

Single-phase Thyristor Unit





THV-1

Instruction Manual

IMR01M01-E5

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 this 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 instrument and equipment.
- This instrument must be used in accordance with the specifications to prevent fire or damage to instrument and equipment.
- This instrument is not intended for use in locations subject to flammable or explosive gases.
- Do not touch high-voltage connections such as power supply terminals, etc. to avoid electric shock.
- RKC is not responsible if this instrument is repaired, modified or disassembled by other than factory-approved personnel. Malfunction can occur and warranty is void under these conditions.

CAUTION

- This product 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 by 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 will occur. Use a soft, dry cloth to remove stains from the instrument.
- To avoid damage to instrument display, do not rub with an abrasive material or push 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 purpose of illustration.
- RKC is not responsible for any damage or injury that is caused as a result of using this instrument, instrument failure or indirect damage.
- Periodic maintenance is required for safe and proper operation of this instrument. Some components have a limited service life, or characteristics that change over time.
- Every effort has been made to ensure accuracy of all information contained herein. RKC makes no warranty expressed or implied, with respect to the accuracy of the information. The information in this manual is subject to change without prior notice.
- No portion of this document may be reprinted, modified, copied, transmitted, digitized, stored, processed or retrieved through any mechanical, electronic, optical or other means without prior written approval from RKC.

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1. CHECKING THE PRODUCT

When unpacking your new instrument, please confirm that the following items are included. If any item is missing, damaged, or if your manual is incomplete, please contact RKC sales office or the agent.

- | | | |
|---|---------|--|
| • THV-1: | 1 unit | Accessories (option) |
| • Instruction manual (IMR01M01-E5): | 1 copy | • Setter for open loop control (potentiometer, knob and scale plate) |
| • Short bar: | 1 piece | • Fuse unit (fast-blow fuse [1 piece] and holder) |
|  The short bar is connected to the "input and power supply terminals." | | • Output voltmeter (150 V span or 300 V span) |
| | | • Connector (plug) |

2. CONFIRMATION OF THE MODEL CODE

Check whether the delivered product is as specified by referring to the following model code list. If the product is not identical to the specifications, please contact RKC sales office or the agent.

THV- 1 P Z □ - □ * □ N - □ (-□.....) *

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

* The code for accessory will be more than one if the product has more than one accessory.

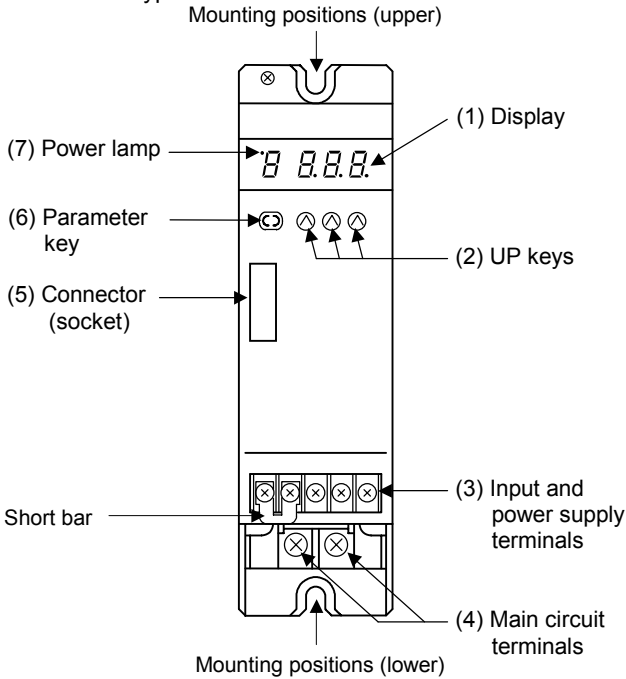
- | | |
|--|--|
| (1) Power supply
1: Single-phase 100 to 240 V AC | (5) Option function 1
N: No heater break alarm, current limiter and constant current control functions
H: Heater break alarm, current limiter and constant current control functions
(The current limiter and constant current control functions are not available when the zero-cross control.) |
| (2) Control method
PZ: Phase control/zero-cross control (configurable) | (6) Option function 2
N: No function |
| (3) Maximum load current
020: 20 A
030: 30 A
045: 45 A
060: 60 A
080: 80 A
100: 100 A | (7) Accessories
1: Setter for open loop control (potentiometer, knob and scale plate) [1 set] and Connector (plug)
2: Setter for open loop control (potentiometer, knob and scale plate) [2 sets] and Connector (plug)
3: Fuse unit for 20 A and 30 A (fast-blow fuse [1 piece] and holder [3 circuits type])
4: Output voltmeter (150 V span) [For phase control]
5: Output voltmeter (300 V span) [For phase control]
6: Fuse unit for 20 A, 30 A, 45 A, 60 A, 80 A and 100 A (fast-blow fuse [1 piece] and holder [1 circuit type])
9: Connector (Plug)
Combination example of accessories
-1-3: Setter for open loop control [1 set] and Connector (plug) and Fuse unit |
| (4) Input signal
5: Voltage input: 0 to 10 V DC
6: Voltage input: 1 to 5 V DC
8: Current input: 4 to 20 mA DC | |

■ Accessories (Order Separately)

- THVP-S01: Setter (potentiometer, knob and scale plate)
- THVP-F21: Fuse unit for 20 A (Fast-blow fuse [1 piece] and holder [3 circuits type])
- THVP-F31: Fuse unit for 30 A (Fast-blow fuse [1 piece] and holder [3 circuits type])
- THVP-F22: Fuse unit for 20 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-F32: Fuse unit for 30 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-F42: Fuse unit for 45 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-F62: Fuse unit for 60 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-F82: Fuse unit for 80 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-FA2: Fuse unit for 100 A (Fast-blow fuse [1 piece] and holder [1 circuit type])
- THVP-F20: Fast-blow fuse for 20 A (3 circuits type)
- THVP-F2A: Fast-blow fuse for 20 A (1 circuit type)
- THVP-F30: Fast-blow fuse for 30 A (3 circuits type)
- THVP-F3A: Fast-blow fuse for 30 A (1 circuit type)
- THVP-F45: Fast-blow fuse for 45 A (1 circuit type)
- THVP-F60: Fast-blow fuse for 60 A (1 circuit type)
- THVP-F80: Fast-blow fuse for 80 A (1 circuit type)
- THVP-FA0: Fast-blow fuse for 100 A (1 circuit type)
- THVP-V01: Output voltmeter (150 V span) [For phase control]
- THVP-V02: Output voltmeter (300 V span) [For phase control]
- THVP-C01: Connector (plug)
- THVP-H01: Fuse holder for 20 A and 30 A (3 circuits type)
- THVP-H02: Fuse holder for 20 A, 30 A and 45 A (1 circuit type)
- THVP-H03: Fuse holder for 60 A, 80 A and 100 A (1 circuit type)

3. PARTS DESCRIPTION

The 20 A and 30 A types are used in the following figures for explanation, but the same explanations also apply to 45 A, 60 A, 80 A and 100 A types.



Name	Description
(1) Display	Display the input signal values and parameters.
(2) UP keys	Used to change the values.
(3) Input and power supply terminals	Used to connect input signal and power supply wires.
(4) Main circuit terminals	Used to connect main circuit wires.
(5) Connector (socket)	Used to connect with a setter (potentiometer), external contact or controller. In addition, used to heater break alarm output.
(6) Parameter key	Used to select the desired parameter group or to call up the desired parameter.
(7) Power lamp	Lit when the power is turned on.

4. MOUNTING

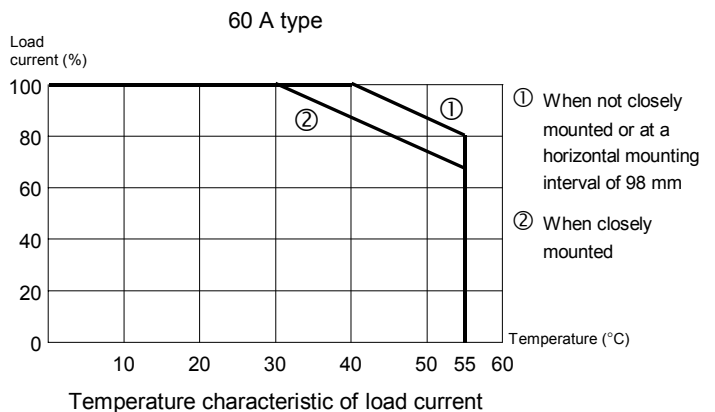
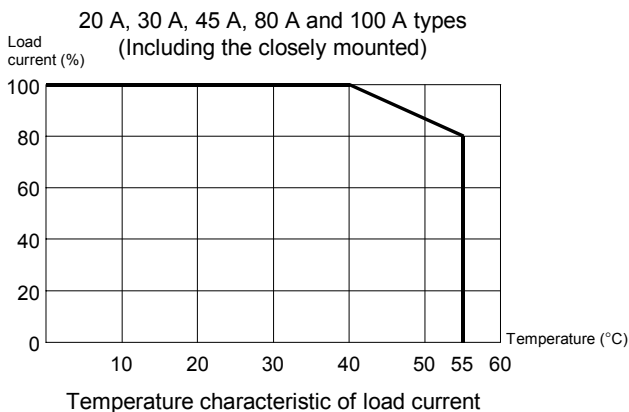


To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.

4.1 Mounting Environment

Avoid the following conditions when selecting the mounting location:

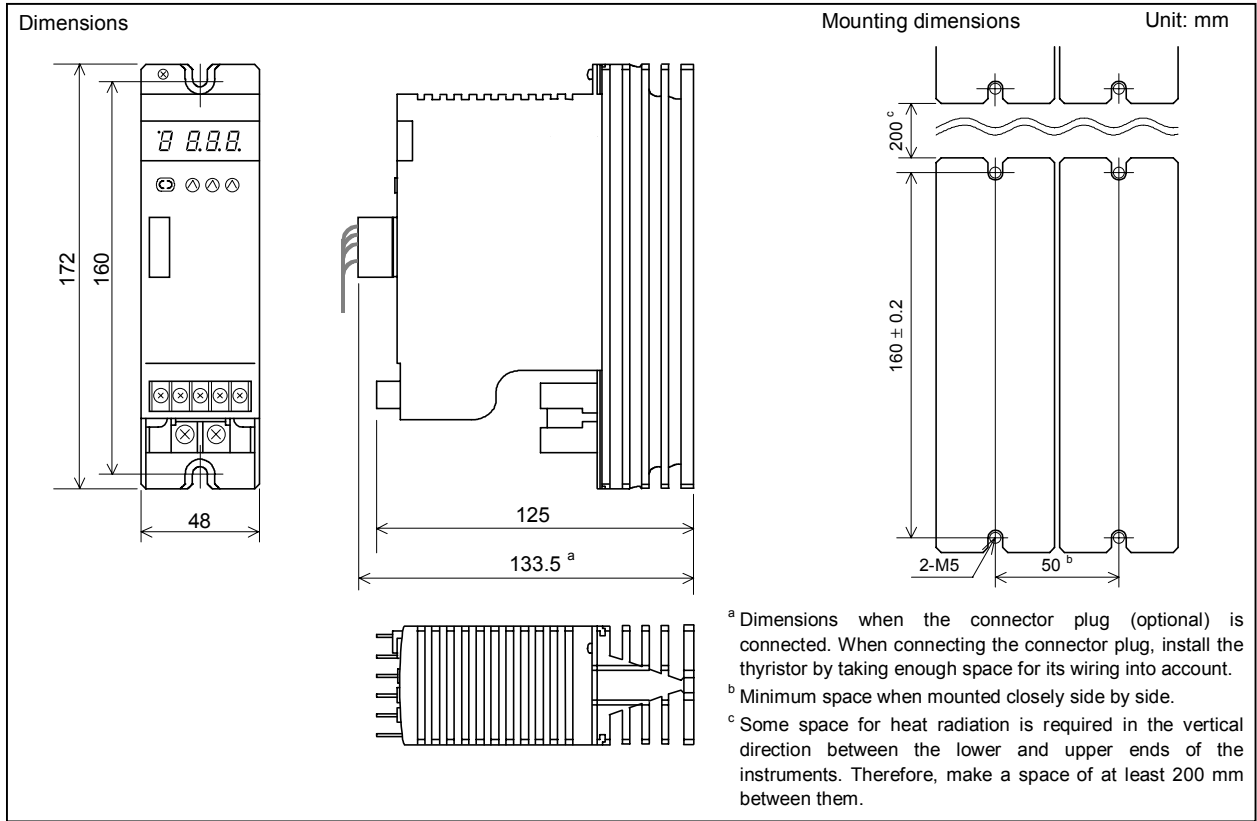
- Ambient temperature of less than 0 °C or more than 40 °C. (The maximum load current drops when the ambient temperature exceeds 40 °C.)



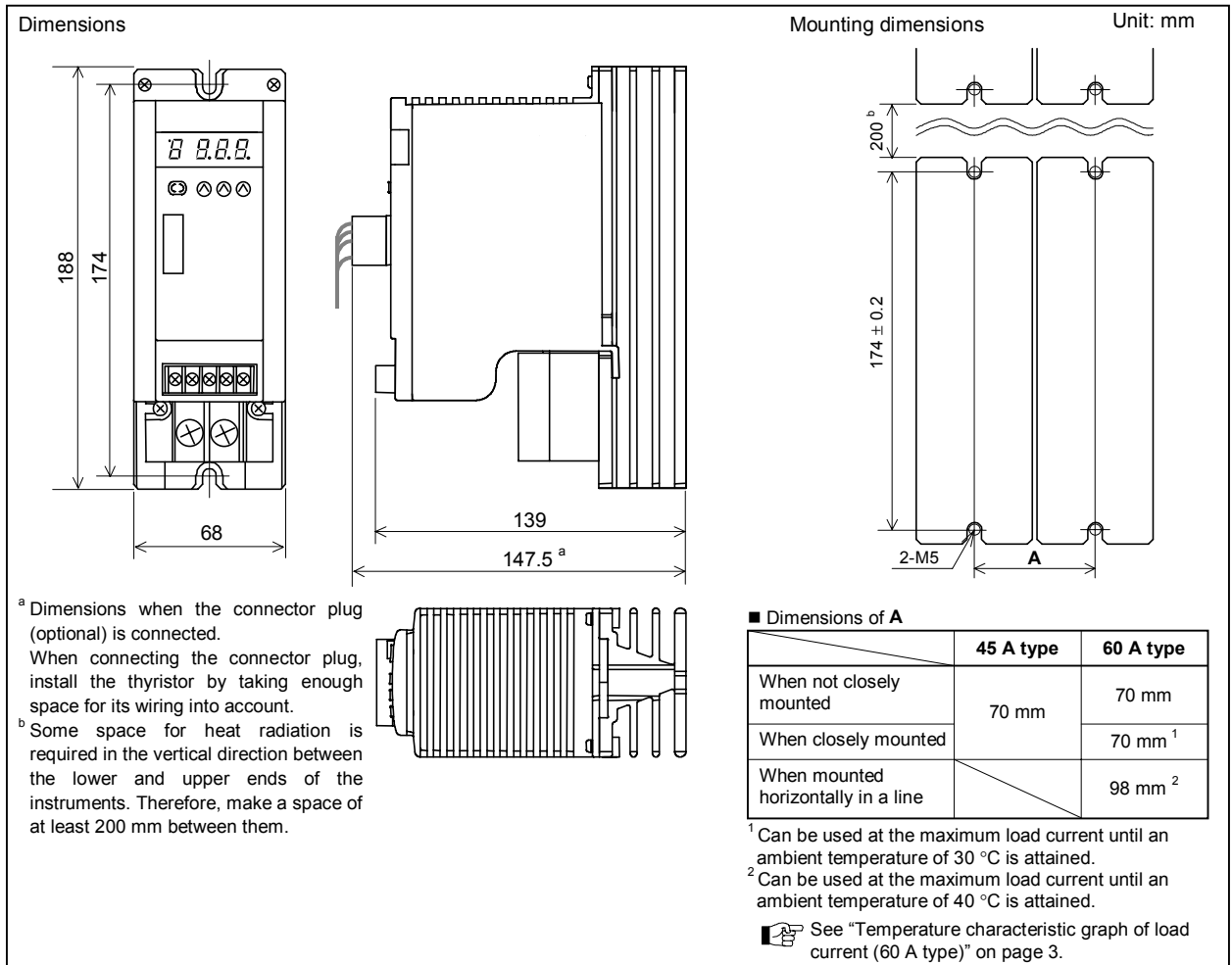
- Ambient humidity of less than 5 % or more than 95 % RH.
- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Direct vibration or shock to the mainframe.
- Water, oil, chemicals, vapor or steam splashes.
- Excessive dust, salt or iron particles.
- Excessive induction noise, static electricity, magnetic fields or noise.
- Exposure to direct sunlight.
- Excessive heat accumulation.

4.2 Dimensions

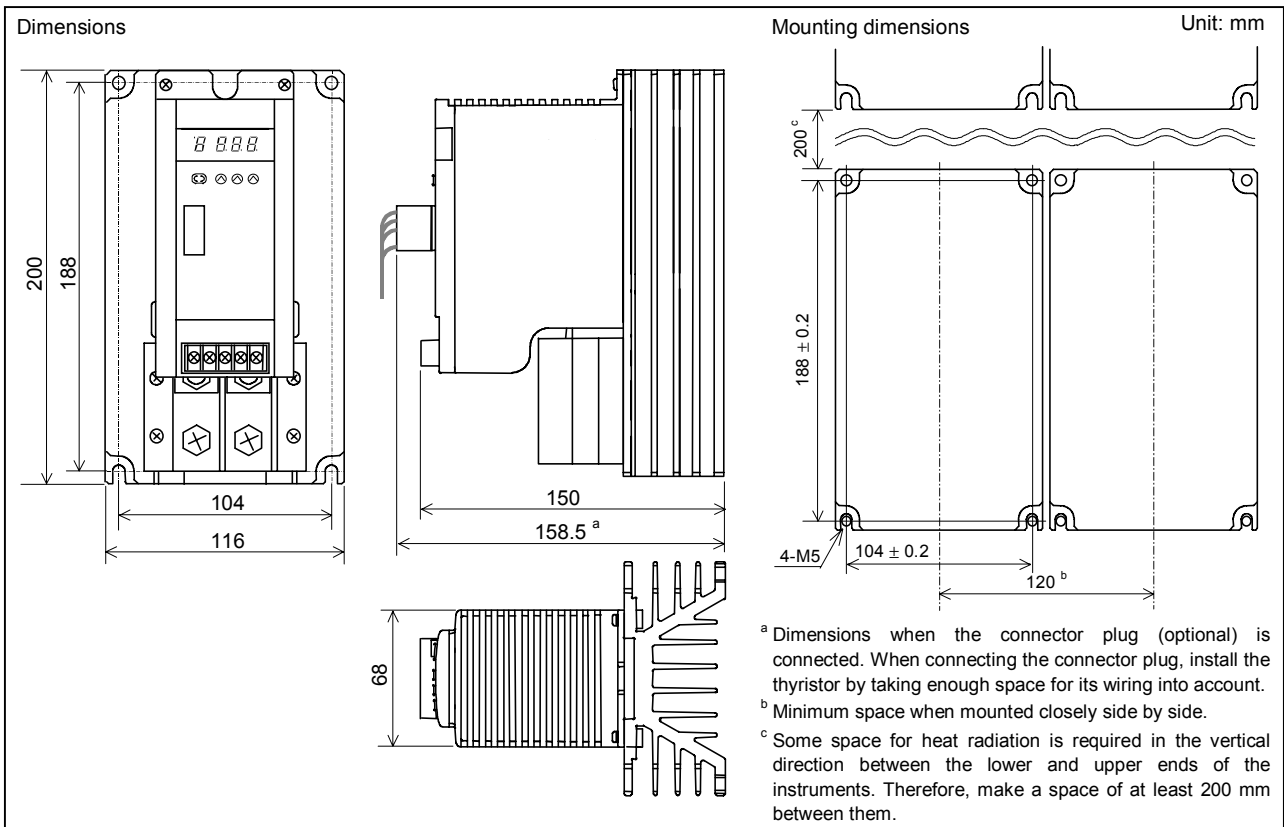
■ 20 A and 30 A types



■ 45 A and 60 A types



■ 80 A and 100 A types



4.3 Mounting Procedures

The mounting direction of the instrument must be the same as the direction shown in the figure below to provide adequate ventilation space so that heat does not build up.

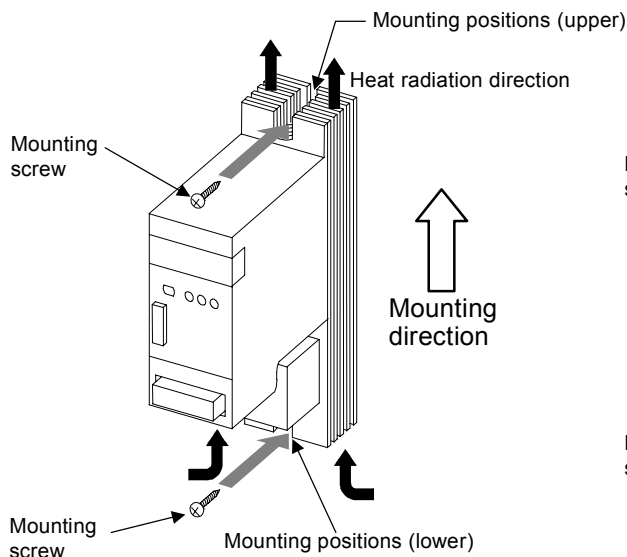
CAUTION

This unit generates heat. It is cooled by air convection when installed as shown. Failure to observe the instructions in 4.2 and 4.3 could cause damage to the instrument, equipment or injury to personnel. Precautions should be made for heat dissipation in the control cabinet.

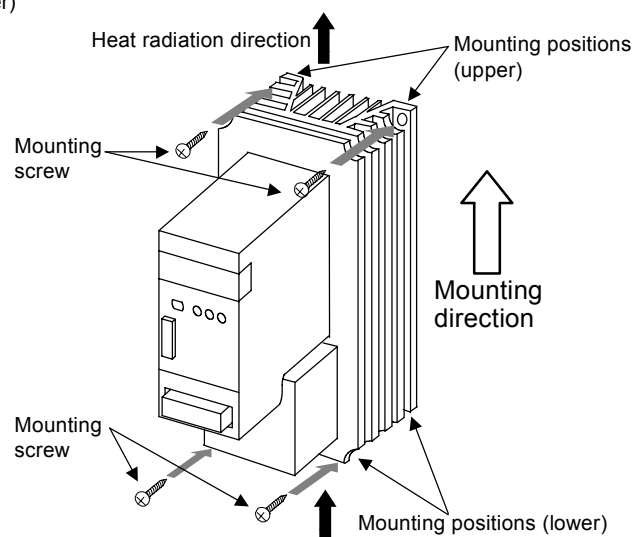
1. Prepare the holes as specified in 4.2 Dimensions.
2. Place the instrument in mounting position.
3. Insert the mounting screws into the holes, then tighten them with a screwdriver.
Recommended tighten torque: 1 N·m [10 kgf·cm]

Customer must provide the set of screws.
Screw type: M5 size, pan-head screws, length 10 mm

■ 20 A, 30 A, 45 A and 60 A types



■ 80 A and 100 A types



5. WIRING



WARNING

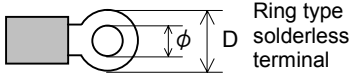
To prevent electric shock or instrument failure, do not turn on the power until all the wiring is completed.

5.1 Wiring of Main Circuit

CAUTION

- Always conduct wiring so that the phase of the main circuit (L1) coincides with that of terminal No. 4 and the phase of the main circuit (L2), with that of terminal No. 5. Otherwise the instrument may not function properly or the load may be damaged.
- Use wires satisfying the rated current capacity.
- Firmly tighten each terminal screw with the tightening torque specified below. Otherwise, electric shock, fire or heat generation may result.
- When using a solderless terminal lug, use ring type. 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.
- There are neither fuses nor power switches in the power circuit of this instrument. Therefore install the fuses and switches near the instrument, if necessary.

Terminal size and tightening torque



Item	Power terminals	Main circuit terminals		
		20 A and 30 A	45 A and 60 A	80 A and 100 A
ϕ	3.2 mm or more	4.3 mm or more	6.4 mm or more	8.4 mm or more
D (mm)	5.5 mm or less	9.5 mm or less	13.2 mm or less	22.6 mm or less
Recommended tightening torque	0.4 N·m (4 kgf·cm)	1.6 N·m (16 kgf·cm)	3.8 N·m (38 kgf·cm)	9.0 N·m (90 kgf·cm)

Wiring diagram of main circuit



Always conduct wiring so that the phase of the main circuit (L1) coincides with that of terminal No. 4 and the phase of the main circuit (L2), with that of terminal No. 5. Otherwise the instrument may not function properly or the load may be damaged.

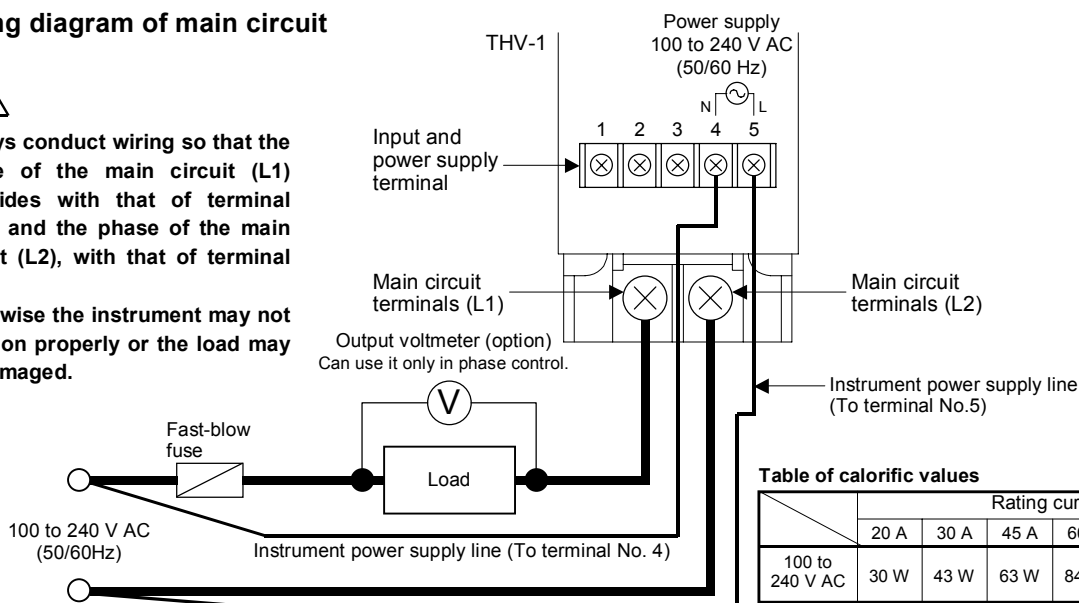


Table of calorific values

100 to 240 V AC	Rating current					
	20 A	30 A	45 A	60 A	80 A	100 A
30 W	43 W	63 W	84 W	112 W	140 W	

5.2 Wiring of Input Signal

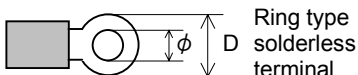
■ Current input 4 to 20 mA DC, voltage input 0 to 10 V DC, 1 to 5 V DC and voltage pulse input 0/12 V DC

The input signal type can be changed by moving the short bar position. Any parameter change is not required for input type change.

CAUTION

- Firmly tighten each terminal screw with the tightening torque specified below. Otherwise, electric shock, fire or the generation of heat may result.
- When using a solderless terminal lug, use ring type.

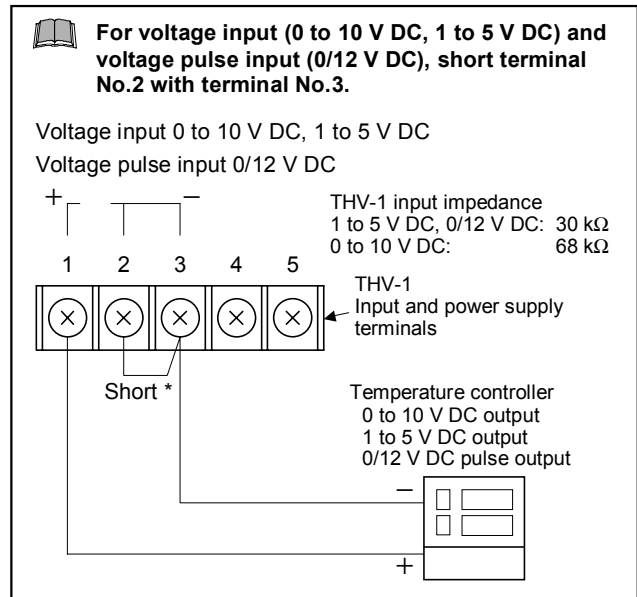
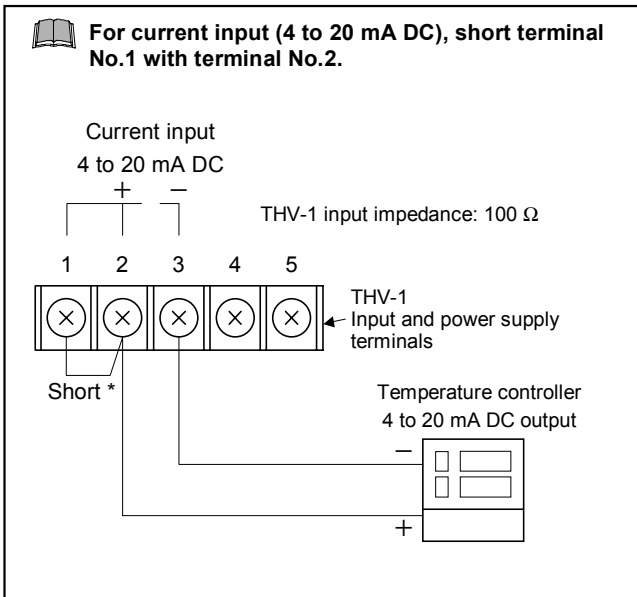
Terminal size and tightening torque



Item	Power terminal
ϕ	3.2 mm or more
D (mm)	5.5 mm or less
Recommended tightening torque	0.4 N·m (4 kgf·cm)

Current input 4 to 20 mA DC

Voltage input 0 to 10 V DC, 1 to 5 V DC or voltage pulse input 0/12 V DC

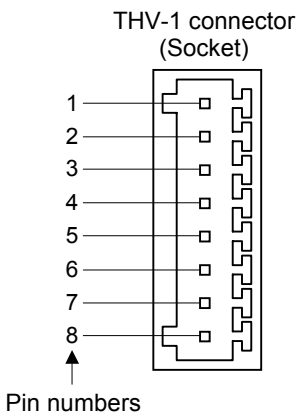


* The input signal type can be changed by moving the short bar position. Any parameter change is not required for input type change. However for a voltage input of 1 to 10 V DC, no input signal can be changed.

5.3 Wiring for connector

The connector is used for contact input, auto/manual mode selection, external gradient setting, heater break alarm 1 output or heater break alarm 2 output. Use the optional connector (plug) for wiring.

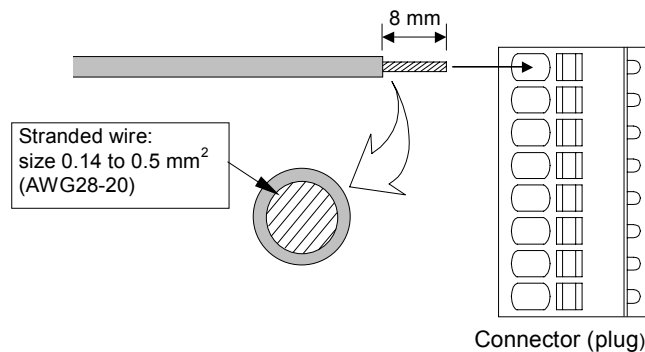
Pin number and details



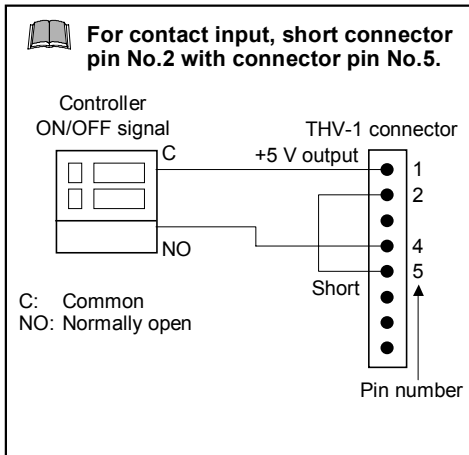
Pin number	Details
1	+5 V output
2	0 V (GND)
3	Gradient setting input (0 to 5 V input by the gradient setter)
4	External manual mode input (0 to 5 V input by the manual setter)
5	Auto/Manual mode transfer (contact open: auto mode) Shorting No.2 pin (GND) with No.5 pin results in the manual mode.
6	Open collector output (+): Used for output of the heater break alarm 1 or heater break alarm 2.
7	Open collector output (-): Used for output of the heater break alarm 1 or heater break alarm 2.
8	Unused

CAUTION

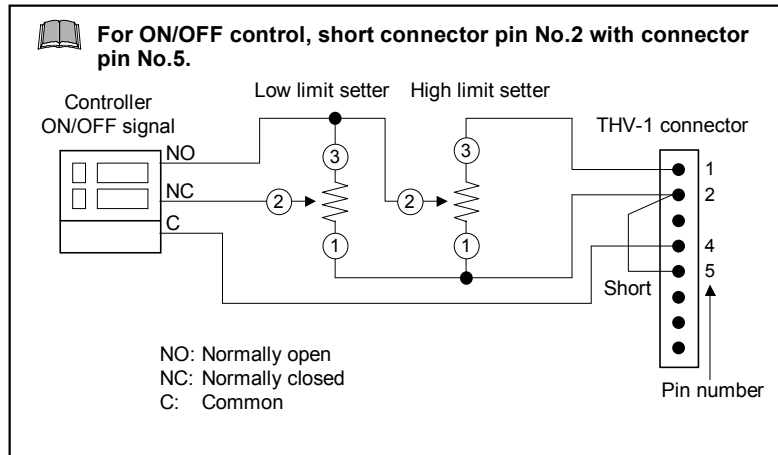
- Use stranded wire of size 0.14 to 0.5 mm² for the leadwires.
- Strip off the sheath from 8 mm from the leadwire end.



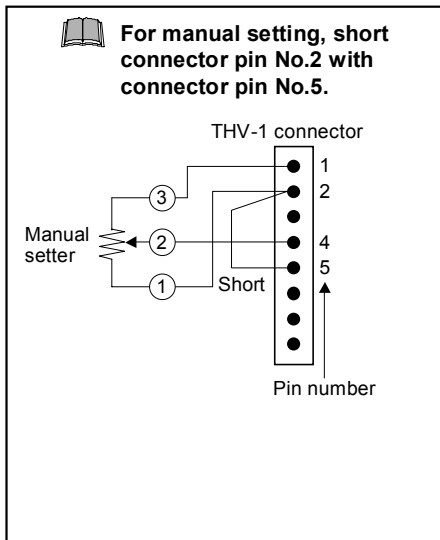
Contact input



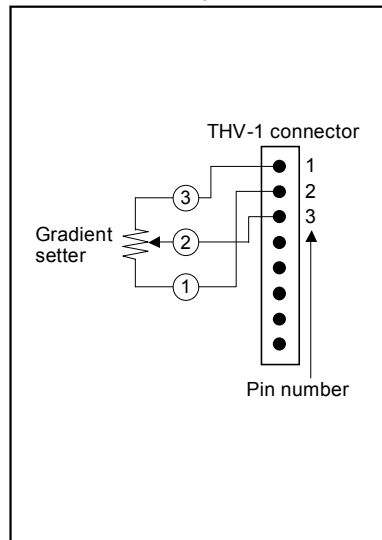
ON/OFF control



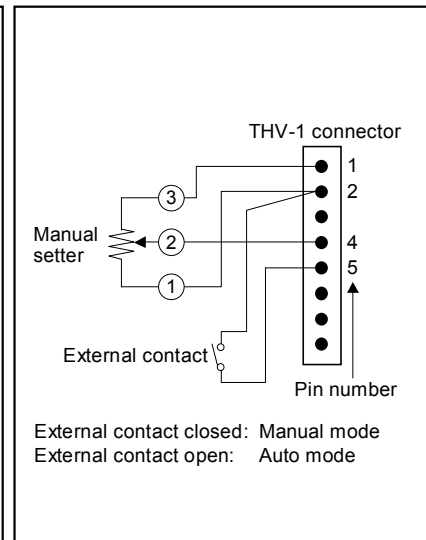
Manual mode



Auto mode (With gradient setter) *

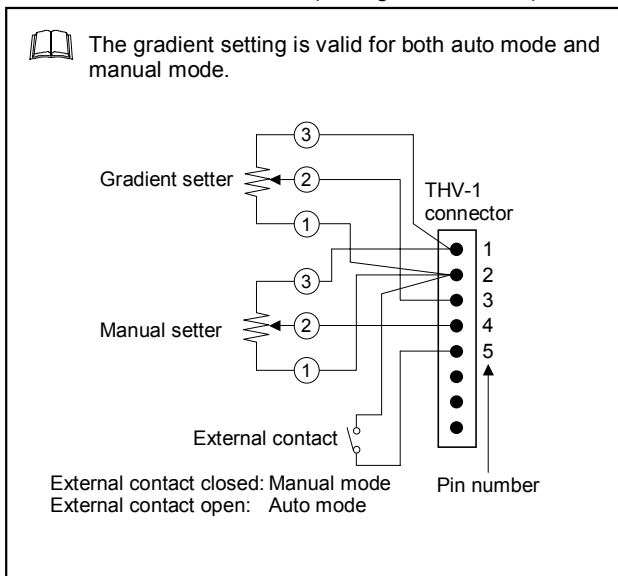


Auto/Manual mode selection *

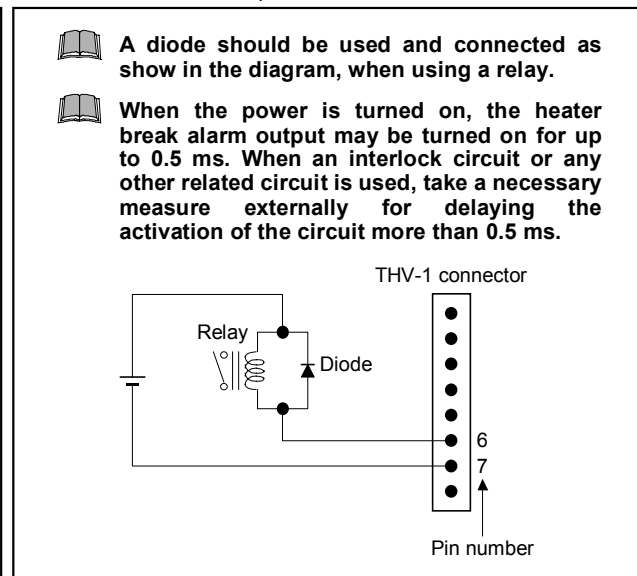


* For input signal wiring, see ■ Current input 4 to 20 mA DC, voltage input 0 to 10 V DC, 1 to 5 V DC and voltage pulse input 0/12 V DC (P. 6).

Auto/Manual mode selection (With gradient setter)



Heater break alarm output



For input signal wiring, see ■ Current input 4 to 20 mA DC, voltage input 0 to 10 V DC, 1 to 5 V DC and voltage pulse input 0/12 V DC (P. 6).

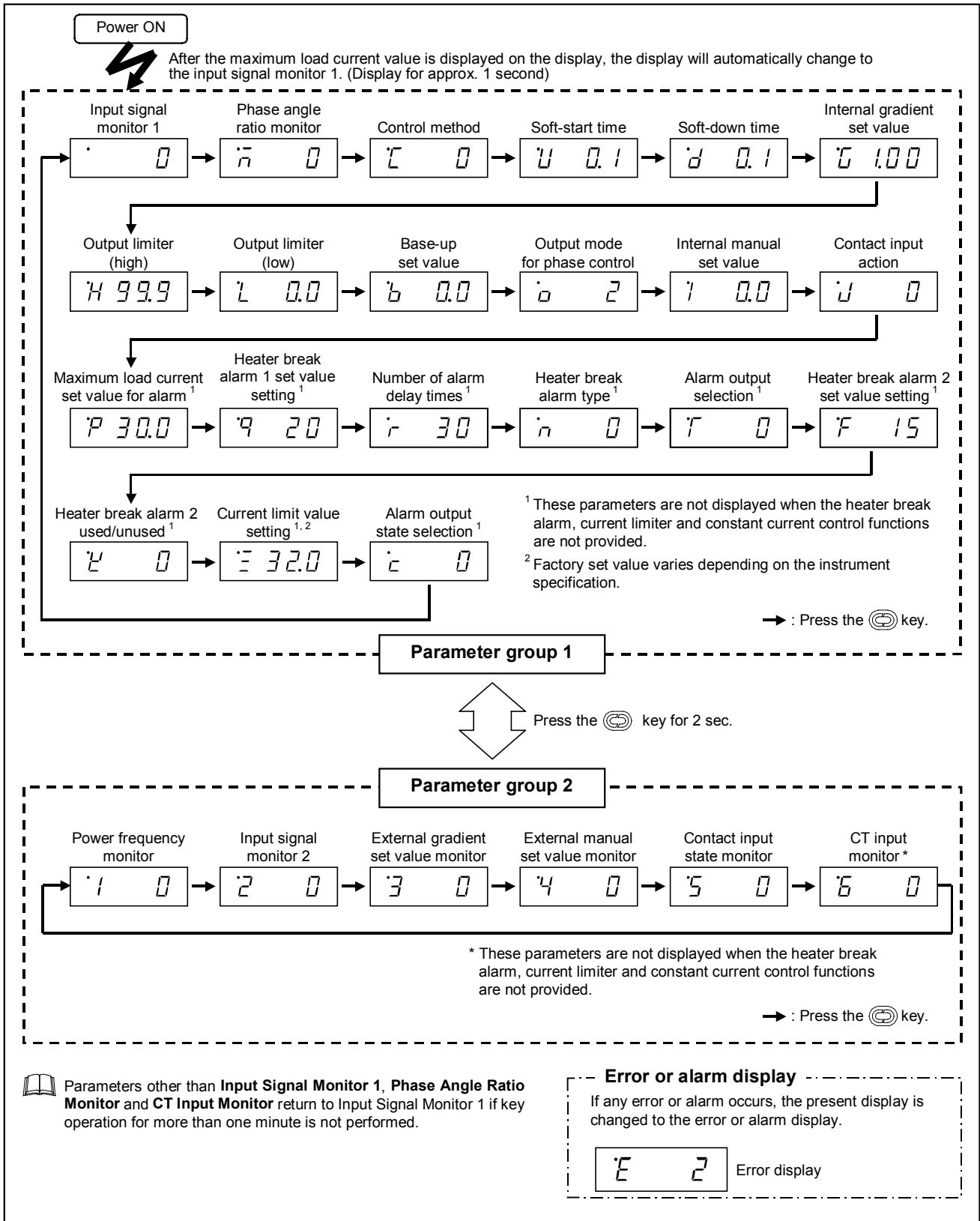
6. SETTING

This chapter describes the display menus on the LED display.

6.1 Display Flowchart for Monitor and Setting Parameters

The instrument has two monitor/setting modes.

- Parameter group 1 includes parameters for both monitoring and setting such as Input Signal Monitor 1, Phase Angle Monitor, Phase/Zero-cross control selection, and others.
- Parameter group 2 includes parameters for monitoring such as Power Frequency Monitor, Input Signal Monitor 2, and others.

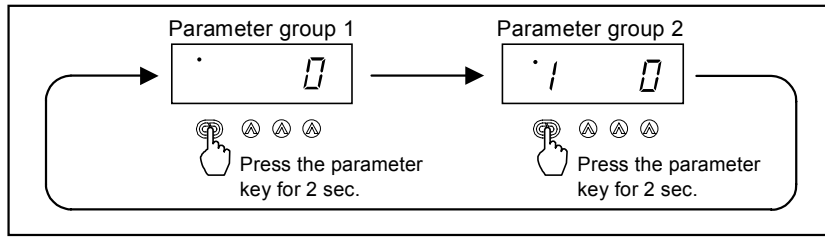


Parameters other than **Input Signal Monitor 1**, **Phase Angle Ratio Monitor** and **CT Input Monitor** return to Input Signal Monitor 1 if key operation for more than one minute is not performed.

6.2 Display Sequence

6.2.1 Selecting parameter group

After power-on to the instrument, the display automatically goes to Input Signal Monitor 1 in Parameter Group 1. To go to Parameter Group 2 display, press and hold the Parameter Key for 2 seconds.

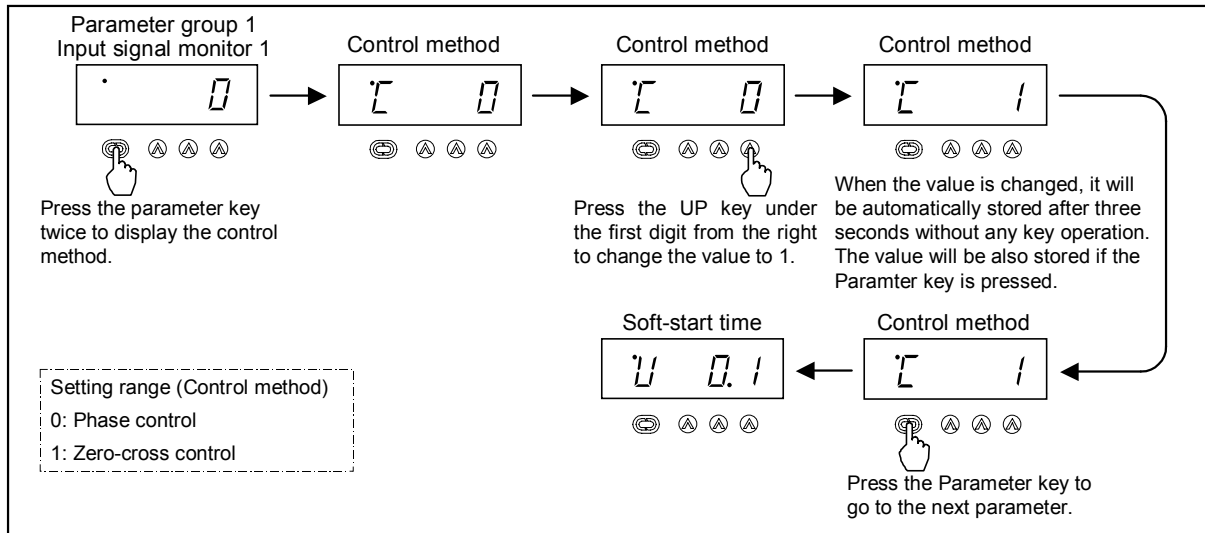


6.2.2 Changing parameter settings

Parameter key: Used for parameter calling up and set value registration.

UP keys: Used to change the numeric value.

Example: Change control method (parameter group 1) from phase control to zero-cross control



Other parameters can be set in the same way as the example above.

6.2.3 Parameter list

■ Parameter group 1

Name	Parameter Symbol	Display range or Setting range	Factory set value	Details	Reference page
Input signal monitor 1	No parameter	0 to 100 %	—	Displays one of the following values depending on the control mode and the setting of Contact Input Action. <ul style="list-style-type: none"> Input signal from controller External Manual Set value Internal Manual Set value For this selection, see item 7.1 Selecting Manual Mode Type and Input Signal Monitor 1 (P.14).	P. 14
Phase angle ratio monitor	\bar{n}	0 to 100 % When 0 %: phase angle 0° When 100 %: phase angle 180°	—		—
Control method	[0: Phase control 1: Zero-cross control	0	Select the control method.	P. 14

Continued on the next page.

Name	Parameter symbol	Setting range	Factory set value	Details	Reference page												
Soft-start time ¹	<i>U</i>	0.0 to 99.9 seconds	0.1	Set the soft-start time.	P. 14												
Soft-down time	<i>d</i>	0.0 to 99.9 seconds	0.1	Set the soft-down time.	P. 14												
Internal gradient set value	<i>G</i>	0.00 to 1.00 0.00: Internal gradient 0 % 1.00: Internal gradient 100 %	1.00	Set the internal gradient set value.	P. 15												
Output limiter (high)	<i>H</i>	0.0 to 99.9 %	99.9	Set the output limiter (high) setting. ²	P. 15												
Output limiter (low) ³	<i>L</i>	0.0 to 99.9 %	0.0	Set the output limiter (low). ² The base-up set value is effective only when the output limiter (low) is set to 0.0.	P. 15												
Base-up set value ³	<i>b</i>	0.0 to 99.9 %	0.0	Set the base-up set value (output bias) of output. ⁴ The base-up set value is effective only when the output limiter (low) is set to 0.0.	P. 15												
Output mode for phase control ⁵	<i>Q</i>	0: Proportional phase angle to input 1: Proportional voltage to input 2: Proportional square voltage (electric power) to input 3: Constant current control ⁶	2	Select the output method for phase control with linearity (R: resistor) load. The setting is invalid when zero-cross control is selected.	P. 16												
Internal manual set value	<i>I</i>	0.0 to 99.9 %	0.0	Set the internal manual set value.	—												
Contact input action	<i>U</i>	0: External manual mode ↔ Auto mode 1: Internal manual mode ↔ Auto mode 2: Internal manual mode (fixed)	0	Select the contact input action. This selection also affects the display of the Input Signal Monitor 1. Display of the Input Signal Monitor 1 <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Contact input action</th> <th>Contact open</th> <th>Contact close</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Input signal from controller</td> <td>External Manual Set value</td> </tr> <tr> <td>1</td> <td>Input signal from controller</td> <td>Internal Manual Set value</td> </tr> <tr> <td>2</td> <td colspan="2">Internal Manual Set value</td> </tr> </tbody> </table> (See P. 10)	Contact input action	Contact open	Contact close	0	Input signal from controller	External Manual Set value	1	Input signal from controller	Internal Manual Set value	2	Internal Manual Set value		See 7.1 on page 14.
Contact input action	Contact open	Contact close															
0	Input signal from controller	External Manual Set value															
1	Input signal from controller	Internal Manual Set value															
2	Internal Manual Set value																
Maximum load current set value for alarm ⁷	<i>P</i>	0.0 to 32.0 A (20 A/30 A) 0 to 55 A (45 A) 0 to 70 A (60 A) 0 to 90 A (80 A) 0 to 110 A (100 A)	30.0	Sets the maximum load current value at an output of 100 %. The value is used for the heater break alarm 1 and heater break alarm 2.	P. 17												

¹ If a load generating large rush current is used, thyristor break-down may occur when no soft-start time is appropriately set. Also in zero-cross control, no rush current can be suppressed even if the soft-start time is set.

² Output Limiter (High) value must be equal or higher than Output Limiter (Low).

³ These function can not be used together.

⁴ The output value will not exceed the Output Limiter (High).

⁵ The output mode setting is invalid when the control method is zero-cross control.

⁶ These parameters cannot be set when the heater break alarm, current limiter and constant current control functions are not provided. If there is a difference between the maximum load currents flowing through the thyristor and the heater with constant current control selected, compensate for the difference by setting the gradient. Set the gradient so that the maximum heater load current will flow through the heater at an input signal of 100% from the controller. (See P. 16)

⁷ These parameters are not displayed when the heater break alarm, current limiter and constant current control functions are not provided.

Name	Parameter symbol	Setting range	Factory set value	Details	Reference page
Alarm output state selection	1	0: ON at alarm output 1: OFF at alarm output	0	Select whether the open-collector output is turned on or off when the heater break alarm is output.	—

■ Parameter group 2

Name	Parameter Symbol	Display range	Details	Reference page
Power frequency monitor	1	0 to 99 Hz	Display the power frequency.	P. 17
Input signal monitor 2	2	0 to 100 %	Display the value of input signal from controller.	—
External gradient set value monitor	3	0 to 100 %	Display the external gradient set value.	—
External manual set value monitor	4	0 to 100 %	Display the external manual set value.	—
Contact input state monitor	5	0: Contact closed (Manual mode) 1: Contact open (Auto mode) ¹	Display the state of the contact input.	—
CT input monitor ²	6	0.0 to 40.0 A (20 A/30 A) 0 to 90 A (45 A) 0 to 120 A (60 A) 0 to 160 A (80 A) 0 to 200 A (100 A)	Display the input value of current transformer.	—

¹When "2: Internal manual mode (fixed)" is selected for Contact Input Action, the auto/manual mode is always in manual mode whichever the contact state is.

²These parameters are not displayed when the heater break alarm, current limiter and constant current control functions are not provided.

7. FUNCTIONS

7.1 Selecting Manual Mode Type and Input Signal Monitor 1

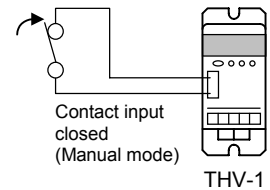
Displays one of the following values depending on the control mode and the setting of Contact Input Action Selection.

- Input signal from controller
- External manual set value (Input signal from external manual setter)
- Internal manual set value

, input signal from controller is always displayed on Input Signal Monitor 1 when the contact input function is not used.

(The displayed item on Input Signal Monitor 1)

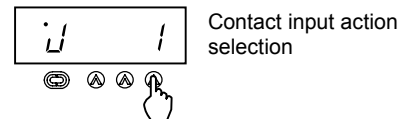
Contact input action selection	State of external contact	
	Contact closed (Manual mode)	Contact open (Auto mode)
0: External manual mode ↔ Auto mode	External manual set value	Input signal from controller
1: Internal manual mode ↔ Auto mode	Internal manual set value	Input signal from controller
2: Internal manual mode (fixed)	Internal manual set value	



■ Select manual mode type

Example: Select manual mode with internal manual set value.

1. Go to the parameter "Contact Input Action" in Parameter Group 1.
Set it to "1: Internal manual mode ↔ Auto mode."
2. The input signal from controller is displayed when the contact is open.
The internal manual set value is displayed when the contact is closed.



7.2 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.



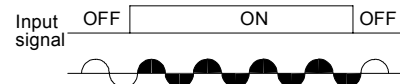
■ Zero-cross control (Continuous)

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)

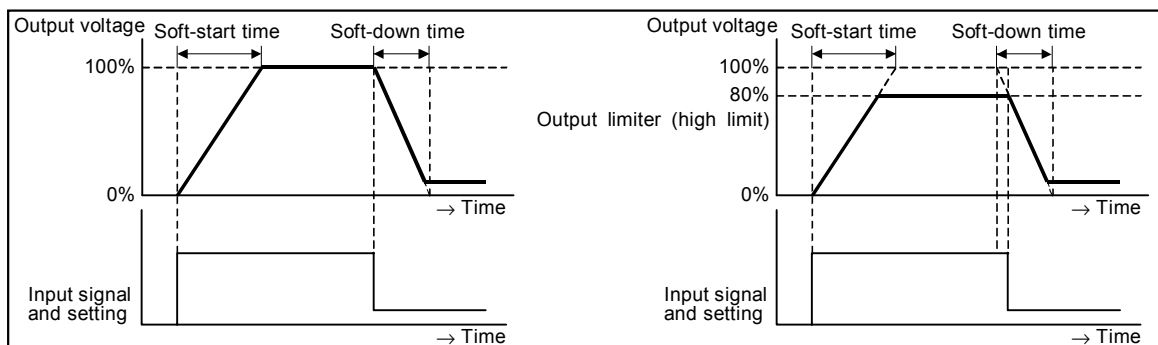
Input Synchronous type Zero-cross control is to turn the power supply ON and OFF synchronously with the pulse signal from a controller. This on and off time is typically measured in seconds.



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

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

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

7.4 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.

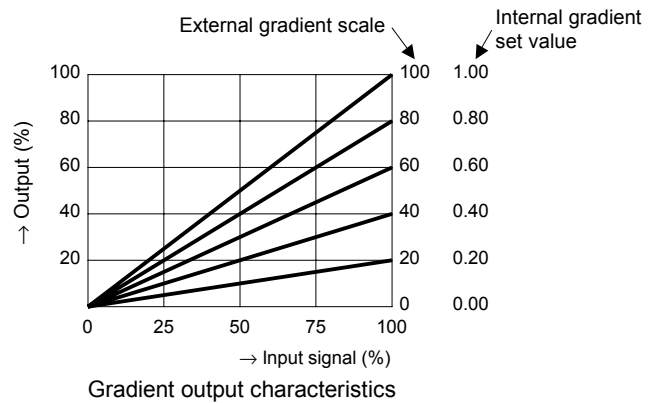
- Internal gradient setting set by the THV-1 front keys
- External gradient setting set by the external gradient setter (external potentiometer)

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)



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



7.5 Output Limiter (High and Low)

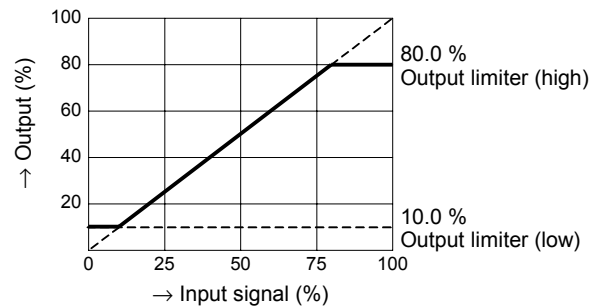
This function limits the output range.

Output limiter function is related to other functions.

- Output limiter (high) and (low) have priority to the output value ¹ calculated with Gradient Setting function. The maximum output from the instrument will not exceed the output limiter (high) and the minimum output will not go below the output limiter (low).
- Output limiter (high) has priority to the output value ² calculated with Gradient Setting and Base-Up setting function. The maximum output from the instrument will not exceed the output limiter (high).
- When output limiter (low) is not set to zero (0), the base-up setting function is invalid.

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

² Output = (Input signal or manual set value) × (gradient set value) + (base-up set value)

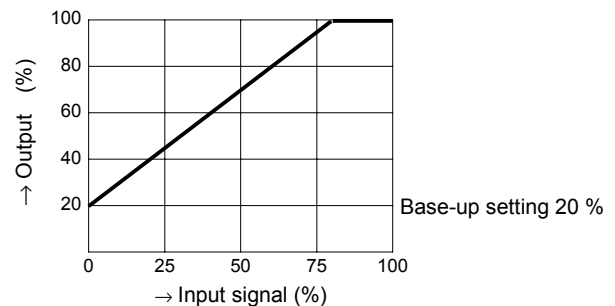


7.6 Base-Up Setting Function

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

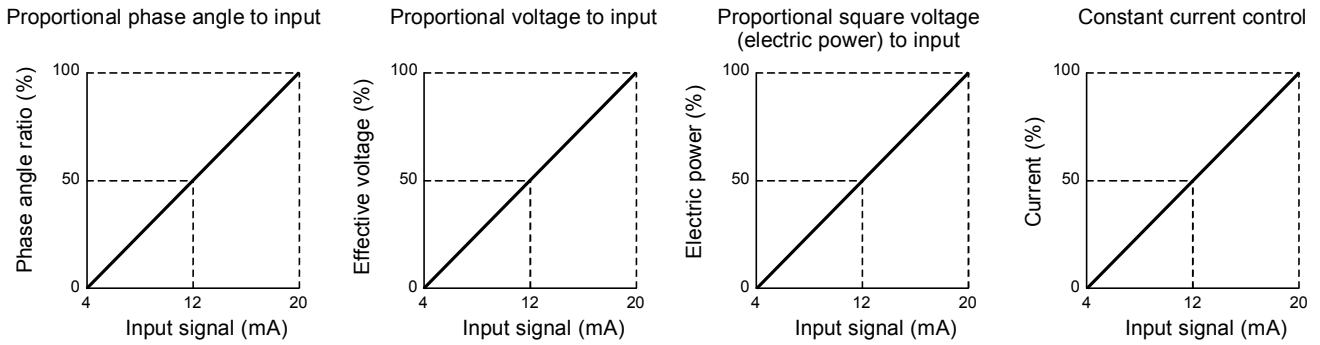
- Base-up setting is valid only when output limiter (low) is set to zero (0).
- Output limiter (high) has priority to the output value calculated with Gradient Setting and Base-Up setting function. The maximum output from the instrument will not exceed the output limiter (high).

* Output = (Input signal or manual set value) × (gradient set value) + (base-up set value)



7.7 Output Mode for Phase Control

When phase control is selected for a linearity (R: Resistance) load, one of the following four output types can be selected. The factory set value is proportional square voltage (electric power) to input. (The output mode setting is invalid when the control method is zero-cross control.)



■ 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 maximum load current in the thyristor specification.

Operating condition	Accuracy
Power supply voltage variation $\pm 10\%$	$\pm 0.2\%$ of full scale
Load variation 2 times	

Caution for using constant current control function

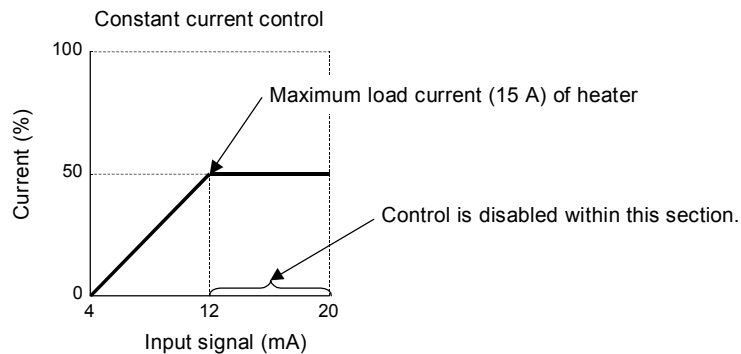
If there is a difference between the maximum load currents flowing through the thyristor and the heater, compensate for the difference by setting the gradient. If there is the difference, a section where control is disabled may come into existence. A compensation example when there is a difference between the maximum load currents flowing through the thyristor and the heater is shown in the following.

Example: When used in the following condition

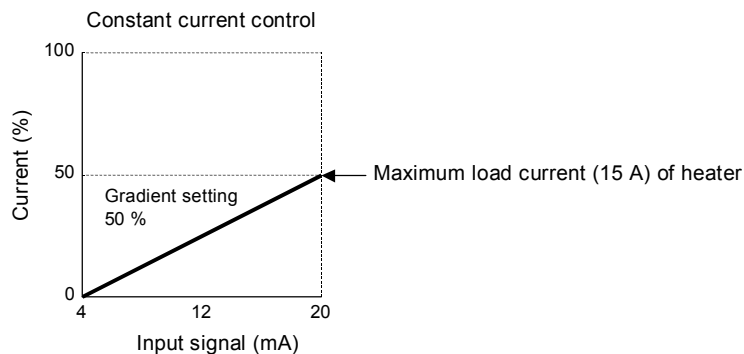
- Maximum load current of Thyristor: 30 A
- Maximum load current of heater: 15 A
- Input signal from controller: 4 to 20 mA DC
- Soft-start time setting: 0.0 seconds

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.



In this case, set the gradient to 50 % so that the maximum heater load current will become 15 A at an input signal of 20 mA. The gradient is valid even if internally set or externally set by the external manual setter.



7.8 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

■ 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.

7.9 Heater Break Alarm Function

The heater break alarm monitors the current flowing through the load by a dedicated current transformer (CT).

The THV compares the measured value with the set values, and detects a fault in the heating or cooling circuit. In addition, there are several types of heater break alarms depending on control methods and applications of these heater break alarms. Read this chapter carefully to choose a suitable method and set an appropriate set value.

7.9.1 Common function for all types

■ Number of alarm delay times

To prevent producing a false alarm, the alarm function waits to produce an alarm status until the measured current by the CT is in an alarm range for the preset number of consecutive sampling cycles. The parameter of the number of alarm delay times is to change the number of consecutive sampling cycles by 5-cycle increment.

Heater break alarm 1: (5 cycles) × (Number of alarm delay times)

Heater break alarm 2: (5 cycles) × (Number of alarm delay times) × 10

7.9.2 Phase control

There are two alarm types (type 1 or type 2) available for phase control.

(1) Type 1

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

Heater break alarm 1 set value: The alarm can be output when a heater break occurs by setting the heater break alarm set value.

Heater break alarm 2 set value: This alarm set value can be used as an auxiliary alarm.

For example, it can be used as a heater deterioration alarm if set to any value slightly 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.

■ 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 input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced.

• When heater current can not be turned off (Thyristor break-down or permanent damage)

When the current transformer 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.



Type 1 cannot be used for the load of which resistance changes with time and/or temperature. In addition, type 1 cannot be used for any power supply waveforms other than a sine waveform.



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).



The alarm will be turned off when the current transformer input value goes in and stays at non-alarm range for five consecutive cycles.

■ Related parameters

- Maximum load current set value for alarm (P. 11)
- Number of alarm delay times (P. 12)
- Heater break alarm type (P. 12)
- Alarm output selection (P. 12)
- Alarm output state selection (P. 13)
- Heater break alarm 1 set value setting (P. 12)
- Heater break alarm 2 set value setting (P. 12)
- Heater break alarm 2 used/unused (P. 12)

■ Example of uses

When each parameter is set to the following conditions

- Maximum load current set value: 20 A
- Number of alarm delay times: 0
- Heater break alarm 1 set value: 20 %
- Heater break alarm 2 set value*: 15 %

* When the set value of heater break alarm 2 is used as a heater deterioration alarm

Heater break alarm 1 set value

$$= (\text{Maximum load current set value}) \times (\text{Heater break alarm 1 set value})$$

$$= 20 \text{ A} \times 20 \% = 4 \text{ A}$$

Heater break alarm 1 set value 4 A

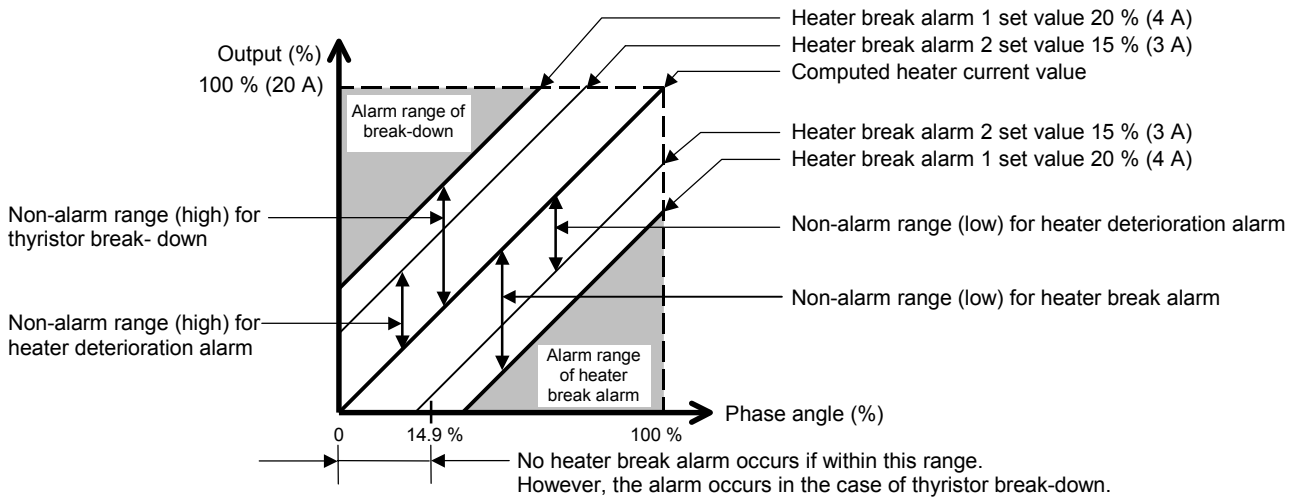
Heater break alarm 2 set value

$$= (\text{Maximum load current set value}) \times (\text{Heater break alarm 2 set value})$$

$$= 20 \text{ A} \times 15 \% = 3 \text{ A}$$

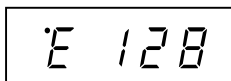
Heater break alarm 1 set value 3 A

The 4 and 3 amperes are set (deviation setting) to the high and low sides of the computed heater current value.



■ How alarm is checked

If the alarm occurs, the relevant error number is shown on the display unit. Therefore in this case, check the alarm contents.



Error display

Error number	Description
128	Heater break alarm 1
256	Thyristor break-down
512	Heater break alarm 2 (heater deterioration)

☞ For the error display, see the “8. ERROR OR ALARM DISPLAY” (P. 21).

(2) Type 2

Type 2 corresponds to a heater break alarm when one heater 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 input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced.

- **When heater current can not be turned off (Thyristor break-down or permanent damage)**

When the phase angle is 0 % and the current transformer 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.



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).



The alarm will be turned off when the current transformer input value goes in and stays at non-alarm range for five consecutive cycles.

■ Related parameters

- Maximum load current set value for alarm (P. 11)
- Number of alarm delay times (P. 12)
- Heater break alarm type (P. 12)
- Alarm output selection (P. 12)
- Alarm output state selection (P. 13)
- Heater break alarm 1 set value selection (P. 12)
- Heater break alarm 2 set value selection (P. 12)
- Heater break alarm 2 used/unused (P. 12)

■ Setting

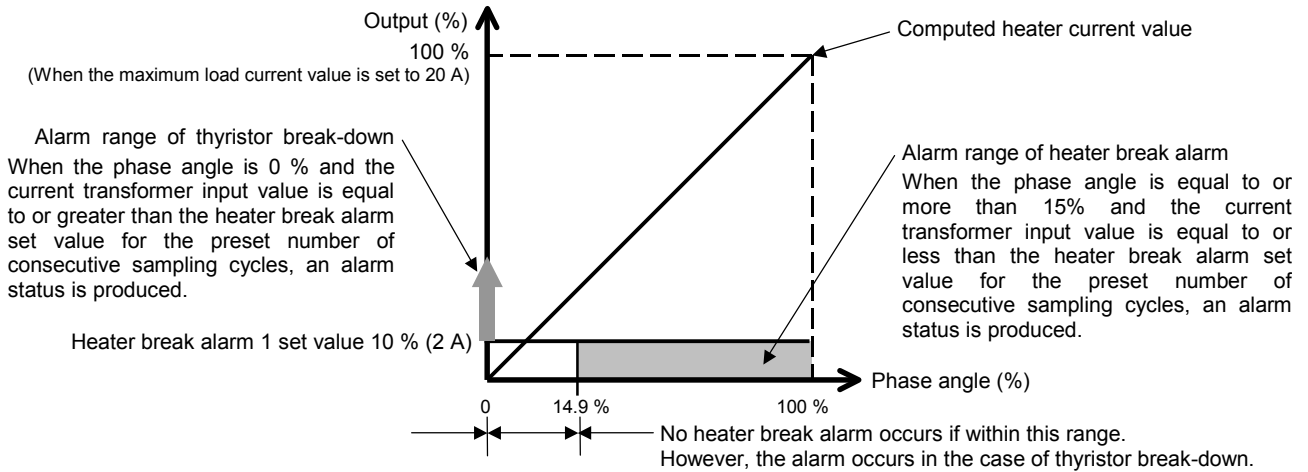
Type 2 uses only the set value of heater break alarm 1. Set the alarm under the following conditions.

- Heater break alarm 1 set value: Set the heater break alarm 1 set value to approximately 10 % of the maximum load current value.



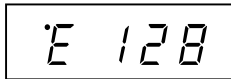
Do not set the heater break alarm set value to more than 15 %.

- Heater break alarm 2 set value: Set the heater break alarm 2 set value to "0: Heater break alarm 2 OFF."
- Heater break alarm 2 used/unused: Set the heater break alarm 2 used/unused to "0: OFF."



■ How alarm is checked

If the alarm occurs, the relevant error number is shown on the display unit. Therefore in this case, check the alarm contents.



Error display

Error number	Description
128	Heater break alarm 1
256	Thyristor break-down



For the error display, see the "8. ERROR OR ALAMR DISPLAY" (P. 21).

7.9.3 Zero-cross control

The following usage is available in zero-cross control.

Heater break alarm 1 set value: The alarm can be output when a heater break occurs by setting the heater break alarm set value.

Heater break alarm 2 set value: This alarm set value can be used as an auxiliary alarm.

For example, it can be used as a heater deterioration alarm if set to any value slightly larger than the heater break alarm set value to output the alarm before a heater break alarm occurs when the load current decreases due to heater deterioration, etc.

■ How alarm is activated

- **When heater current does not flow (Heater break, malfunction of the control device, etc.)**

When the control output is ON and the current transformer input value is equal to or less than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced.

- **When heater current can not be turned off (Thyristor break-down or permanent damage)**

When the control output is OFF and the current transformer input value is equal to or greater than the heater break alarm set value for the preset number of consecutive sampling cycles, an alarm status is produced.



The alarm will be turned off when the current transformer input value goes in and stays at non-alarm range for five consecutive cycles.

■ Related parameters

- Maximum load current set value for alarm (P. 11)
- Number of alarm delay times (P. 12)
- Alarm output selection (P. 12)
- Alarm output state selection (P. 13)
- Heater break alarm 1 set value (P. 12)
- Heater break alarm 2 set value (P. 12)
- Heater break alarm 2 used/unused (P. 12)

■ Example of uses

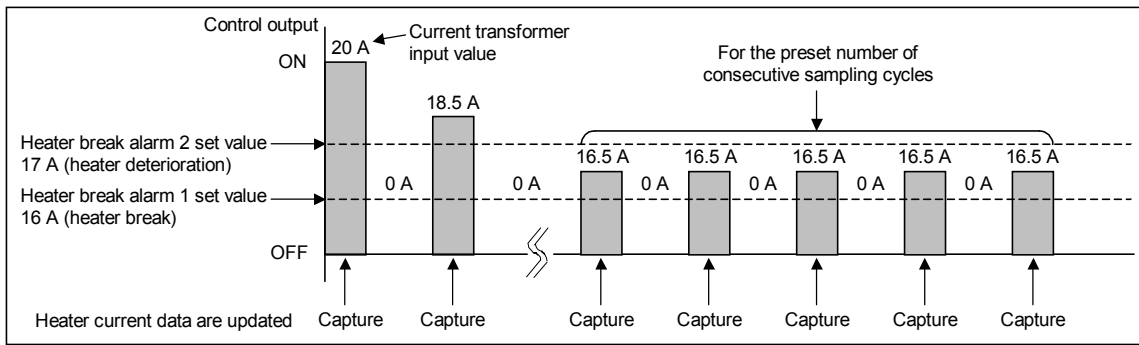
When each parameter is set to the following conditions

- Maximum load current set value: 20 A
- Number of alarm delay times: 0
- Heater break alarm set value 1: 80 % (16 A)
- Heater break alarm set value 2*: 15 % (17 A)

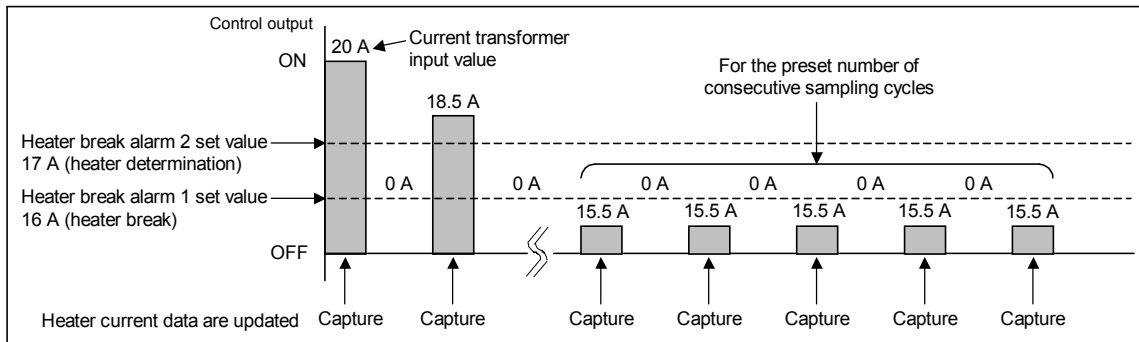
* When the set value of heater break alarm 2 is used as a heater deterioration alarm

Continued on the next page.

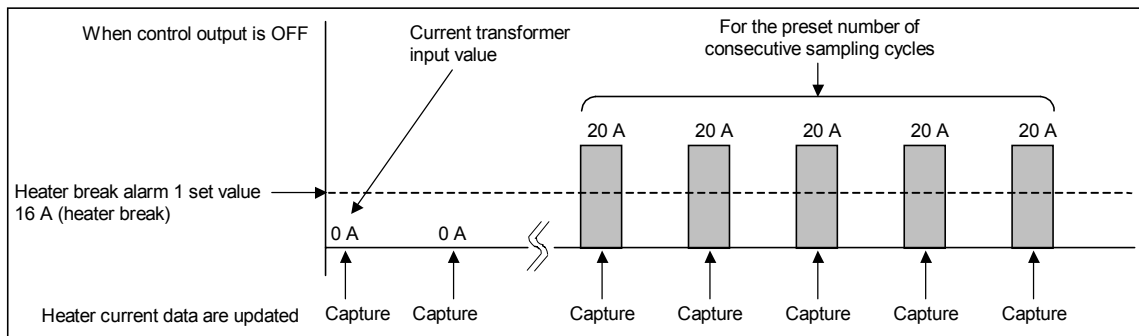
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Heater deterioration



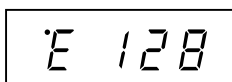
Heater break



Thyristor break-down

■ How alarm is checked

If the alarm occurs, the relevant error number is shown on the display unit. Therefore in this case, check the alarm contents.



Error display

Error number	Description
128	Heater break alarm 1
256	Thyristor break-down
512	Heater break alarm 2 (heater deterioration)

☞ For the error display, see the “8. ERROR OR ALARM DISPLAY” (P. 21).

7.10 Current Limiter Function

This is the function of limiting a measured current value to a value not exceeding the preset current limit value. A current value is measured for each constant cycle and then the maximum phase angle not exceeding the current limit value is calculated from the above current value thus measured. If the phase angle at that current output is larger than the maximum phase angle calculated, the current is output at the maximum phase angle to restrict that current. The maximum phase angle is calculated during a time period of 0.1 seconds 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 2.5 from the time when it exceeds “Current limit value + Differential gap.”

* Differential gap 0.5 A: 20 A, 30 A types Differential gap 1.0 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.

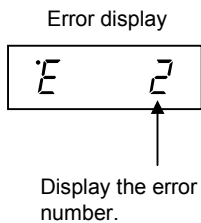
8. ERROR OR ALARM DISPLAYS

When the error or alarm occurs, the display changes to the error display. When two or more errors occur simultaneously, the error code numbers are totaled and displayed as one number. When any of the errors show below occurs, other displays will not be displayed.

- Board error
- Data error 1
- Data error 2
- EEPROM error
- Calibration data error

When the power frequency error is displayed, the display can be changed only to the power supply frequency monitor.

Error display



Error number	Description	Action	Solution
1	Board error	Thyristor output OFF	Turn off the power once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
2	Data error 1		
4	Data error 2		
8	EEPROM error		
16	Power frequency error 1	Thyristor output OFF The output can be turned ON when the error is canceled.	Check the stability of power supply frequency, and turn off the power once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
32	Power frequency error 2	Thyristor output OFF	Check the value of power supply frequency, and turn off the power once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.
64	Calibration data error	Thyristor output OFF	Turn off the power once. If an error occurs after the power is turned on again, please contact RKC sales office or the agent.

Alarm display

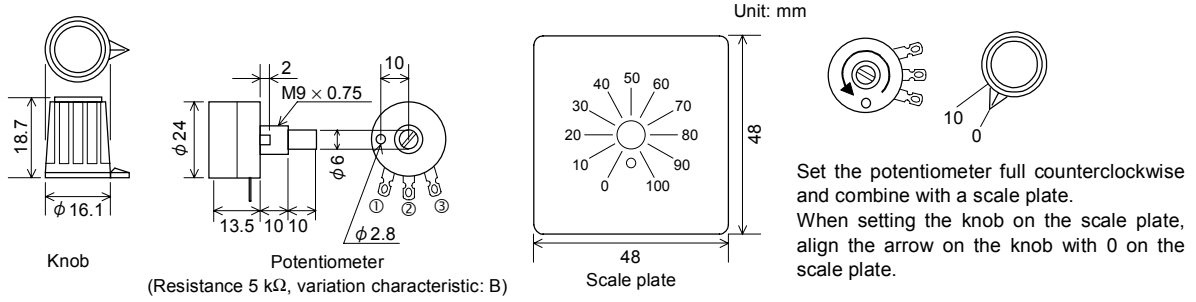
Error number	Description	Action	Solution
128	Heater break alarm 1	Control is continued.	Turn off the power, and check or replace the heater, etc.
256	Thyristor break-down		If a load generating large rush current is used, thyristor break-down may occur when no soft-start time is appropriately set. In such a case, make the soft-start time longer. For any causes other than the above, turn the power off and then contact to your nearest RKC sales agent or our sales office.
512	Heater break alarm 2 (heater deterioration)		Turn off the power, and check or replace the heater, etc.

9. SPECIFICATIONS

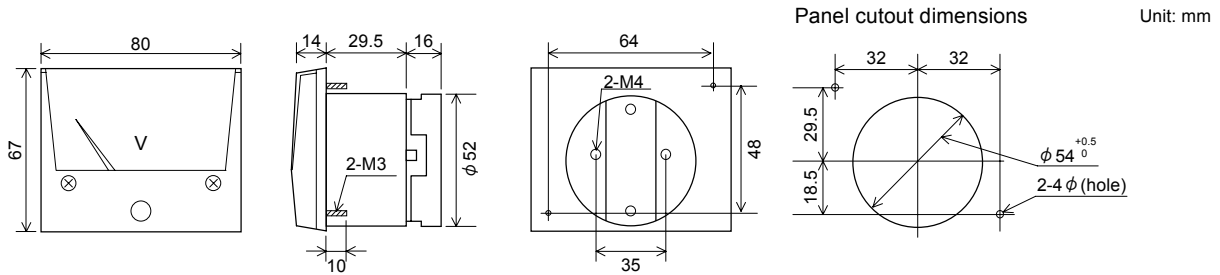
Number of phase:	Single-phase
Maximum load current:	20 A AC, 30 A AC, 45 A AC, 60 A AC, 80 A AC and 100 A AC For the temperature characteristic of maximum load current, see temperature characteristic graph of load current. (P. 3)
Minimum load current:	0.6 A (20 A type), 1 A (30 A, 45 A, 60 A, 80 A and 100 A types)
Power supply voltage:	90 to 264 V AC [Including power supply voltage variation] (Rating: 100 to 240 V AC)
Power frequency:	50/60 Hz (Automatic discriminating)
Allowable power frequency variations:	±1 Hz (Performance guarantee) ±2 Hz (Operation guarantee)
Input signal:	Current input 4 to 20 mA DC (Input impedance: 100 Ω) Voltage input 0 to 10 V DC (Input impedance: 68 kΩ) Voltage input 1 to 5 V DC (Input impedance: 30 kΩ) Voltage pulse input 0/12 V DC (Input impedance: 30 kΩ) Dry contact input (Input impedance: 47 kΩ)
Output voltage range:	0 to 98 % of rating voltage
Applicable load:	Phase control: Linearity (R: resistor) load Control of primary side of a transformer (magnetic field density 1.25 T or less) Zero-cross control: Linearity (R: resistor) load
Control method:	Phase control (No feedback) Zero-cross control (No feedback)
Output setting range:	Internal manual set value: 0.0 to 99.9 % (Set by the THV-1 front keys) External manual set value: 0 to 100 % (Set by the setter ¹) External gradient set value: 0 to 100 % (Set by the setter ¹) Internal gradient set value: 0 to 100 % (0.00 to 1.00) (Set by the THV-1 front keys) Output limiter (high) set value: 0.0 to 99.9 % (Set by the THV-1 front keys) Output limiter (low) set value: 0.0 to 99.9 % (Set by the THV-1 front keys) Base-up set value: 0.0 to 99.9 % (Set by the THV-1 front keys) ¹ Option
Output mode:	Proportional phase angle to input ² Proportional voltage to input ² Proportional square voltage (electric power) to input ² Constant current control (option) ² ² When the phase control use the linearity (R: resistor) load
Ramp (Soft-start/Soft-down) function:	Setting range: 0.0 to 99.9 seconds (Set by the THV-1 front keys)
Auto/Manual mode selection:	External dry contact External contact closed: Manual mode External contact open: Auto mode
Heater break alarm function (option):	When the power source ripples of main circuit is sine-wave Input: Current transformer (built-in) Measured accuracy: Within ±2 A (20 A and 30 A types) Within ±10 % of maximum load current (45 A, 60 A, 80 A and 100 A types) Output: 1 point, open collector output 24 V DC, Max. 100 mA Output ON/OFF at alarm is selectable.
Current limiter function (option):	Setting range 20 A, 30 A: 0.0 to 32.0 A 45 A: 0 to 55 A 60 A: 0 to 70 A 80 A: 0 to 90 A 100 A: 0 to 110 A If a current limit value is set to its maximum value, the current limit function is deactivated.
Cooling method:	Natural convection
Ambient temperature:	0 to 40 °C (Performance guarantee range), -15 to +55 °C (Operation guarantee range)
Ambient humidity:	5 to 95 % RH (Non-condensing)
Withstand voltage:	Between main circuit, power terminals and radiation fins: 1 minute at 2000 V AC
Insulation resistance:	Between main circuit, power terminals and radiation fins: 20 MΩ or more at 500 V DC
Mounting method:	Vertical mounting
Dimensions:	See 4.2 Dimensions (P. 4).
Weight:	Approx. 0.9 kg (20 A and 30 A types) Approx. 1.3 kg (45 A and 60 A types) Approx. 1.9 kg (80 A and 100 A types)

10. ACCESSORIES (OPTION)

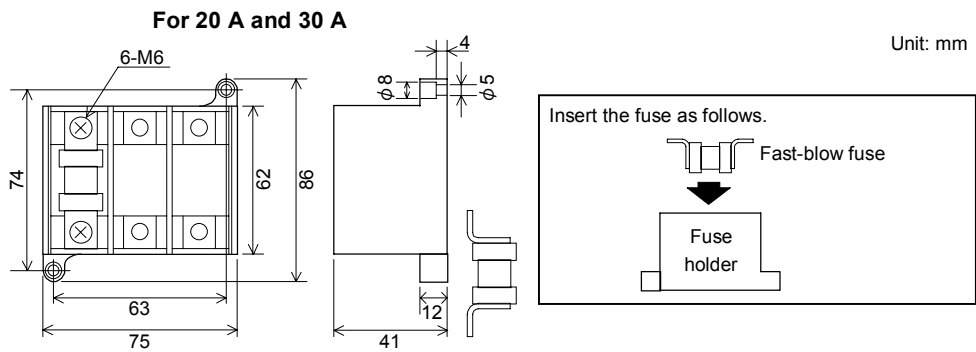
■ Setter (Potentiometer, Knob and Scale plate)



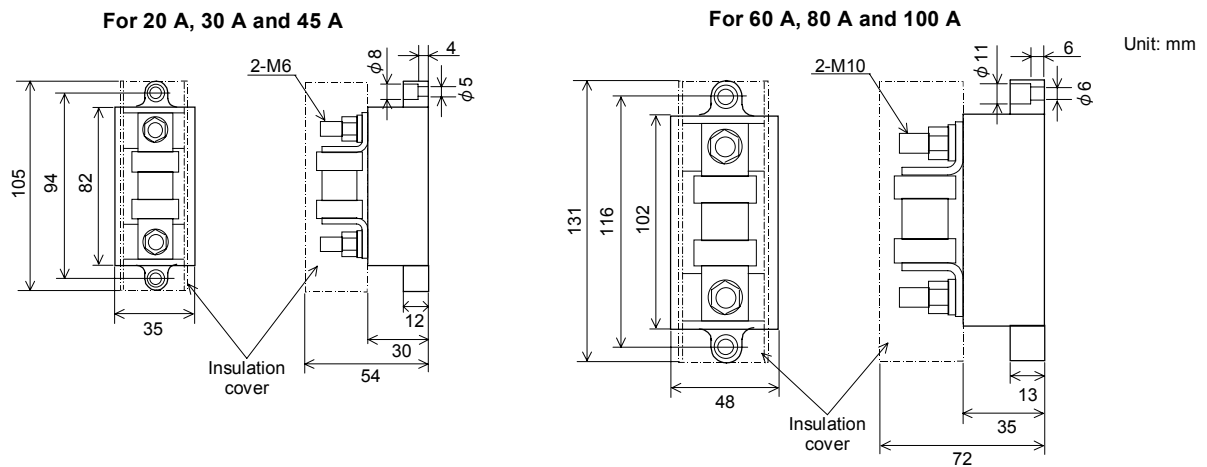
■ Output voltmeter (150 V span or 300 V span)



■ Fuse unit (Holder: 3 circuits type)



■ Fuse unit (Holder: 1 circuit type)



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