 1, Thyristor break-down alarm and Heater break alarm 2 (ON at alarm output)
	6: Logical <i>OR</i> of FAIL alarm, Power frequency error, Negative phase sequence, Over current and Fuse break (ON at alarm output)
	7: Logical <i>OR</i> of all alarms (ON at alarm output)
	8: Heater break alarm 1 (OFF at alarm output)
	9: Thyristor break-down alarm (OFF at alarm output)
	10: Heater break alarm 2 (OFF at alarm output)
	11: Logical <i>OR</i> of Heater break alarm 1 and Thyristor break-down alarm (OFF at alarm output)
	12: Logical <i>OR</i> of Heater break alarm 1, Thyristor break-down alarm and Heater break alarm 2 (OFF at alarm output)
	13: Logical <i>OR</i> of FAIL alarm, Power frequency error, Negative phase sequence, Over current and Fuse break (OFF at alarm output)
	14: Logical <i>OR</i> of all alarms (OFF at alarm output)

Factory set value: 0



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

- Heater break alarm 1
- Heater break alarm 2
- Fuse break
- Over current
- Thyristor break-down alarm

(3) Function block 45 ($F 4 5$)

■ Number of heater break alarm 1 delay times ($H b C 1$)

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 item: 1 to 99 times

Factory set value: 30



Setting data is invalidated when heater break alarm function is not specified.



For the function description, refer to P. 58.

■ Heater break alarm 1 type (*AS1*)

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

Setting item: 0: Type 1 (Deviation alarm)
1: Type 2 (Absolute value alarm)

Factory set value: 0



Setting data is invalidated when heater break alarm function is not specified.



Setting data is invalidated for zero-cross control.



For the function description, refer to P. 58.

■ Alarm interlock (*ILS*)

Use to select Use/Unuse of alarm interlock function.

Setting item: 0: Unused
1: Use

Factory set value: 0



For the function description, refer to P. 58.



For the release method of alarm interlock, refer to **5.17 External Contact Input (DI) Function** (P. 70).

(4) Function block 46 (*F46*)

■ Number of heater break alarm 2 delay times (*HbC2*)

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

Setting item: 1 to 999 times

Factory set value: 300



Setting data is invalidated when heater break alarm function is not specified.



For the function description, refer to P. 58.

■ Heater break alarm 2 type (*AS2*)

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

Setting item: 0: Type 1 (Deviation alarm)
1: Type 2 (Absolute value alarm)

Factory set value: 0



Setting data is invalidated when heater break alarm function is not specified.



Setting data is invalidated for zero-cross control.



For the function description, refer to P. 58.

(5) Function block 51 (F51)**■ Control method (C001)**

Use to select the control method.

Setting item: 0: Phase control
1: Zero-cross control *

* When in constant current control, constant voltage control or constant power control, no zero-cross control can be set. It cannot be registered even if the SET key is pressed after the corresponding number is selected. Not to be changed to the next parameter.


Factory set value: 0

■ RUN/STOP action (r5A)

Use to select Use/Unuse of RUN/STOP transfer function.


Setting item: 0: Unused
1: Use


Factory set value: 0

 For the function description, refer to P. 70.

■ Input signal (I055)

Use to select the type of input signal.

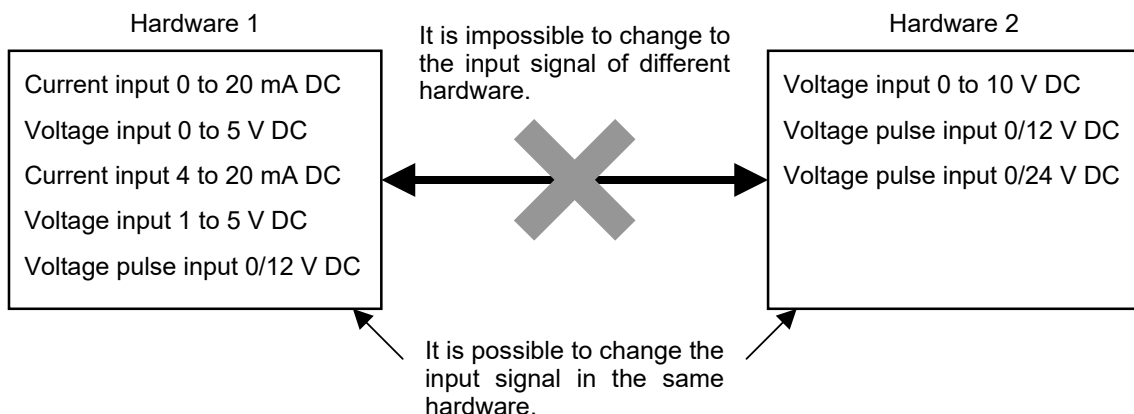
 It is not necessary to change the setting for the voltage pulse inputs: 0/12V DC and 0/24V DC.

 The current or voltage input is selected by a short bar on the input terminals. (Refer to P. 18)

Setting item: 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

* As the hardware differs for 0 to 10 V DC, it is impossible to change to any input signal other than the voltage pulse input.

Factory set value: Factory set value varies depending on the instrument specification.



(6) Function block 52 (F52)**■ Output limiter (high) (o L H)**

Use to set the high limit value of output.

Setting item: 0.0 to 100.0 %

Factory set value: 100.0



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



For the function description, refer to P. 51.

■ Output limiter (low) (o L L)

Use to set the low limit value of output.

Setting item: 0.0 to 100.0 %

Factory set value: 0.0



Output limiter (low) value must be equal or lower than Output limiter (high).



The Base-up function cannot be used together. The output limiter (low) function is effective only when the Base-up setting is set to 0.0.



For the function description, refer to P. 51.

■ Output limiter (high) at operation start (S o L H)

Use to set the high limit value of output at operation start. Output limiter (high) value at operation start must be lower than output limiter (high).

Setting item: 0.0 to 100.0 %

Factory set value: 50.0



For the function description, refer to P. 52.

■ Output limiter (high) time at operation start (S o L T)

Use to set the high limit time of output at operation start.

Setting item: 0.0 to 600.0 seconds

Factory set value: 0.0



For the function description, refer to P. 52.

■ Base-up set value (b A U P)

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

Setting item: 0.0 to 100.0 %

Factory set value: 0.0



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



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



For the function description, refer to P. 53.

(7) Function block 60 (F 6 0)

This item is not available.

(8) Function block 91 (F 9 1)

Only displayed for the F91 function block.

■ ROM version

Display the version of loading software.

■ Integrated operating time [upper 2 digits] ($\bar{u} \bar{r} H$)

Display the integrated operating time (upper 2 digits) of instrument.

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

Up to 999,999 from 0 including the upper and lower digits can be displayed.

■ Integrated operating time [lower 4 digits] ($\bar{u} \bar{r} \bar{l}$)

Display the integrated operating time (lower 4 digits) of instrument. 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] ($\bar{u} \bar{r} H$).

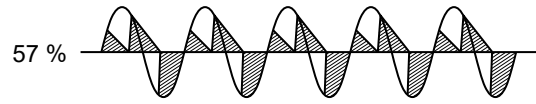
Details of display: 0 to 9999 (Resolution of display: 1 hours)

5. FUNCTIONS

5.1 Control Method

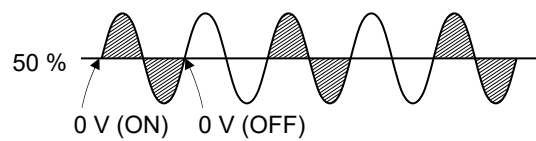
■ Phase control

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)

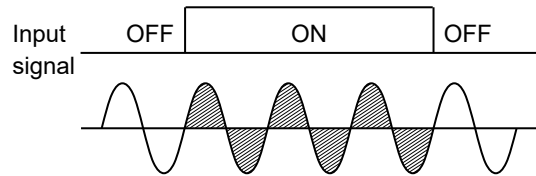
Continuous Zero-cross control is to control electric power supplied to a load by turning the power supply voltage ON and OFF at the point of 0 V AC so that the high frequency noise can be suppressed compared with phase control. This on and off time is typically measured in milliseconds.



■ 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.

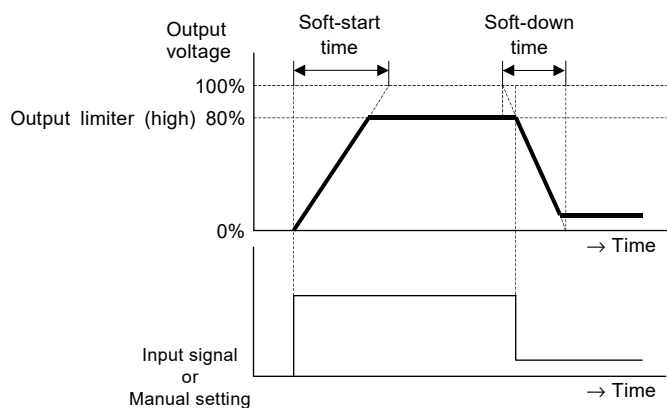
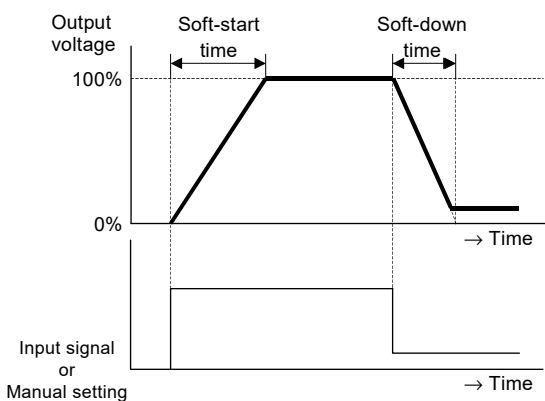
This on and off time is typically measured in seconds.



5.2 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 0 to 100 %.



Soft-start/Soft-down action diagram



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

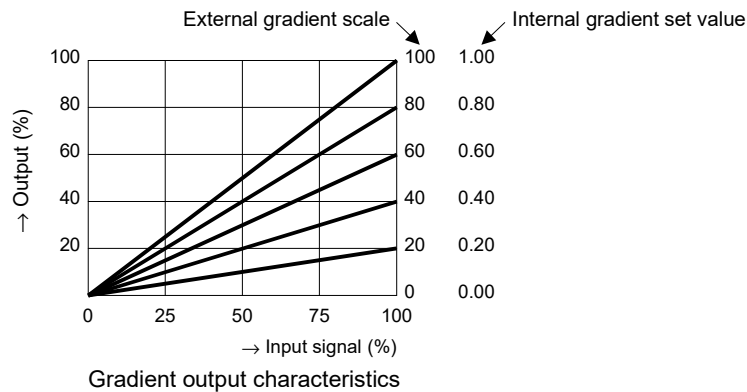


In zero-cross control, no rush current can be suppressed even if the soft-start time is set.

5.3 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 following two types of gradient setting are available.

- Internal gradient setting set by the THW-A1 front keys
- External gradient setting set by the external gradient setter (external potentiometer)



The output value is adjusted by Gradient Setting Function as follows.

- (Output voltage calculated by Auto mode) × (Internal gradient setting) × (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)



To validate external gradient set value only, set the internal gradient set value to 1.00.

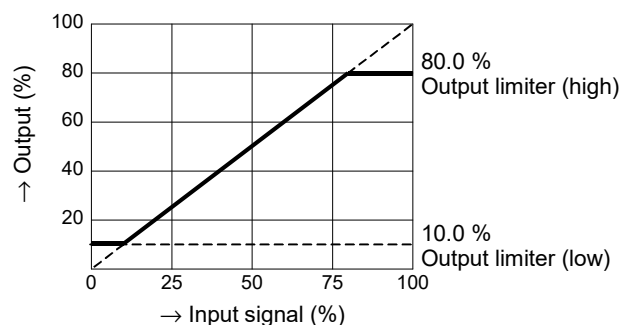
5.4 Output Limiter (High and Low)

This function limits the output range. Output limiter function is related to other functions.

- Output limiter (high) and (low) have priority over the output value¹ calculated with Gradient Setting function. Output limiter (high) has priority over Output limiter (low).
- 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 over 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). To use base-up setting function, set Output limiter (low) to zero (0.0).

¹ Output value = (Input signal or manual set value) × (Gradient set value)

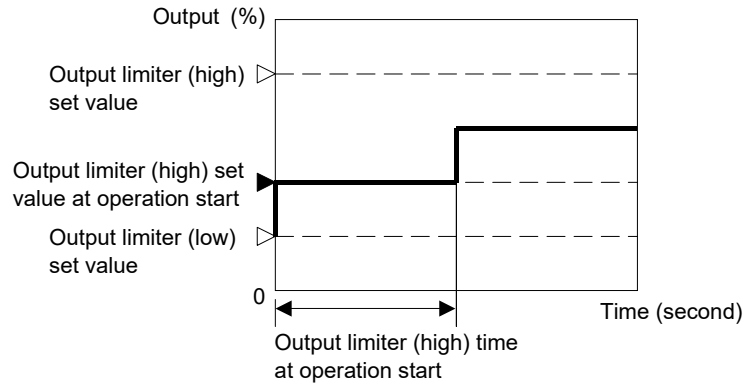
² Output value = (Input signal or manual set value) × (Gradient set value) + (Base-up set value)



5.5 Output Limiter (High) at Operation Start

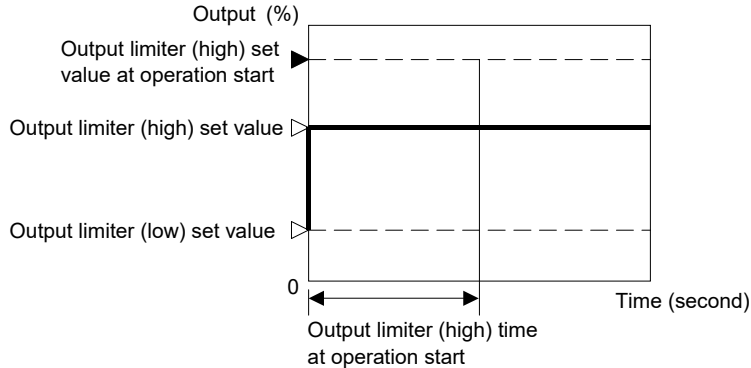
This is the function used to restrict the output for any preset time [output limiter (high) time at the time of start] when power is turned on. It is possible to lessen rush current by using this function.

The use of this function is effective for any heater (halogen lamp, platinum, tungsten, molybdenum, etc.) through which rush current flows.

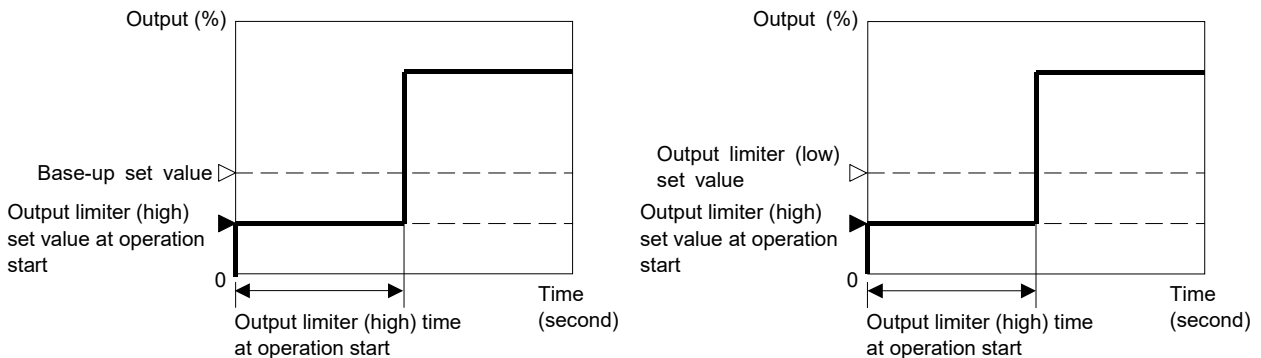


■ Priority order of output limiter

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.



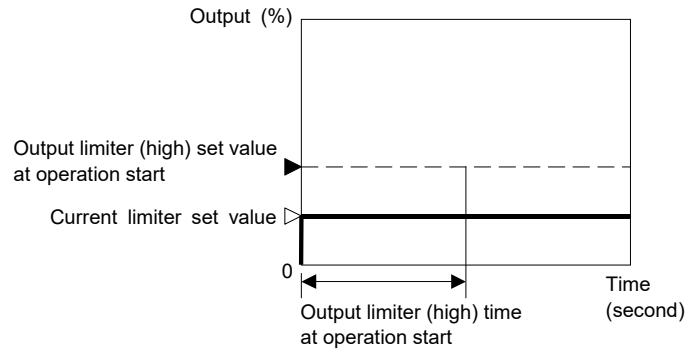
If the output limiter (high) at the time of start is set to any value smaller than the base-up set value or output limiter (low), the former has priority over the latter.



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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.

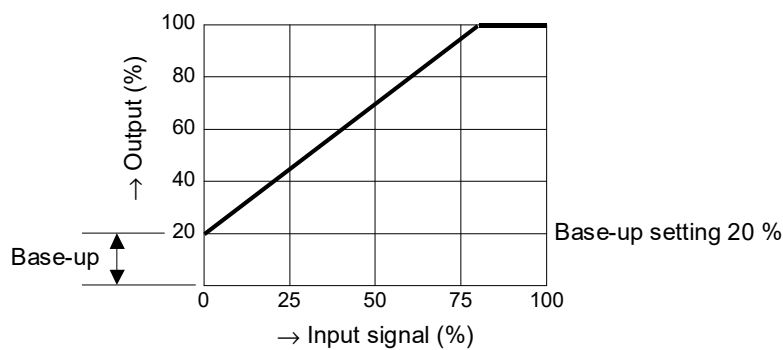


5.6 Base-Up Setting Function

Base-up setting function adds positive bias to the output value calculated with gradient setting function.

- Output limiter (high) has priority over base-up setting value.
- 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).

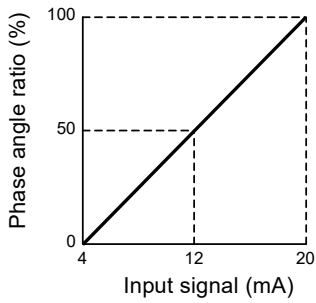
* Output value = (Input signal or manual set value) × (Gradient set value) + (Base-up set value)



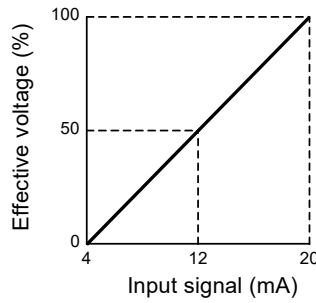
5.7 Output Mode for Phase Control

When phase control is selected for a linearity load (resistance load), one of the following six output types can be selected. The factory set value is proportional square voltage (electric power) to input. (Output mode setting is invalidated for Zero cross control.)

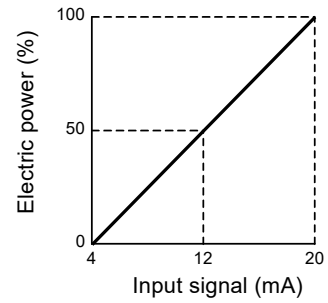
Proportional phase angle to input



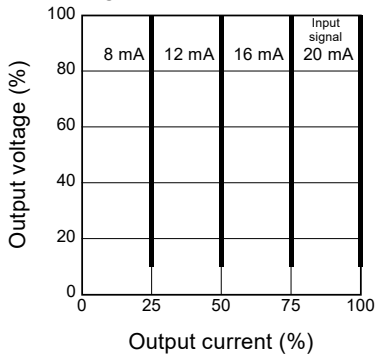
Proportional voltage to input



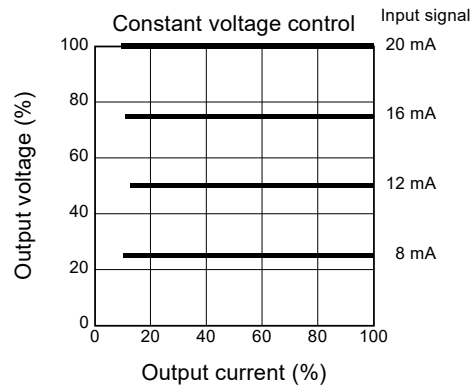
Proportional square voltage (electric power) to input



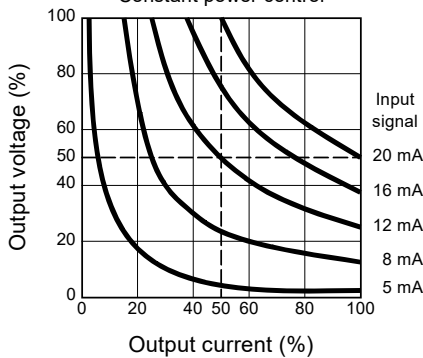
Constant current control



Constant voltage control



Constant power control



Constant current, Constant voltage and Constant power controls are optional.

(1) 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 thyristor specification.

Operating condition	Stability
Power supply voltage variation $\pm 10\%$	$\pm 2\%$ of full scale
Load variation 2 times	

■ Caution for using constant current control function

If the rated current of thyristor 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 thyristor and the heater is shown in the following.

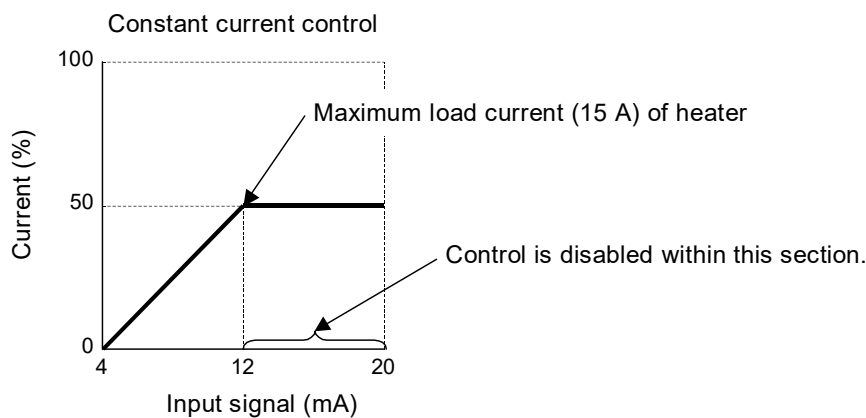
Example: When used in the following condition

- Rated current of Thyristor: 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



The soft-start function is activated during four cycles from load operation start even at a soft-start time of 0.0 seconds.

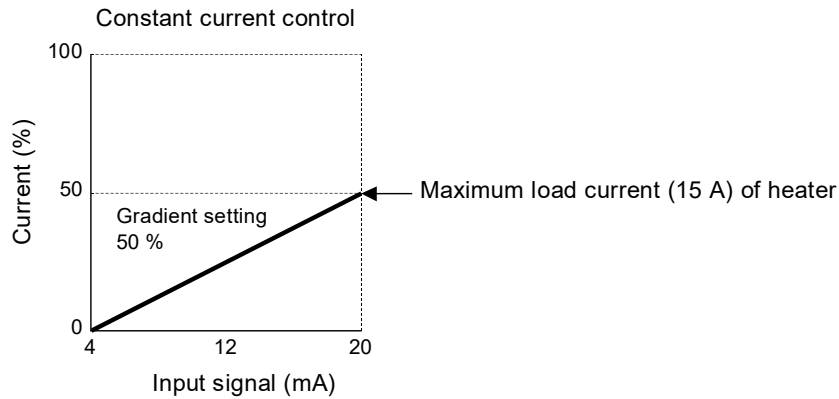
When used without setting the gradient, the maximum heater load current becomes 15 A at an input signal of 12 mA. In this case, control is disabled if the input signal exceeds 12 mA.



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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. Gradient can be set by internal gradient setting or an external gradient setter.



(2) 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 $\pm 10\%$	$\pm 2\%$ of full scale
Load variation 2 times	

(3) 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 $\pm 10\%$	$\pm 4\%$ of full scale
Load variation 2 times	



The soft-start function is activated during four cycles from load operation start even at a soft-start time of 0.0 seconds.

5.8 Current Limiter Function (optional)

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 from the start of load operation, and 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 at a soft-start time of 0.0 seconds, the soft-start function is activated in order to calculate the maximum phase angle during a time period of 0.1 seconds from the start of load operation.



If a current value exceeds “Current limit value + Differential gap (0.5 A or 1.0 A)*” due to voltage variations or load resistance changes while the current limit function is being activated, the maximum phase angle is immediately re-calculated to restrict it within a cycle of 3 from the time when it exceeds “Current limit value + Differential gap.”

* Differential gap 0.5 A: 20 A, 30 A types

Differential gap 1 A: 45 A, 60 A, 80 A and 100 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.

5.9 Automatic Power Frequency Detection and Power Frequency Monitoring Function

■ Automatic power frequency detection

The instrument automatically detects a power supply frequency (50 Hz or 60 Hz) when the power is turned on.

Detection range: 50 Hz: 45.0 to 54.9 Hz 60 Hz: 55.0 to 64.9 Hz

Action on occurrence of error: FREQ lamp is lit.
Thyristor output is turned off.

■ 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: 50 Hz: 45.0 to 54.9 Hz 60 Hz: 55.0 to 64.9 Hz

Action on occurrence of error: FREQ lamp is lit.
Thyristor output is turned off.
(The output can be turned ON when the error is canceled.)

5.10 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. Power frequency error (FREQ), heater break alarm 1 (HBA1), thyristor breakdown alarm (THY. B) and heater break alarm 2 (HBA2) can be interlocked.

- 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.

5.11 Heater Break Alarm 1 (HBA1), Heater Break Alarm 2 (HBA2) and Thyristor Break-Down Alarm Functions (optional)

The heater break alarm (HBA) and thyristor break-down alarm monitors the current flowing through the load by a dedicated current transformer (CT). The THW-A1 compares the measured value with the set values, and detects a fault in the heating circuit. In addition, there are several types of alarms depending on control methods and applications of these alarms.

Read this chapter carefully to choose an suitable method and set an appropriate set value.

5.11.1 Number of 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.

When the alarm types are the Heater break alarm 1 and Thyristor break-down alarm:

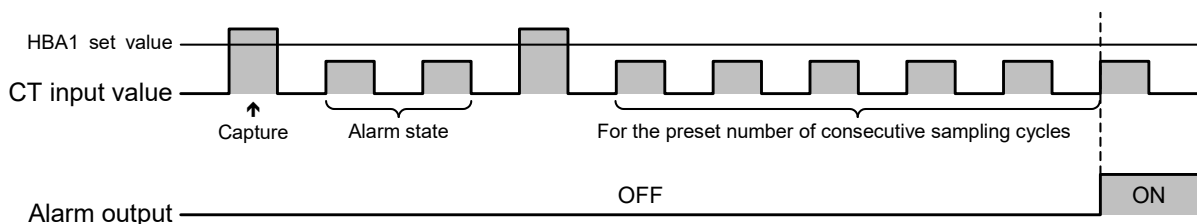
Alarm state > 5 sampling cycles* × Number of alarm delay times (1 to 99 times)

When the alarm is the Heater break alarm 2:

Alarm state > 5 sampling cycles* × Number of alarm delay times (1 to 999 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



5.11.2 Heater break alarm for phase control (Type 1)

Type 1 can be used as follows by using three heater break alarm set values.

(Refer to Application 1 [P. 62].)

Heater break alarm 1 (HBA1) 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:

It is possible to output an alarm when a thyristor element is shorted or broken by setting the thyristor breakdown set value.

Heater break alarm 2 (HBA2) 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 smaller than the heater break alarm set value to output the alarm before a heater break occurs when the load current decreases due to heater deterioration, etc.



The heater break alarm of Type 1 cannot be used for heat generation substances such as noble metals * making large resistance changes with temperature variations.

In addition, it cannot be used for heat generation substances such as silicon carbide making resistance changes with temperature variations and a lapse of time.

* Noble metals (Such as platinum, molybdenum, tantalum, tungsten, or superkanthal)



Type 1 cannot be used for any load (such as lamp heater) whose resistance change due to a change in temperature is large.



Type 1 cannot be used for any power supply waveforms other than a sine waveform.

(1) How alarm is activated

- When heater current does not flow (Heater break, malfunction of the control device, 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 (HBA) 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 (CT) input value is equal to or greater than the heater break alarm set value * for the preset number of consecutive sampling cycles, an alarm status is produced.

* Thyristor break-down set value or Heater break alarm 2 (HBA2) set value



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.)

(2) Setting the Heater break alarm



When using the heater break alarm, it is necessary to set the maximum load current set value for alarm (MAXC). (Refer to P. 38)

The following table shows the amount of current to be reduced when one heater is broken with heaters parallel connected. It shows how much current is reduced when one heater is broken at the output (phase angle) shown in the table. Set the heater break alarm set value by referring to the amount of current reduced.

■ Delta connected

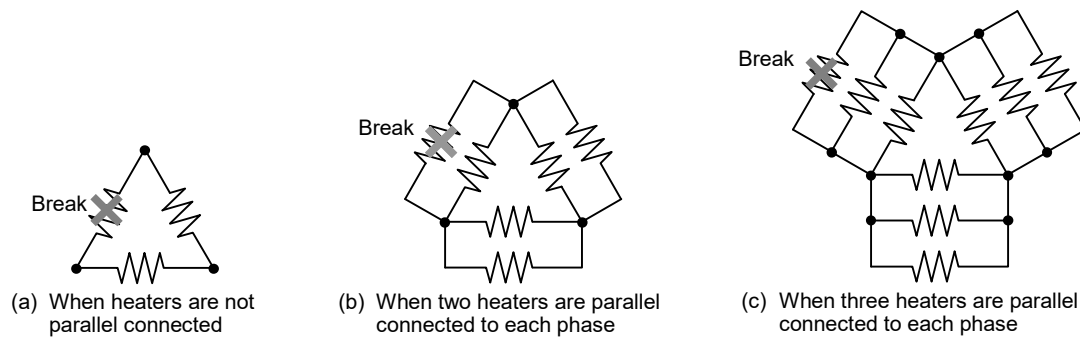
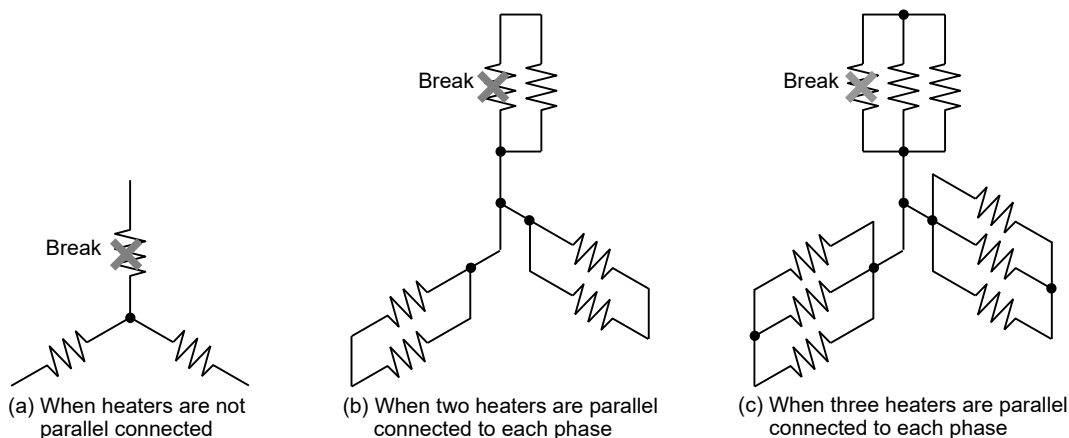


Table 1: The amount of current reduced (Delta connected)

Number of parallel connection of heater	Output (Phase angle)						
	14 % (180°)	29 % (150°)	42 % (120°)	57 % (90°)	71 % (60°)	86 % (30°)	100 % (0°)
When heaters are not parallel connected	Reduction of 6 %	Reduction of 16 %	Reduction of 26 %	Reduction of 29 %	Reduction of 31 %	Reduction of 31 %	Reduction of 28 %
When two heaters are parallel connected to each phase	Reduction of 3 %	Reduction of 7 %	Reduction of 11 %	Reduction of 13 %	Reduction of 15 %	Reduction of 16 %	Reduction of 16 %
When three heaters are parallel connected to each phase	Reduction of 2 %	Reduction of 4 %	Reduction of 7 %	Reduction of 9 %	Reduction of 10 %	Reduction of 11 %	Reduction of 11 %

In order to prevent malfunctioning, it is so designed that no heater break alarm occurs at a phase angle of less than 15 % (less than 15 % of maximum load current).

■ Star connected (Y connected)



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Table 2: The amount of current reduced (Star connected)

Number of parallel connection of heater	Output (Phase angle)						
	14 % (180°)	29 % (150°)	42 % (120°)	57 % (90°)	71 % (60°)	86 % (30°)	100 % (0°)
When heaters are not parallel connected	Reduction of 8 %	Reduction of 20 %	Reduction of 32 %	Reduction of 38 %	Reduction of 43 %	Reduction of 44 %	Reduction of 42 %
When two heaters are parallel connected to each phase	Reduction of 3 %	Reduction of 8 %	Reduction of 13 %	Reduction of 16 %	Reduction of 18 %	Reduction of 19 %	Reduction of 19 %
When three heaters are parallel connected to each phase	Reduction of 2 %	Reduction of 5 %	Reduction of 8 %	Reduction of 10 %	Reduction of 11 %	Reduction of 12 %	Reduction of 12 %

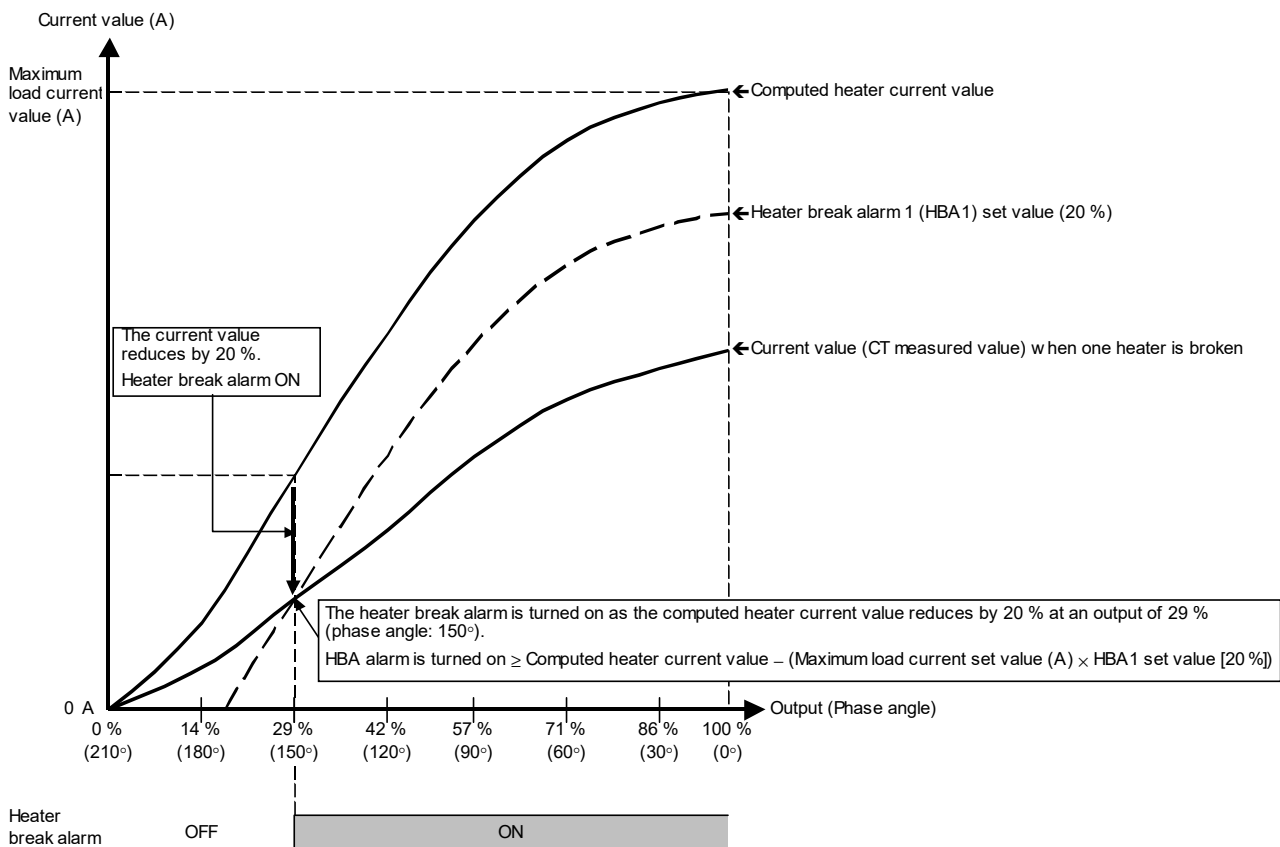
In order to prevent malfunctioning, it is so designed that no heater break alarm occurs at an phase angle of less than 15 % (less than 15 % of maximum load current).

■ Explanation of Table 1 and Table 2

Example: When heaters are not parallel connected with these heaters star-connected:

(Refer to table 2.)

Heater break alarm 1 (HBA1) is set at 20 % before factory shipment. The heater break alarm is turned on when the current reduces by more than 20 % from the computed heater current value at each output (phase angle) as shown in Table 2. In table 2, the current reduces by more than 20 % with one heater broken when the output is larger than 29 % (phase angle: 150°).



■ Setting example of Heater break alarm

Application: Heater with the specification of a maximum load current of 100 A

Three-phase star connected

The heater is not connected in parallel.

The set value of heater break alarm 1 (HBA1) is used for heater break detection.

(The heater break alarm needs to be output at an output of more than 15 %.)

The set value of heater break alarm 2 (HBA2) is used for heater deterioration detection.

Set the related parameters as follows.

Parameter in Setting mode

- Maximum load current set value for alarm (MAXC) *: 100 A
* Always set the maximum heater current value. (Refer to P. 38)
- Heater break alarm 1 set value setting (HBA1): 8 %
When the heater break alarm is detected at an output of more than 15 %, check for a value near an output of 15 % by referring to Table 2. From Table 2, an output of 14 % (phase angle: 180°) is very close to an output of 15 %. Therefore, set 8 % corresponding to the amount of current reduced at an output of 14 % (phase angle: 180°) as the set value of heater break alarm 1 (HBA1).
- Heater break alarm 2 set value setting (HBA2): 6 %
As the heater deterioration alarm must detect the degree of deterioration before the heater break alarm occurs, set the set value of heater break alarm 2 (HBA2) to any value smaller than the set value of heater break alarm 1 (HBA1). Here, the former is set at 6 % as an example.
- Thyristor break-down set value setting (THb): 0 % [Thyristor break-down alarm unused]



The computed current value used for heater break alarm (HBA) determination point

The computed current value used for heater break alarm 1 (HBA1) determination point

= (Maximum load current set value) × (Heater break alarm 1 (HBA1) set value)

= 100 A × 8 % = 8 A

Heater break alarm 1 (HBA1) current value 8 A

The computed current value used for heater break alarm 2 (HBA2) determination point

= (Maximum load current set value) × (Heater break alarm 2 (HBA2) set value)

= 100 A × 6 % = 6 A

Heater break alarm 2 (HBA2) current value 6 A

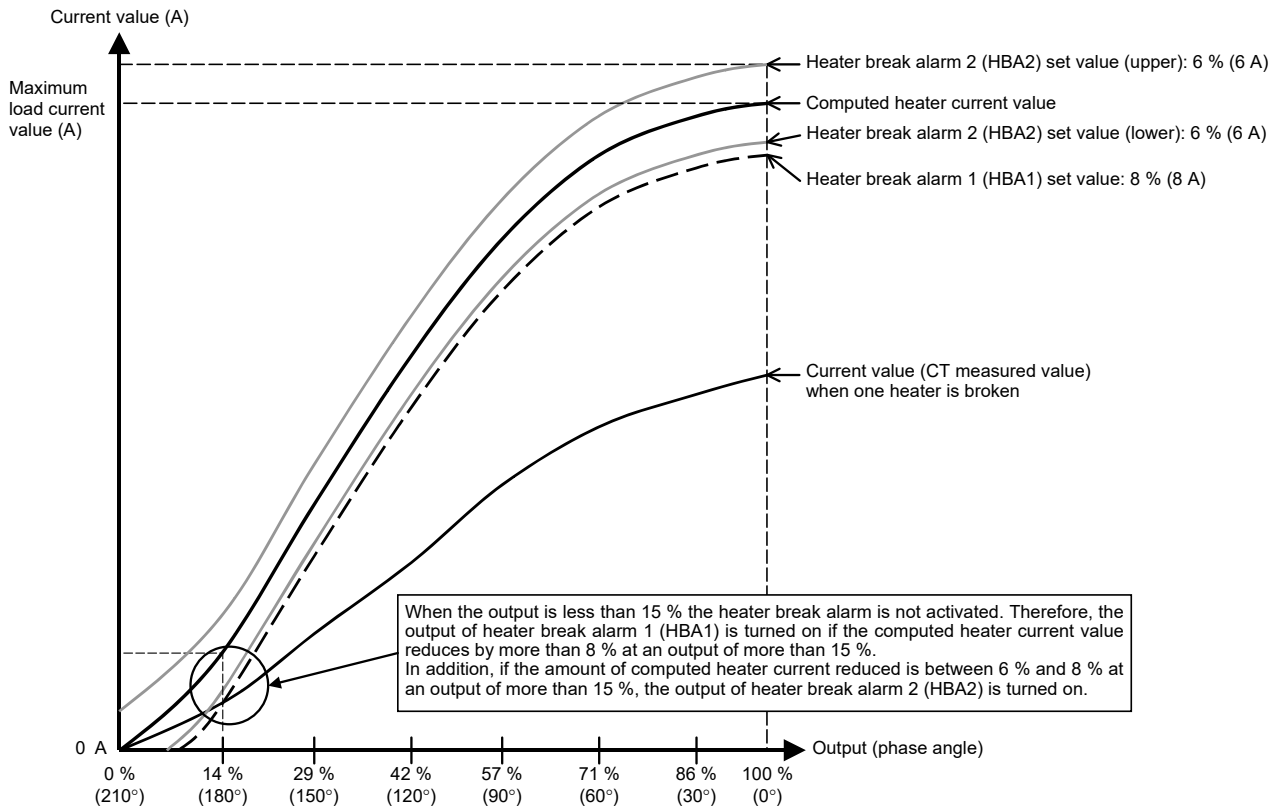
The current value (8 Ampere) of heater break alarm 1 (HBA1) is set below the computed heater current value. The current value (6 Ampere) of heater break alarm 2 (HBA2) is set above and below the computed heater current value. (Refer to the graph of next page.)

Parameter in Engineering mode

- Alarm 1 output logic (LGA1): 1 [Heater break alarm 1 (ON at alarm output)]
- Alarm 2 output logic (LGA2): 3 [Heater break alarm 2 (ON at alarm output)]
- Number of heater break alarm 1 delay times (HbC1): 1 time
- Heater break alarm 1 type (AS1): 0 [Type 1 (deviation alarm)]
- Alarm interlock (ILS): 0 [Unused]
- Number of heater break alarm 2 delay times (HbC2): 1 time
- Heater break alarm 2 type (AS2): 0 [Type 1 (deviation alarm)]
- Control method (ConT): 0 [Phase control]

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The set value of heater break alarm 2 (HBA2) is set above and below the computed heater current value (deviation high/low alarm).

The set value (above) of heater break alarm 2 (HBA2) is an alarm on the thyristor break-down side.



This setting example shows the operation performed under the following ideal condition. The actual operation differs depending on power supply voltage and load variations. Therefore, set the value meeting the customer's operating condition.

- Power supply voltage: Constant
- Load variation: None
- Balanced three-phase load

How alarm is checked

If an alarm occurs, the indication lamp (HBA1/HBA2) at the front lights.

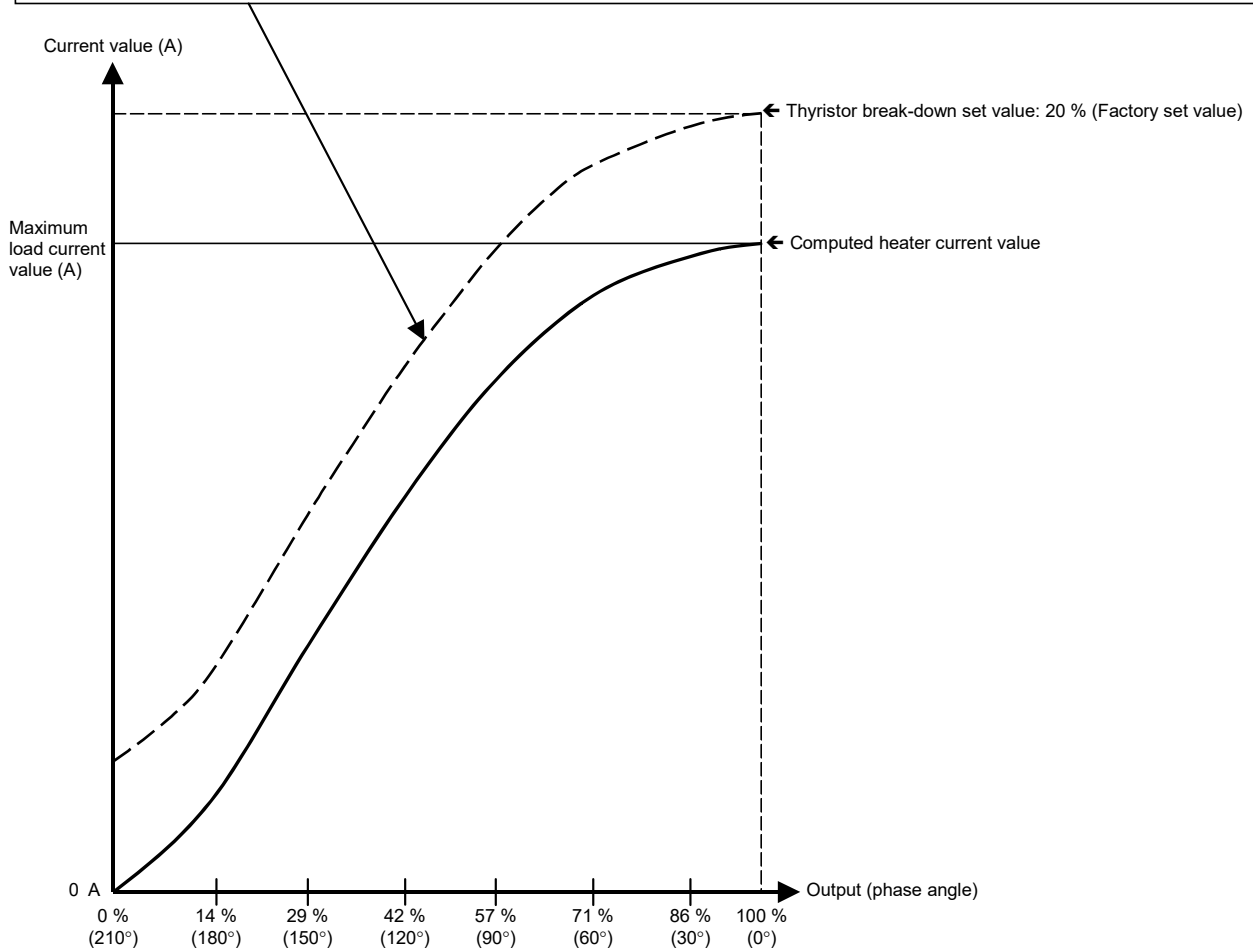
In addition, the alarm signal is output from the alarm 1 or 2 of the input/output connector.

(3) Thyristor break-down alarm

The thyristor break-down alarm is turned on when the computed heater current value is larger than the thyristor break-down set value set at each output (phase angle).

The thyristor break-down alarm is turned on when the computed heater current value is larger than the thyristor break-down set value set at each output (phase angle).

Thyristor break-down alarm is turned on \geq Computed heater current value + (Maximum load current set value (A) \times Thyristor break-down set value [20 %])



When using the thyristor break-down alarm, it is also necessary to set the maximum load current set value for alarm (MAXC). (Refer to P. 38)



Conduct the setting by referring to ■ **Setting example of Heater break alarm (P. 62).**

How alarm is checked

If an alarm occurs, the indication lamp (THY.B) at the front lights.

In addition, the alarm signal is output from the alarm 1 or 2 of the input/output connector.

5.11.3 Heater break alarm for phase control (Type 2)

Type 2 corresponds to a heater break alarm when one heater is used. (Refer to ■ Application)
Use the heater break alarm of Type 2 when a noble metal heater with large resistance changes caused by temperature variations is used.



No Type 2 can be used when two or more heaters are used in parallel connection.

■ How alarm is activated

- When heater current does not flow (Heater break, malfunction of the control device, 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 (HBA) 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 (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 heater break alarm 1 is used for heater break detection and the thyristor break-down alarm, for thyristor element shorting detection)

For Type 2, no set value of heater break alarm 2 (HBA2) is used. Setting the parameter as shown in the following performs the operation as illustrated in the Figure (P. 66).



Set the heater break alarm 1 set value and thyristor break-down set value to approximately 5 % of the maximum load current value. Do not set the heater break alarm set value to more than 15 %.

Parameter in Setting mode

- Maximum load current set value for alarm (MAXC)¹: 20.0 A
- Heater break alarm 1 set value setting (HBA1): 5 %
- Thyristor break-down set value setting (THb): 5 %
- Heater break alarm 2 set value setting (HBA2)²: 0 (Heater break alarm 2 unused)

¹ Always set the maximum heater current value. (Refer to P. 38)

² Always set the heater break alarm 2 to "0: Heater break alarm 2 unused."



The computed current value used for heater break alarm (HBA) and thyristor break-down alarm determination points

The computed current value used for heater break alarm 1 (HBA1) determination point

= (Maximum load current set value) × (Heater break alarm 1 (HBA1) set value)

= 20.0 A × 5 % = 1.0 A

Heater break alarm 1 (HBA1) current value 1.0 A

The computed current value used for thyristor break-down alarm determination point

= (Maximum load current set value) × (Thyristor break-down set value)

= 20.0 A × 5 % = 1.0 A

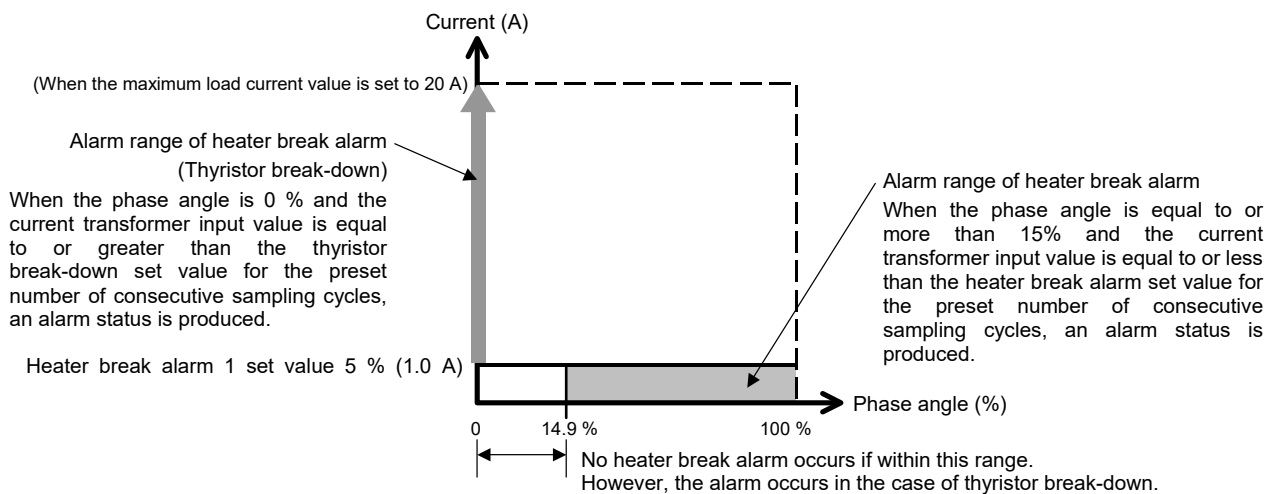
Thyristor break-down current value 1.0 A

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Parameter in Engineering mode

- Alarm 1 output logic (LGA1): 1 [Heater break alarm 1 (ON at alarm output)]
- Alarm 2 output logic (LGA2): 2 [Thyristor break-down alarm (ON at alarm output)]
- Number of heater break alarm 1 delay times (HbC1): 1 time
- Heater break alarm 1 type (AS1): 1 [Type 2 (Absolute value alarm)]
- Alarm interlock (ILS): 0 [Unused]
- Number of heater break alarm 2 delay times (HbC2): This parameter does not use.
- Heater break alarm 2 type (AS2): This parameter does not use.
- Control method (ConT): 0 [Phase control]



How alarm is checked

If an alarm occurs, the indication lamp (HBA1/THY.B) at the front lights.

In addition, the alarm signal is output from the alarm 1 or 2 of the input/output connector.

5.11.4 Heater break alarm for zero-cross control

The following usage is available in zero-cross control. (Refer to ■ Application)

Heater break alarm 1 (HBA1) 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:

It is possible to output an alarm when a thyristor element is shorted or broken by setting the thyristor break-down set value.

Heater break alarm 2 (HBA2) set value:

The heater break alarm 2 (HBA2) set value does not use when in the zero-cross control.

Set the set value of Heater break alarm 2 to "0: Heater break alarm 2 unused."

■ How alarm is activated

- When heater current does not flow (Heater break, malfunction of the control device, etc.)
When the control output is ON and the current transformer (CT) input value is equal to or less than the heater break alarm 1 (HBA1) 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 (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 heater break alarm 1 is used for heater break detection and the thyristor break-down alarm, for thyristor element shorting detection)

Parameter in Setting mode

- Maximum load current set value for alarm (MAXC)¹: 20.0 A
- Heater break alarm 1 set value setting (HBA1): 80 %
- Thyristor break-down set value setting (THb): 30 %
- Heater break alarm 2 set value setting (HBA2)²: 0 (Heater break alarm 2 unused)

¹ Always set the maximum heater current value. (Refer to P. 38)

² Always set the heater break alarm 2 to "0: Heater break alarm 2 unused."



The computed current value used for heater break alarm (HBA) and thyristor break-down alarm determination points

The computed current value used for heater break alarm 1 (HBA1) determination point

= (Maximum load current set value) × (Heater break alarm 1 set value)

= 20.0 A × 80 % = 16.0 A

Heater break alarm 1 (HBA1) current value 16.0 A

The computed current value used for thyristor break-down alarm determination point

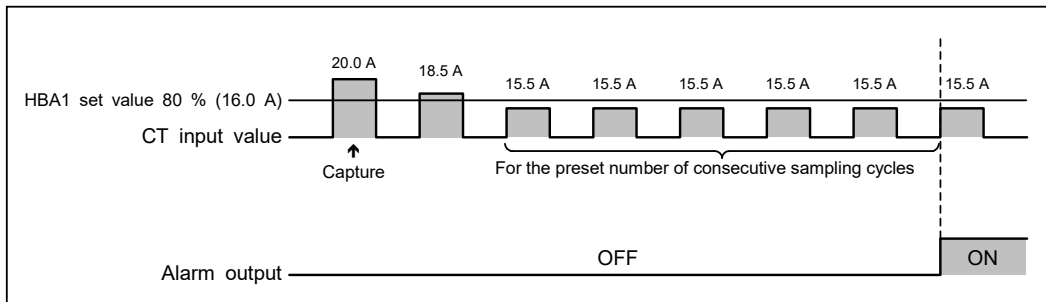
= (Maximum load current set value) × (Thyristor break-down set value)

= 20.0 A × 30 % = 6.0 A

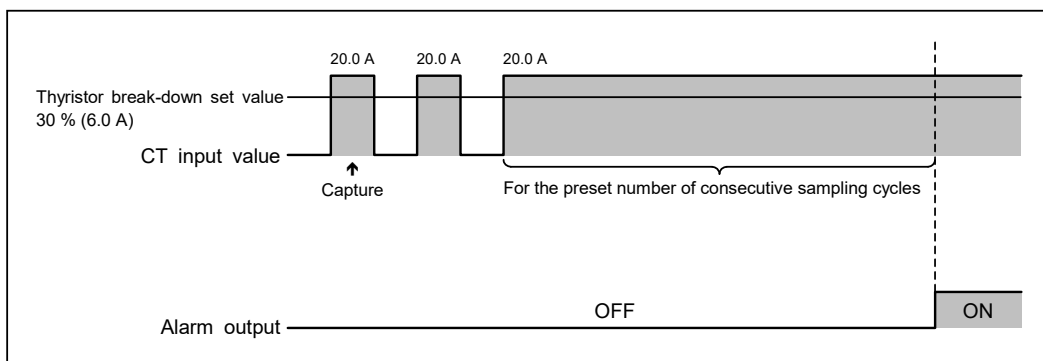
Thyristor break-down current value 6.0 A

Parameter in Engineering mode

- Alarm 1 output logic (LGA1): 1 [Heater break alarm 1 (ON at alarm output)]
- Alarm 2 output logic (LGA2): 2 [Thyristor break-down alarm (ON at alarm output)]
- Number of heater break alarm 1 delay times (HbC1): 1 time
- Heater break alarm 1 type (AS1): This parameter does not use.
- Alarm interlock (ILS): 0 [Unused]
- Number of heater break alarm 2 delay times (HbC2): This parameter does not use.
- Heater break alarm 2 type (AS2): This parameter does not use.
- Control method (ConT): 1 [Zero-cross control]



Heater break alarm



Thyristor break-down alarm

How alarm is checked

If an alarm occurs, the indication lamp (HBA1/THY.B) at the front lights.

In addition, the alarm signal is output from the alarm 1 or 2 of the input/output connector.

5.12 FAIL Alarm

An alarm occurs if a board error of this instrument is detected by the self-diagnostic function.

Action taken when an alarm occurs: The FAIL lamp lights.

Thyristor output is turned off.

5.13 Negative Phase Sequence Alarm

It is fudged whether or not each phase is in positive phase sequence when power is turned on, and an alarm occurs if wiring is made by mistaking phase sequence.

In addition, an alarm occurs also when only two phases are wired.

Action taken when an alarm occurs: The PHASE lamp lights.

Thyristor output is turned off.

5.14 Over Current Alarm (optional)

An alarm occurs when the current exceeding 1.2 times the rating flows through this instrument.

Action taken when an alarm occurs: The OCR lamp lights.

Thyristor output is turned off.

5.15 Fuse Break Alarm (optional)

An alarm occurs when the fast-blow fuse in this instrument blew.

Action taken when an alarm occurs: The FUSE lamp lights.

Thyristor output is turned off.



Fuse break alarm is not available when the fast-blow fuse (with microswitch) is not provided.

5.16 Set Data Lock Function

The set lock level restricts parameter setting changes by key operation. This function prevents the operator from making errors during operation. The setting of data lock is made for each mode.

×: Mode unlock (Settable) –: Mode lock (Unsettable)

Set value	Engineering mode	Setting mode
0000	–	×
0001	–	–
0010	×	×
0011	×	–



The numeric value can be checked in Setting mode even if locked.



The Engineering mode cannot be called up if locked.

5.17 External Contact Input (DI) Function

The following operation is performed by the external contact signal. The external contact state can be checked by the contact input state monitor.

(1) Auto/Manual mode transfer

Use to select the Auto/Manual mode by the external contact input.

When the external contact is open: Auto mode

When the external contact is closed: Manual mode

- How auto set value or manual set value is checked

These values can be checked on the Input signal monitor 1 and Input signal monitor 2 (only auto set value).

- External contact action selection

Auto/Manual mode transfer can select the operating item. The action type can be selected on the Contact input action (dISL). (P. 44).

(2) RUN/STOP transfer

The RUN/STOP can be selected by the external contact signal.

When the external contact is open: STOP

When the external contact is closed: RUN



If the RUN/STOP transfer function is used, set the RUN/STOP action (rSA) to “1: Use.” (Refer to P. 47)

(3) Alarm interlock release

The alarm interlock is released by the external contact signal.

When the external contact is closed: Alarm interlock release



No alarm interlock can be released when in the alarm state. Release the alarm interlock after the cause of the alarm is cleared up.

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. 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 (20 A, 30 A)3.8 N·m (45 A, 60 A)9.0 N·m (80 A, 100 A) <p>For the torque wrench, refer to page 14.</p>
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 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	Probable cause	Solution
The FAIL 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 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 once. If a lamp lights after the power is turned on again, please contact RKC sales office or the agent.
No 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.
	The fast-blow fuse is broken.	Replace the fast-blow fuse.
The FUSE lamp lights	The fast-blow fuse is broken.	Replace the fast-blow fuse.
The PHASE lamp lights	Wiring is conducted by mistaking phase sequence	Conduct wiring so that the phase of each power supply terminal (R, S or T) coincides with that of each main circuit terminal (1/L1, 3/L2 or 5/L3).
	The three-phase power supply is not supplied	Supply the three-phase power.
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.
The HBA2 lamp lights		
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.
	A thyristor element is damaged.	For any causes other than the above, turn the power off and then contact to your nearest RKC sales agent or our sales office.
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.

6.3 Replacement of the Fast-Blow Fuse

CAUTION

Use a torque wrench for removing or tightening each hexagon headed bolt which fixes the fuse. Always remove or tighten the bolt by contacting the diagonal surfaces of the wrench with those of the bolt head.

Recommended tool:

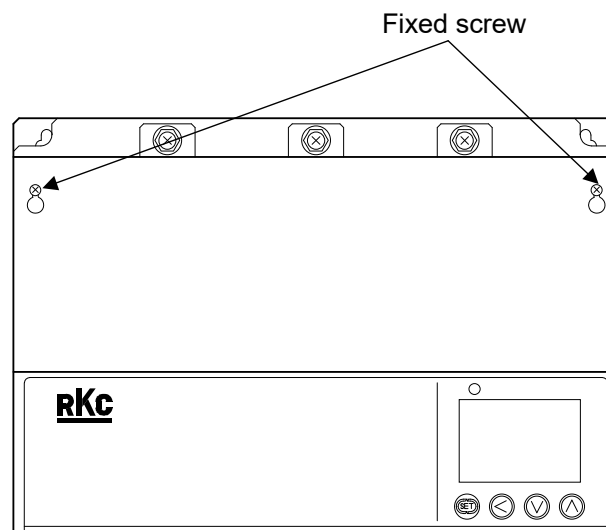
- Torque wrench and Socket: Manufactured by TOHNICHI MFG. CO., LTD
- Extension: Manufactured by KTC (KYOTO TOOL)

	Model code of adjustable type torque wrench with ratchet head	Socket size
20 A to 80 A	QL6N	M6
100 A	QL12N	M8

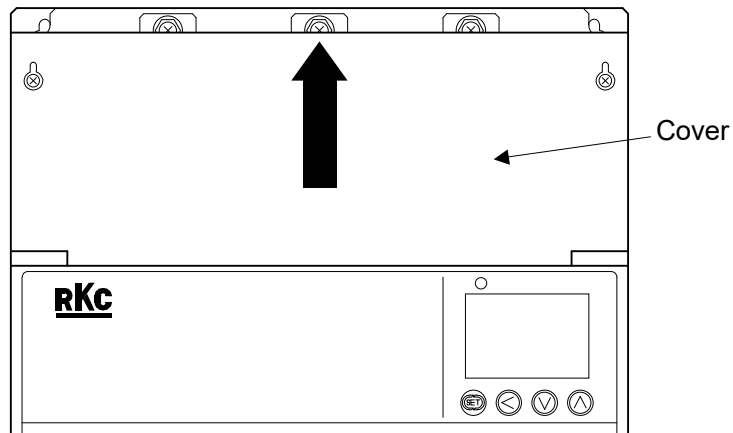
	Model code of the extension
20 A to 100 A	BE10-50

6.3.1 Replacement of the fast-blow fuse (without microswitch)

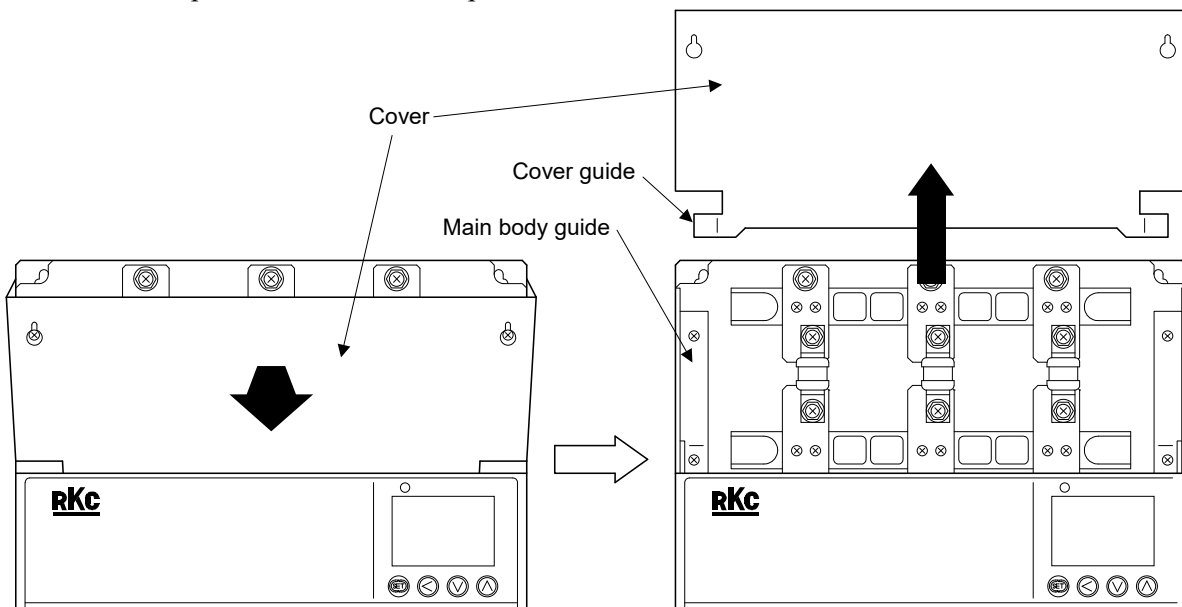
1. Loosen two screws which fix the cover using a Phillips screwdriver.



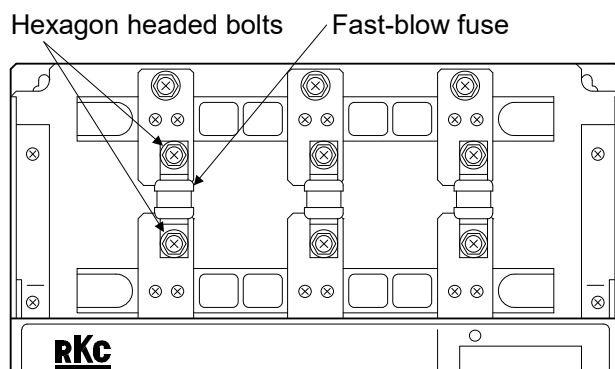
2. Slide the cover upward.



3. Slant the top of the cover and then pull out the cover.



4. Remove two hexagon headed bolts which fix the fast-blow fuse using a torque wrench and then remove the blown fast-blow fuse.



Hexagon headed bolt size
 20 A to 80 A: M6
 100 A: M8

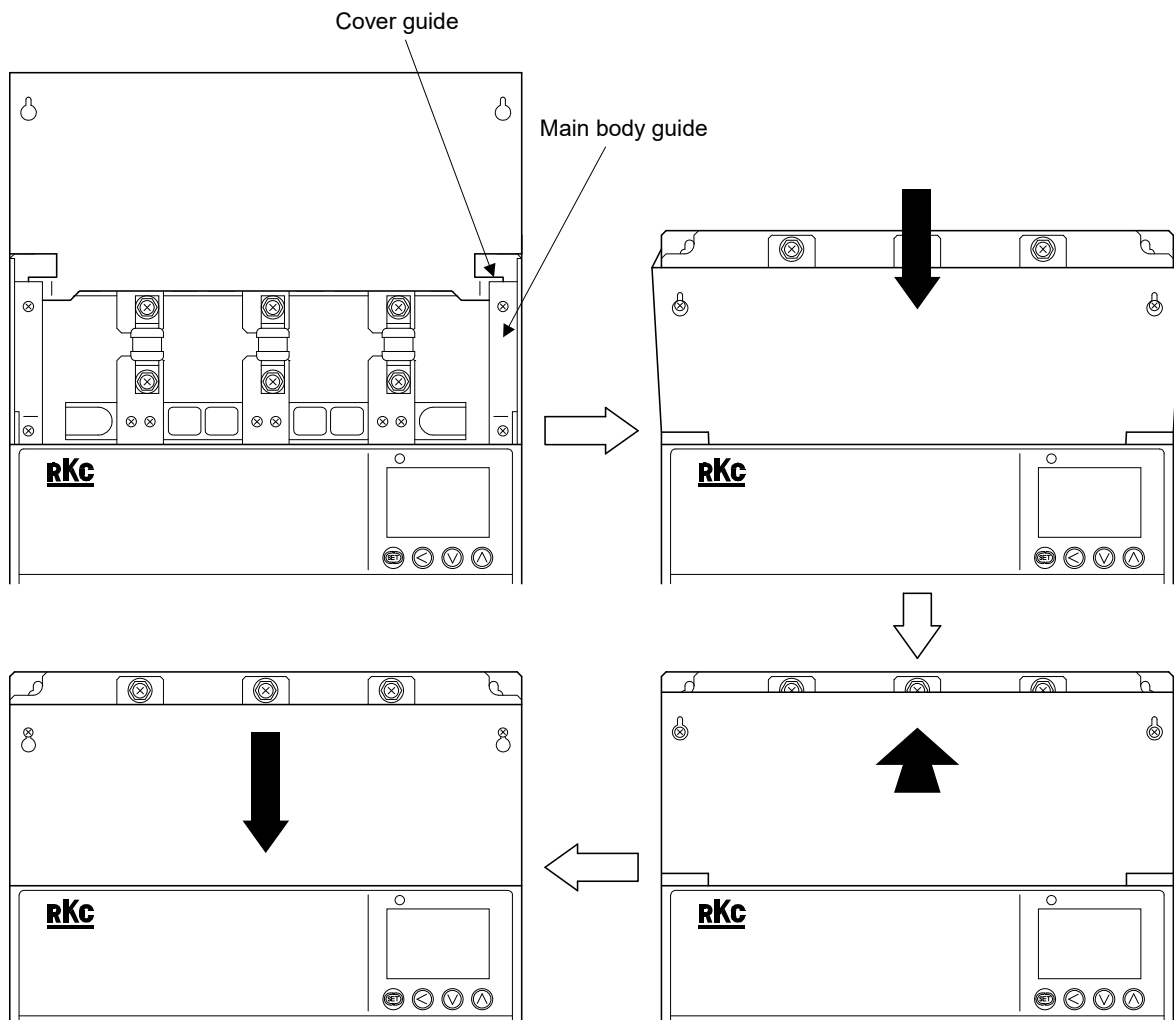
5. Replace the blown fast-blow fuse with a new one. **First temporarily tighten these two hexagon headed bolts to fix the fast-blow fuse** and then tighten them at specified torque using the torque wrench.



Always temporarily tighten the two hexagon headed bolts first.

	Recommended tightening torque
20 A to 80 A	5.0 N·m (50.98 kgf·cm)
100 A	11.8 N·m (120.32 kgf·cm)

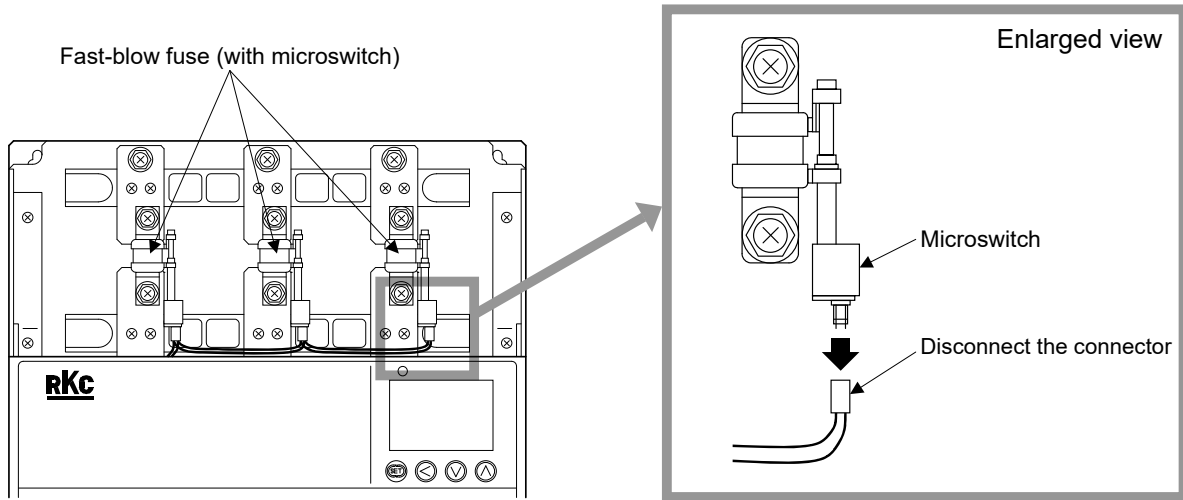
6. Match the cover guide with the rear of the main body guide, and close the cover.



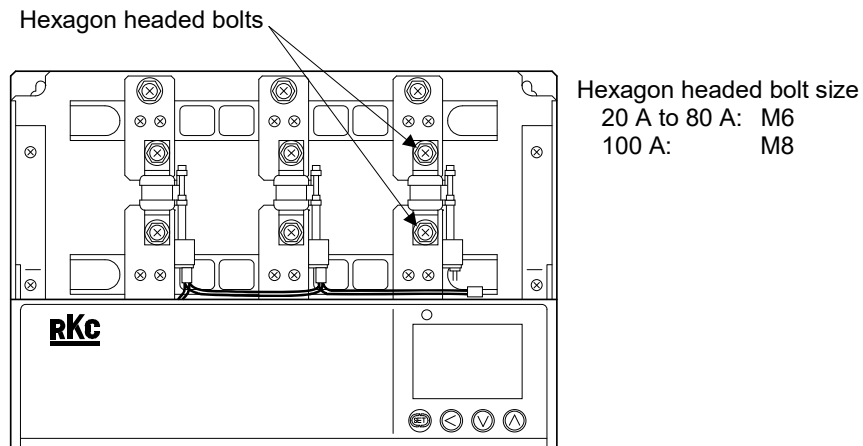
7. Tighten the two screws which fix the cover using the Phillips screwdriver to finish the work.

6.3.2 Replacement of the fast-blow fuse (with microswitch)

1. Remove the front cover according to the same way as replacing the fast-blow fuse (without microswitch).
2. Disconnect the connector which connects the fast-blow fuse to the main body.



3. Remove two hexagon headed bolts which fix the fast-blow fuse using a torque wrench and then remove the blown fast-blow fuse.



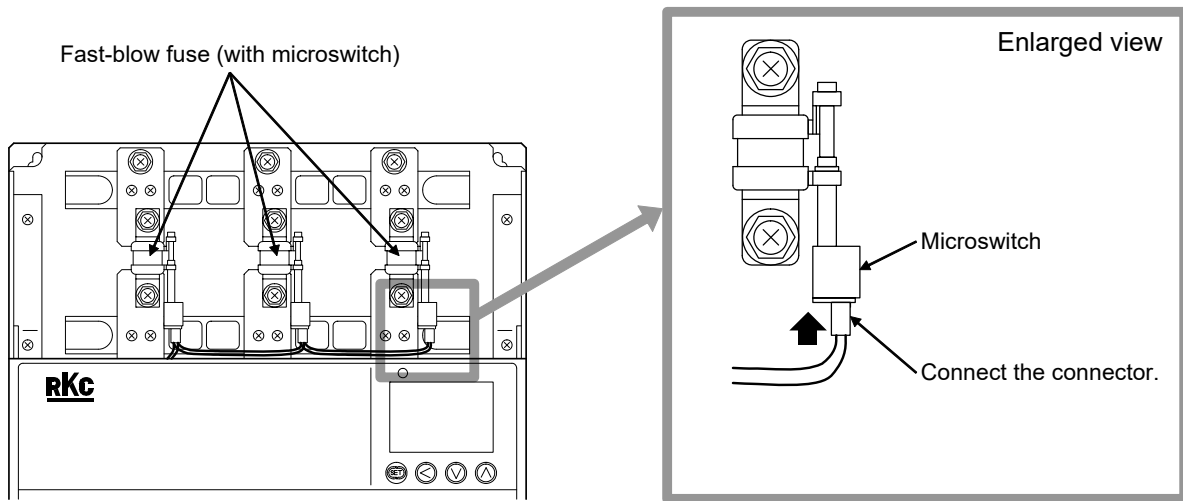
4. Replace the blown fast-blow fuse with a new one. First temporarily tighten these two hexagon headed bolts to fix the fast-blow fuse and then tighten them at specified torque using the torque wrench.



Always temporarily tighten the two hexagon headed bolts first.


	Recommended tightening torque
20 A to 80 A	5.0 N·m (50.98 kgf·cm)
100 A	11.8 N·m (120.32 kgf·cm)

5. Connect the connector which connects the fast-blow fuse to the main body.



6. Close the front cover to finish the work. Close the front cover according to the same way as fixing the fast-blow fuse (without microswitch).

7. SPECIFICATIONS

Number of phase:	Three-phase
Rated current:	20 A AC, 30 A AC, 45 A AC, 60 A AC, 80 A AC and 100 A AC (The rated current drops when the ambient temperature exceeds 40 °C.)
Minimum load current:	1 A
Power supply voltage:	180 to 264 V AC [Including power supply voltage variation] (Rating: 200 to 240 V AC)
Power frequency:	50/60 Hz (Automatic discriminating)
Allowable power frequency variations:	Performance guarantee: 50 Hz \pm 1 Hz, 60 Hz \pm 1 Hz Operation guarantee: 45.0 to 54.9 Hz (50 Hz) 55.0 to 64.9 Hz (60 Hz)
Output voltage range:	0 to 98 % of rated voltage
Applicable load:	Phase control: Linearity load (resistor load) Control of primary side of a transformer (Recommended magnetic field density: Approx. 0.8 tesla (8, 000 gauss) or less) Zero-cross control: Linearity load (resistor load)
Output mode:	Proportional phase angle to input Proportional voltage to input Proportional square voltage (electric power) to input Constant current control (optional) Constant voltage control (optional) Constant power control (optional)  Output mode is validated when using a linearity load (R: resistor) at the phase control.
Control method:	Phase control Zero-cross control
Input signal:	Hardware 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: 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:

- 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 input 0 to 10 V DC: 68 k Ω
- Voltage pulse input 0/12 V DC: 30 k Ω (Hardware 1), 68 k Ω (Hardware 2)
- Voltage pulse input 0/24 V DC: 68 k Ω
- Dry contact input: 47 k Ω

Action at input break:

- Current input: Downscale (control output OFF)
- Voltage input: Downscale (control output OFF)
- Voltage pulse input: Downscale (control output OFF)

Allowable input voltage:

- Current input: Equivalent to 0 to 2.2 V
- Voltage input: 0 to 19 V (0 to 5 V DC, 1 to 5 V DC)
0 to 30 V (0 to 10 V DC)
- Voltage pulse input: Hardware 1: 0 to 19 V (0/12 V DC)
Hardware 2: 0 to 30 V (0/12 V DC, 0/24 V DC)

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: 10 Ω or less
- Contact current: 10 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

Current transformer (CT) input (optional):

- Number of input point: 2 or 3 points
- Input range: 0.0 to 100.0 A
- Sampling cycle: 20 ms (50 Hz), 16.6 ms (60 Hz)

Potential Transformer (PT) input (optional):

- Number of input point: 3 points
- Input range: 0.0 to 280.0 V
- Sampling cycle: 20 ms (50 Hz), 16.6 ms (60 Hz)

- External manual set value:** 0 to 100 %
Set by the setter (optional)
- Internal manual set value:** 0.0 to 100.0 %
Set by the THW-A1 front keys
- External gradient set value:** 0 to 100 %
Set by the setter (optional)
- Internal gradient set value:** 0.00 to 1.00 (0 to 100 %)
Set by the THW-A1 front keys
- Output limiter (high) set value:** 0.0 to 100.0 %
Set by the THW-A1 front keys
- Output limiter (high) at the time of start:**
0.0 to 100.0 %
Set by the THW-A1 front keys
- Output limiter (high) time at the time of start:**
0.0 to 600.0 seconds
Set by the THW-A1 front keys
- Output limiter (low) set value:** 0.0 to 100.0 %
Set by the THW-A1 front keys
- Base-up set value:** 0.0 to 100.0 %
Set by the THW-A1 front keys
- Ramp (Soft-start/Soft-down) function:**
0.0 to 99.9 seconds
Set by the THW-A1 front keys
- Current limiter function (optional):**
20 A: 0.0 to 22.0 A
30 A: 0.0 to 33.0 A
45 A: 0 to 50 A
60 A: 0 to 66 A
80 A: 0 to 88 A
100 A: 0 to 110 A
Set by the THW-A1 front keys



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

Alarm function:	Number of output point: 2 points
	Output type: Open collector output 24 V DC, maximum 100 mA
	Alarm type: Power frequency error Negative phase sequence alarm Heater break alarm 1 (optional) Thyristor break-down alarm (optional) Heater break alarm 2 (optional) Over current alarm (optional) Fuse break (optional)
Self-diagnostic function:	Check item: Board error, EEPROM error, Calibration data error Range check of set value
	Error displays: The FAIL lamp lights
Ambient temperature:	0 to 40 °C (Performance guarantee range) -15 to +55 °C (Operation guarantee range)
Ambient humidity:	5 to 95 %RH (Non-condensing) (Absolute humidity: MAX.W.C 29 g/m ³ dry air at 101.3 kPa)
Power consumption:	17 VA
Withstand voltage:	Between main circuit and grounding terminals: 1 minute at 2000 V AC
Insulation resistance:	Between main circuit and grounding terminals: 20 MΩ or more as 500 V DC
Cooling method:	Natural convection
Mounting method:	Vertical mounting
Dimensions:	Refer to 2.3 Dimensions (P. 8) .
Weight:	Approx. 5.8 kg (20 to 60 A types) Approx. 13.6 kg (80 and 100 A types)

APPENDIX

■ Description of terms


Following table is descriptions of term used in this manual.

Term	Description
Maximum load current (value)	The maximum load current value means a current value which flows through the heater at an output of 100 % (phase angle: 0°).
Auto mode	This is to automatically adjust power (output value) by the input signal from the controller. Input signal type: 0 to 20 mA DC, 4 to 20 mA DC, 0 to 5 V DC, 1 to 5 V DC, 0 to 10 V DC, 0/12 V DC, 0/24 V DC
Manual mode (External/Internal)	External manual mode: This is to manually adjust power (output value) by manipulating the external setter (potentiometer). Internal manual mode: This is to manually adjust power (output value) by manipulating the front keys.
Input signal	In this manual, the following three items are called input signals. • Auto set value (value of Auto mode) • Internal manual set value • External manual set value
Gradient setting (External/Internal)	External gradient setting: This is to set the gradient value by the external setter (potentiometer). Internal gradient setting: This is to set the gradient value by the front keys.
RUN	The operation of this instrument is started.
STOP	The operation of this instrument is stopped.
HBA	This is the Heater Break Alarm. HBA1: Heater Break Alarm 1 HBA2: Heater Break Alarm 2
CT	C <u>u</u> rrent T <u>r</u> ansformer
PT	P <u>o</u> tential T <u>r</u> ansformer


■ 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	C	D	E	F	G	H	I	J	K	L
A	b	C	d	E	F	G	H	I	J	K	L
M	N	O	P	Q	R	S	T	U	u	V	W
m̄	n̄	ō	P	q	r	S	T	U	u	V	W
X	Y	Z	Degree	/							
x	y	z	°	/							

● Lighting state of the character LED

 : Dim lighting

 : Bright lighting

 : Flashing

The first edition: OCT. 2010 [IMQ00]
The third edition: JUL. 2023 [IMQ01]



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