INST. No. INE-361

CHINO

Three-Phase Thyristor Regulator

JW Series

General

Instruction Manual

INSTRUCTIONS

Thank you for purchasing the JW Series thyristor regulator.
♦ To use this instrument correctly and safely and to prevent troubles, read the manual carefully.

Note for Dealers and Instrument Suppliers
Be sure to deliver this manual to the final user.

Note for Users
Retain this manual carefully until this instrument is disposed of.

CHINO

- Contents -

INTRODUCTION

This instruction manual describes the handling procedures and specifications of the JW Series thyristor regulator.

The JW Series thyristor regulators are designed for exclusive use in the 3-phase angle control. They are power regulators used to receive signals from controllers and manual setting units and adjust the power applied to an electric furnace heater, etc.
The JW Series 3-phase angle control thyristor regulators feature a compact size and light weight and enable high-density instrumentation. Their methods of control include two ways, the phase angle control and zero-cross control systems. In the phase angle control systems, the voltage, current and power feedback control types and a type without feedback control are available for the selection of an optimum type according to the characteristics of the heater used. This instrument is also capable of advanced 3-phase control based on 6-arm control and fine control by setting from the setting communication unit. Furthermore, this instrument can be connected to a master unit via communications for remote controls and data monitoring.

Reference manuals

This instruction manual describes the “General” instructions only on the JW Series. For the descriptions on the setting communication unit and Communication Interfaces, refer to the separate manuals.

1) JW setting communication unit (Instruction manual: INST. No. INE-362☐)
2) JW communication Interfaces (Instruction manual: INST. No. INE-363☐)

CAUTION

(1) The information given in this manual may be subject to change without notice.
(2) Every possible care was taken in compiling this manual. However, if you find a question, error or mistake in it, please contact your nearest distributor.
(3) In spite of (2) above, CHINO does not assume any liabilities concerning the results of this instrument’s operation.

1 FOR SAFE USE OF THIS INSTRUMENT (⚠ Warning)

This chapter is to use this instrument correctly and to avoid injuries to you or other persons and damage to properties. Be sure to understand the following information thoroughly and observe the warnings and cautions given.

1. Checking the product

This instrument has passed our severe shipment inspections. When this instrument is delivered, be sure to check the following items before use.

(1) Check if the delivered instrument is the one you ordered.
Ensure the specifications including the model number, rated voltage, rated current, etc., are correct.

(2) Check if this instrument was damaged during transportation, etc.
Thoroughly ensure that this instrument is not damaged.

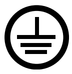
If you notice any point, please contact your nearest distributor.

2. Preconditions for use

This instrument has been designed for the installation inside an indoor instrumentation panel. Do not use it in any other condition.

3. Labels attached to this instrument

The following labels are attached to this instrument to ensure its safe use.

Label	Name	Description
	Alert symbol mark	This label is pasted on the place requiring care in handling where there is a risk of electric shock or injury.
	Protection conductor terminal	To prevent an electric shock, connect the protective conductor terminal to the protective conductor (grounding) of the facility.
	Hand care caution	Keep your hands away from the mobile part (top panel fan) to prevent from injuries.
	High temperature surface caution	To prevent burns, keep your hands away from the top and side panels.

4. Symbols used in this manual

The following symbols are used for the safety use of this instrument, protect it against damage and prevent unexpected accidents.

Symbol	Scope
⚠WARNING	The information for preventing the risk of death or critical injury to the user such as an electric shock is described.
⚠CAUTION	The information for preventing the risk of injury to the user or damage to peripheral equipment is described.

⚠WARNING

The following information is critical for safety. Be sure to read and understand the following warnings thoroughly before reading this instruction manual. Remember that every warning is critical for preventing human injuries and other accidents.

1. Installation on an instrumentation panel
   Make sure to install this instrument inside an indoor instrument panel. Never use it on a desktop. As some of the main circuit terminals of this instrument are exposed, protect them against human contact by using a safety measure such as protective covers.

2. Over-current protection device
   This instrument does not have a power switch. In consequence, the power supply to this instrument should be protected with an over-current protection device (such as a circuit breaker) matching the power rating.

3. Installation of a safety device
   When using this instrument in equipment, whereby the failure of this instrument may lead to important loss, make sure to attach a safety device to the equipment. Also, never use this instrument in equipment on which human life is dependent or in nuclear equipment.

4. Before turning this instrument on
   To prevent malfunction, make sure to connect a load to this instrument before turning it on. Also, check that the protective conductor terminal of this instrument is connected to the protective conductor (grounding) of the facility.

5. During operation
   Do not touch this instrument during operation (as well as when it is turned on). High-voltage parts and high-temperature parts are very hazardous. Particularly, never to touch the top panel, side panels, cooling fan, terminals and their surroundings.

6. Modification or repair
   To avoid an electric shock, fire or malfunction, this instrument must not be repaired, modified or disassembled by any person other than our authorized service personnel.

7. Conformance to this instruction manual
   To use this instrument correctly and safely, use it in accordance with this instruction manual. We will not assume any liabilities for claims based on injuries, damage and loss of profit incurred due to abuse or misuse of this instrument.

8. Stop supplying power immediately if an abnormal symptom occurs
   Turn off the power immediately and contact your nearest distributor if there is any abnormal odor or if this instrument generates abnormal heat.

2 CHECKING THE MODEL NUMBER

The model code of this instrument represents the following information.

JW□□□□□□□□□□

Power voltage *1:
20: 200VAC (200V/220V/240V)
40: 400VAC (380V/400V/440V)
99: Others

Rated current *1

010:	10 A	020:	20 A
030:	30 A	050:	50 A
075:	75 A	100:	100 A
150:	150 A	200:	200 A
250:	250 A	300:	300 A
400:	400 A	500:	500 A
750:	750 A	X00:	1000 A

Control system
V: Phase angle control (Voltage feedback)/Zero-cross control
A: Phase angle control (Current feedback)/Zero-cross control
W: Phase angle control (Power feedback)/Zero-cross control
N: Phase angle control (No feedback)/Zero-cross control
Z: Zero-cross control

Rapid-break fuse *2
N: Not used.
A: Used.

Setting communication unit *3
0: No
1: Installed on main part.
2: Installed on panel.
3: Installed on main part (with communication)
4: Installed on panel (with communication)

CT function *4
0: Externally attached (Not built in)
1: Built in

Arms
3: 3 arms
6: 6 arms

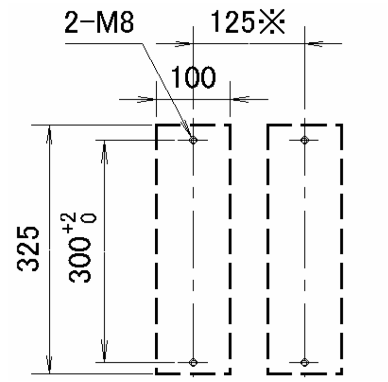
*1. The power voltage "99" and the rated current "750" and "X00" are fabricated to special order.
*2. When the rated current is "010" or "020", "A" is not available in a rapid-break fuse.
*3. When the setting communication unit is "Installed on panel," an optional exclusive cable (SH-JUK3 for 3 m or SH-JUK5 for 5 m) is required additionally.
*4. When the rated current is 100 A or more, "1" is not available in the CT function.
When the CT is required to be externally attached, select "0" even when the rated current is 75 A or less.

3 INSTALLATION

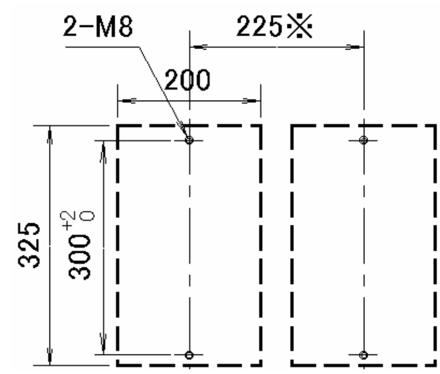
3.1 Installation Dimensions

For the dimensions of this instrument itself, see chapter 4, “Dimensions and Nomenclature.”

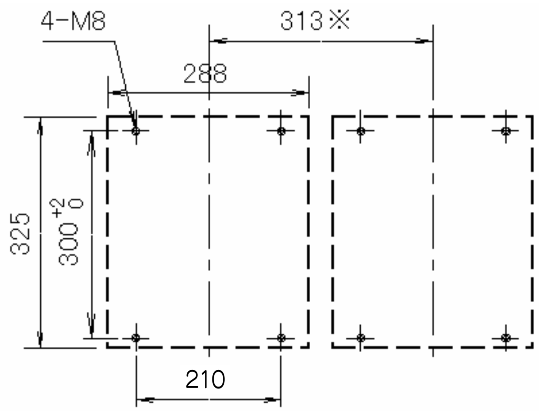
Rated current: 10/20 A



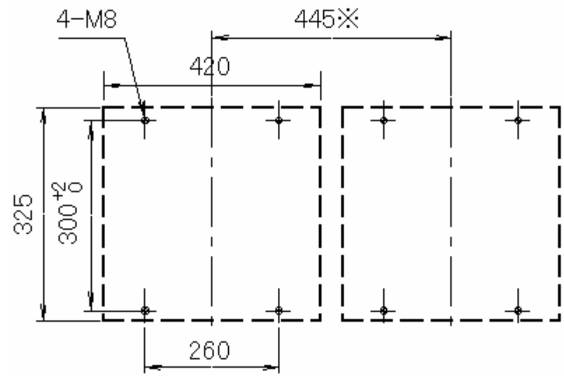
Rated current: 30 A/50 A



Rated current: 75 A/100 A

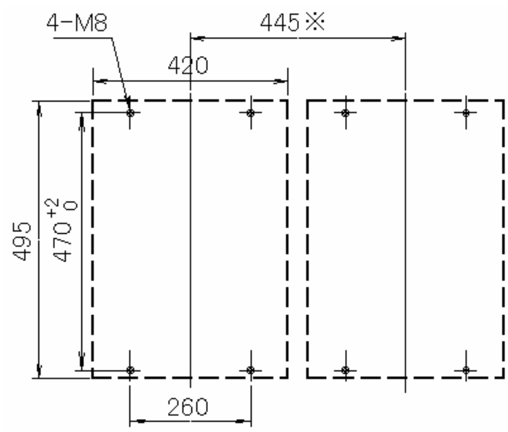


Rated current: 150 A/200 A/250 A

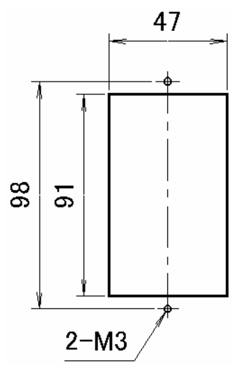


Unit: mm

Rated current: 300 A/400 A/500 A



Setting communication unit (Installed on panel))



* Caution: Minimum distance when plural instruments are installed side by side

3.2 Installation Precautions

⚠ WARNING	To prevent accidents, make sure to turn this instrument off before proceeding to the following operations.

Except for the accessories of the setting units, this instrument has been designed as a panel-back unit to be installed inside an instrumentation panel.

⚠ CAUTION

Environment

- Use this instrument indoors.
- Install it away from a source of electrical or magnetic field and avoid a place subject to mechanical oscillations and impact.
- Install it away from a source of strong noise (magnetic switch, motor, inverter, etc).

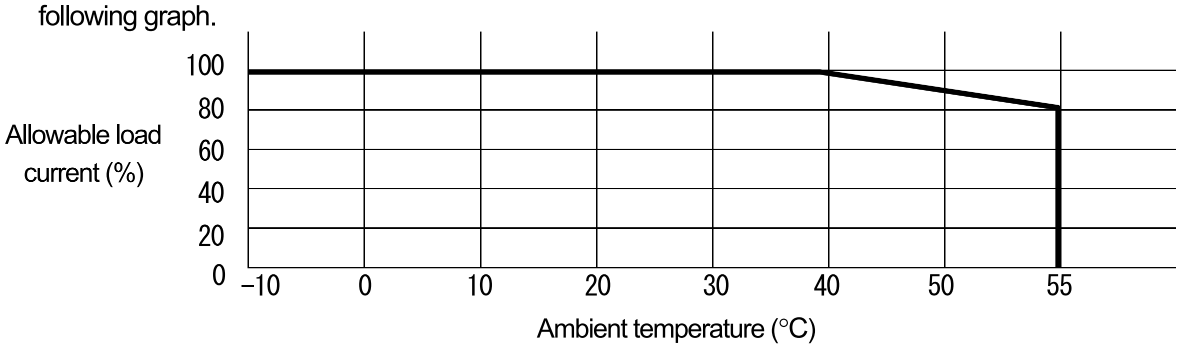
Atmosphere

- Do not install this instrument in a place exposed to an explosive gas, flammable gas, steam or conductive materials such as carbon or iron.
- Install it in a well-ventilated place with low dust or dirt.
- Install it away from a source of high temperature.
- Do not use it at the place generating corrosive gas.

Ambient temperatures

- Avoid exposing this instrument to the direct sunlight and do not seal it hermetically to prevent its temperature from rising. Install a cooling fan(s) in this instrumentation panel as required to prevent the ambient temperature from rising.

♦ The working ambient temperatures are between -10 and +50°C, but the rated current is up to the ambient temperature of 40°C. If the temperature exceeds 40°C, be sure to lower the load current by referring to the following graph.



♦ The working ambient humidity is between 30% and 90%RH. Make sure to avoid condensation.

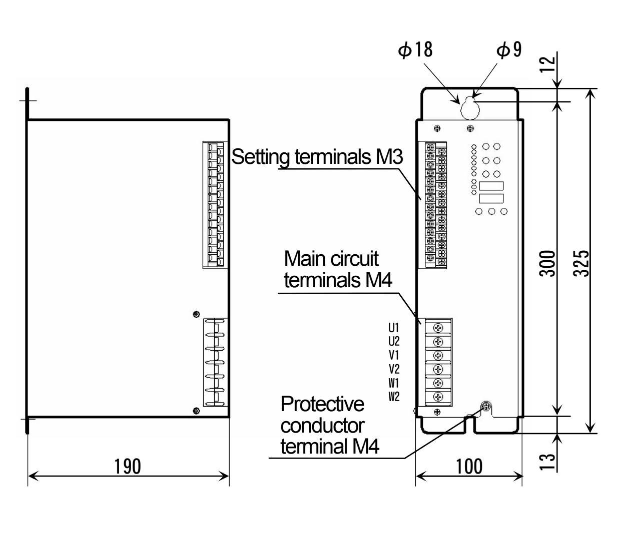
Other

- This instrument has high-voltage and high-temperature parts exposed outside it. When installing this instrument, take proper measures to avoid the user's contact with those parts.
- The altitude of the installation location should be 2,000 meters or less.
- To allow the ventilation/cooling effect to achieve full performance, be sure to install this instrument so that the UP marking (↑) faces upward. Reserve a space of 200 mm or more above the top of this instrument and a space of 100 mm or more below it.
- Ensure that the panel on which this instrument is installed is strong enough to support it.
- To protect the system, be sure to install an external rapid-break fuse when the instrument does not have a built-in rapid-break fuse.
- The output waveform of this instrument contains harmonic components, which may become the source of power wave distortion or harmonic noise to other equipment. To prevent such troubles, be sure to install the peripheral equipment with countermeasures against them.
- Do not connect anything to the terminals that are not used. Otherwise, malfunction may result.

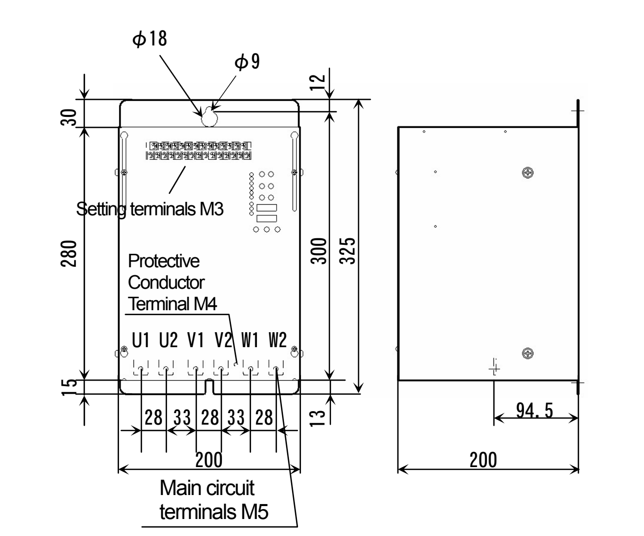
4 DIMENSIONS AND NOMENCLATURE

4.1 External Dimensions

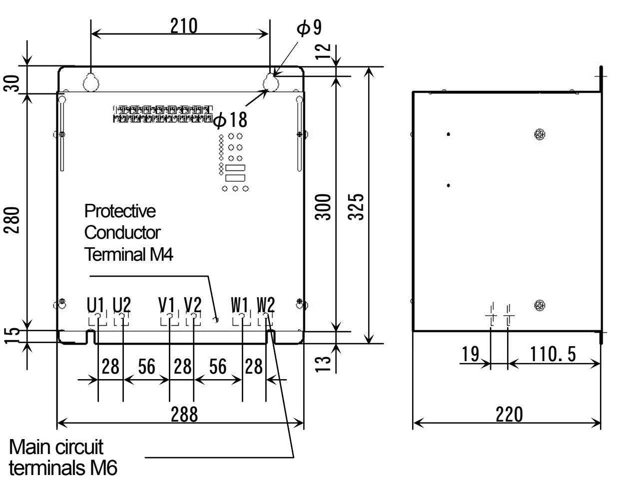
Rated current: 10 A/ 20 A



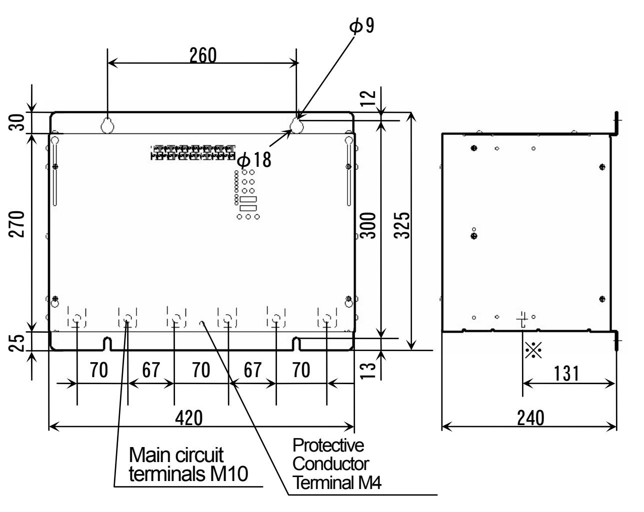
Rated current: 30 A/50 A



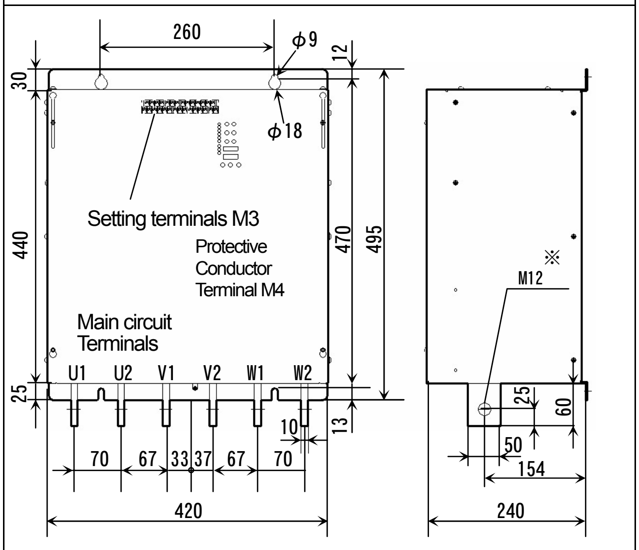
Rated current: 75 A/100 A



Rated current:150 A/200 A/250 A

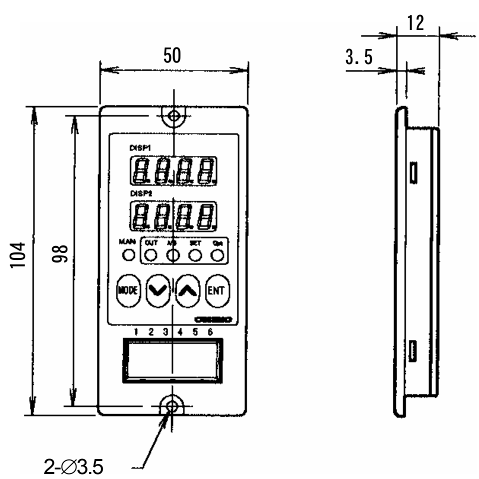


Rated current: 300 A/400 A/500 A



*M16 with 500 A type

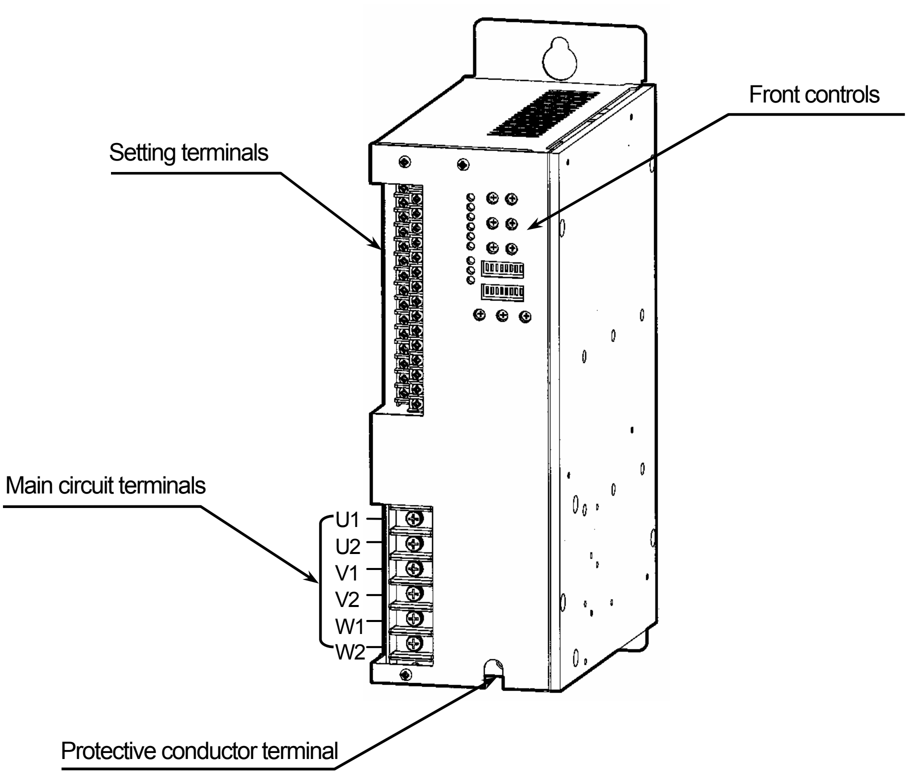
Setting communication unit



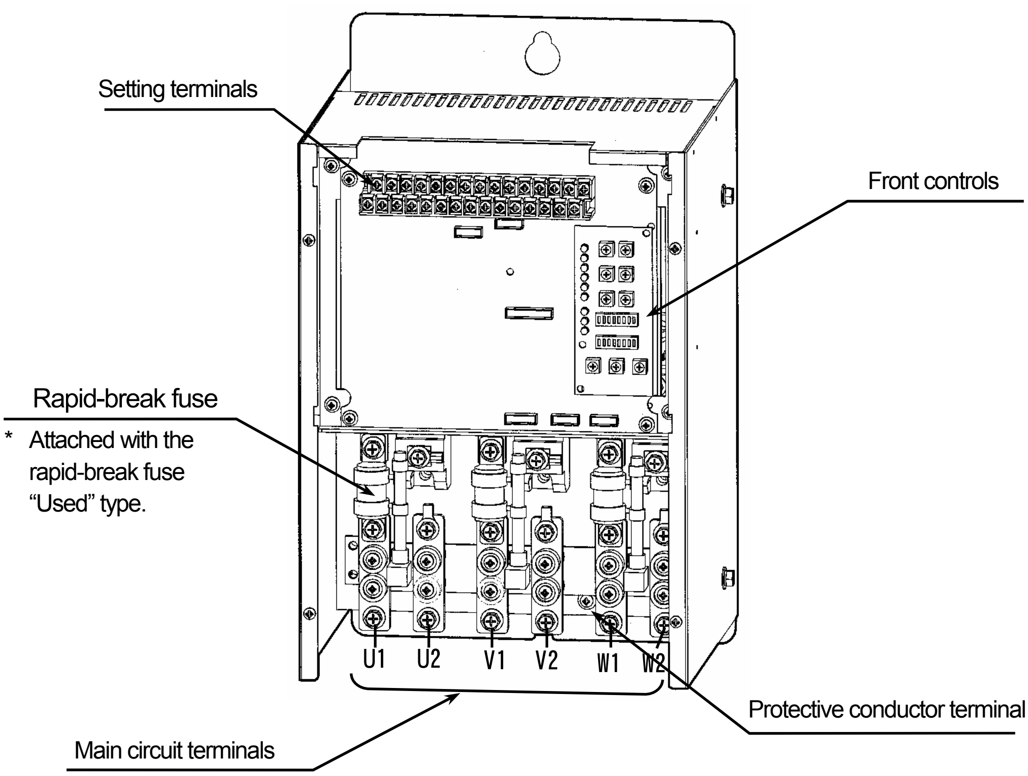
*The actual designs differ from those shown.

4.2 Nomenclature

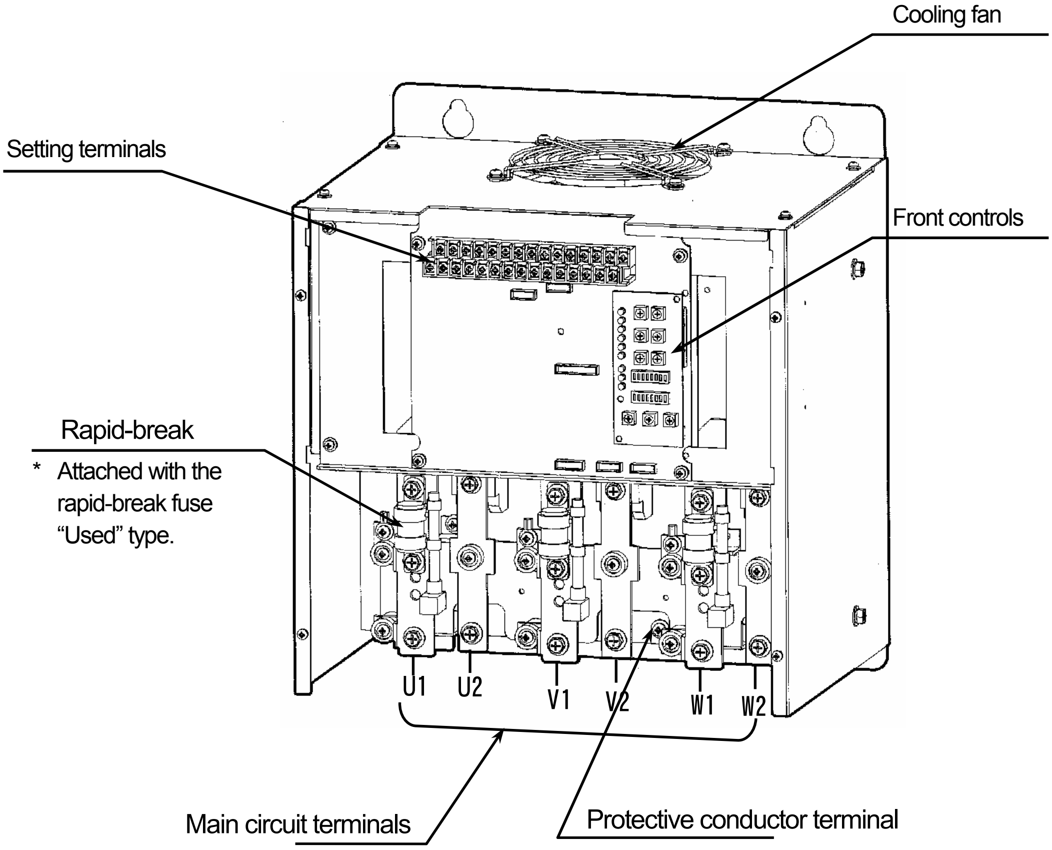
Rated current: 10 A/20 A



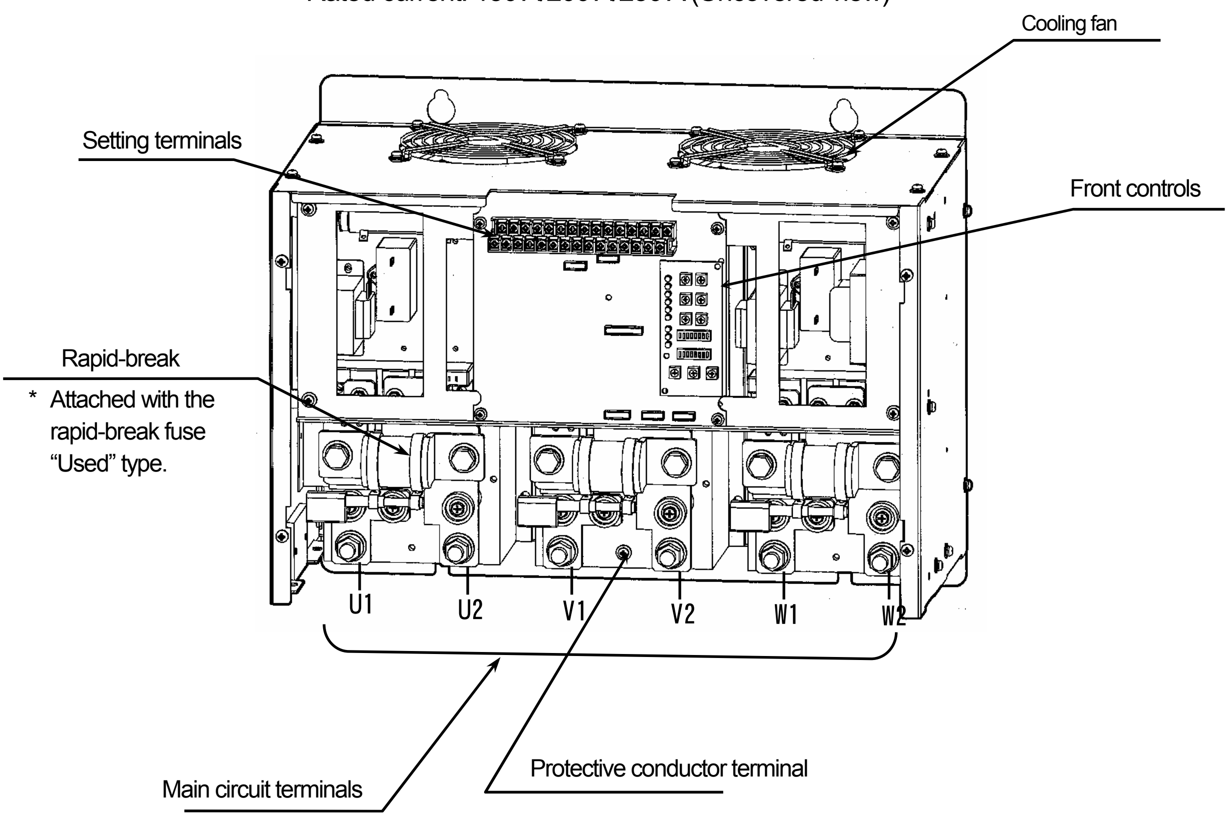
Rated current: 30 A/50 A (Uncovered view)



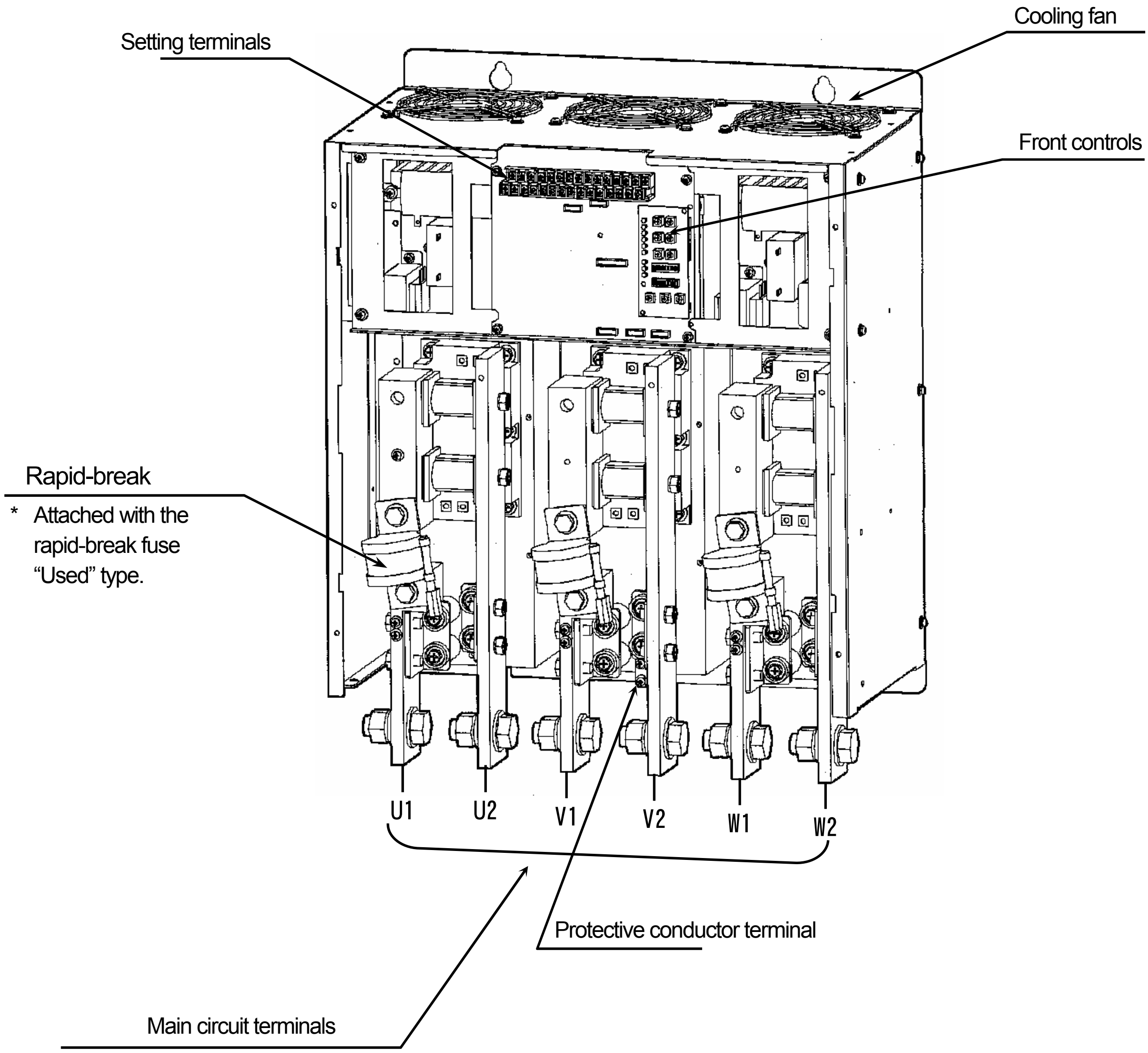
Rated current: 75 A/100 A (Uncovered view)



Rated current: 150 A/200 A/250 A (Uncovered view)



Rated current: 300 A/400 A/500 A (Uncovered view)



5 CONNECTIONS

5.1 Connection Precautions

⚠ WARNING

(1) To prevent accidents, make sure to turn this instrument off before proceeding to the following operations.
(2) For safety, make sure to connect the protective conductor terminal to the protective conductor of the facility.
(3) For the main circuit wiring, connect the power supply side to the terminals U1, V1 and W1, and the load side to the terminals U2, V2 and W2.
(4) Make sure to coat the conductive parts with insulating materials (tubes, tapes, etc.) in the power supply connection part. Any exposed connection part may result in a fire due to an electric shock or short-circuiting.

⚠ CAUTION

(1) Ensure that the rated voltage of this instrument matches the supply voltage.
(2) Check the size of each screw/bolt and tighten it with a force within ±10% of the specified securing torque.

Screw securing torque							
M3	M4	M5	M6	M8	M10	M12	M16
0.5 N•m	1.2 N•m	3 N•m	5 N•m	12 N•m	25 N•m	40 N•m	100 N•m

(3) Select wires with the gauge matching this instrument. Using a too thin wire may result in heat generation or a fire. The dielectric strength of the wires should be high enough to withstand the circuit voltage. Otherwise, an electric shock may result.
(4) Use crimp type terminals for connection to the setting terminals. Imperfect connection may result in an electric shock or malfunction.

(1) To prevent noise, distribute the wires to the setting terminals apart from the main circuit terminals (U1, V1, W1, U2, V2, W2) and do not put them in the same duct as the wires for the main circuit.
(2) The crimp type terminals for use with the setting terminals should be the R1.25-3S (small diameter for M3 screws).
(3) Even when this instrument is not in the output operation, its output terminals generate a voltage from the internal snubber circuit. This makes it necessary to attach an over-current protection device to prevent electric shock accidents during maintenance and inspection.
(4) Due to the performance of this instrument, its wires may cause noise interference with external equipment. Be sure to distribute the wires of this instrument away from those of the peripheral equipment.
Also take noise countermeasures, such as insertion of noise filters, as required.
(5) Noise source equipment (magnetic switch, motor, inverter, etc.) in the surroundings may affect the operation of this instrument. Distribute the wires of this instrument away from those of the peripheral equipment and also take noise countermeasures, such as insertion of noise filters, as required.
(6) In case of the transformer primary control (with which a transformer is connected between this instrument and the load), take the following care and countermeasures against an over-current, rapid-break fuse meltdown and transformer burnout that may be caused by magnetic hysteresis of the transformer.
- The recommended magnetic flux density of the transformer is 1.2 (T) or less.
- Connect a dummy resistor, in which the current of 0.5A or more flows, in parallel to the primary winding.
- The load on the transformer's secondary side should be the load balanced between 3 phases (with an imbalance rate of 10% or less).
- The control method of this instrument should be the phase angle control system.
- Use a JW Series with 6-arm control.

(7) After connections, be sure to attach the cover on the original position to ensure safety.

5.2 Functions of Setting Terminals

⚠ CAUTION	If settings are performed immediately after turning this instrument on, sudden changes in the output may affect the load or peripheral equipment. Perform the setting change gradually after the output stabilizes.

This instrument has setting terminals in addition to the main circuit terminals. Use them as required.

5.2.1 Layout and names of setting terminals

♦ Terminal layout

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)

*The actual layout is either horizontal or vertical depending on models.

♦ Terminal list

(1)	Remote setting input common (AI com)	(16)	Control input signal (+)
(2)	Remote setting input ref. voltage (AI V-ref)	(17)	Control input signal selection (mA/V)
(3)	Remote setting input 1 (AI1)	(18)	Control input signal (-)
(4)	Remote setting input 2 (AI2)	(19)	Control signal output (OUT)
(5)	Remote setting input 3 (AI3)	(20)	Control signal output (IN)
(6)	Remote contact input common (DI COM)	(21)	CT•U (K)
(7)	Remote contact input 1 (DI1)	(22)	CT•U (L)
(8)	Remote contact input 2 (DI2)	(23)	CT•V (K)
(9)	Remote contact input 3 (DI3)	(24)	CT•V (L)
(10)	N•C	(25)	CT•W (K)
(11)	N•C	(26)	CT•W (L)
(12)	N•C	(27)	N•C
(13)	Alarm output 1 (AL1)	(28)	Alarm output 1 (AL1)
(14)	Alarm output 2 (AL2)	(29)	Alarm output 2 (AL2)
(15)	N•C	(30)	N•C

*The “N•C” terminals are not used and should not be connected to anything. Otherwise, malfunction may result.

⚠ CAUTION	To reject noise and protect the contacts, be sure to connect a contact protection device, matching the load specification, to alarm output terminals and connect the load to it through a buffer relay.

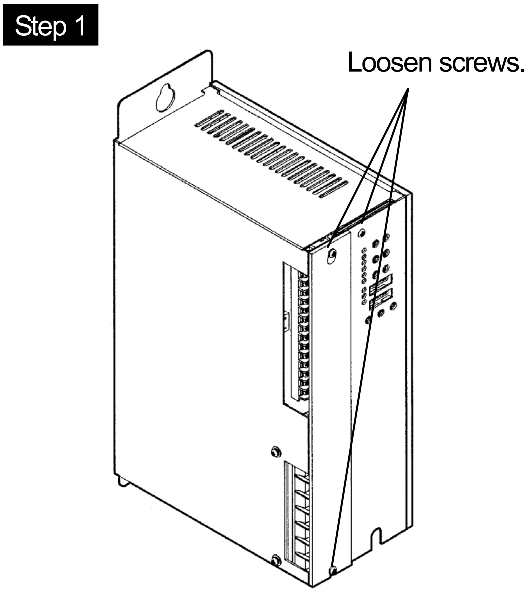
5.2.2 Details of setting terminals

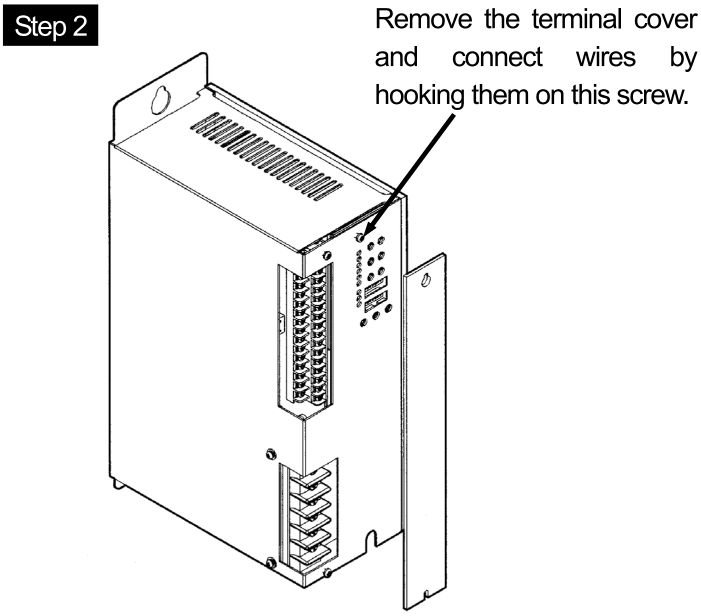
Pin No.	Name	Function
(1)	Remote setting input common (AI com)	Common (reference ground) terminal for the remote setting input (AI)
(2)	Remote setting input ref. voltage (AI V-ref)	Outputs 2.5VDC reference voltage for the remote setting input (AI)
(3)	Remote setting input 1 (AI1)	Inputs analog signal for the slope setting 0 to 2.5V analog signal corresponds to the slope from 0% to 100%.
(4)	Remote setting input 2 (AI2)	Inputs the analog signal for the elevation setting 0 to 2.5 V analog signal corresponds to the elevation from 0% to 100%.
(5)	Remote I setting input 3 (AI3)	Inputs the analog signal for the current limit settings 0 to 2.5 V analog signal corresponds to the current limit from 0 to 100%.
(6)	Remote contact input common (DI COM)	Common (reference ground) terminal for the remote contact input (DI).
(7)	Remote contact input 1 (DI1)	Inputs the remote contact for operation status (Run/Stop) switching When “Stop” is switched to “Run”, the internal SV (control SV used in processing) starts from 0%.
(8)	Remote contact input 2 (DI2)	Input the remote contact for the control system (Phase angle/Zero-cross) switching. When switched during operation, the internal SV (control SV used in processing) starts from 0%.
(9)	Remote contact input 3 (DI3)	Input the remote contact for the setting type (Front/External) switching.
(13) (28)	Alarm output 1 (AL1)	Goes ON when an over-current, rapid-break fuse meltdown or radiation fin over temperature, or their complex is occurred To reject noise and protect contacts, be sure to connect a contact protection device and connect the load to it through a buffer relay. The following contact protection devices are available from us. • Type CX-CR1: Relay contact protection device (for light loads) • Type CX-CR2: Relay contact protection device (for heavy loads)
(14) (29)	Alarm output 2 (AL2)	Goes ON when the heater disconnection, thyristor element abnormality or operation abnormality, or their complex is occurred. To reject noise and protect contacts, be sure to connect a contact protection device and connect the load to it through a buffer relay.
(16)	Control input signal (+)	Connect the (+) signal of the control input signal.
(17)	Control input signal selection (mA/V)	Terminal to select whether the 4 to 20mADC control input signal or 1 to 5VDC control input signal is used. To use the 4 to 20mADC control signal, short terminals (16) and (17). To use the 1 to 5VDC control signal, short terminals (18) and (17). Use the provided short-circuit plate for the short-circuiting.
(18)	Control input signal (-)	Connect the (-) signal of the control input signal.
(19)	Control signal output (OUT)	Outputs 0 to 2.5VDC control signal corresponding to 0 to 100% converted from the control input signal through the internal circuitry Usually, connect this terminal (19) directly to the control signal input (IN) terminal (20). Use the provided short-circuit plate for connection between (19) and (20).
(20)	Control signal input (IN)	Inputs 0 to 2.5 V DC corresponding to 0% to 100% control signal. Usually, connect the control signal output (OUT) terminal (19) directly to this input terminal (20).
(21)	CT•U (K)	CT input (K) terminal for the U-phase.
(22)	CT•U (L)	CT input (L) terminal for the U-phase.
(23)	CT•V (K)	CT input (K) terminal for the V-phase.
(24)	CT•V (L)	CT input (L) terminal for the V-phase.
(25)	CT•W (K)	CT input (K) terminal for the W-phase.
(26)	CT•W (L)	CT input (L) terminal for the W-phase.

5.3 Preparation for Connection

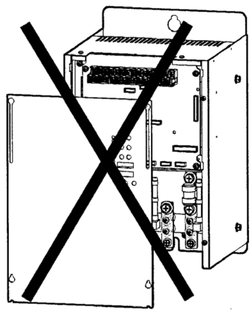
The locations of the main circuit and setting terminals differ depending on models.

(10 A/20 A type)

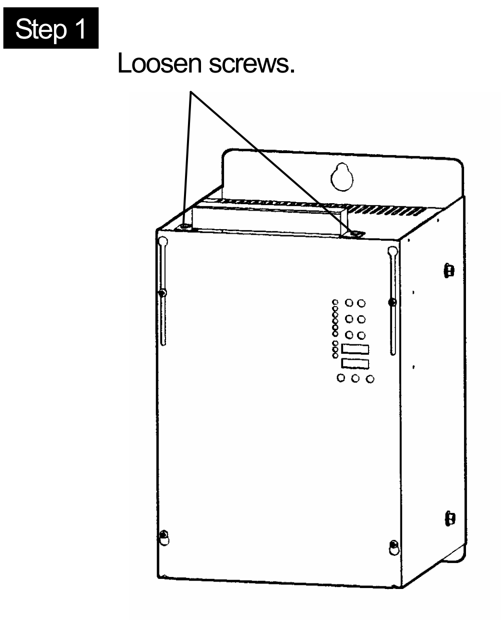


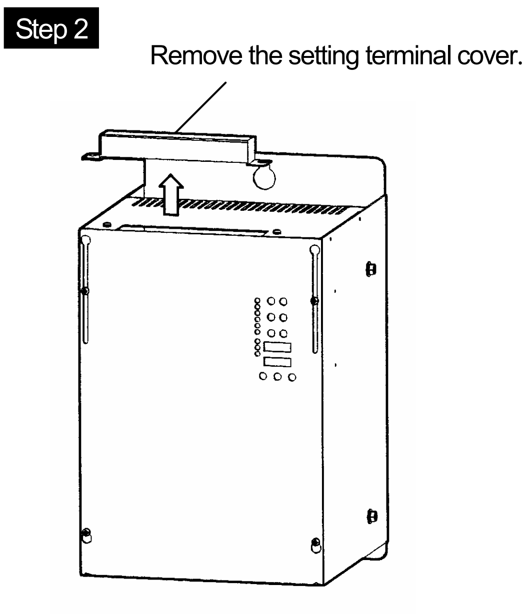


* After wiring, reattach the terminal cover firmly with the screws.

⚠ **CAUTION**	Do not remove the cover for wiring. Otherwise, malfunction of this instrument, including damage to the internal electronic circuitry, may result. When the setting communication unit is used, disconnection of internal wires or damage to the connector may also result.	

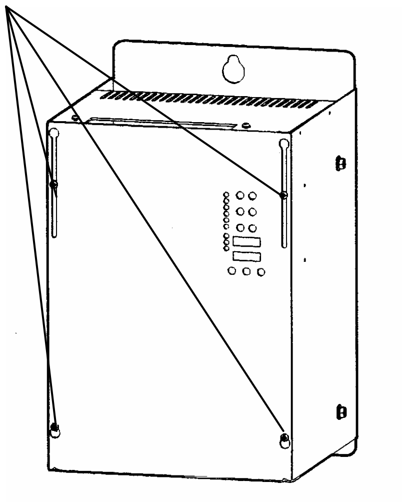
(30 A – 500 A type)





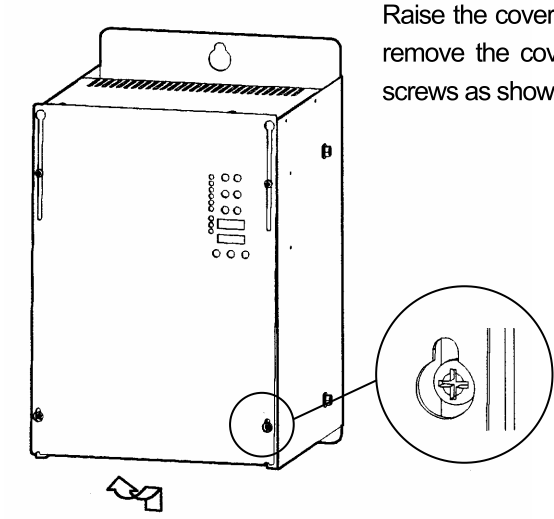
Step 3

Loosen screws.



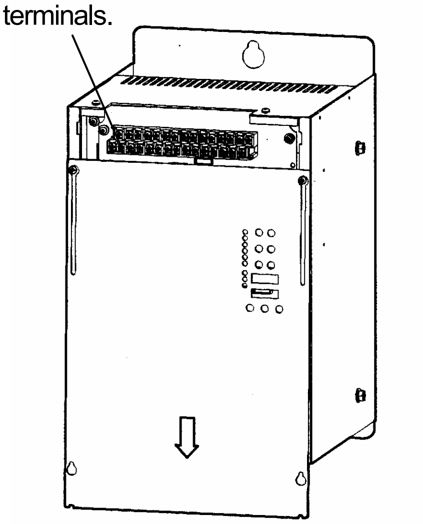
Step 4

Raise the cover slightly and remove the cover from the screws as shown.



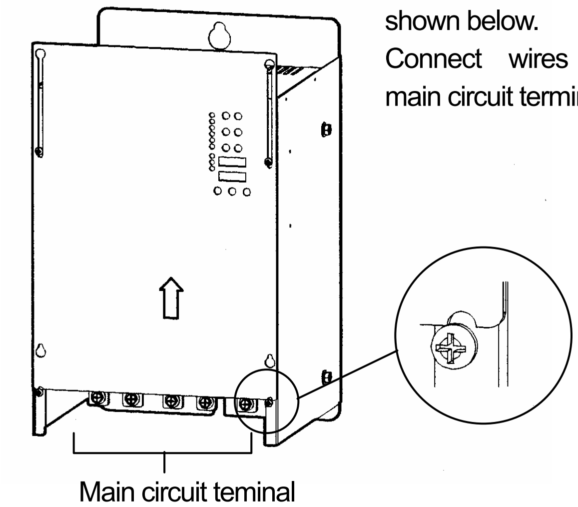
Step 5

Lower the cover and connect wires to the setting terminals.



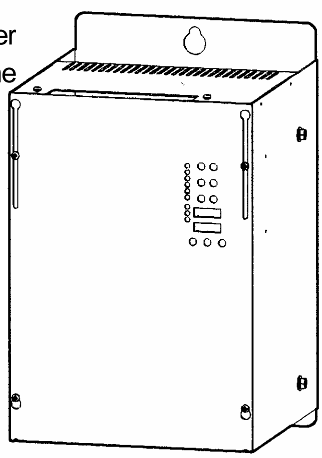
Step 6

Raise the cover and place the notch of the cover on the screw as shown below.
Connect wires to the main circuit terminals.



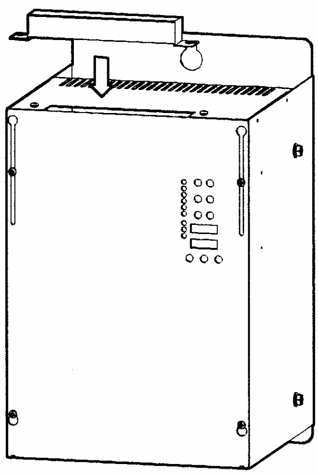
Step 7

Reattach the cover and tighten the screws.



Step 8

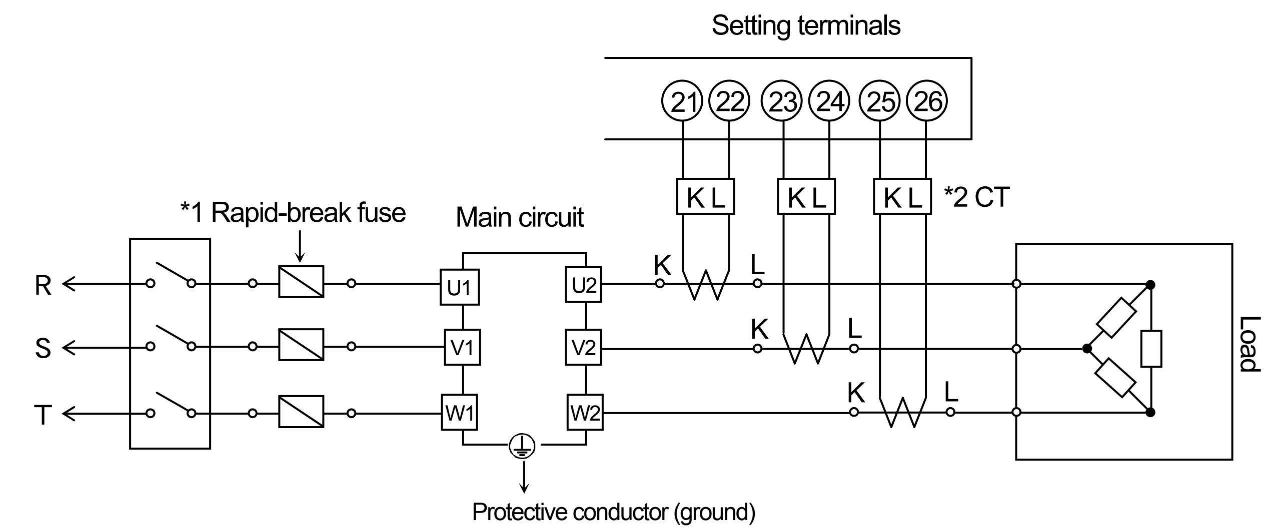
Reattach the setting terminal cover and tighten the screws.



5.4 Connection of Main Circuit Terminals

WARNING	(1) To prevent accidents, be sure to turn this instrument off before proceeding to the following operations. (2) The connection should be performed by personnel with basic knowledge and practical experience of wiring work.

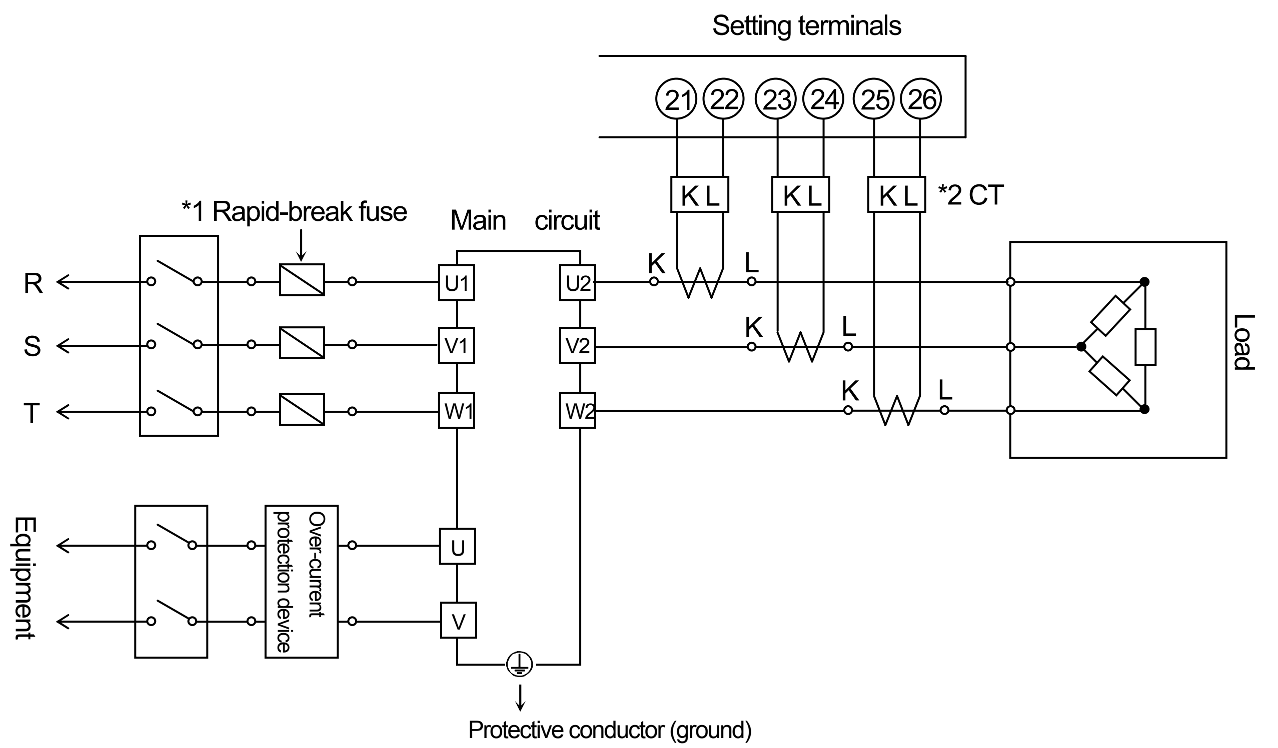
5.4.1 Basic connection



*1: For models without the rapid-break fuse, make sure to connect a rapid-break fuse externally to protect a system.

*2: When the CT is not built in, externally connect a CT as required.

Standard type (Main and control circuit power supply is common.)

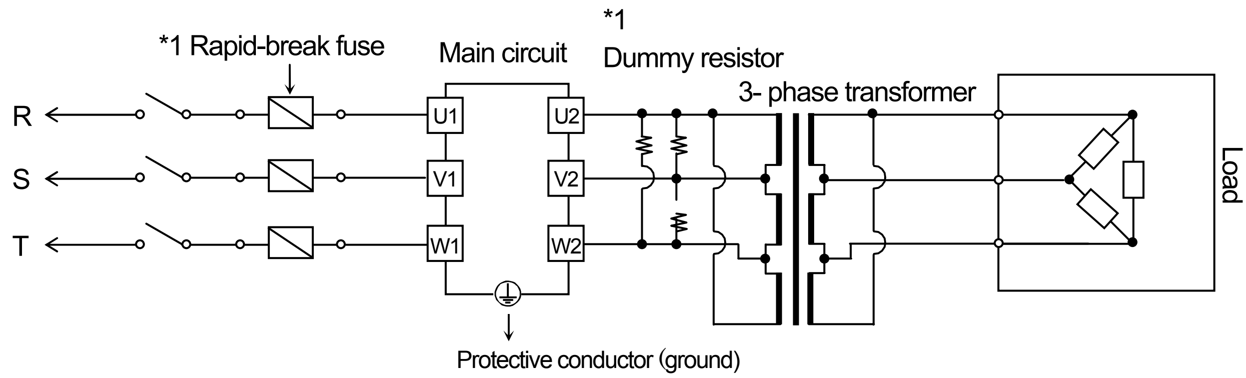


*1: For models without the rapid-break fuse, make sure to connect a rapid-break fuse externally to protect a system.

*2: When the CT is not built in, externally connect a CT as required.

Special type (Main and control circuit power is separate)

5.4.2 Connection of the transformer load



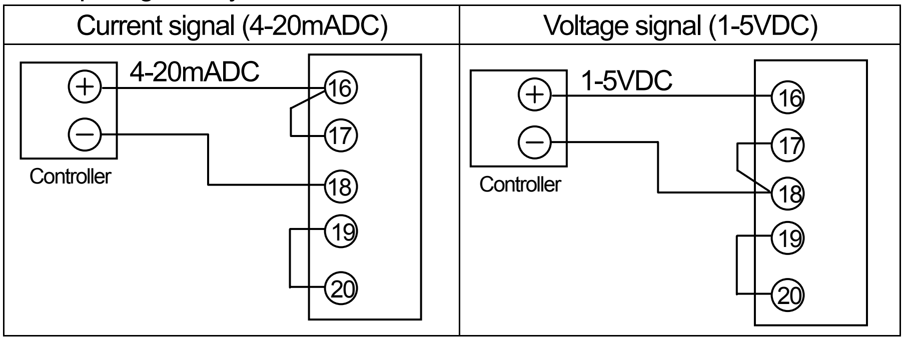
1 A non-load running in case of the transformer load may cause damage to this instrument and/or peripheral equipment (including the transformer). To prevent such damages, connect dummy resistors across the phases on the primary side of the transformer.
Use dummy resistors with resistance that can set currents between phases at 0.5A or more. For example, when the power voltage is 200V, the resistance should be 400Ω. In addition, the resistors should have the higher power value being three times or more of the calculated value: For example, for the 400Ω resistor, select the resistor with 300W or more as the calculated power value is 100W. Also, take necessary countermeasures, such as cooling fans, as required according to the heat generation situation.
Never touch the dummy resistors because they generate heat and are hazardous.

⚠ **CAUTION**	(1) Be sure to match the power phase on the power supply and load sides. (2) Use a high-quality power supply. If the waveform is distorted or noise is contained, normal control will not be possible. This care is particularly important when using a private electric generator.

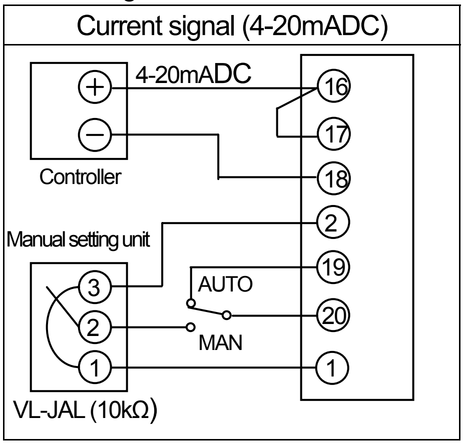
5.5 Connection of Setting Terminals

⚠ WARNING	(1) To prevent accidents, be sure to turn this instrument off before proceeding to the following operations. (2) The connection should be performed by personnel with basic knowledge and practical experience of wiring work.

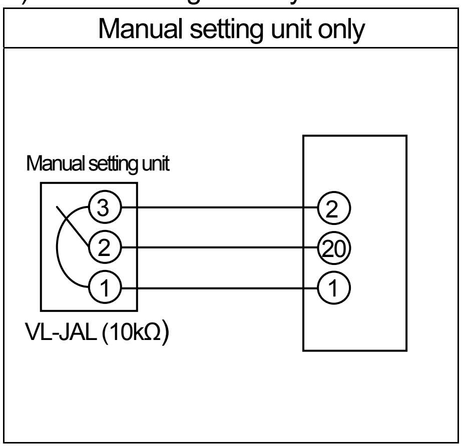
1) Control input signal only



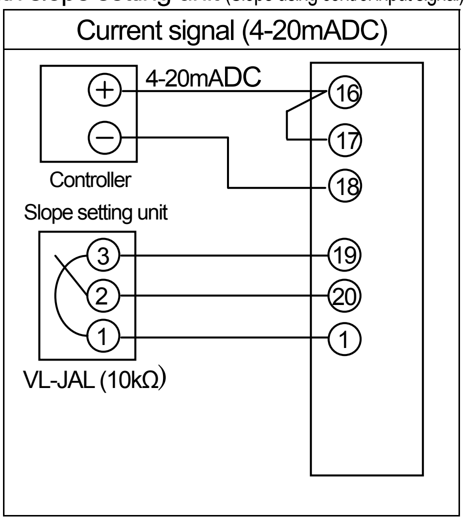
2) Manual setting unit and with auto/man switching



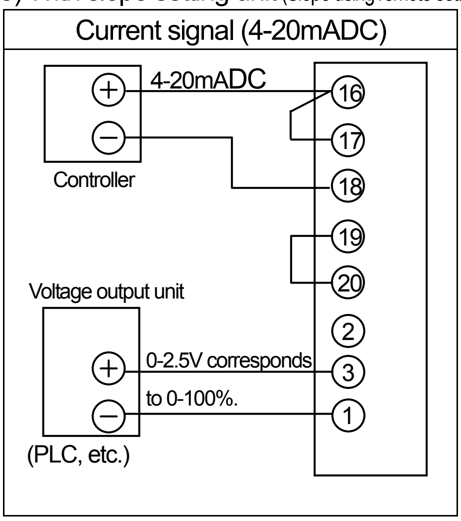
3) Manual setting unit only



4) With slope setting unit (Slope using control input signal)



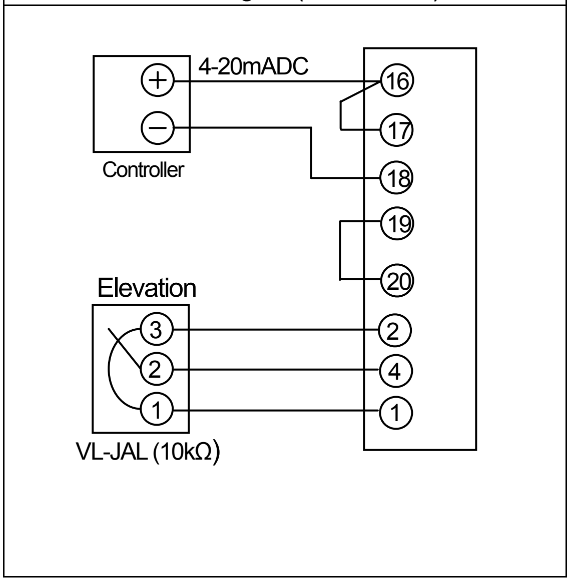
5) With slope setting unit (Slope using remote setting input)



* Use the two short-circuit plates, which are provided for the connections between (16) and (17) (or (17) and (18)), and between (19) and (20), as required. Be sure to check the terminal numbers when connecting them.

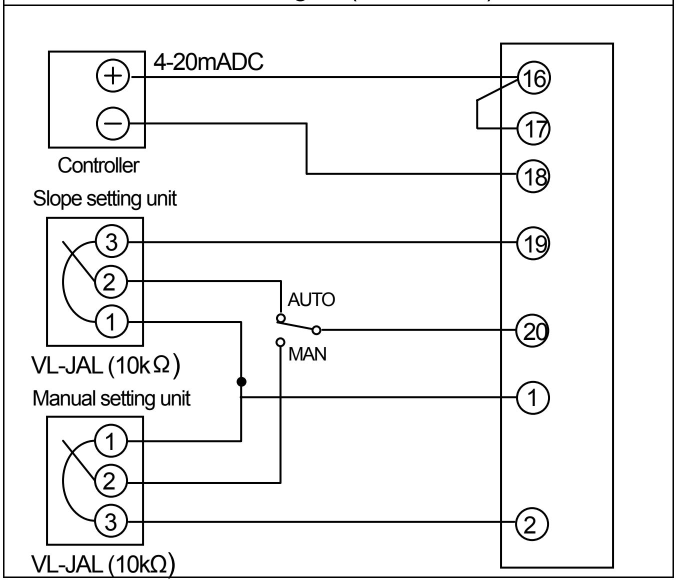
6) With elevation setting unit (Elevation using remote setting input)

Current signal (4-20mADC)



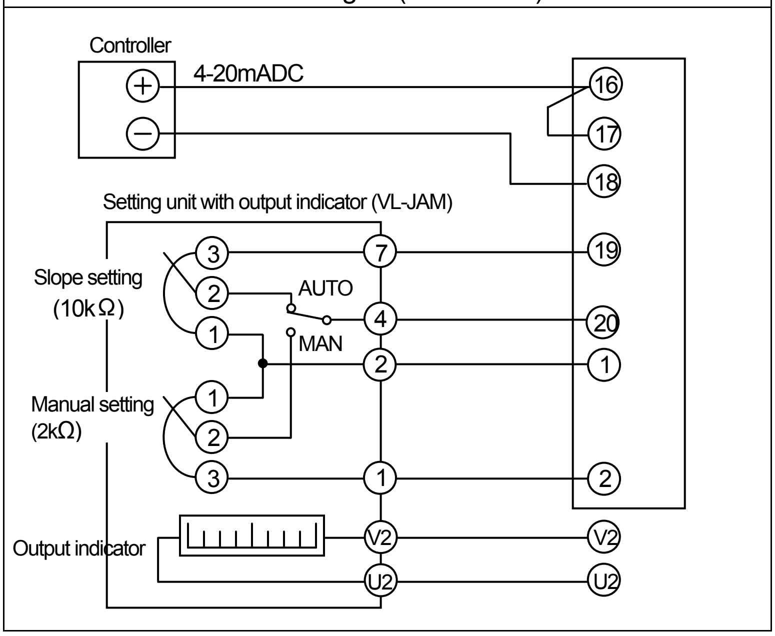
7) Manual setting unit, slope setting unit & Auto/Man SW

Current signal (4-20mADC)

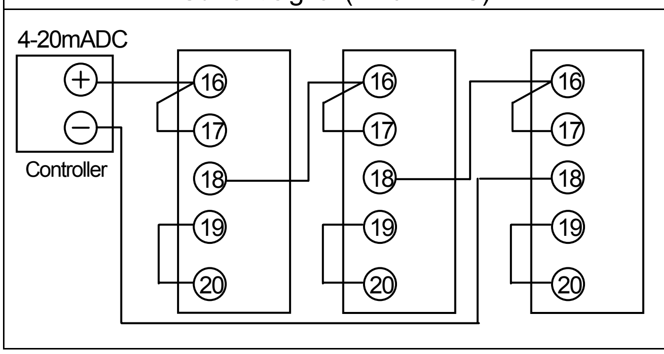
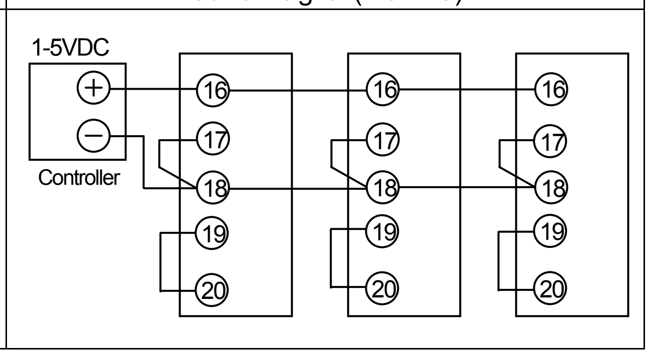


8) Setting unit with output indicator *Cannot be used in zero-cross control.

Current signal (4-20mADC)



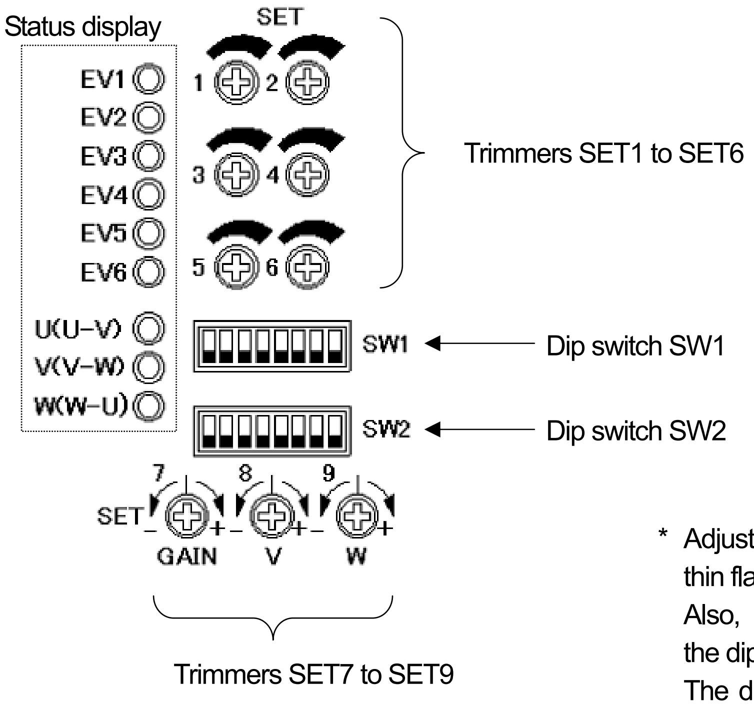
9) Operation of multiple instruments

Current signal (4-20mADC)	Current signal (1-5VDC)
	

CAUTION	
	(1) After completing connections, be sure to reattach the setting terminal cover. (2) The internal circuitry may be destroyed if an over-current or over-voltage is applied to the control input signal terminal. Be careful when applying a signal to this terminal.

6 PARAMETER SETTING

6.1 Front Panel



* Adjust each trimmer by turning it slowly using a thin flat screwdriver.
Also, use the same screwdriver for switching the dip switches.
The dip switch is ON with the up position and OFF with the down position.

[Functions of the SET trimmers]

SET trimmers	Function	Setting range	Default (Factory set)
SET1 trimmer	Slope	0 to 100%	100% (Full clockwise)
SET2 trimmer	Elevation	0 to 100%	0% (Full counterclockwise)
SET3 trimmer	Soft Start	Approx. 1 to 20 sec.	Approx. 1 sec. (Full counterclockwise)
SET4 trimmer	Current Limit	0 to 100%	100% (Full clockwise)
SET5 trimmer	Ratio of heater disconnection alarm	10 to 100%	100% (Full clockwise)
SET6 trimmer	Imbalance ratio of imbalance alarm	1 to 40%	40% (Full clockwise)
SET7 trimmer	Output gain of imbalance adjustment	60 to 140%	Approx. 100% (Center)
SET8 trimmer	V phase output of imbalance adjustment	-40 to +40%	Approx. 0% (Center)
SET9 trimmer	W phase output of imbalance adjustment	-40 to +40%	Approx. 0% (Center)

* The scales of the trimmers are given as approximate references. Even when a trimmer is set to the center position, the set value is not always the center value of the setting range (it is nevertheless approximately the center value).
Each trimmer has the deadband near the fully counterclockwise and fully clockwise positions. A position slightly before the fully counterclockwise or fully clockwise position becomes the low or high limit value of the setting range.

6.2 Slope

(1) Selecting the setting method

・The slope can be set either with the front panel setting (SET1 trimmer) or the remote setting input as shown in the following table.

Setting method	Setting terminals (6) to (9)	Dip SW2 No. 3	Dip SW2 No. 4
Front panel (SET1 trimmer)	Open	OFF	Any position
	Short	ON	Any position
Remote setting input	Open	ON	ON
	Short	OFF	ON

(2) Setting on the front panel

- The setting values on the front panel setting (SET1 trimmer) become 0% at the fully counterclockwise position and 100% at the fully clockwise position.
- Turn the trimmer with a thin flat screwdriver while monitoring the output to adjust to the desired setting.
- The default value of the front panel setting (SET1 trimmer) is 100%.

(3) Setting using the remote setting input

- Turn the knob of the remote setting unit while monitoring the output to adjust to the desired setting.

(4) Alternative setting method

- The slope can also be set, without using the function of this instrument, by inserting a remote setting unit between the control signal output (OUT) terminal (19) and control signal input (IN) terminal (20).

6.3 Elevation

(1) Selecting the setting method

- The elevation can be set either with the front panel setting (SET2 trimmer) or the remote setting input as shown in the following table.

Setting method	Setting terminals (6) to (9)	Dip SW2 No. 3	Dip SW2 No.5
Front panel (SET2 trimmer)	Open	OFF	Any position
	Short	ON	Any position
Remote setting input	Open	ON	ON
	Short	OFF	ON

(2) Setting on the front panel

- The setting values on the front panel setting (SET2 trimmer) become 0% at the fully counterclockwise position and 100% at the fully clockwise position.
- Turn the trimmer with a thin flat screwdriver while monitoring the output to adjust to the desired setting.
- The default value of the front panel setting (SET2 trimmer) is 0%.

(3) Setting using the remote setting input

- Turn the knob of the remote setting unit while monitoring the output to adjust to the desired setting.

6.4 Soft Start

(1) Setting value
- The setting values on the front panel setting (SET3 trimmer) become approx. 1 second at the fully counterclockwise position and approx. 20 seconds at the fully clockwise position.
- The default value of the front panel setting (SET3 trimmer) is approx. 1 second.

(2) Note
- When all control SVs are changed, the output (actually the internal SV used in processing) is changed gradually according to this setting.

6.5 Current Limit

(1) Selecting the setting method
- The current limit can be set either with the front panel setting (SET4 trimmer) or the remote setting input as shown in the following table.

Setting method	Setting terminals (6)-(9)	Dip SW2 No. 3	Dip SW2 No.6
Front panel (SET4 trimmer)	Open	OFF	Any position
	Short	ON	Any position
Remote setting input	Open	ON	ON
	Short	OFF	ON

(2) Setting on the front panel
- The setting values on the front panel setting (SET4 trimmer) become 0% at the fully counterclockwise position and 100% at the fully clockwise position.
- Turn the trimmer with a thin flat screwdriver while monitoring the output to adjust to the desired setting.
- The default value of the front panel setting (SET4 trimmer) is 100%.

(3) Setting values using the remote setting input
- Turn the knob of the remote setting unit while monitoring the output to adjust to the desired setting

(4) Activating the function
- After completing the setting, set the front panel setting (Dipswitch SW1 No. 1) to ON to activate the current limit.

(5) Note
- This function cannot be used with the zero-cross control.
- Connect a CT matching the rated current.

6.6 Heater Disconnection Alarm

(1) Preparation
- Enter the setting value (SV) to be used in normal control and run this instrument until the control stabilizes.
  The load current must be 10% or more of the rated current.

(2) Storing the initial resistance
- When the load current is stabilized, set the front panel setting (Dipswitch SW1 No. 3) to ON to store the initial resistance value in memory.
- When the initial resistance value is stored normally, “EV1” in the status display on the front panel blinks for a few seconds.
  If “EV1” does not blink, the load current is too low to calculate the resistance value. Be sure to set the load current in the normal control range before retrying the storage operation.
- When “EV1” blinks after the switch is set to ON, immediately return the switch to OFF. Make sure to return it to OFF.

(3) Setting value

- Set the setting value (ratio) with the following formula.

  Ratio = { (Disconnection detection target resistance – Initial resistance) ÷ Initial resistance } × 100
- The setting values on the front panel setting (SET5 trimmer) become 10% at the fully counterclockwise position and 100% at the fully clockwise position.
- The default value of the front panel setting (SET5 trimmer) is 100%.

(4) Activating the function

- After completing the setting, set the front panel setting (Dipswitch SW1 No. 2) to ON to activate the heater disconnection alarm.

(5) Note

- The load resistance value is not the resistance of the heater alone, but represents the approximate synthesized resistance between phases. This means that it does not allow the user to identify deterioration or disconnection of the heater, but that it can be used only as reference information.
- Do not apply this function to a heater, of which heater resistance varies significantly (such as a silicone carbide SiC heater). Otherwise, erroneous alarm may activate.
- Connect a CT matching the rated current.
- A certain deadband (a delay time of approx. 2 min.) is provided with the alarm judgment set to OFF.
- Storage of the initial resistance value should be stored while the load current is within the normal control range.
- After storing the initial resistance value, be sure to return the dipswitch to OFF.
- Judgment of the heater disconnection alarm is started by totalizing the period in which the output (actually the internal SV used in processing) exceeds 10% or more and when the total period exceeds the detection period (Default: 1 minute).
- The alarm judgment is not performed while this instrument stops to run.

6.7 Imbalance Adjustment

6.7.1 Outline

The imbalance adjustment function is used to adjust the imbalanced status to the balanced status. The adjustment is possible within a certain range based on either the voltage or current value.

First, select the voltage or current according to the control system. Then set No. 7 of the dipswitch SW1 to ON to activate the imbalance adjustment function, and adjust it using the following three trimmers.

- SET7 trimmer: Output gain. The adjustment range is from 60% at the fully counterclockwise (decrease direction) position to 140% at the fully clockwise (increase direction) position. The default value is 100%.
- SET8 trimmer: V-output timing. The adjustment range is from 40% at the fully counterclockwise (decrease direction) position to 40% at the fully clockwise (increase direction) position. The default value is 0%.
- SET9 trimmer: W-output timing. The adjustment range is from 40% at the fully counterclockwise (decrease direction) position to 40% at the fully clockwise (increase direction) position. The default value is 0%.

⚠WARNING	To prevent an accident, turn this instrument off before connecting a voltmeter or ammeter.

⚠ CAUTION	(1) Adjust the adjustment trimmers by turning them slowly while monitoring the measured value. (2) When an adjustment trimmer is turned, the over-current alarm or rapid-break fuse meltdown alarm may activate by the change of output. (3) After the adjustment, be careful not to turn any adjustment trimmers during normal running.

6.7.2 Imbalance adjustment with voltage

(1) Preparation

- Connect three RMS type measuring units between each phase to measure the voltage values (U2-V2, V2-W2, W2-U2) between each phase.
- Turn this instrument ON, enter the set value (SV) to be used in normal control and run this instrument until the control stabilizes.
- Set the SET7, SET8 and SET9 trimmers to the center positions.

(2) Activating the function

- Set the front panel setting (Dipswitch SW1 No. 7) to ON to activate the imbalance adjustment.

(3) Output gain adjustment 1

- After the output has stabilized, reduce the outputs of the three phases by about 10% to ensure the safety of adjustment.
- Turn the SET7 trimmer (output gain) slowly counterclockwise while monitoring the voltage values on the measuring units so that the highest voltage values in the three phases is about –10% of the voltage value corresponding to the set value (SV).

(4) Imbalance adjustment

- While monitoring the voltage values on the measuring units, turn the SET8 trimmer (V phase output timing) and SET9 trimmer (W phase output timing) slowly and alternately so that the voltage values of the three phases are almost same.

(5) Output gain adjustment 2

- When the voltage values of the three phases are almost same, turn the SET7 trimmer (output gain) slowly clockwise so that the voltage value of each phase becomes the voltage value corresponding to the set value (SV).
- Fine-adjust the SET8 trimmer (V phase output timing) and SET9 trimmer (W phase output timing) as required.

(6) Note

- Use the RMS type measuring units (3 units) and adjust voltage values by monitoring the measured values on them.
- This function cannot be used with the zero-cross control.

6.7.3 Imbalance adjustment with current

(1) Preparation

- Connect three RMS type measuring units between each phase to measure the current values (U2, V2, W2) between each phase.
- Turn this instrument ON, enter the set value (SV) to be used in normal control and run this instrument until the control stabilizes.
- Set the SET7, SET8 and SET9 trimmers to the center positions.

(2) Activating the function

- Set the front panel setting (Dipswitch SW1 No. 7) to ON to activate the imbalance adjustment.

(3) Output gain adjustment 1

- After the output has stabilized, reduce the outputs of the three phases by about 10% to ensure the safety of adjustment.
- Turn the SET7 trimmer (output gain) slowly counterclockwise while monitoring the voltage values on the measuring units so that the highest current values in the three phases is about –10% of the current value corresponding to the set value (SV).

(4) Imbalance adjustment

- While monitoring the voltage values on the measuring units, turn the SET8 trimmer (V phase output timing) and SET9 trimmer (W phase output timing) slowly and alternately so that the current values of the three phases are almost same.

(5) Output gain adjustment 2

- When the current values of the three phases are almost same, turn the SET7 trimmer (output gain) slowly clockwise so that the current value of each phase becomes the current value corresponding to the set value (SV).
- Fine-adjust the SET8 trimmer (V phase output timing) and SET9 trimmer (W phase output timing) as required.

(6) Note

- Use the RMS type measuring unit (3 unit) and adjust current values by monitoring the measured values on them.
- This function cannot be used with the zero-cross control.
- Connect a CT matching the rated current..

6.8 Imbalance Alarm

(1) Preparation

- Enter the setting value (SV) to be used in normal control and run this instrument until the control stabilizes. The load current must be 10% or more of the rated current.
- When the load current stabilizes, perform the imbalance adjustment if necessary.

(2) Setting value

- Calculate and set the setting (imbalance ratio) with the following formula.

  Imbalance rate = { (Load current max value - Load current min value) ÷ Load current max value } × 100
- The setting values on the front panel setting (SET6 trimmer) become 1% at the fully counterclockwise position and 40% at the fully clockwise position.
- The default value of the front panel setting (SET6 trimmer) is 40%.

(3) Activating the function

- After completing the setting, set the front panel setting (Dipswitch SW1 No. 4) to ON to activate the imbalance alarm function.

(4) Note

- This function judges the imbalance ratio of the load current.
- This function cannot be used with the zero-cross control.
- Connect a CT matching the rated current.
- A certain deadband (a delay time of approx. 2 min.) is provided with the alarm judgment set to OFF.
- Judgment of the imbalance alarm is started by totalizing the period in which the output (actually the internal SV used in processing) exceeds 10% or more and when the total period exceeds the detection period (Default: 1 minute).
- The alarm judgment is not performed while this instrument stops to run.

6.9 Alarm Output Forced OFF

When the alarm activates, AL1 or AL2 is turned on as the alarm output. It is possible to turn it off forcibly.

(1) Setting

- The alarm output relay is set to OFF when the front panel setting (Dipswitch SW 1 No. 5) is set to ON.
- The alarm output relay is not set to ON until the front panel setting (Dipswitch SW 1 No. 5) is set to OFF.

(2) Note

- Even when the alarm output is forced to OFF, the status LED display on the front panel indicates the alarm activation.

6.10 Feedback Control OFF

In case of the instrument with the feedback control specification, the feedback control function can be forced to OFF.

(1) Setting

- The feedback control function is set to OFF when the front panel setting (Dipswitch SW 1 No. 6) is set to ON.

(2) Note

- This function is not available with models with no-feedback specification or zero-cross control specification.
- If this function is switched duringoperation, the output (actually the internal SV used for processing) starts from 0%.

6.11 Dipswitch Functions

The front panel has two dipswitches for various settings. Set them as required.

1. Dipswitch SW1

No.	Function	Default (Factory set)
1	Current limit ON/OFF. By switching to ON, the function activates.	OFF
2	Heater disconnection alarm ON/OFF. By switching to ON, the function activates.	OFF
3	Storage of the initial resistance value for heater disconnection alarm. By switching to ON, the initial resistance is stored 1 time only. * Be sure to set the switch to OFF in normal running and after storage.	OFF
4	Imbalance alarm ON/OFF. By switching to ON, the function activates.	OFF
5	Alarm output forced OFF. By switching to ON, the function activates.	OFF
6	Feedback control ON/OFF. By switching to ON, the function becomes OFF.	OFF
7	Imbalance adjustment ON/OFF. By switching to ON, the function activates.	OFF
8	Initialization. When the power is supplied to this instrument, the function activates. * Be sure to set the switch to OFF in normal running and after initialization.	OFF

2. Dipswitch SW2

No.	Function		Default (Factory set)
1	**Logical switching of remote contact input 1 (Run/Stop)**		OFF
	SW2 and remote contact input status	**Operation mode**	
	SW2 (OFF), remote contact input (Open)	Run	
	SW2 (OFF), remote contact input (Short)	Stop	
	SW2 (ON), remote contact input (Open)	Stop	
	SW2 (ON), remote contact input (Short)	Run	
2	**Logical switching of remote contact input 2 (Phase/Zero-cross)**		OFF
	SW2 and remote contact input status	**Operation mode**	
	SW2 (OFF), remote contact input (Open)	Phase angle control	
	SW2 (OFF), remote contact input (Short)	Zero-cross control	
	SW2 (ON), remote contact input (Open)	Zero-cross control	
	SW2 (ON), remote contact input (Short)	Phase angle control	
	* The control system cannot be switched with the zero-cross control type.		
3	**Logical switching of remote contact input 3 (Front panel/Remote setting input)**		OFF
	SW2 and remote contact input status	**Selected setting**	
	SW2 (OFF), remote contact input (Open)	Front panel setting	
	SW2 (OFF), remote contact input (Short)	Remote setting input	
	SW2 (ON), remote contact input (Open)	Remote setting input	
	SW2 (ON), remote l contact input (Short)	Front panel setting	
4	**Individual selection of remote setting input: Slope**		OFF
	SW2 status	**Selected setting**	
	SW2 (ON)	Remote setting input	
	SW2 (OFF)	Front panel setting	
5	**Individual selection of remote setting input: Elevation**		OFF
	SW2 status	**Selected setting**	
	SW2 (ON)	Remote setting input	
	SW2 (OFF)	Front panel setting	
6	**Individual selection of remote setting input: Current limit**		OFF
	SW2 status	**Selected setting**	
	SW2 (ON)	Remote setting input	
	SW2 (OFF)	Front panel setting	
7 8	**Selection of actually used supply voltage**		No.7: OFF No.8: ON 200V line: (200V) 400V line: (400V)
	SW2 status	**Selecting status** To prevent malfunction, do not select the switch status of "Not used."	
	No.7 (ON), No.8 (ON)	240V /Not used	
	No.7 (ON), No.8 (OFF)	220V/440V	
	No.7 (OFF),No.8 (ON)	200V/400V	
	No.7 (OFF), No.8 (OFF)	Not used/380V	

7 Running

7.1 Check before Running

⚠ WARNING	(1) To prevent an accident, be sure to turn this instrument off before proceeding to the following operations. (2) The withstand voltage test should be performed by personnel with basic knowledge and practical experience of testing.

1. Checking the installation orientation
   Check that this instrument is installed with the UP (↑) marking pointing up. Otherwise, the heat radiation effect will be hindered and the rise in the internal temperature may result in malfunction.

2. Checking the connections
   Check if wiring is correct, the short-circuit plates are connected properly, the connections are secure, etc. Particularly, check the main circuit terminals such as the power supply terminals are tightened securely.
   This instrument and peripheral equipment (such as the transformer) may be damaged in case of non-load running. Check that the load is connected before running.

3. Checking the balanced status
   Check that the power voltages between each phase and loads between each phase are balanced. If they are imbalanced too much, the errors in the input/output characteristics of this instrument will increase, deteriorating the controllability.

4. Checking the power voltage and load capacity
   Check once again that the power voltage and load capacity are appropriate for the ratings of this instrument.

5. Checking the insulation
   Check the insulation of the load circuit as required. Use a 500V megger for the measurement of insulation resistance.
   When performing the withstand voltage test, short-circuit all of "U1 and U2," "V1 and V2" and "W1 and W2" of the main circuit terminals. As the withstand voltage test could degrade this instrument and injure the test personnel, it should be conducted with the minimum required voltage. The test voltage must be lower than 1500VAC.

6. Setting the power voltage
   Set the dipswitch SW2 on the front panel to set the power voltage as shown in the following table.

Check the rated voltage of the JW and the actual power voltage.		Set Nos. 7 and 8 of SW2 according to the actual power voltage.
Power voltage 200 V (JW20□□□······)	200 V	Set No. 7 to "OFF" and No. 8 to "ON".
	220 V	Set No. 7 to "ON" and No. 8 to "OFF"
	240 V	Set No. 7 to "ON" and No. 8 to "ON"
Power voltage 400 V (JW40□□□······)	380 V	Set No. 7 to "OFF" and No. 8 to "OFF "
	400 V	Set No. 7 to "OFF" and No. 8 to "ON"
	440 V	Set No. 7 to "ON" and No. 8 to "OFF"

7. Checking the control system and parameter settings
   Check the control system (phase angle control, zero-cross control, feedback, etc.) and the parameters set on the front panel.

8. Other check
   Check other items by reading warnings and cautions given in this instruction manual.

7.2 Start of Operation

⚠WARNING	(1) Do not approach the terminals (main circuit terminals and setting terminals) of this instrument. Electric shock due to the high-voltage parts is hazardous to human life. (2) This instrument has high-temperature parts. Particularly, do not touch the top panel, side panels, radiation fins, etc. (3) Do not allow a finger, stick or any object to enter or drop into the cooling fan area. The cooling fan(s) are rotating at a high speed and may cause injury or damage.

1. Turn the system ON. If possible, set the manual run or control input signal to 0% so that this instrument maintains the 0% output when it is turned ON.

2. Check that the system components including this instrument are normal. Also, check that all of the connected signal levels (voltages, current, ON/OFF signals, etc.) are normal.

3. Check that the power voltages between each phase and loads between each phase are balanced.

4. Switch to the auto run (or keep manual run), start the control and observe the operation.

5. There is no problem when the control is stable. If it is unstable, adjust the controller's parameters (particularly the PID constants) and this instrument's parameters (particularly the slope).

6. Set the parameters as required.

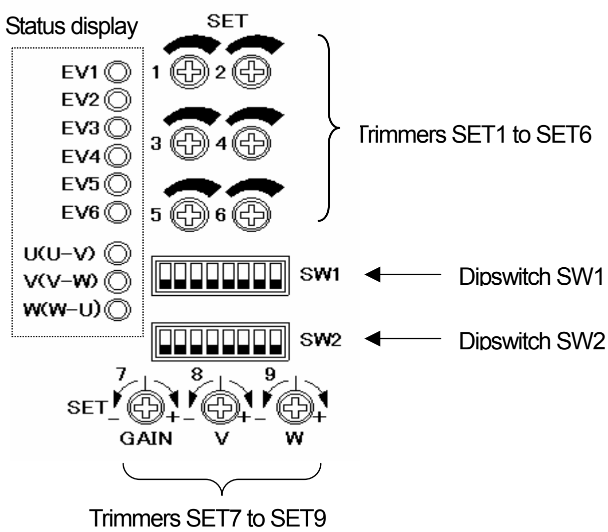
7. In a few hours after the start of operation, check again that the system components including this instrument are normal.

8. When stable control is established, it is recommended to record (save) the settings including those of this instrument.

⚠ CAUTION	(1) Never run this instrument without the load. Non-load running may result in damage to this instrument and/or peripheral equipment (such as the transformer). (2) Check the signals of the peripheral equipment connected to this instrument. Applying an over-voltage or over-current may damage the internal circuitry of this instrument.

7.3 Status Display

During running, the EV (Event) lamps as status displays on the front panel indicate various status including running status and alarm activation status.



Front panel

No.	Description
EV1 (Green)	This is for the running status. The lamp lights at the normal running and blinks when the running becomes abnormal. The lamp also blinks in the following cases. (1) When this instrument is initialized (the internal memory is reset to the factory default); → The lamp stops blinking after the completion of initialization. (2) When this instrument is turned ON with No. 8 of the dipswitch SW1 being set to ON (for initialization); → Be sure to set the switch to OFF before re-turning this instrument ON. (3) During storage of the initial resistance value for the heater disconnection alarm; → The lamp starts blinking after the start of storage and stops blinking after a few seconds. (4) During storage of the setting in case of the instrument with the setting communication unit; →The lamp starts blinking after the start of storage and stops blinking after a few seconds.
EV2 (Red)	The lamp lights when the over-current alarm is ON and blinks when the heater disconnection alarm is ON.
EV3 (Red)	The lamp lights when the rapid-break fuse meltdown alarm is ON and blinks when the abnormality alarm for the thyristor element is ON.
EV4 (Red)	The lamp lights when the overheating abnormality alarm for the radiation fin is ON.
EV5 (Red)	The lamp lights when the phase-sequence abnormality alarm is ON and blinks when the open-phase detection alarm is ON. * Note: For these 2 kinds of alarms, certain determination/discrimination of alarm status cannot be performed. Please use it for your reference. When either alarm is ON, check both of the phase-sequence abnormality and the open-phase.
EV6 (Red)	The lamp lights when the frequency abnormality alarm is ON and blinks when the imbalance alarm is ON.
EV7 (Green)	The lamp interlocks with EV2 to EV6 and provides the display-by-phase “U (U-V)” showing the applicable phase.
EV8 (Green)	The lamp interlocks with EV2 to EV6 and provides the display-by-phase “V (V-W)” showing the applicable phase.
EV9 (Green)	The lamp interlocks with EV2 to EV6 and provides the display-by-phase “W (W-U)” showing the applicable phase.

⚠ CAUTION	• When multiple alarms activate simultaneously, the alarm types may not be determined due to overlapped lighting of the EV lamps. The display-by-phase may also not be performed. Furthermore, when the display-by phase is performed, certain display-by-phase may not be obtained. • All status display lamps light temporarily when this instrument is turned ON or the control system is switched.

8 ALARM

8.1 Alarm Activation and Alarm Output

Alarm name	Status display	Alarm output
Over-current alarm	• EV2 lights up and one of EV7 to EV9 lights to indicate the phase in alarm. • In case of the over-current alarm, even when the current value has returned within the rated current range after the alarm activation. It cannot be turned OFF until this instrument is turned OFF then ON again. (Latched output)	AL1
Rapid-break fuse meltdown alarm	• EV3 lights up and one of EV7 to EV9 lights to indicate the phase in alarm. • This alarm activates only in the instrument with the rapid-break fuse.	AL1
Radiation fin overheat alarm	• EV4 lights up.	AL1
Heater disconnection alarm	• EV2 blinks and one of EV7 to EV9 lights to indicate the phase in alarm.	AL2
Thyristor element abnormality alarm	• EV3 blinks and one of EV7 to EV9 lights to indicate the phase in alarm.	AL2
Running abnormality alarm	• EV1 blinks. • This alarm is turned OFF automatically in about 1 minute after the alarm activation. It can also be turned OFF by turning this instrument OFF then ON again.	None
Phase-sequence abnormalities alarm	• EV5 lights up.	None
Open-phase alarm	• EV5 blinks and one of EV7 to EV9 lights to indicate the phase in alarm.	None
Imbalance alarm	• EV6 blinks and one of EV7 to EV9 lights to indicate the phase in alarm.	AL2
Frequency abnormality alarm	• EV6 lights up.	None

* Even when the alarm outputs are OFF, they may be turned ON instantaneously when this instrument is turned OFF/ON. If required, take countermeasures externally against such error outputs.

8.2 Alarms and Countermeasures

Alarm name	Running status	Countermeasures
Over-current alarm	Running stops. (Thyristor gate OFF)	Turn this instrument OFF, identify the cause and take countermeasures against it, and then turn this instrument ON again. This instrument will recover.
Rapid-break fuse meltdown alarm	Running stops. (Thyristor gate OFF)	Turn this instrument OFF, identify the cause and replace the fuse, and then turn this instrument ON again. This instrument will recover.
Radiation fin overheat alarm	Running stops. (Thyristor gate OFF)	Check that the cooling fan(s) of the thyristor unit is rotating normally and that the ambient temperature is not abnormally high, and then turn this instrument ON again. If the fan(s) is malfunctioning, turn this instrument OFF, replace the fan(s) and turn this instrument ON again. This instrument will recover.
Heater disconnection alarm	Running continues.	Turn this instrument OFF and check the heater, etc. This alarm may also activate when the CT is not connected to the thyristor unit.
Thyristor element abnormality alarm	Running continues.	Turn this instrument OFF and check the load and connections. If still not recovered, repair of this instrument is required.
Running abnormality alarm	Running continues.	Turn this instrument OFF then ON again. If still not recovered, repair of this instrument is required.
Phase-sequence abnormalities alarm	Running stops. (Thyristor gate OFF)	The connections of the three phases (U, V, W) are not correct. Turn this instrument OFF and correct the connections, and then turn this instrument ON again. This instrument will recover.
Open-phase alarm	Running stops. (Thyristor gate OFF)	One of the connections of the three phases (U, V, W) is disconnected: Turn this instrument OFF and correct the connections, and then turn this instrument ON again. This instrument will recover.
Imbalance alarm	Running continues.	Turn this instrument OFF and check the power voltage, load, heater, etc.
Frequency abnormality alarm	Running stops. (Thyristor gate OFF)	Turn this instrument OFF and check the power voltage, noise, etc. Especially, in case of an abnormal voltage waveform by noise, the correct control cannot be performed. Take appropriate countermeasures against it.

9 TROUBLESHOOTING

Symptom	Check Items
1. No output (0%).	(1) Check that the connections of the main circuit terminals are correct. • Connect U1, V1 and W1 to the 3-phase power supply (R, S and T), and connect U2, V2 and W2 to the load (such as a heater). • Confirm the phase-sequence of the 3-phase power supply with a phase detector and the connections are in positive-phase-sequence.
	(2) Check that the connections of the setting terminals are correct. • Confirm that the correct signal is connected to the control input signal. • Confirm that the output varies by the manual output.
	(3) Check that the parameter settings are correct. • Confirm that the running status is not “Stop.” • Confirm that the slope setting is not “0%.” • Confirm that the current limit setting is not “0%.”
	(4) Check that the following alarms are not ON. • Over-current alarm • Rapid-break fuse meltdown alarm • Radiation fin overheat alarm • Phase-sequence abnormalities alarm • Open-phase alarm • Frequency abnormality alarm
	(5) Check that the power supply is not interfered with by noise. • When there is strong noise, the frequency abnormality is determined and the output becomes 0%. Noise countermeasures are required in such a case.
2. Continuous output (100%).	(1) Check that the following connections are correct. • Confirm that the load is connected correctly. If the load is too light, the output is generated continuously. • With the current or power feedback type, confirm that the CT is connected properly. • Confirm that the correct signal is connected to the control input signal.
	(2) Check that the parameter settings are correct. • Confirm that the elevation setting is not “100%.”

Symptom	Check Items
3. Output does not vary correctly.	(1) Check that the following connections are correct. • Confirm the phase-sequence of the 3-phase power supply with a phase detector and the connections are in positive-phase-sequence. • With the current or power feedback type, confirm that the CT is connected properly. Make sure that the secondary side of the CT is not grounded. • Confirm that the correct signal is connected to the control input signal.
	(2) Check that the power waveform is normal. • If the power waveform contains noise or distortion, the output will not be proportional to the control input signal. • If a private electric generator is in use, check the power voltage and power frequency. Particularly, make sure that the power frequency is either 50 Hz or 60 Hz.
	(3) Check that the load is not in imbalanced. • If it is extremely imbalanced, the output will not be proportional to the control input signal. Achieve a balanced status by correcting the power supply and/or load and performing the imbalance adjustment.
	(4) Check that the parameter settings are correct. • Confirm that the slope, elevation and soft start settings are correct.
4. This instrument malfunctions.	(1) Check all of the check items in 1 to 3 above.
	(2) If this instrument still malfunctions, initialize it as described below (i.e. resetting its internal memory to the default settings). • Turn this instrument OFF. • Set No. 8 of the dipswitch SW1 on the front panel to ON. • Turn this instrument ON. • Confirm that the EV1 status display lamp on the front panel blinks. • Set No. 8 of the dipswitch SW1 on the front panel to OFF. • Now the initialization is complete; see if the malfunction is recovered. For the instrument with the setting communication unit, the initialization must be performed from the setting communication unit (Ref. Instruction manual for the setting communication unit). For the instrument with the setting communication unit, the initialization from the front panel is not available.
5. Control output is different from the actual value on a measuring unit.	(1) Check that RMS type measuring units are used. • For the measurement of the control output of the thyristor unit, use RMS type or armature type measuring units. A rectifier type measuring unit cannot be used.

10 MAINTENANCE

10.1 Routine Inspection and Maintenance

⚠ WARNING	(1) To prevent an accident, be sure to turn this instrument off before proceeding to the following operations. (2) To prevent burns, do not touch a hot part, such as the radiation fin, immediately after turning this instrument OFF.

10.1.1 Inspection items

Inspect the following items in order to maintain this instrument in the best condition.

Item	Description
Terminal bolts and screws	If the bolts of the main circuit terminals are loose, heat will be produced due to the large current and the wiring may be burned. Be sure to inspect the tightness of the bolts and screws periodically.
Cooling fan(s)	The types with a rated current of 100 A or more are equipped with a cooling fan(s) on the top panel. Periodically inspect that there are no rotation irregularities or noise. Note that the cooling fan(s) is a consumable part that must be replaced periodically.
Cleaning	When this instrument is used in a dusty or dirty environment, the attached dust or dirt may degrade the insulation or cause other malfunction. To prevent this, remove dust or dirt periodically using a cleaner.

⚠ CAUTION	Never attempt to replace a part other than the cooling fan(s) and rapid-break fuse. You cannot replace other parts correctly and may also have the risk of injury if you replace them. For the replacement of parts other than the cooling fan(s) and fuse, please contact your nearest distributor.

10.1.2 Consumable parts

The following table shows the consumable parts and their replacement timings.

Part name	Replacement interval	Operating conditions
Cooling fan(s)	2 years	• Normal working temperature • 50% or less operating rates
Printed circuit boards	5 years	

10.2 Fuse Replacement

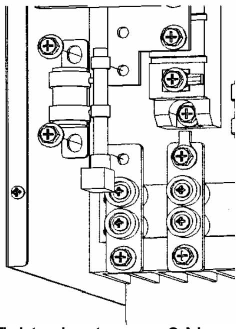
⚠WARNING	(1) To prevent an accident, be sure to turn this instrument off before proceeding to the following operations. (2) To prevent accidents, be sure to tighten the fuse with the specified torque when replacing it. Also, be sure that the new fuses are of the same specifications as the previous fuses.

When a rapid-break fuse is melted down, be sure to check the cause of meltdown and take proper countermeasures against it before replacing it. As the fuse may be melted down due to a malfunction of this instrument, you are required to check carefully.

The following table shows the types of rapid-break fuses being used with this instrument. Confirm the specifications (voltage and current) of the fuse being used and be sure to replace it with the same fuse.

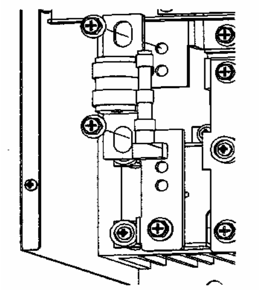
Rated voltage	Rated current	Fuse	Rated current	Fuse
200VAC	30A	Hinode Electric 250GH-50 S	200A	Hinode Electric 250GH-315 S
	50A	Hinode Electric 250GH-75 S	250A	Hinode Electric 250GH-350 S
	75A	Hinode Electric 250GH-100 S	300A	Hinode Electric 250GH-450 S
	100A	Hinode Electric 250GH-160 S	400A	Hinode Electric 250GH-630 S
	150A	Hinode Electric 250GH-200 S	500A	Hinode Electric 250GH-710 S
400VAC	30A	Hinode Electric 660GH-50 S	200A	Hinode Electric 660GH-315 S
	50A	Hinode Electric 660GH-80 S	250A	Hinode Electric 660GH-350 S
	75A	Hinode Electric 660GH-100 S	300A	Hinode Electric 660GH-450 S
	100A	Hinode Electric 660GH-160 S	400A	Hinode Electric 660GH-630 S
	150A	Hinode Electric 660GH-200 S	500A	Hinode Electric 660GH-710 S

Rated current: 30A/50A



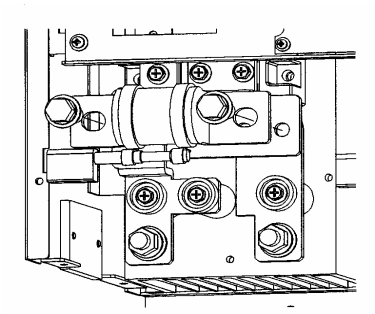
Tightening torque: 3 N•m

Rated current: 75A/100A



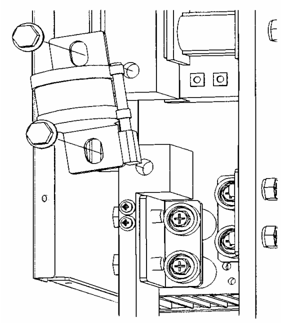
Tightening torque: 5N•m

Rated current: 150A/200A/250A



Tightening torque: 12 N•m

Rated current: 300A/400A/500A



Tightening torque: 25 N•m

⚠CAUTION	For the instrument with the setting communication unit, the cover to which the setting communication unit is attached and this instrument are connected with a cable. When removing the cover, you are required to remove the cable from the connector at a place where the cover is separated too far from this instrument. If the cover is removed without removing the cable, the internal cable or connector may be damaged.

10.3 Cooling Fan Replacement

WARNING	To prevent an accident, be sure to turn this instrument off before proceeding to the following operations.

(1) Turn this instrument off.

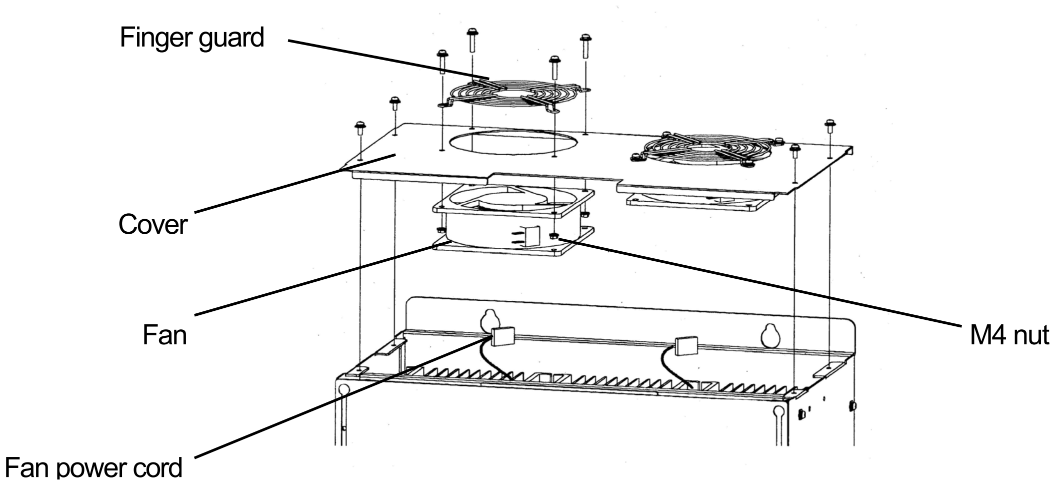
(2) Remove the cover and unplug the fan power cord connecting to the fan.

(3) Replace the fan as shown below.
* Note that the type, number and installation method of cooling fans are variable according to the rated current.

(4) Be sure to install the fan in the correct orientation when replacing it.
* The power cord can be connected in any position but be sure to plug the cord firmly.

(5) Attach the cover by reversing the removal procedure.

(6) After replacement, turn this instrument on and ensure that all the cooling fans are rotating.



11 GLOSSARY

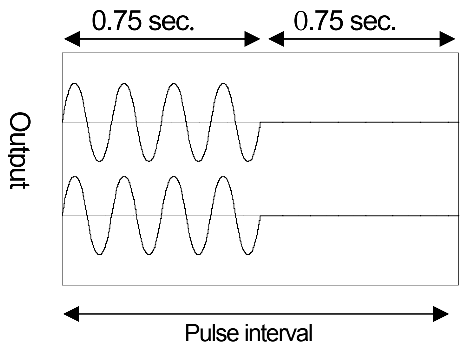
11.1 Control Systems

11.1.1 Phase angle control

The phase angle control system controls the output by varying the conducting angle θ (ON timing) within 210° (3-arm operation) or 150° (6-arm operation) of the power frequency. Most thyristor regulators employ this system.
This control is continuous compared to the zero-cross control and can be used in the primary side control of the transformer.

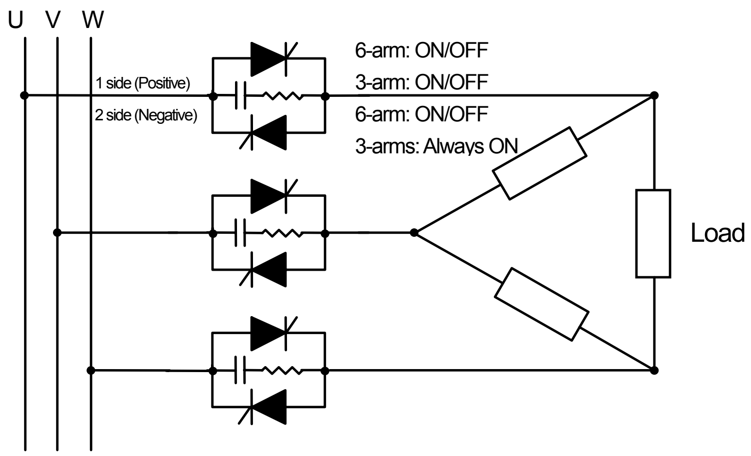
11.1.2 Zero-cross control

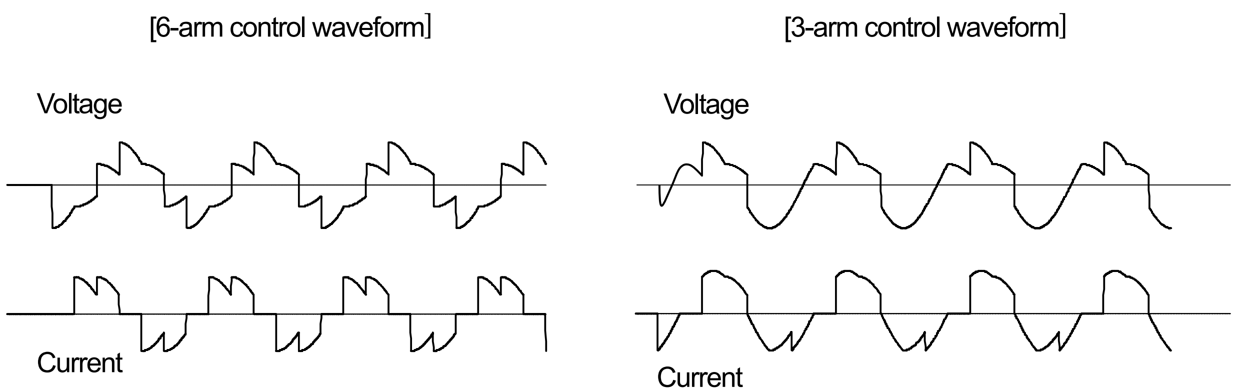
The zero-cross control system controls the output by defining ON/OFF for each power waveform cycle.
It generates less noise than the phase angle control. However, as the maximum current flows during the ON period and it is intermittent, the flickering phenomena (Example: Lighting flicker) may be generated.
The zero-cross control can use only a Nichrome heater. Do not use it for the purposes other than the primary side control of the transformer and Nichrome heater, otherwise, the over-current alarm will activate or the rapid-break fuse will be melted down.
The pulse interval corresponds to the output updating interval. For example, when the pulse interval is 1.5 sec. (default value) and the output is 50%, the ON/OFF waveform becomes as shown on the right.



11.1.3 6-arm and 3-arm types

The "6-arm" type performs ON/OFF control of both the 1-side (positive) and 2-side (negative) gates of 1-power phase at the thyristor gate control. The "3-arm" type leaves the 2-side (negative) gate permanently ON.

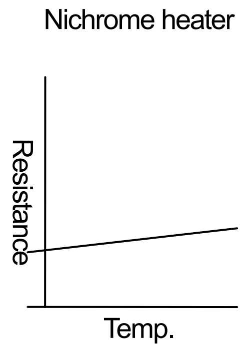




11.2 Feedback Type

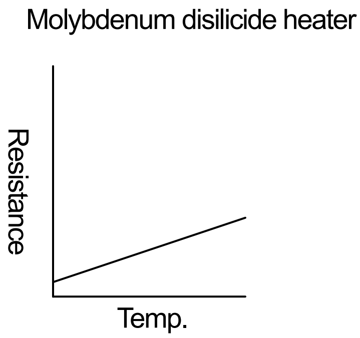
11.2.1 Voltage feedback type

This is a type to control with the feedback of the voltage of the load, and is optimum for a heater with a low resistance-temperature characteristic as shown on the right (Nichrome heater, etc.).
Such a heater can be controlled stably by maintaining the output voltage from the thyristor regulator to a constant level.
This feedback can be used only with the phase angle control type.



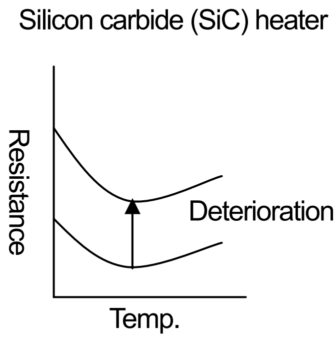
11.2.2 Current feedback type

This is a type to control with the feedback of the current of the load, and is optimum for a heater with a high resistance-temperature characteristic as shown on the right (Molybdenum disilicide heater, etc.).
Such a heater can be controlled stably by setting the maximum output of the thyristor regulator to the maximum rated current of the heater because this makes it possible to output the current in proportion to the control input signal regardless of changes in the resistance value.
This feedback can be used only with the phase angle control type.



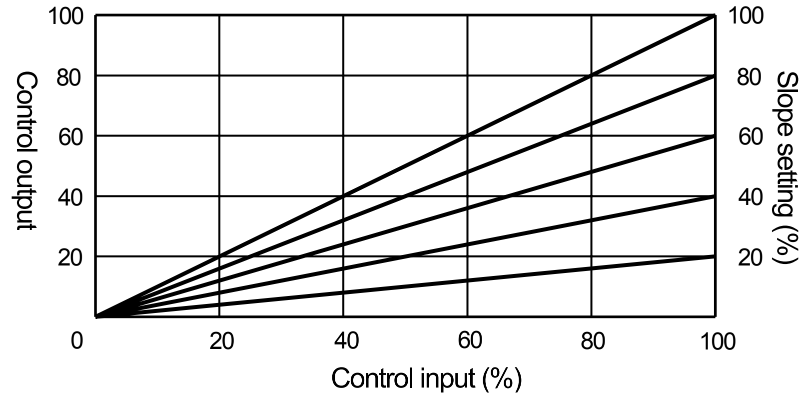
11.2.3 Power feedback type

This is a type to control with the feedback of the power of the load and is optimum for a heater, the resistance of which varies according to the generated heat temperature and varies by nearly 4 times the initial resistance value across the ages (silicon carbide heater, etc.).
Such a heater can be controlled stably by detecting both the voltage and current applied to the load and by feeding back the power multiplying them.
This feedback can be used only with the phase angle control type.



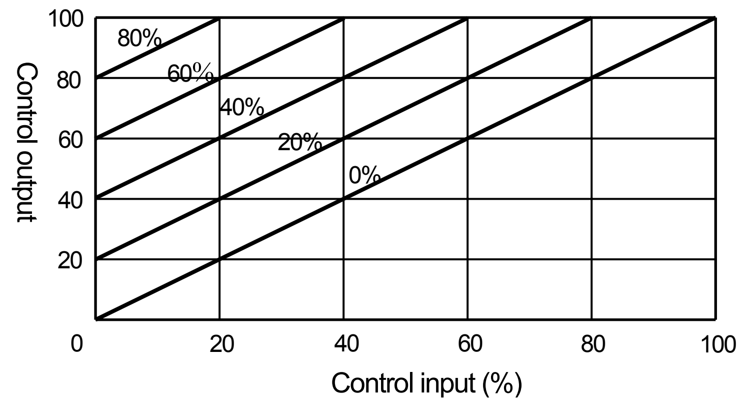
11.3 Settings

11.3.1 Slope



The slope setting provides the output (actually the internal SV used for processing) with a slope (inclination). It is effective for example in a electric furnace with 3-zone control which 3 sets of the thyristor regulator is operated by one set of controller.

11.3.2 Elevation



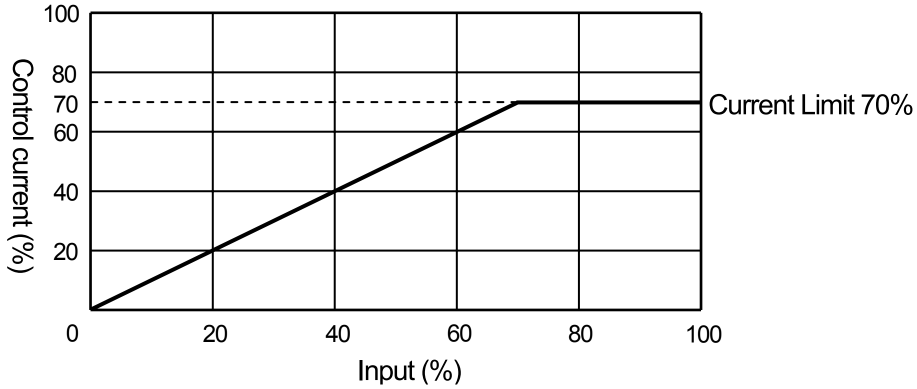
The elevation setting provides the output (actually the internal SV used for processing) with a bias. For example, even when the controller output becomes minimum, a constant base power can be applied to an electric furnace, etc.

11.3.3 Soft start

This function varies the output (actually the internal SV used for processing) gradually in order to prevent sudden change in the control output when this instrument is turned on or when the control input changes drastically. For example, a rush current can be suppressed in case of the primary side control of transformer. With this instrument, the reaching time of the SV from 0% to 100% can be set arbitrarily from about 1 to 20 seconds.
Note that this function controls the changing time of output value, and the actual change of output is delayed further because operation time of the feedback control time, etc. is added.

11.3.4 Current limit

This function sets the maximum limit to the control current. For example, when the voltage feedback is used, the current flows according to the resistance of the load and the rated current of the thyristor regulator may be exceeded if only the voltage control it used. The current limit function is used in such cases. The determination value is the average current value of the three phases.
The following chart shows an example of current limit.



11.3.5 Imbalance adjustment

For the 3-phase control, although it is desirable that the voltage and current values of the three phases are the same values (balanced status), they are actually not the same values due to the reliability of the power supply and the imbalanced load (imbalanced status). When the imbalanced status is serious, the controllability is deteriorated as well as the overall reliability of the system.

The JW Series incorporates the imbalance adjustment function adjusting the output value of each phase in certain range in case of the imbalanced status. This function solves the imbalanced status in a simulated manner and enables stable control. The imbalance adjustment is performed based on either the voltage or current.

11.4 Alarm

11.4.1 Over-current alarm

This alarm is turned ON when a current of 120% or more of the rated current flows.

This alarm means that a current above the rated current of the thyristor regulator is flowing. Check if the rated current of the thyristor regulator and load specifications are met.

(Note)

- Connect a CT matching the rated current.

11.4.2 Rapid-break fuse meltdown alarm

This alarm is turned ON when the rapid-break fuse is melted down because a current of 150% to 200% of the rated current flowed.

The meltdown of the rapid-break fuse clearly indicates a system error. Check the cause and take countermeasures.

(Note)

- This alarm is available only in the specification with a rapid-break fuse.
- The fuse meltdown indicates an abnormality. Be sure to check the cause and take countermeasures, and then replace the fuse with the same type of fuse.

11.4.3 Radiation fin overheat alarm

For the instrument with the rated current of 100A or more, this alarm is turned ON when the radiation fin temperature is abnormally high.

This alarm may be caused by a malfunction of the cooling fan(s), so these should be replaced.

(Note)

- This alarm is available only with the instrument with the rated current of 100 A or more.
- The cooling fan(s) should be replaced. Be sure to replace it with the same type of fan.

11.4.4 Heater disconnection alarm

This alarm is turned ON when the load resistance exceeds the set disconnection ratio.

- Load resistance = [Voltage] ÷ [Current]
- Disconnection ratio = [(Load resistance - Initial resistance) ÷ (Initial resistance)] ×100

(Note)

- This alarm is available only with the phase angle control type.
- Connect a CT matching the rated current.

11.4.5 Thyristor element abnormality alarm

This alarm is turned ON when the feedback input value is 50% or more when the output of this instrument is 0%. In other words, an abnormality is judged when the actual load is subjected to a high power while the thyristor regulator output is 0%. However, even when this alarm is ON, the thyristor element of this instrument is not always abnormal but there may be an abnormality somewhere in the system (including the load).

(Note)

- Identify if the thyristor element or the system side (including the load) is abnormal.
  Particularly, check if the load is connected properly.
- If the thyristor element is abnormal, this instrument should be repaired.
- There is a deadband (delay time) when the alarm judgment is OFF.

11.4.6 Running abnormality alarm

This alarm activates when the self-diagnostic function of this instrument identifies an abnormality
This is for checking the internal memory of this instrument and an alarm to inform that the internal memory has been initialized by a certain cause. The alarm is released in about 1 minute after its activation or when this instrument is turned OFF then ON again. As the internal memory may be initialized at the time, check the parameter settings and perform a simulation run to confirm that the control is normal before restarting the normal control operations.

(Note)

- If the settings are altered by this alarm, return them to the previous settings.
- The alarm is released usually by turning this instrument OFF then ON again, but if it is still not released, this instrument should be repaired.

11.4.7 Phase-sequence abnormality alarm

This alarm is turned ON when the connections of the 3-phase power supply (U, V and W) are wrong.
To release this alarm, turn this instrument OFF, connect wires properly, and turn it ON again.

11.4.8 Open-phase alarm

This alarm is turned ON when any of the 3-phase power supply connections (Y, V or W) are disconnected.
To release this alarm, turn this instrument OFF, connect wires properly, and turn it ON again.

(Note)

- In case of a standard type (The main circuit power supply and the control circuit power supply are common.), the determination of the W phase only is enabled. If the U-phase or V-phase opens, the operation of this instrument will stop. (The power becomes OFF.)
- In case of a light-load, worse imbalance status, the rated voltage not used or a special type (The main circuit power supply and the control circuit power supply are separated.), the determination of open-phase may not performed correctly.
- Use an abnormality alarm relating to the three-phase power supply together with the phase-sequence abnormality alarm. (Even when the phase-sequence abnormality alarm is ON, the open-phase status may exist. It means the certain determination of status cannot be performed on these 2 kinds of alarms.

11.4.9 Imbalance alarm

This alarm is determined by the “imbalance rate” being the alarm setpoint (judgment value) and by the load currents of the three phases with the following formula.

- Imbalance rate ={(Load current max value - Load current min value) ÷ (Load current max value)} × 100(%)

(Note)

- This alarm is not available with the zero-cross control type.
- Connect a CT matching the rated current.

11.4.10 Frequency abnormality alarm

This instrument detects the power frequency automatically when it is turned ON. This alarm is turned ON when the power frequency is neither 50 Hz ± 2 Hz nor 60 Hz ± 2 Hz.

The alarm can be released by checking the power frequency and by supplying power with a normal waveform. In addition, this alarm may activate by noise in the power supply. Countermeasures against noise are required.

11.5 Load

11.5.1 Resistive load

The typical load of this kind is a heater. There are three kinds of heater according to their resistance-temperature characteristics.

(1) Nichrome heater

- This heater has a low resistance-temperature characteristic and its current change is small. It is therefore not necessary to be controlled based on the current.
  In general, it can be controlled with voltage feedback or without feedback.
- In case of feedback types, the rated current of the thyristor should have a safe side of 10% or more of the heater rating, by considering the variance in the resistance value (about ±10%). In case of no-feedback types, the rated current of the thyristor should have a safe side of 20% or more of the heater rating, by considering the variance in the resistance (about ±10%). When feedback is not used, the headroom should be 20% or more of the heater rating, considering the variance in the resistance value (about ±10%) and the power voltage fluctuation (about ±10%).

(2) SiC heater

- The resistance value of this heater varies greatly as time passes and increases in the course of using. This means that the current flow gradually reduces and the generated heat will eventually become insufficient. Therefore, the power feedback type, by which the control voltage is increased to maintain the generated heat constant, is suited.
- The service life of this heater should be regarded as expired when the resistance value becomes about 4 times the initial resistance value. At this time, the control voltage to the heater increases double.
- The rated current of the thyristor should have a safe side of 20% or more of the heater rating.

(3) Molybdenum disilicide heater, metallic heater and lamp

- The resistance value in the normal temperature and in temperature other than the normal temperature range varies 10 to 10 several times. This heater should therefore be controlled with current feedback.
- The rated current of the thyristor should have a safe side of 20% or more of the heater rating.

11.5.2 Inductive load

The typical load of this kind is the transformer. Special care is required on the transformer's flux density. If this is too high, the iron core of the transformer is easily saturated magnetically, causing troubles such as the melting-down of the rapid-break fuse or transformer damage due to heat. Be sure that the flux density of transformer should be 1.2 (T) or less.

The feedback type can be determined according to the resistance-temperature characteristic of the heater connected to the secondary side of the transformer.

The rated current of the thyristor should have a safe side of 30% or more of the heater rating. Such primary side control of a transformer should be performed with the phase angle control.

11.6 Other

11.6.1 Leak current

By a surge-absorbing snubber (series connection of resistors and capacitors) being connected inside the thyristor regulator, the power supply and the load become a connecting condition and a very small current will flow at the output side, even when the output level is 0%. Therefore, the voltage or current at the load side can be observed even when the output is 0%, and this is not a malfunction. Control a load with a load current being large enough compared to the leak current.

11.6.2 Output voltage measurement

The output waveform (phase angle control) of thyristor regulator is not a sine wave and is distorted.

With a rectifying type measuring unit, a correct measurement value cannot be obtained as such unit is for sine waves. Use an RMS type or armature type measuring unit for the measurement of the output of thyristor regulator.

The following table shows differences between the measurements of RMS and armature type measuring unit.

Type	Actual Voltage Measurement (V)								
RMS type	0	30	60	90	120	150	180	190	200
Rectifying type	0	12	28	50	76	107	147	166	190

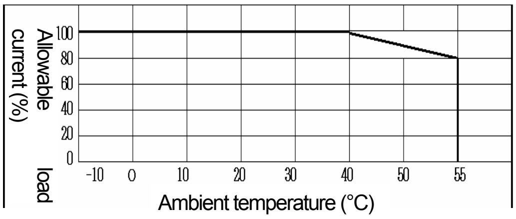
11.6.3 Surge countermeasure

The thyristor regulator may be affected by a strong surge noise that may be generated during the switching (ON/OFF) of peripheral equipment such as a magnetic switch. It is recommended to attach a noise absorbing capacitor (oil capacitor or film capacitor) on the load side in order to absorb the surge noise.

12 GENERAL SPECIFICATIONS

Phases: 3 phases
Rated voltage: 200VAC (Selection with the 200V/220V/240V switch)
400VAC (Selection with the 380V/400V/440V switch), to be specified
* With the standard specifications, the power supply to the main circuit and control circuit is common. A special type using separate power supplies for the circuits can also be manufactured as an option.
Rated current: 10A, 20A, 30A, 50A, 75A, 100A, 150A, 200A, 250A, 300A, 400A, 500A, 750A, 1000A, to be specified
Rated frequency: 50/60 Hz (Automatic switching)
Allowable voltage fluctuation: ±10% of the rated voltage
Allowable frequency fluctuation: ±2 Hz of the rated frequency
Control system: Phase angle control, zero-cross control
Arms: 3-arm or 6-arm, to be specified
Feedback type: Voltage, current, power
Control input signal: 4 to 20mADC (input resistance approx. 100 Ω, max. allowable current 25mADC)
1 to 5VDC((input resistance approx. 50 kΩ, max. allowable voltage 10VDC)
Remote setting input: Trimmer signal (10 kΩ recommended, 2 to 20 kΩ allowable)
Remote contact input: Non-voltage contact signal or open-collector signal (External contact capacity 1mA, 5VDC or more)
Remote CT input: 0 to 5AAC of the rated current
Slope: 0% to 100% of the output range
Elevation: 0% to 100% of the output range
Soft start time: Approx. 1 to 20 sec.
Current limit: 0% to 100% of the output range
Imbalance rate adjustment: Output balance adjustment in the range of approx. 40% is enabled.
Output range: 0 to 98% of the supply voltage
Output accuracy: Without feedback: ±10% of the rated voltage
With voltage feedback: ±3% of the rated voltage
(when rated voltage fluctuation is within ±10% and the load resistance fluctuation is within 1 to 10 times)
With current feedback: ±3% of the rated voltage
(when rated voltage fluctuation is within ±10% and the load resistance fluctuation is within 1 to 10 times)
With power feedback: ±3% of the rated voltage
(when rated voltage fluctuation is within ±10% and the load resistance fluctuation is within 1 to 3 times)
The accuracy is under the reference operating condition and in the range of 10% to 90% of the ratings and is not specified under other conditions. The error of the CT is not included.
Applied load: Resistive load, inductive load
The inductive load is applicable only in the control of the primary side of a transformer in the phase angle control method. The flux density recommended for the transformer is 1.2 T or less.
Minimum load current: 0.5A or more (at 98% output at the rated voltage)
Alarm types: Over-current alarm (Alarm output: AL1)
Rapid-break fuse meltdown alarm (Alarm output: AL1)
Radiation fin over-heat alarm (Alarm output: AL1)
Heater disconnection alarm (Alarm output: AL2)
Thyristor element abnormality alarm (Alarm output: AL2)
Running abnormality alarm
Phase-sequence abnormality alarm
Open-phase abnormality alarm
Imbalance alarm (Alarm output: AL2)
Frequency abnormality alarm
Alarm output points: 2 points (AL1, Al2)

Alarm output: Max. load 240VAC/1A, 30VDC/1A, min. load 5VDC/10mA or more
Electrical life: 100,000 cycles or more
Contact protection element: Not built in (optionally available)
Over-current protection device: Rapid-break fuse is melted down when the load is short-circuited.
Output 0% (gate OFF) at approx. 120% of the rated current
The current limit function can set the upper current limit arbitrarily.
On the condition that a CT matching the rated current should be connected
Remote setting types: Slope (AI1)
Elevation (AI2)
Current limit (AI3)
Remote contact types: Running status (DI1: Run/Stop)
Control system (DI2: Phase angle control/zero-cross control)
Setting method (DI3: Front panel/Remote setting)
Cooling system: Rated current 75 A or less: Natural air cooling
Rated current 100 A or more: Forced air cooling
Working temperature: -10°C to 55°C
The following derating characteristic is applicable at 40°C or more.



Working humidity: 30% to 90%RH, Without condensation.
Insulation resistance: Between power supply terminal and protective conductor (GND) terminals:
500VDC/50MΩ or more
Withstanding voltage: Between power supply terminal and protective conductor (GND) terminals:
2000VAC/1 min. (200V type)
Between power supply terminal and protective conductor (GND) terminals:
2500VAC/1 min. (400V type)
With the instrument with the cooling fan(s) (i.e. rated current 100A or more), the fan power cord should be unplugged (the cooling fan has a withstanding voltage of 2000VAC and should be eliminated).
Power consumption:

	200V supply type	400V supply type
Rated current 10A, 20A, 30A, 50A, 75A	15VA	20VA
Rated current 100A	40VA	55VA
Rated current 150A, 300A	65VA	90VA
Rated current 200A, 250A, 400A, 500A	90VA	125VA

Generated heat:

Rated current	Max. heat generation	Rated current	Max. heat generation
10A	40W	150A	500W
20A	90W	200A	790W
30A	140W	250A	920W
50A	180W	300A	1100W
75A	260W	400A	1530W
100 A	380 W	500 A	1980 W

External Dimensions:	325 (H) x 100 (W) x 190 (D) (Rated current 10A/20A types)		
	325 (H) x 00 (W) x 00 (D) (Rated current 30A/50A types)		
	325 (H) x 288 (W) x 220 (D) (Rated current 75A/100A types)		
	325 (H) x 420 (W) x 240 (D) (Rated current 150A to 250A types		
	495 (H) x 420 (W) x 240 (D) (Rated current 300A to 500A types)		
	Excluding projections		
Weight:	Approx. 6 kg (Rated current 10A/20A types)		
	Approx. 8 kg (Rated current 30A/50A types)		
	Approx. 13 kg (Rated current 75A/100A types)		
	Approx. 22 kg (Rated current 150A to 250A types)		
	Approx. 36 kg (Rated current 300A to 500A types)		
Case assembly material:	Ordinary steel sheets		
Color:	Gray		
Installation instruction:	Panel installation		
Reference operation condition:		Ambient temperature:	23°C ± 2°C
		Operating humidity:	55% ± 5%RH
		Power voltage:	Rated voltage ± 1%
		Power frequency:	Rated frequency
		Installation posture:	0° in the front, rear, left and right.
Normal operation condition:		Ambient temperature:	-10 to 55°C
		Operating humidity:	30% to 90%RH
		Power voltage:	Rated voltage ± 10%
		Power frequency:	Rated frequency ± 2 Hz
		Installation posture:	Front, rear, left and right
		Vibration/impact:	None.
		Altitude:	2000 m or less

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