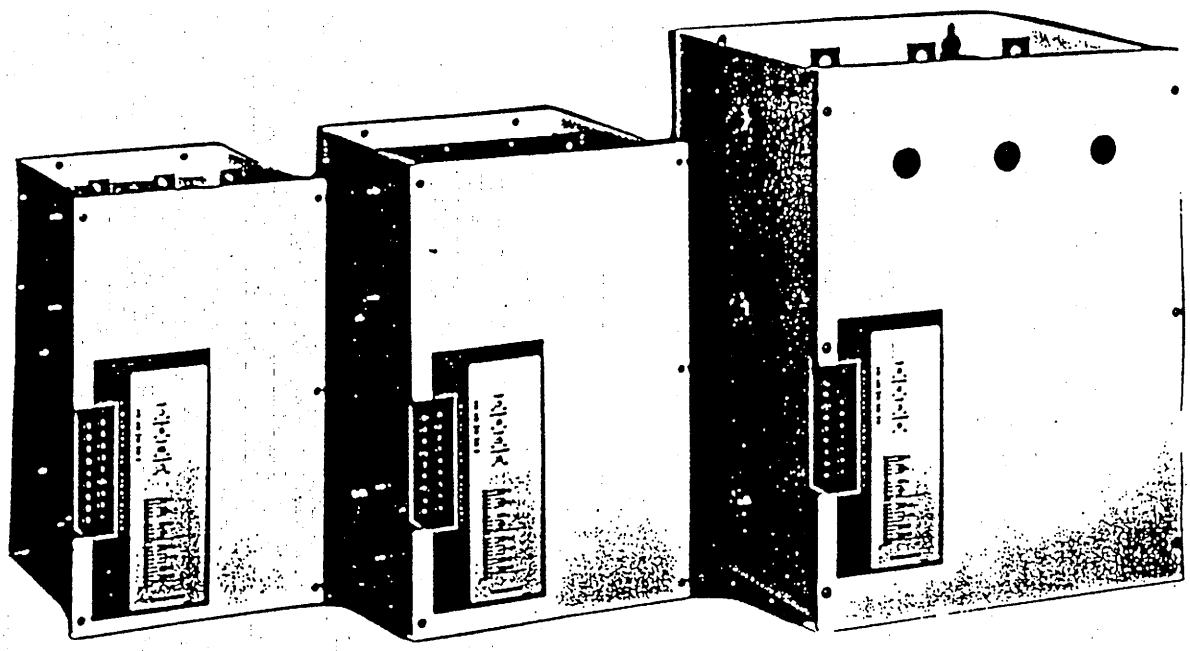
THYRISTOR THREE-PHASE POWER REGULATOR

PAC36P SERIES

INSTRUCTION MANUAL



SHIMADEN CO., LTD.

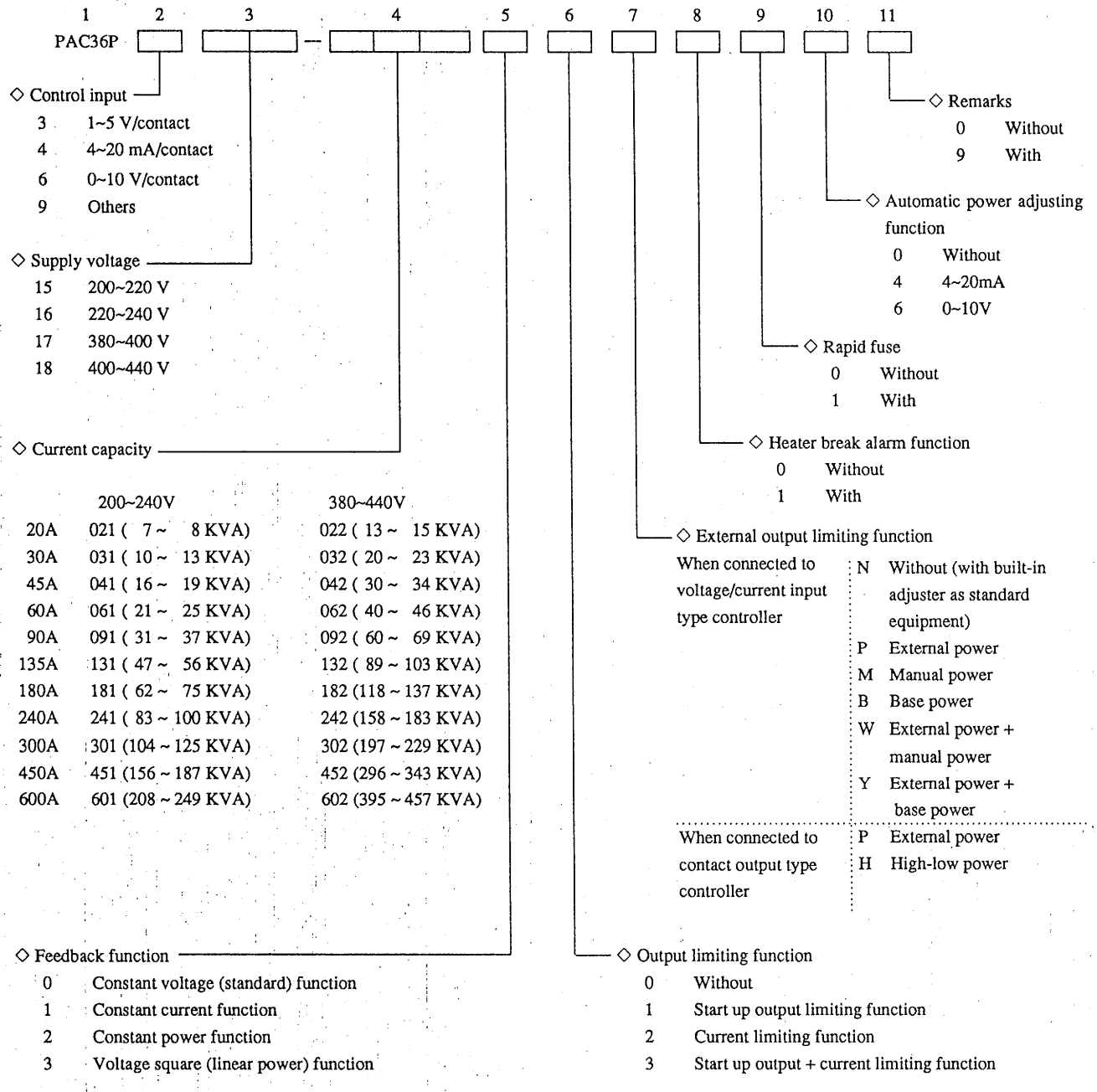
Please see that this instruction manual reaches the final user.

Contents

1 Checking of Specifications

PAC36P codes

Following are the meanings of the codes on your instrument label:



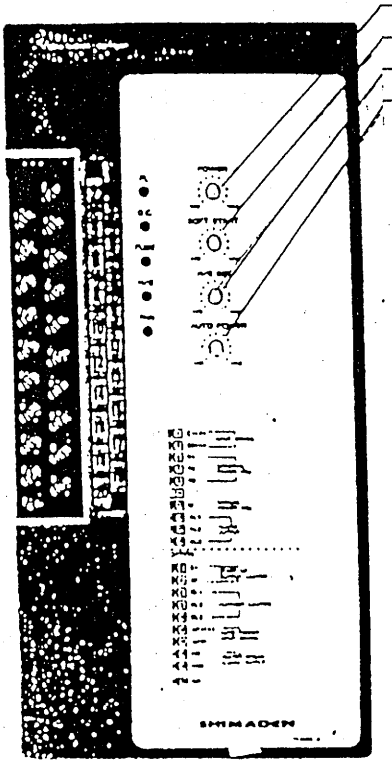
PAC36P415-06100N1040

4-20MA DC
200~220V AC
60A

9301 NO.02179101001

2 Panel Information and Control Terminals

2-1 Panel Information



☐ Adjusters

- Internal power adjuster (standard)
- Soft start time adjuster (standard)
- Heater break alarm setting device (option)
- Automatic power adjuster (option)

☐ Monitor lamps

- P, L: Power supply and output indication
  - Correct phase sequence — Green lamp lights.
  - Open/opposite phase sequence — Red lamp lights.
- O.C: Over-current
- FUSE: Burning-out of rapid fuse (option)
- H/B: Heater break alarm (option)
- FAN: Stoppage of cooling fan (standard for 180A or above)

☐ Terminal codes and functions

- C1, C2: Control input
- R1, R2, R3: External power (option)
- M: Manual/base adjustment (option)
- AL1, AL2, AL3: Alarm output common to over-current, fan and fuse
- S1, S2: External sequence signal for limiting start power
- CL1, CL2, CL3: Current limiting adjuster
- AP1, AP2: Automatic power signal input
- RB1, RB2: Heater break alarm output

2-2 Control terminals

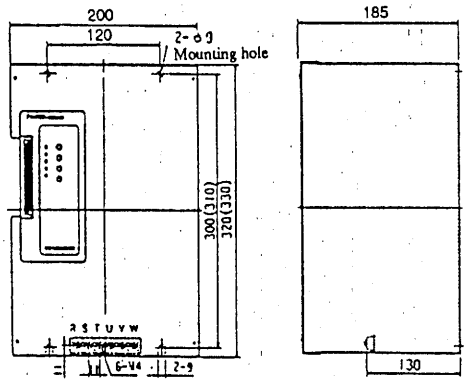
There are 20 terminals divided between the upper and lower rows. The terminals in the upper row have odd numbers while those in the lower row have even numbers. They take care of control signals, various adjusting signals, alarm output, automatic power signals, heater break alarm output, etc.

Wiring should be done properly, referring to the wiring label attached to the instrument.

	Terminal No.		Terminal Code	Brief Description of Function
Upper terminals		1	C1(+)	Control signal (+) terminal
		3	C2(–)	Control signal (–) terminal
		5	R1	External power connection terminal
		7	R2	If VR is not used,
		9	R3	R2-R3 are short-circuited for use.
		11	NC	Vacant terminal
		13	M	Manual and base power terminal
		15	AL1(COM)	Produces output when O.C/FUSE/FAN monitor lamp (alarm) lights.
		17	AL2(NO)	When alarm is output: AL1-AL2: Conducting
		19	AL3(NC)	AL1-AL3: Not conducting (Conductive when alarm is not output)
Lower terminals	2		S1	Start output limiting function external synchronization contact
	4		S2	S1-S2 short-circuited for use only when power is supplied.
	6		CL1	Current limiting function/current setting device connection terminal
	8		CL2	
	10		CL3	
	12		AP1(+)	External automatic power control terminal
	14		AP2(–)	Function to control power by means of external signals
	16		HB1	Heater break alarm terminal
	18		HB2	HB1-HB2: Conducting when set current is not attained.
	20		G	Earth terminal

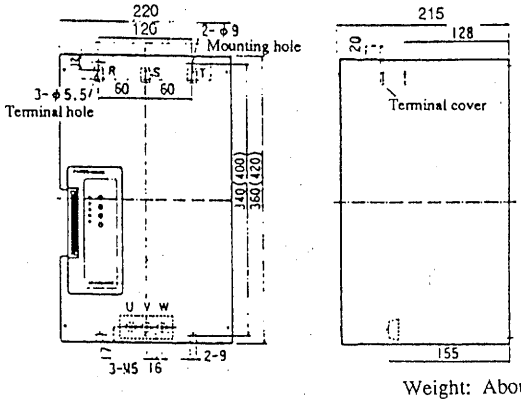
3 External Dimensions and Weight

• 20A



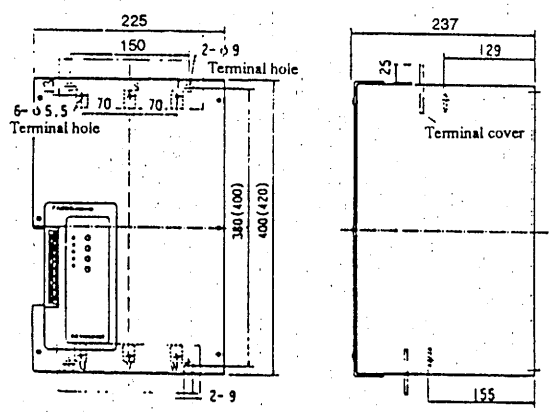
Weight: About 9kg

• 30A·45A



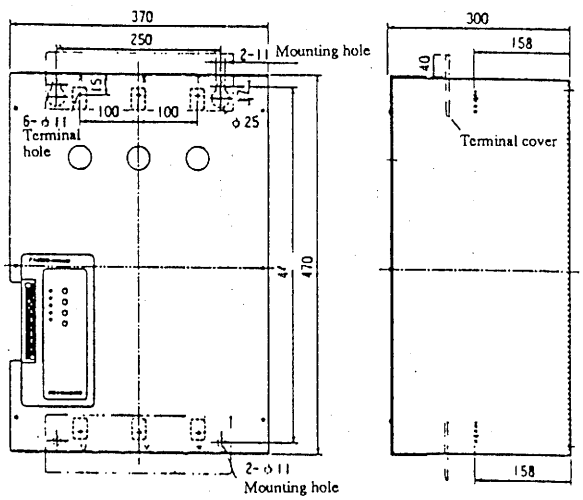
Weight: About 12kg

• 60A·90A



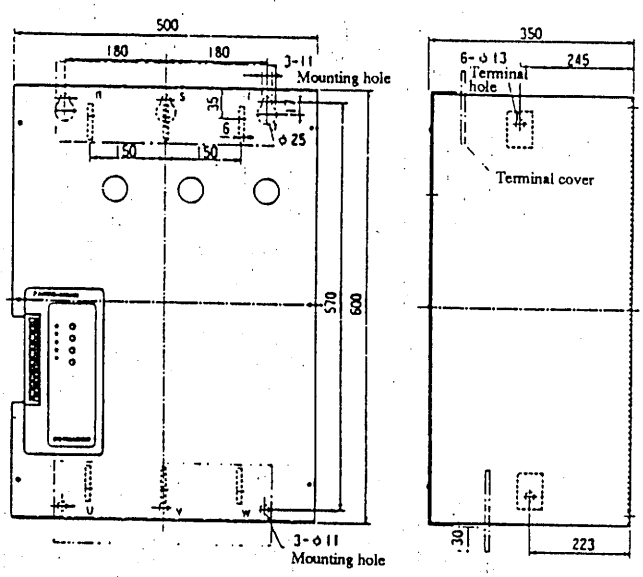
Weight: About 16.5kg

• 135A·180A·240A·300A



Weight: About 36kg

• 450A·600A

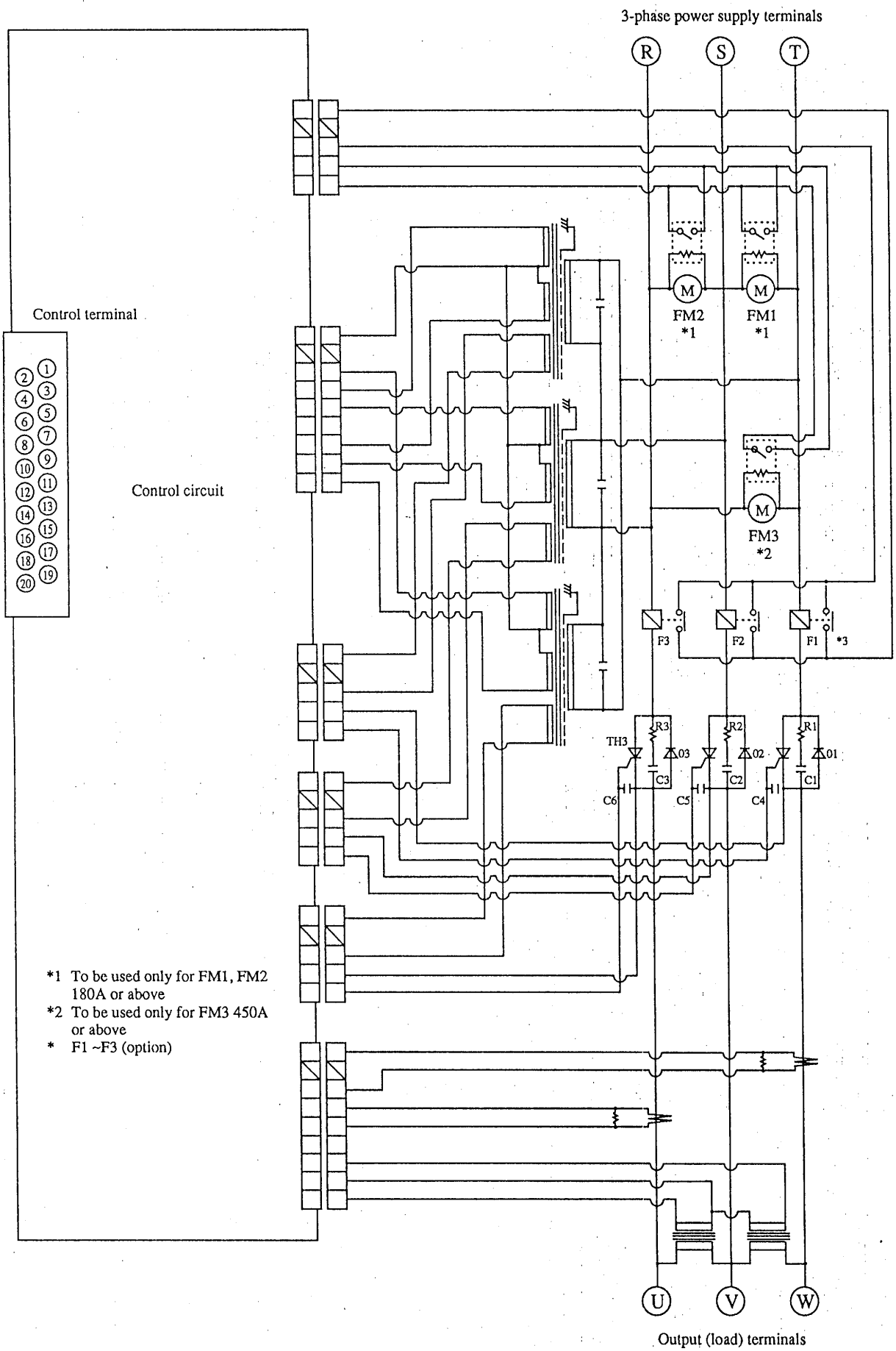


Weight: About 55kg

Unit: mm

- The numbers in brackets are the sizes of the former PAC30P.
- 135A, 180A, 240A and 300A have the same sizes as those of the former PAC30P.
- 450A and 600A have the same sizes as those of the former PAC30P.

4 Circuit Block Diagram



*1 To be used only for FM1, FM2 180A or above
*2 To be used only for FM3 450A or above
* F1 ~F3 (option)

5 Installation Area

As surrounding conditions affect the reliability and life of the instrument, a favorable environment should be chosen. The following conditions are required:

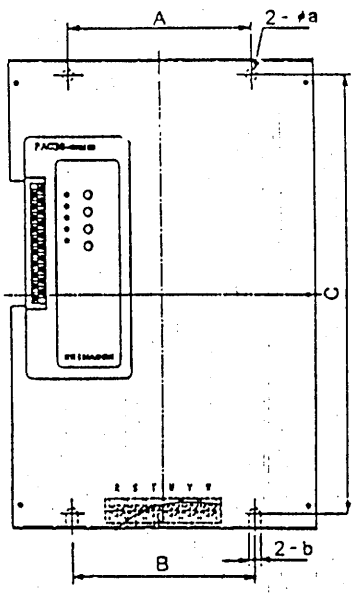
1) The ambient temperature does not exceed 40°C. (An ambient temperature above 50°C is highly unsuitable.)
2) The humidity is below 90%. (No condensation)
3) There is no inflammable or corrosive gas, or gas that impairs insulation, in the place of installation.
4) The place allows maintenance work to be carried out safely.

6 Mounting

The instrument should be fixed to a control panel, wall, rack, etc. For safety's sake, it should not be easily accessible.

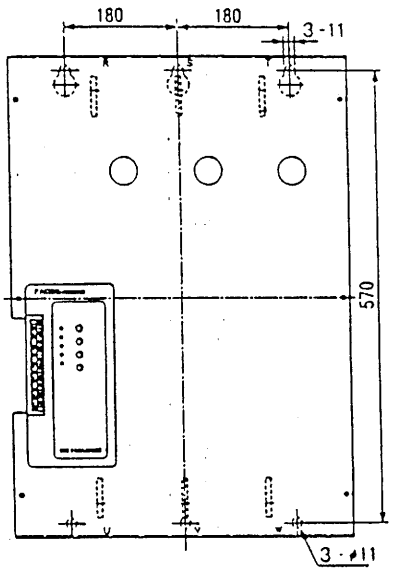
6-1 Mounting sizes

☐ 20A, 30A, 45A, 60A, 90A, 135A, 180A, 240A, 300A



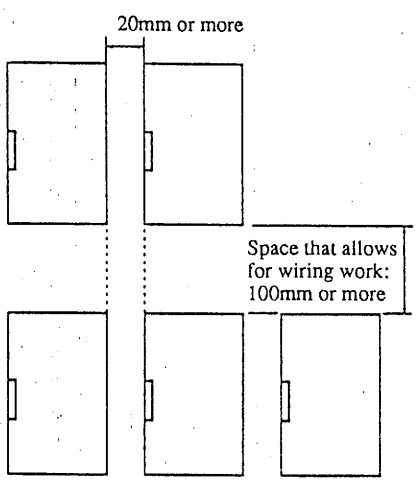
Current Capacity	Size A	Size B	Size C	Hole Diameter a	Hole Diameter b
20A	120	120	300	9	9
30A 45A	120	120	340	9	9
60A 90A	150	150	380	9	9
135A 180A 240A 300A	250	250	445	11	11

☐ 450A, 600A



6-2 Space required for mounting

If multiple instruments are installed, spaces (100mm or more) that allow wiring operation to be done should be left on the power (upper) side and the load (lower) side. Measures to minimize the influence of heat generated from the lower units are also required.



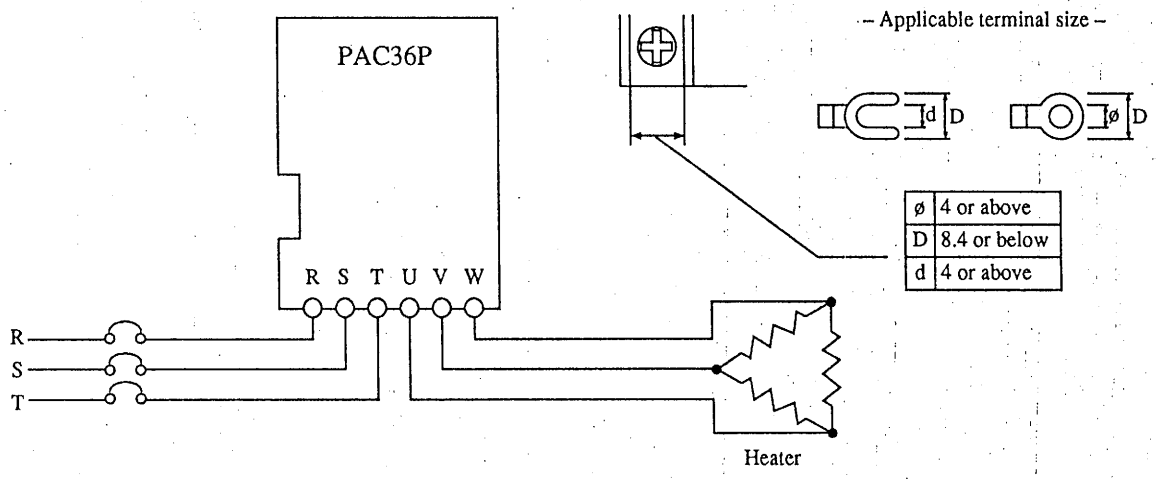
7 Wiring and Terminal Sizes

7-1 Wiring and terminal sizes of power supply and load circuits

When wiring the power circuit for the instrument, make sure to check the phase order (R-S-T). Never make a trial run, etc., with an open phase.
If you check using the PL lamps of the instrument, do so without connecting a load or after removing the control signal line.
When the green lamp lights, the order is correct. If the red lamp rights, change the connection of any two lines.

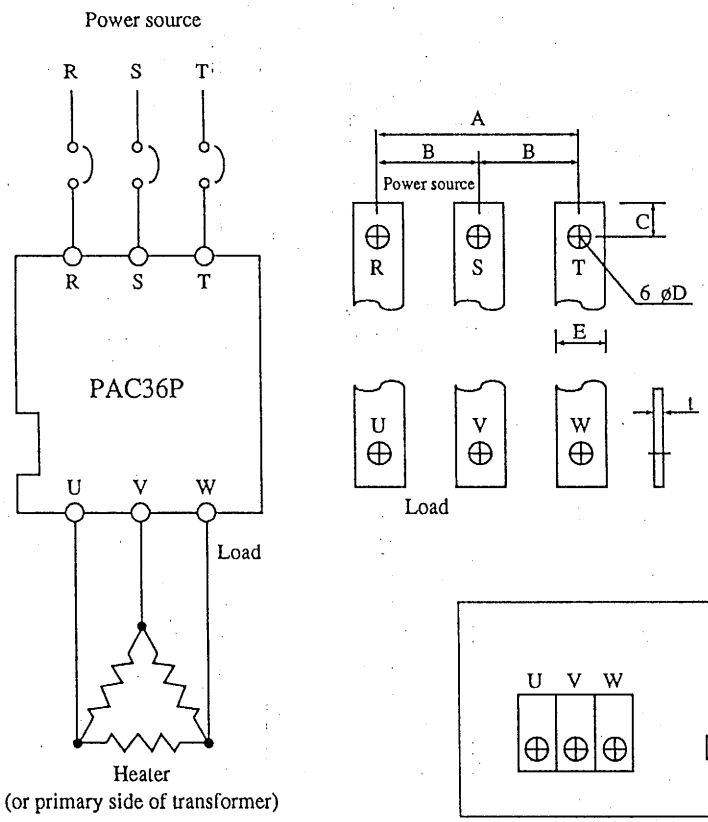
■ 7-1-1 Terminal wiring for 20A

In the case of 20A output, there are 6P terminals on the bottom of the unit for power and load wiring.



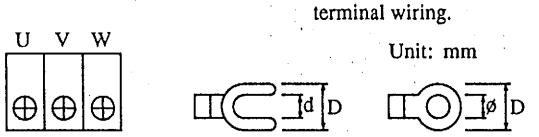
ø	4 or above
D	8.4 or below
d	4 or above

■ 7-1-2 Terminal wiring for 30~600 A



	A	B	C	t	øD	E	Remarks
20A	–	–	–	–	–	–	6P terminal box
30A 45A	120	60	10	2	5.5	20	Load side only
60A 90A	140	70	12	2	6.5	20	
135A 180A 240A 300A	202	101	14	4	9	30	
450A 600A	300	150	25	6	13	50	

(Note) For 30 and 45A outputs, use the following terminal wiring.



Unit: mm

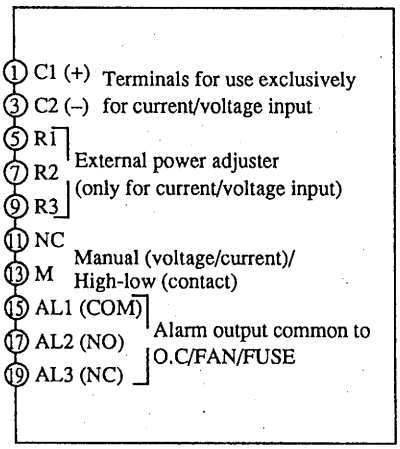
ø	6 or above
D	13 or below
d	6 or above

7-2 Wiring of control signal circuit

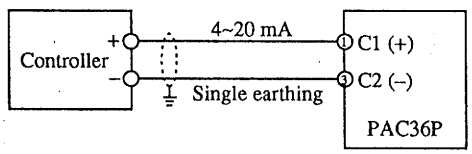
The control signal terminals (C1-C2) receive control signals (4~20 mA, 1~5 V, 0~10 V) from the controller. Attention should be paid to positive and negative polarity. Wire carefully so as to prevent noise from a strong electric circuit.

■ 7-2-1 Connection to 4~20 mA output controller

There are two PAC36P input types: 4~20 mA and 1~5 V.



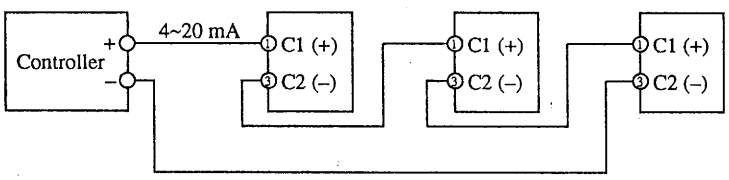
• 7-2-1-1 4~20 mA input (PAC36P:4 -)



If an instrument is connected to one controller, wiring between controller and PAC36P must be done as shown on the diagram on the left.

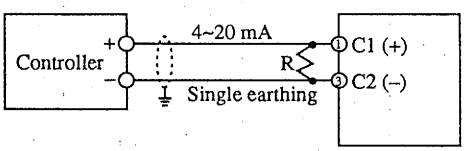
☐ Receiving resistance: 100Ω

☐ To connect multiple PAC36Ps, wire them in a series as shown below. If the allowable range of load resistance of the controller is 600Ω, six instruments can be connected.



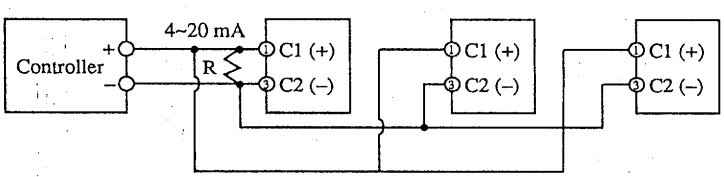
• 7-2-1-2 1~5 V input (PAC36P:3 -)

If the controller output is not rated for 1~5 V, receive 4~20 mA inputs with a 250Ω resistor and convert it to 1~5 V.



When one PAC36P is connected to one controller, connect a 250Ω resistor in parallel to the terminals of the controller as shown on the diagram on the left, to convert 4~20 mA to 1~5 V.

◇ A 250Ω resistor rated for ±1%1/2W suffices.



■ 7-2-2 Connection to 0~10 V output type controller

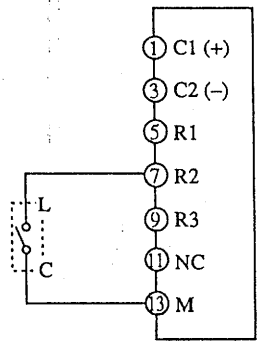
For this connection, the 0~10 V input type PAC36P (PAC36P:6 -) should be used. As the input impedance is high in this voltage range, use two-core shielded cable and cut off noise by single earthing.

☐ All wiring should be in parallel. Connect the (+) and (-) terminals of the controller respectively to input terminals (C1) and (C2) of the PAC36P. When connecting multiple PAC36Ps, they should be wired in parallel as shown in the lower wiring diagram 7-2-1-2. However, no 250Ω resistor is required.

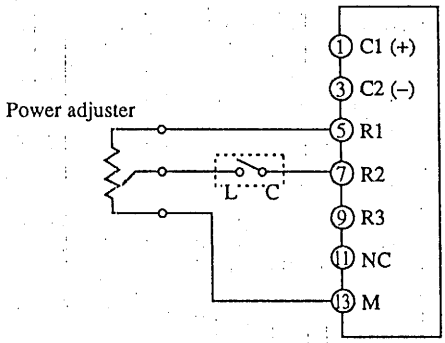
■ 7-2-3 Connection to contact output type controller

When the PAC36P is connected to a contact output type controller, the latter may employ the 2 position (ON/OFF), proportional, or PID system. In wiring, you need not consider polarity, or wiring resistance up to 10Ω. As this is a weak electric circuit, however, it should be wired separately from a strong electric circuit to prevent noise.

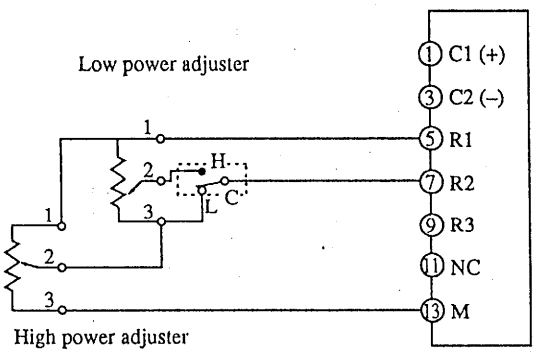
• 7-2-3-1 100% On-Off type



• 7-2-3-2 With external power adjuster



• 7-2-3-3 With high-low power adjuster

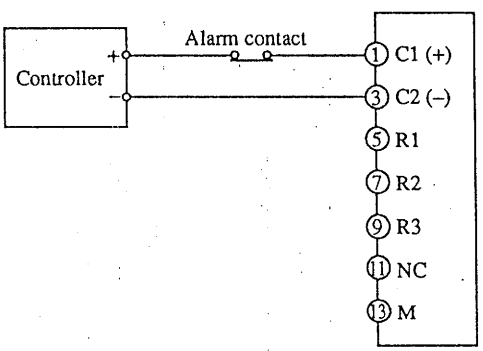


L-C : Controller contacts

■ 7-2-4 Over-rise prevention circuit

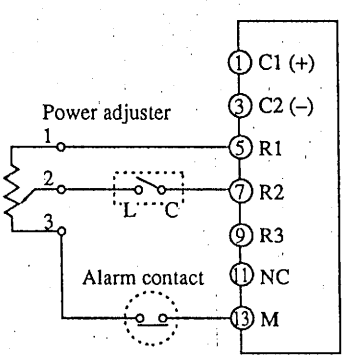
• 7-2-4-1 Connection to voltage/current

This is a method of cutting off signals from the controller to stop control output.



• 7-2-4-2 Connection to contact signal

In the following wiring diagram, the contact is provided to the M terminal (13) to turn the circuit off (open) and stop output when the over-rise prevention becomes active. The same effect is produced when it is connected in a series to the contact of the controller.



7-3 Wiring of alarm circuit

A single alarm circuit is used for three alarm functions (over-current, fan stop and fuse break). When the circuit functions, check the monitor lamps.

■ 7-3-1 Over-current alarm [O.C] circuit

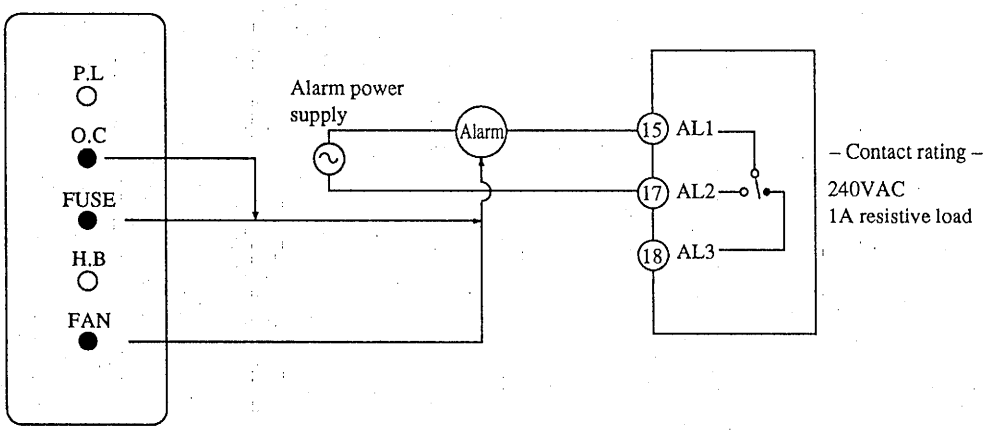
The instrument has a built-in electronic protective circuit which detects over-current (about 130% of rated current), cuts off the over-current immediately and flashes the (O.C) monitor lamp.

■ 7-3-2 Cooling fan stop alarm [FAN] circuit (180A or above)

A PAC36P of 180A or above is equipped with two fans for cooling the thyristor element (three fans for 450, 600A). If a fan stops or its temperature rises due to foreign matter sticking to it, a fan sensor detects it and an alarm is output. In this case, control output continues as usual.

■ 7-3-3 Rapid fuse break alarm [FUSE] circuit (option)

If a rapid fuse is added, over-current (about 130%~150%) breaks the fuse to prevent the destruction of the thyristor element, and an alarm is output. When an alarm is output, AL1 and AL2 are conducting; otherwise, AL1 and AL3 are conducting.

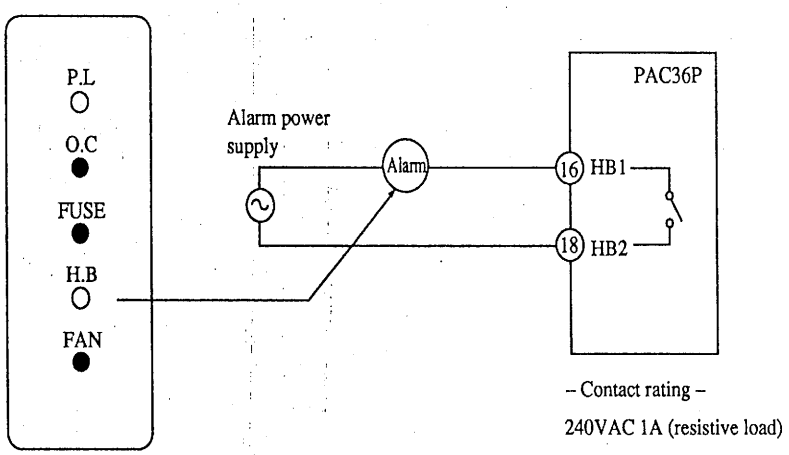


☐ To turn the alarm circuit on while any of the alarm functions is active, use alarm terminals no.15 (AL1) and no.17 (AL2) to make up the circuit.

☐ To turn the alarm circuit off while any of the alarm functions is active, use alarm terminals no.15 (AL1) and no.19 (AL3) to make up the circuit.

■ 7-3-4 Heater break alarm [H.B] circuit (option)

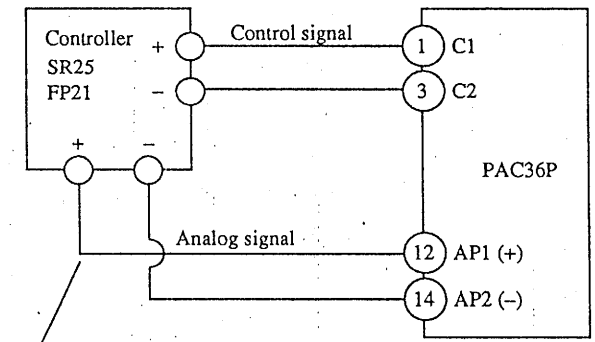
When the heater break alarm is added, a break alarm is output across terminals no.16 (HB1) and no.18 (HB2). The circuit has the 'a' contact only and conducts only when in action.



8 Wiring of Output Adjustment Circuit (Option)

8-1 Automatic power adjustment circuit

The automatic power adjustment circuit automatically adjusts maximum output from an external source (controller, sequencer, etc.) for optimum control.
Automatic control signals (4~20 mA/0~10 V) are input in terminals no.12 (AP1) and no.14 (AP2).



In this example, SV analog output from SR25/FP21 is used as automatic power signals.

☐ Control signals are input in the C1 and C2 terminals. Pay attention to polarity (contact signals have no polarity) when wiring.

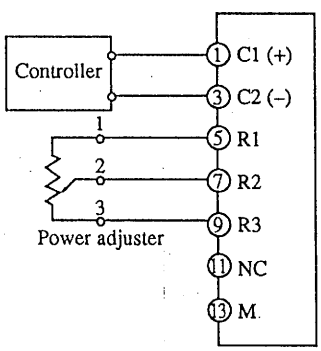
☐ Automatic power input terminals
Input automatic power signals in the two terminals, AP1 and AP2. Be sure to pay attention to polarity.

8-2 Wiring of external power adjuster

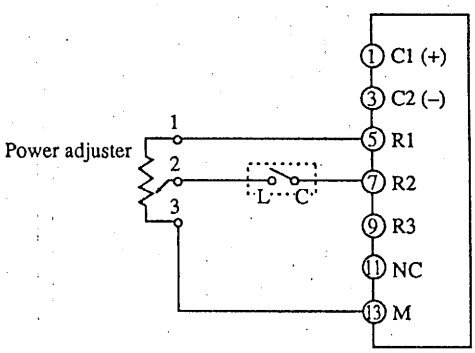
Generally, the external power adjusting function is used when power is adjusted at a place removed from the instrument.

This function is obtained when an external adjuster (B10KΩ/ VR) is connected to terminals of appropriate functions. Hence, the function can be added even after the instrument is delivered.

☐ Connection to voltage/current output type controller



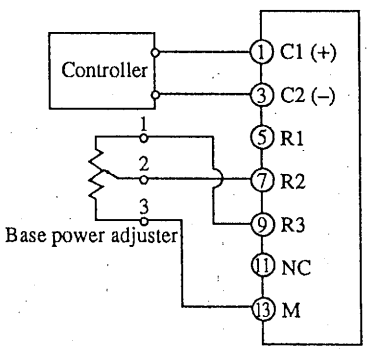
☐ Connection to contact signal output type controller



8-3 Wiring of base power adjuster

Generally, the base power adjusting function is used to keep output steady even when the control signal is at 0%.

☐ Connection to voltage/current output type controller

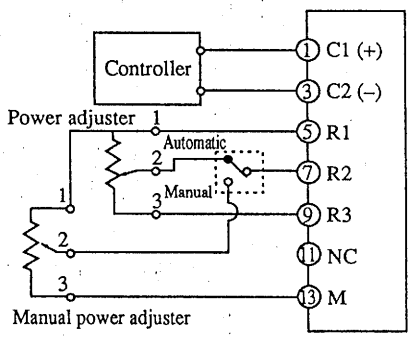


8-4 Wiring of Auto/Man structure with external power and manual power

An external contact is provided to switch between auto and manual for power adjustment in the automatic mode and output adjustment in the manual mode.

☐ Connection to voltage/current output type controller

Adjustment

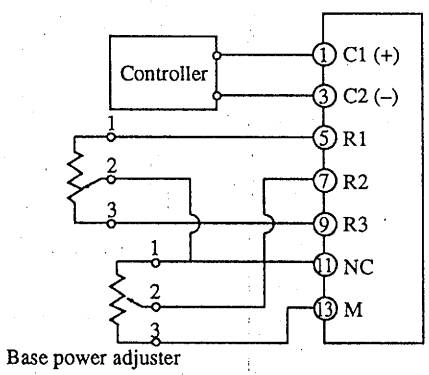


8-5 Wiring of external power and base (residual) power adjuster

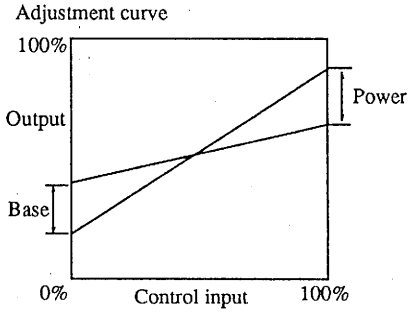
This circuit functions to adjust (reduce) the maximum output while retaining minimum output in some degree so as to improve control efficiency and better cope with load characteristics.

☐ Connection to voltage/current output type controller

Adjustment

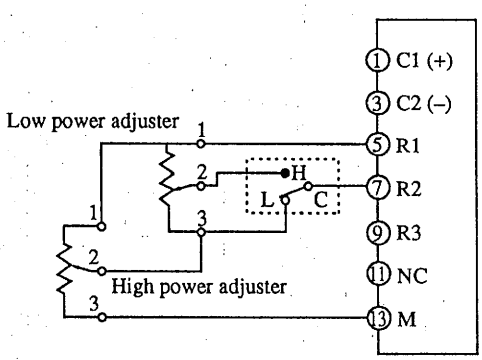


Adjustment curve



8-6 Wiring of high-low adjuster/connection to contact output type controller only

This circuit functions to adjust (reduce) the maximum output when the contact is on and to keep output steady when the contact is off so as to improve control efficiency and better cope with load characteristics.



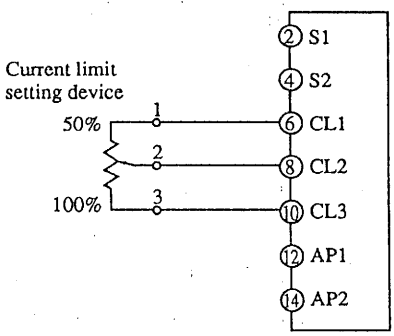
☐ High power adjustment/C-L: While the contact is on, output can be adjusted in the range of 0 to 100%.
Select the power suitable for the set temperature.

☐ Low power adjustment/C-H: While the contact is on, residual output is adjustable.
Although the adjuster is graduated from 0 to 100%, residual output is determined by the following equation:
Residual output = (High power) × (Low power)

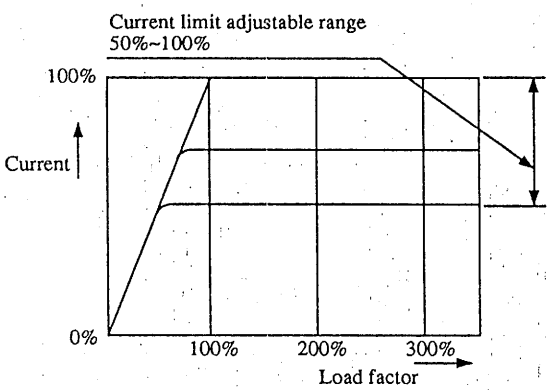
Example: When high power = 70% and low power = 40%, the residual output is 70% × 40% = 28%.

8-7 Current limiting adjuster

When the instrument has the current limiting function, connect a current limit setting device to the CL1~CL3 terminals as shown below.



– Characteristic Diagram –

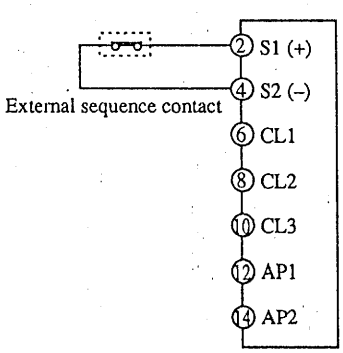


8-8 Start up output limiting circuit

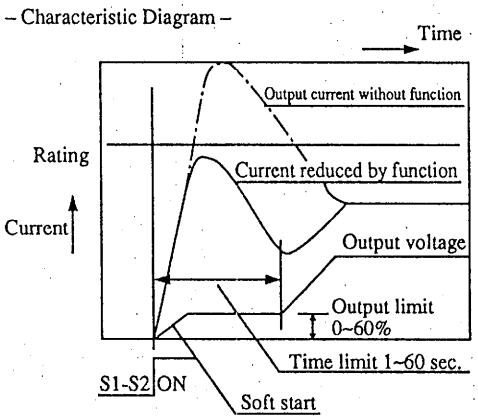
This circuit can be used in two ways.

◇ To limit output when power is supplied, use it by short-circuiting the S1 and S2 terminals. Care should be taken because leaving them open at that time results in a shortage of capacity as the instrument continues to run with limited output.

◇ For operation synchronized with external sequence:
If the load is changed without turning the power off, opening the S1 and S2 terminals in synchronization with the switching signal reduces the output and, upon the completion of switching, it starts with the output thus relimited.



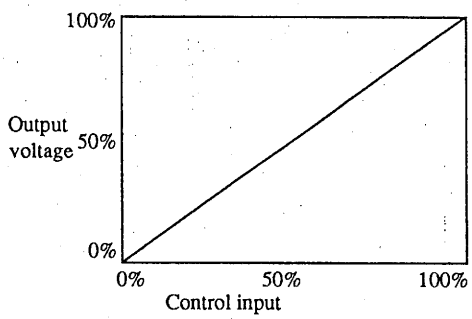
– Characteristic Diagram –



9 Characteristic Diagrams of Various Functions (Option)

The PAC36P has various types (constant current/constant power/power linear) of feedback control, which facilitates its use as no externally added component is required.
The feedback control is another controller which detects the current, power, etc., of the thyristor inside the instrument body and adjusts them to values set by control signals from the controller.
Even with fluctuations of the primary voltage or on the load side, outputs thus controlled remain stable without fluctuation. This is a highly effective function to guarantee load characteristics and carry out precision control.

9-1 Constant voltage (voltage feedback) characteristic (standard)

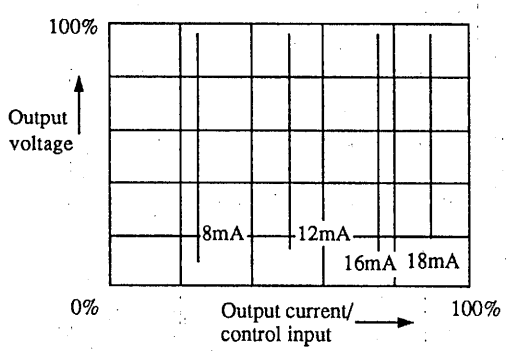


As shown in the characteristic diagram, voltage feedback is characterized by linear movement of control output and output voltage. Output is controlled by a voltage controller and even when the primary voltage fluctuates, the secondary voltage moves only slightly, that is, less than 2% of the fluctuation range on the primary side (0.2V or below against a 10V change); an ideal function for precision control.

9-2 Constant current (current feedback) control

As shown in the following characteristic diagram, output current is controlled to remain at a predetermined level in response to current setting signals from the controller. In this case, the voltage is changed as a matter of course.

– Characteristic Diagram –



This characteristic is to compute current setting values given as control signals and current signals from a current transformer (built-in CT) and to control by using the result. When control inputs are at a fixed level, current is kept constant even if the load and/or power fluctuate. Accordingly, the characteristic is used suitably for controlling heaters of platinum, molybdenum, tungsten, Supercantal, etc.

Note on characteristic:
The voltage should be adjusted so as to correspond to current values given as control signals. Try to select the same capacity for the thyristor and the load. If a 30A load is connected to a 60A thyristor, control outputs of 0~50% (4~12 mA) control inputs will be 0 to 30 A. On the other hand, if a 60A load is connected to a 30A thyristor, the control range will also be 0 to 30A.

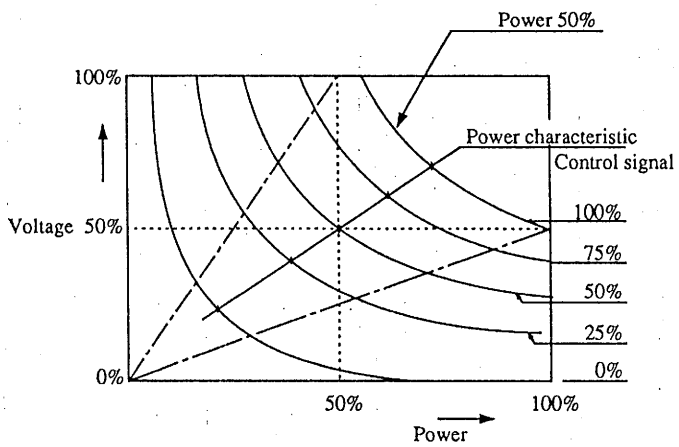
An instrument including the constant current control function works effectively on the following heaters:

- ☐ Heaters in which rush current flows: Platinum, molybdenum, tungsten and Supercantal
- ☐ Heaters in which current changes significantly: Carbon, salt bath
- ☐ When an electrolytic current needs to be stabilized: Plated heaters

9-3 Constant power (power feedback) control

Since the amount of heat generated is proportional to power, stabilizing power means stabilizing temperature and this is an effective way to compensate heater characteristics in precision control or when a SiC heater is used.

– Power Characteristic Diagram –



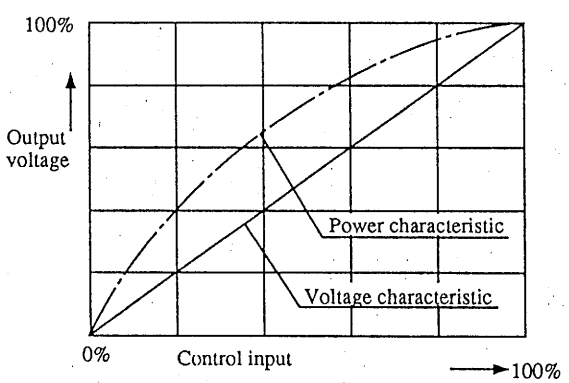
In this control system, power is half the thyristor rating.

As seen in the diagram on the left, the curves run between the points of 100% voltage x 50% current and those of 50% voltage × 100% current, meaning that power at 50% of the thyristor rating is controlled. In other words, even when a thyristor of 200V-100A is used, 10KVA power can be controlled.

9-4 Power linear (voltage square feedback) control

Power linear control is a way to output power linearly in response to control signals, as shown in the following characteristic diagram, and is used for heaters of nickel, chrome, iron and chrome heater.

– Characteristic Diagram –



- ☐ Control signals and output power have a linear relation to improve control efficiency.
- ☐ In manual adjustment, the power in % can be adjusted correspondingly to the graduations on the regulator.
- ☐ Power equation

$$P = V \times I = V \times \frac{V}{R} \quad \text{— constant}$$

$$\therefore P \propto V^2$$

[P: Power, V: Voltage, I: Current, R: Resistance]

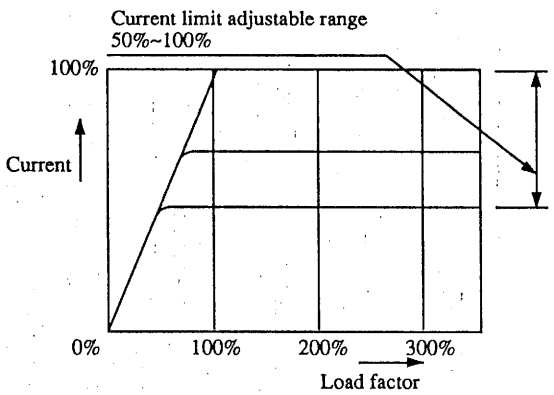
9-5 Output limiting function

The output limiting function prevents adverse effects (abnormal decline in voltage) on the power line, it will automatically protect the thyristor from over-current by saving rush current at the start time when various types of lamp heaters are used. It also limits the current so as not to exceed the rating due to fluctuation on the load side.

■ 9-5-1 Current limiting function

This is the function to limit current in the range of 50% to 100% of the rated current of the thyristor and is used when the current exceeds the rating temporarily or continuously, for example, because of heater characteristics, or when the current needs to be limited for some other reason. Unlike the constant current control function, which controls current itself, this functions to keep the current below an upper limit.

– Characteristic Diagram –



☐ Applicable heaters:

- Platinum
- Tungsten
- Molybdenum
- Supercantal, etc.

☐ Note:

When the thyristor has this function, power decreases as the load factor exceeds 100%. Decreases in maximum power are shown in the following table.

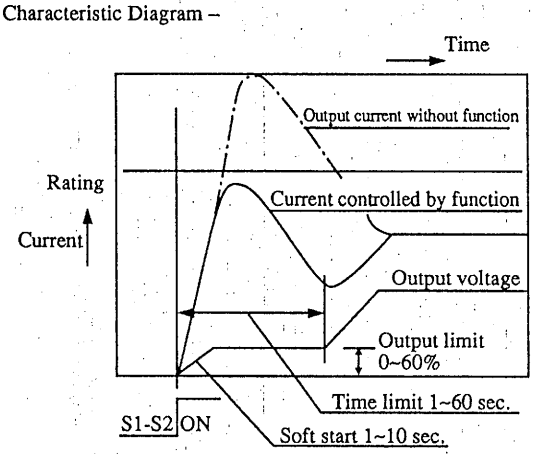
– Load Factor and Power Decline –

Load factor / Output	Load factor 100%	200%	300%	500%
Current	97%	100%	100%	100%
Voltage	97%	50%	33%	20%
Power	94%	50%	33%	20%

■ 9-5-2 Start up output limiting function

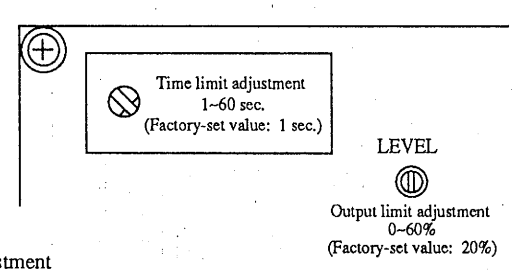
If a heater in which rush current flows when power is applied or the load is changed (a platinum, molybdenum or tungsten heater or a halogen lamp) is used, this function limits output to a predetermined level for a fixed period of time to ensure smooth operation.
Constant current control is similar to this function but the latter is ideal if the load has to be changed.

– Characteristic Diagram –



☐ Adjustment

To carry out an adjustment, open the panel cover and use the potentiometer on the printed board. Set a time (1~60 seconds) and a level (0~60%).



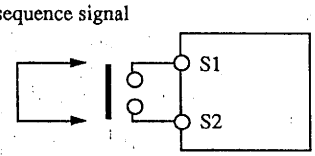
☐ Timer adjustment

Set a time during which a large current, flowing when a certain output is gradually applied, falls within the rated range.

☐ Level adjustment

Set a level which enables output to allow the current to fall within the rated range during the set time.

External sequence signal



☐ To activate the function when power is applied

S1-S2: To be short-circuited.

☐ To synchronize with external signals

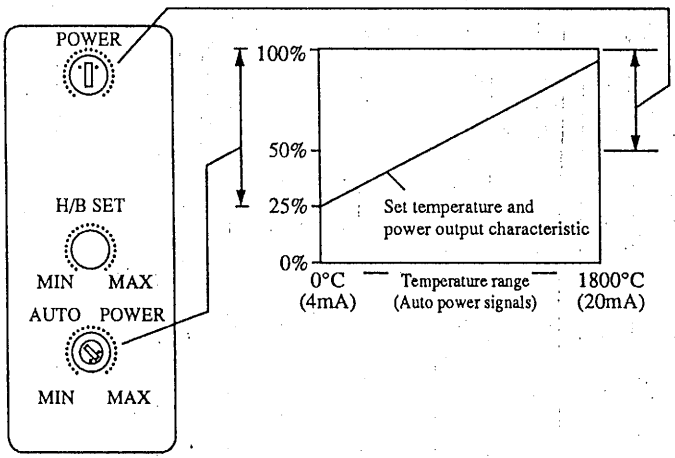
S1-S2: To be synchronized with signals.

Note: Keeping S1-S2 open means that the output continues to be limited.

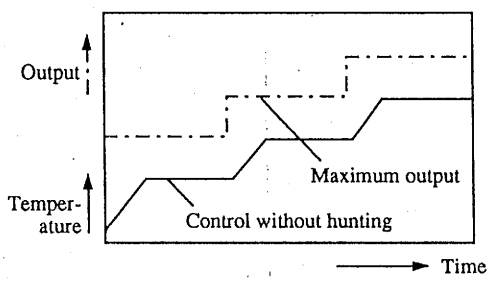
10 Adjustment (Option)

10-1 Automatic power adjusting function

By providing the maximum power which is optimum for the temperature set by a controller, sequencer, etc., the automatic power adjusting function can improve control accuracy and create the characteristics that maintain the temperature fluctuation rate (ramp) within a required range.
The adjustment is done by controlling the start output (Auto Power) and setting the maximum output which is most suitable for the highest temperature set.

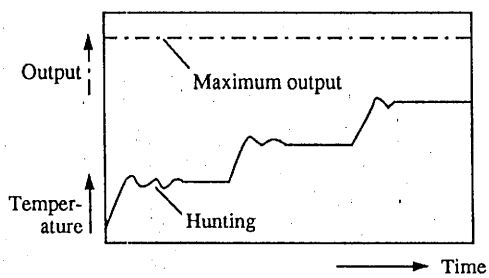


- Output with automatic power control function and result of control



Power changes along with the SV value to prevent overshooting and allow optimum control.

- Output without automatic power control function and result of control

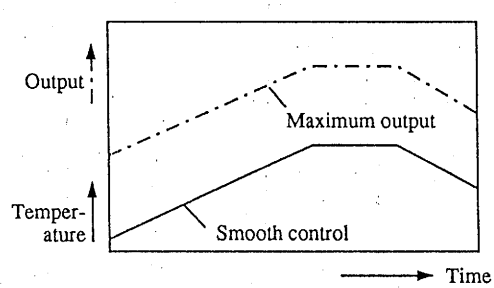


The power gets excessive in a low range, resulting in overshooting and hunting.

☐ Comparison with program control

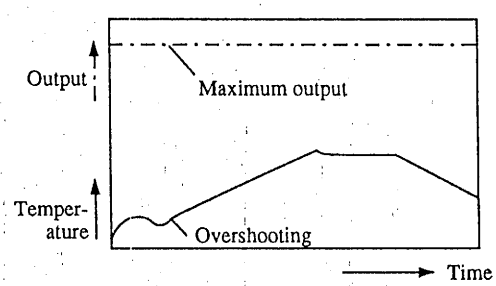
In program control, this function is characterized by the prevention of overshooting, particularly at the start time, and proper handling of ultralow-speed ramping of temperature.

- Output with automatic power control function and result of control



Soft control of the program is possible without transient characteristic (overshooting) at the start time.

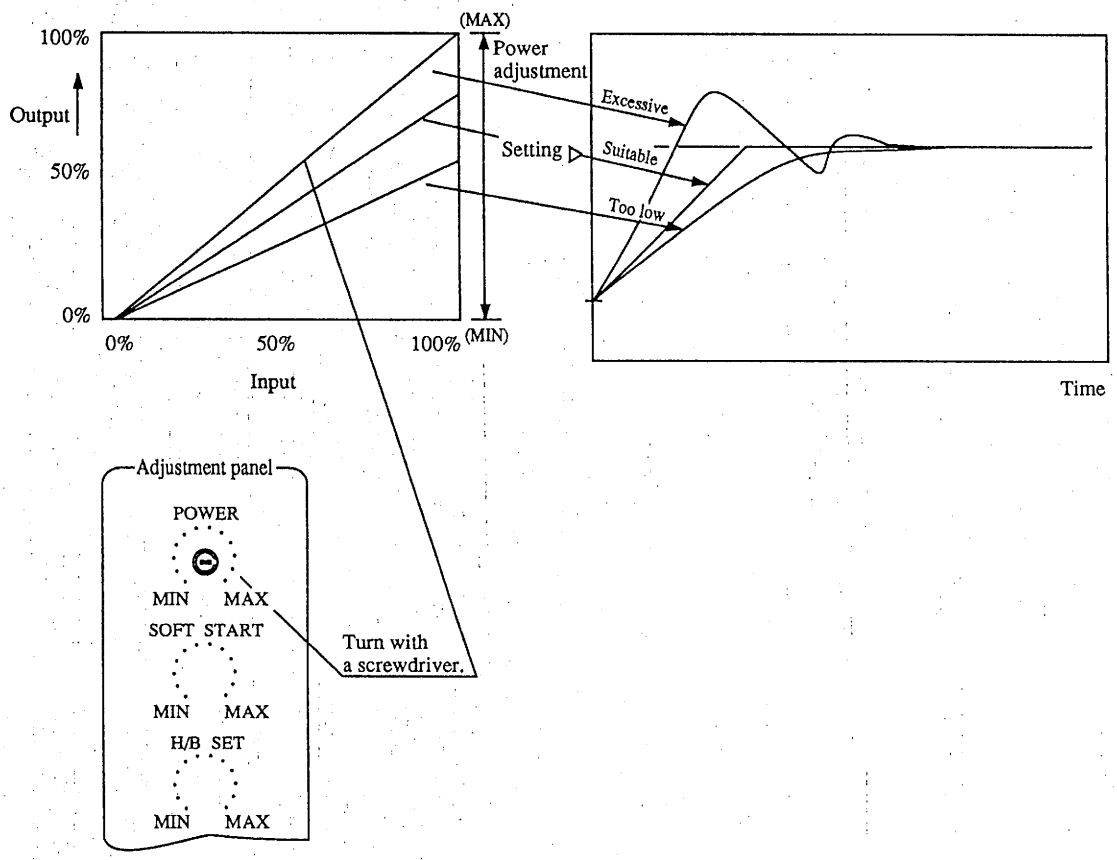
- Output without automatic power control function and result of control



Power gets excessive at the start time, resulting in overshooting, and in some cases control characteristics deteriorate in a low range.

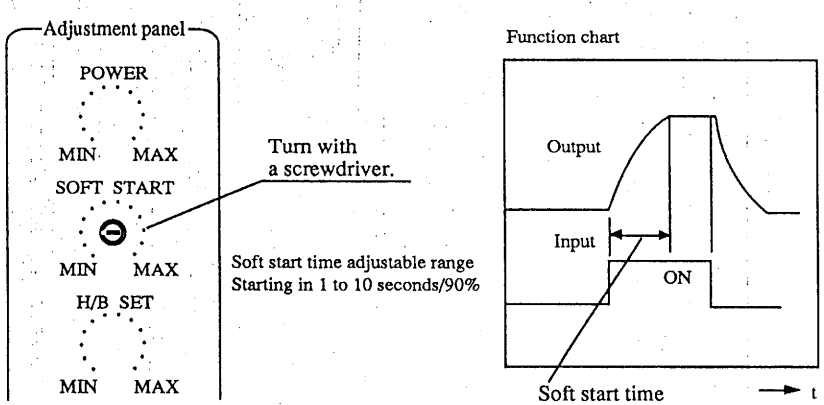
10-2 Power (ramp) adjustment

There are two power adjusting functions: standard internal power adjustment and optional external power adjustment. The following diagrams show the relation between the dial graduation and output. To improve control accuracy, providing optimum power easily makes it possible for the controller to achieve its capacity 100% (percent).



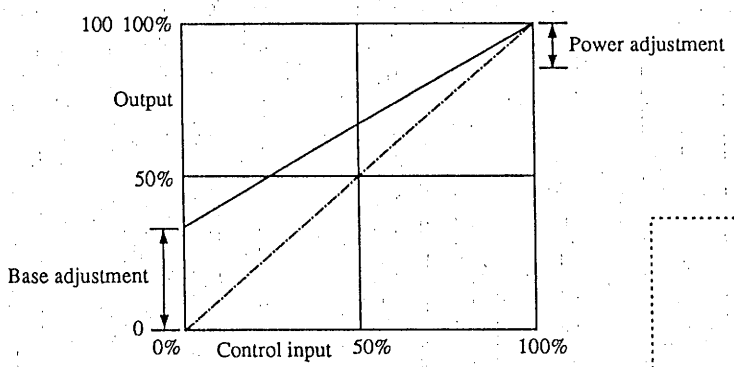
10-3 Soft start and soft down adjustment

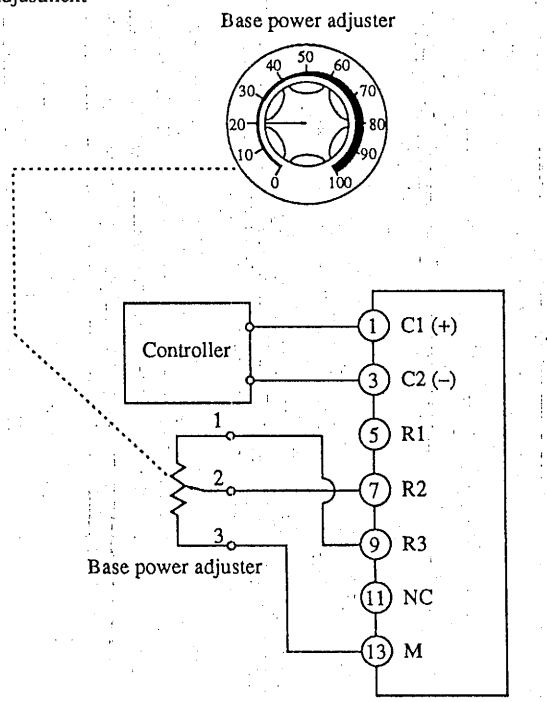
The PAC36P can be given the characteristic shown below toward a control signal change or starting output when power applied. Adjust the delay time in the range of 1 to 10 seconds in accordance with the characteristics of the load (heater).



10-4 Base (residual) power adjustment

The base power adjuster is capable of keeping output steady in the range of 0 to 100% even when the control signal is at 0%. This is useful in keeping current of a certain minimum percentage flowing because of the characteristics of the heater even when the control input is at 0%. This is also usable as a manual adjuster if output is stopped due to trouble in the controller.

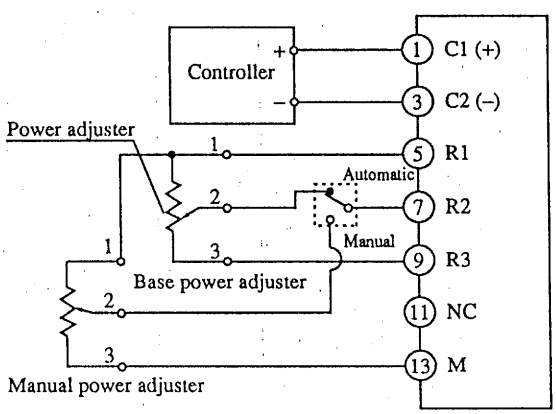


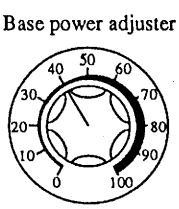


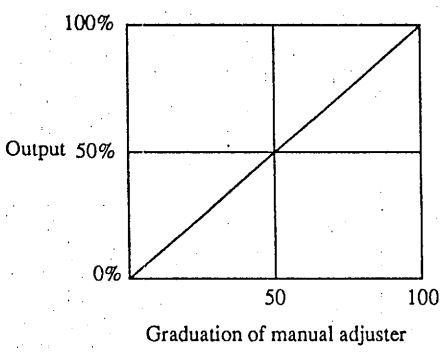
10-5 Manual power adjustment

The manual power adjuster is generally used to adjust output without using the automatic function, to carry out adjustment in a trial run, and to switch to the automatic mode in selecting a manually set output by means of external signals.
An example of wiring for Auto/Man switching and method of adjustment are shown below.

An external contact is provided for switching between Auto and Man for power adjustment in the Auto mode and for manual adjustment of output in the Man mode.





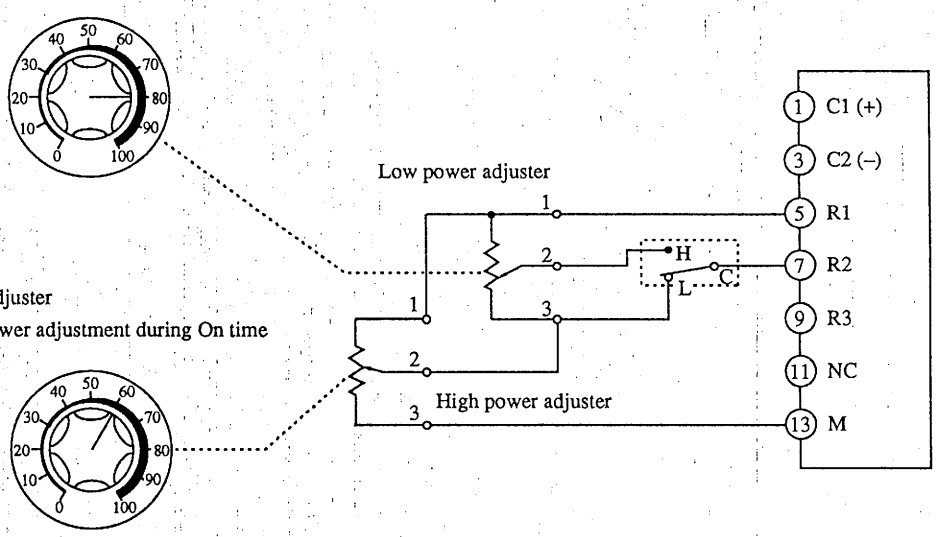


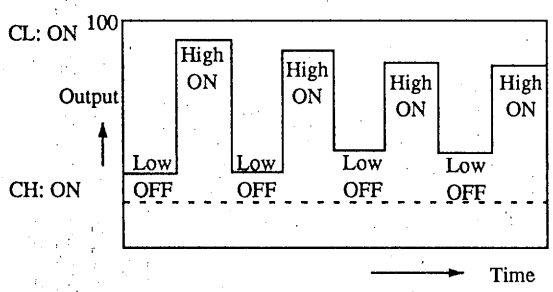
10-6 High-low power adjustment

The high-low power adjuster uses contact signals to adjust high power output during On time and low power output during Off time for the enhancement of control efficiency. It is also used when the heater characteristically requires voltage at a certain minimum level to be supplied constantly.

◇ Low power adjuster
C-H: Low power adjustment during On time

◇ High power adjuster
C-L: High power adjustment during On time





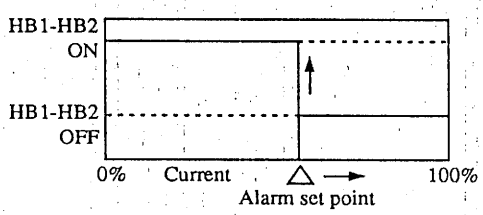
10-7 Heater break alarm adjustment

When the heater break alarm function is added, a break in the heater or load circuit is detected and an alarm is output.

– Specifications –

- Setting range: 0~100% of rated current
- Setting accuracy: Within ±5%
- Operation system: To keep alarm signals only
- Output when alarm is functioning: Control output intact
- Resetting of alarm output: Power turned off and then on
- Allowable range of voltage fluctuation: Within ±10%
- Setting for non-operation: Set at 0%

– Alarm Function Chart –



■ 10-7-1 Setting of heater break alarm

HB/SET can be set between Min (0%) and Max (100%). The percentage is a value relative to current capacity, not installed capacity.

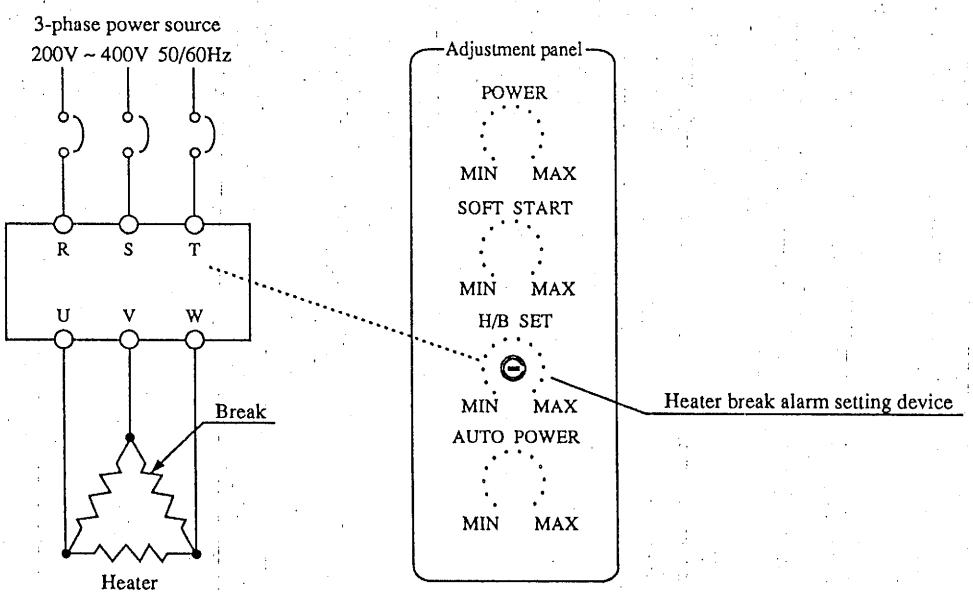
Example of setting

To output an alarm when one heater breaks in a 3-phase circuit comprising three heaters:

– Condition –	Thyristor current capacity	20A
	3-phase heater	200V 6kW (17A)
	Number of heaters	3

Under normal conditions, current of 17A flows, amounting to about 85% of the rated capacity. It should not be set at 85% or above, otherwise a break alarm will be output even under normal conditions.

In the three-phase circuit, breakage of one heater reduces the current to 0.865 of the rated level. Accordingly, the setting should be about 80%, that is, between 85% in the normal state and (85% of rated current) × (current drop 87%) = about 74% in an abnormal state.
Note: Setting a value close to the one in the normal state tends to cause malfunctioning.



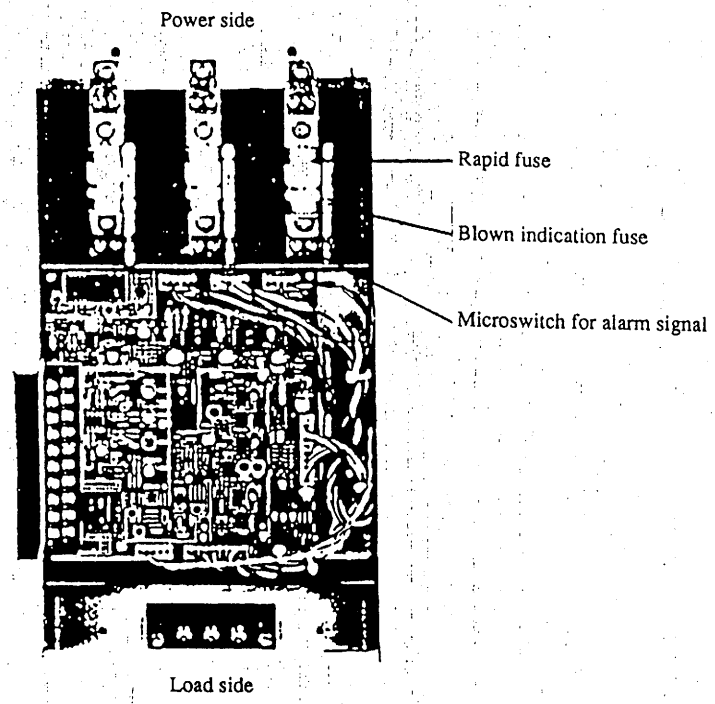
■ 10-7-2 Resetting (restoring of alarm function)

When the heater break alarm functions once, the alarm output is retained as it is even after the break is mended. To reset it, turn the power off and then on again. This releases the alarm output.

11 Replacement of Rapid Fuse (Option)

11-1 Position of rapid fuse

When the cover is opened, you will see three fuses on the top, as shown in the picture below. To find the broken fuse, check the microswitches for alarm signals attached to the sides of the various fuses. The one that presses the switch has burnt out. Make sure which of them has burnt out, as the these switches may burn out at different times depending on the condition of over-current.



11-2 Current capacity and fuse ratings/types

Current Capacity	Capacity of Installed Fuse	Fuse Type Code
20A	30A	CR6L - 30S
30A	40A	50SHA 40S
45A	60A	50SHA 60S
60A	100A	50SHB 100S
90A	120A	50SHB 120S
135A	200A	CS5F 200
180A	250A	CS5F 250
240A	350A	CS5F 350
300A	450A	CS5F 450
450A	600A	CS5F 600
600A	800A	CS5F 800

CR6L and CS5F type fuses:
Products of Fuji Electric
50SHA and 50SHB types:
Products of Kyosan

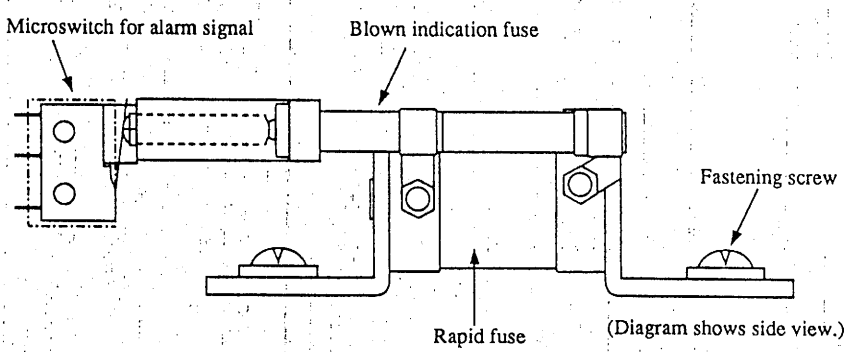
11-3 Replacement of rapid fuse

- When a rapid fuse has burnt out, it is indicated by an alarm and the protrusion of blown fuse indicator.
- Check the load side to find the cause of the burning-out of the rapid fuse, and replace the burnt fuse with a new one. The steps for replacement are described below.
- The replacement rapid fuse should be of the same rating. (See the above table.)
- Spare rapid fuses are not included in the instrument package. They are available from us or a fuse dealer.

■ 11-3-1 20~90A (CR6L, 50SAH, 50SHB types)

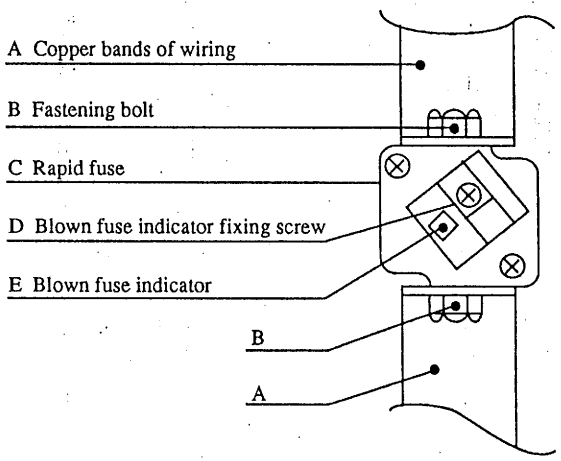
1. Remove the cover of the instrument.
2. Draw the microswitch for alarm signal out from the blown indication fuse.
3. Unscrew the fastening screw to detach the burnt fuse and attach a new rapid fuse. (Tighten the screw firmly.)
4. Firmly insert the microswitch for alarm signal into the blown indication fuse. (Insert it until it reaches the stopper.)
5. Attach the instrument cover.

Note: To replace a CR6L fuse (20A), a plus screwdriver has to be used to detach and reattach the microswitch for alarm signal.



11-3-2 135~600A (CS5F Type)

1. Remove the cover of the instrument.
2. Detach the blown fuse indicator from the rapid fuse.
3. Loosen two fastening bolts between the copper bands of cable.
4. Insert a new rapid fuse and tighten it firmly by means of the two fastening bolts.
5. Attach the blown fuse indicator on the fuse body by means of the fixing screw.
6. Attach the instrument cover.



12 Heat Generation of Thyristor Unit

The PAC36P generates heat as shown in the following table. The temperature rise should be kept minimum by ventilation. Heat values generated from SCRs and diodes are those when the amperage is maximum (rated values). When the current drops, the heat value falls in proportion to the rate of current decrease.

Rated current (A) / Internal heat value (W)	20	30	45	60	90	135	180	240	300	450	600
Without rapid fuse	82	121	151	196	274	442	620	731	1040	1567	2000
With rapid fuse	92	133	170	218	308	477	686	810	1123	1702	2192

13 Measures to Counter Noise

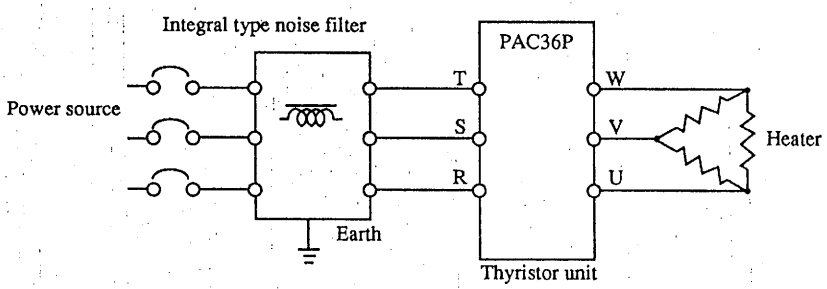
When power is controlled by means of a three-phase thyristor, noise caused by switching may affect the electronic equipment. If the load does not allow the use of the zero-cross system which is free of noise (with a transformer), use a PAC36P employing the phase control system and take action to counter noise.

Simple measures commonly used are described below for your reference.
Measures to counter noise are divided into two categories: those that prevent an effect on the power source side and others that emit electromagnetic waves from the output wiring. In the following, the former, that is, ways to prevent influence on the power source, are described.

Installation of noise filter between power source and PAC36P

13-1 Small capacity types

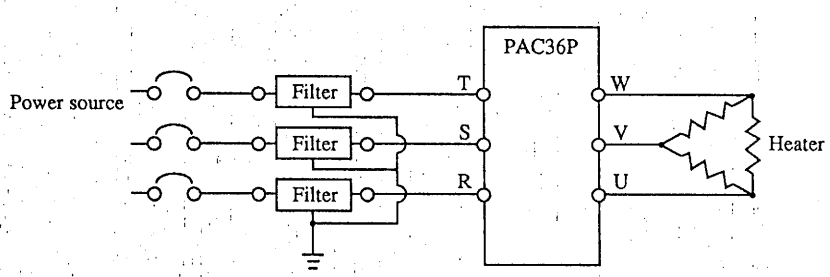
Integral type noise filter



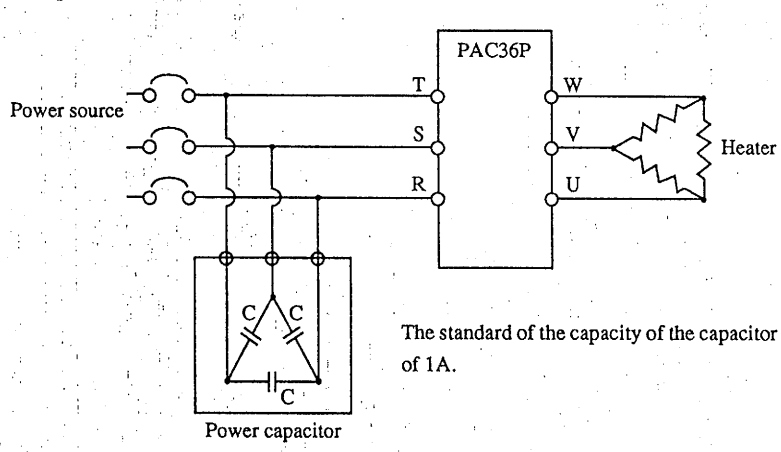
☐ Major manufacturers of noise filters
The major manufacturers of noise filters are TDK, Tokin and Shoshin.

13-2 Large capacity types

Insert a filter in each line.



13-3 Connection of power capacitor



The standard of the capacity of the capacitor is preferably 1μF against a current of 1A.

14 Note on Use of Transformer

Purposes of using a transformer:

1) To match two voltages with each other when the heater voltage is different from the power voltage
2) To raise the withstanding voltage to ground by using a separate type transformer in case insulation to the earth decreases, for example, in a vacuum device

14-1 Magnetic flux density of transformer

If a magnetic circuit is saturated while a transformer is used, the transformer does not function and excess current is allowed (a load is applied to the transformer). This might damage the thyristor.
Since switching (On-Off) takes place every cycle in thyristor control, the circuit tends to be saturated easily as the load increases. Therefore, it is necessary to keep the magnetic flux density lower than in the ordinary transformer.

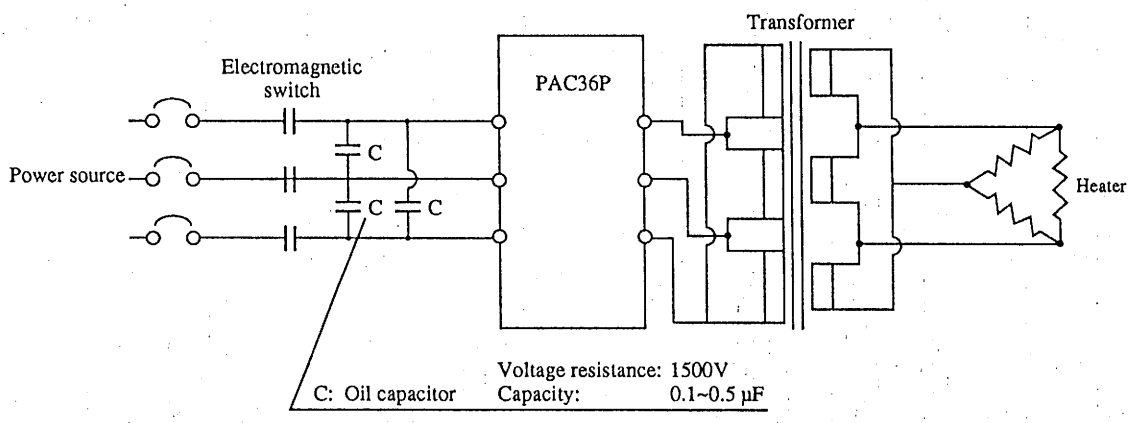
Example) The magnetic flux density of the ordinary transformer is 10,000~12,000 Gs.
Keep it at 7,000~8,000 Gs with the combined use of a transformer and a thyristor.
When an ordinary transformer is employed, use it at 60~70% of the rated load. Then, there will be no problem.

14-2 Use of separate (compound) transformer

If the heater structurally tends to cause ground fault, and the withstanding voltage to ground decreases as in a vacuum device, a separate type transformer should be used so that the thyristor and power source can be protected in a mishap.

14-3 Note on use of electromagnetic switch

The use of an electromagnetic switch in a circuit connected with a transformer (i.e., inductive load) may cause malfunctioning due to a bound of a contact.
If such is the case, a capacitor should be connected on the power source side of the thyristor, as shown below, to absorb noise.



14-4 Use of transformer with rapid fuse

To protect the thyristor element from excess current which is caused due to high-frequency noise or a load problem, a transformer with rapid fuses should be used.

14-5 Do not open secondary side of transformer.

I a load cannot be connected, for example, in a trial run, disconnect the transformer wiring and operate the instrument connected with a dummy such as an electric heater or a light bulb. Do not operate it without a load on the transformer. Do not switch the load, etc., either. (The functioning of the soft circuit will be hampered).

15 Specifications

■ Control Input and Ratings
- Current input ..... 4~20 mA DC/Receiving impedance: 100Ω
- Voltage input ..... 1~5 V DC/Input impedance: 200kΩ or more
  ..... 0~10 V DC/Input impedance: 200kΩ or more
- Contact signal .... Non-voltage contact signal

  Note: Select external power (P) or (H) in the Table for Code Selection Item 7. Output Adjusting Function.

■ Power Supply and Ratings
- 200V type ..... 200~220V AC±10% 50/60Hz
  220~240V AC±10% 50/60Hz
- 400V type ..... 380~400V AC±10% 50/60Hz
  400~440V AC±10% 50/60Hz

■ Current Capacity
20A, 30A, 45A, 60A, 90A, 135A
180A, 240A, 300A, 450A, 600A

■ Control Mode
Phase angle control

■ Soft-start Function
Adjustable between about 1 to 10 seconds (time for reaching 90%)

■ Possible Loads
Resistive load, inductive load (transformer primary side control)

■ Output Voltage Control Range
0 to above 98% of input voltage

■ Output Stability (95% or less of output voltage)
Input fluctuation ±2% or less when input fluctuation is ±10%

■ Control Element Composition
Mixed antiparallel composition of SCRs and diodes

■ Overcurrent Protection System
- Electronic system (gate signal shutoff) (standard) ..... About 130% of rated current
- Rapid fuse (option) ..... About 130~150% of rated current
- Reset Electronic system ..... Turn power off and then on.
  Rapid fuse ..... Replace fuse.

■ Cooling System
- Self-cooling system 20A, 30A, 45A, 60A, 90A, 135A
- Forced air cooling system 180A, 240A, 300A, 450A, 600A

■ Alarm Monitors
- Overcurrent ..... [O.C] monitor lights./ AL1-AL2 conducting
- Fan stop ..... [FAN] monitor lights./ AL1-AL2 conducting
- Fuse break ..... [FUSE] monitor lights./ AL1-AL2 conducting
- Heater break ..... [H/B] lamp lights./ HB1-HB2 conducting
- Output contact rating ... 240V AC 1A/Resistive load

■ Power Lamp
Correct phase sequence ... Green LED lights.
Open/opposite phase sequence ..... Red LED lights.

■ Operating Environment
- Ambient temperature range ..... −10~50°C
- Ambient humidity range ..... 90% RH or less without condensation

■ Insulation Resistance
- 20MΩ minimum at 500V DC between power supply terminal and chassis
- 20MΩ minimum at 500V DC between input terminal and power supply terminal

■ Dielectric Strength
- Between power terminals and chassis
  200V~240V ..... 1 minute at 2000V AC
  380V~440V ..... 1 minute at 2500V AC

■ Material/Finish
Ordinary steel plate/paint coating (equivalent to Munsell N8.5)

■ External Dimensions and Weight
See external dimension drawings.

■ Terminal Cover installed as standard equipment

■ Additional Functions (option)
- Power adjusters

  Connection to voltage/current output type controller
  Internal power (standard) ..... 0~100%
  External power ..... 0~100%
  Manual power ..... 0~100%
  Base power ..... 0~100%
  External power + Manual power ..... 0~100%
  External power + Base power ..... 0~100%

  Connection to contact output type controller
  External power ..... 0~100%
  High-low power ..... 0~100%

- Constant current control (current feedback)
  Possible loads ..... Pure metal, Supercantal, etc.
- Constant power control (power feedback)
  Possible loads ..... SiC, carbon heater
- Current linear control (voltage square feedback)
  Possible loads ..... Nickel chrome heater
- Output limiting function
  Current limit ..... 50~100% of rated current
  Start-up time output limit .. 0~60% output for 1~60 seconds
- Rapid fuse
  With alarm output function
- Heater break alarm
  Setting at 0~100% of rated current
- Automatic power adjusting function
  50~100%

16 Inspection

16-1 Inspection and remedial measure when alarm is output

Alarm Indication	Inspection and Remedial Measure
When over-current cut-off circuit has functioned, [O.C] monitor lamp lights.	Turn off power. Check and find cause of functioning of over-current cut-off circuit and take appropriate measure. Resupply power. Note: 1. Over-current cut-off circuit is not restored unless power supply to instrument is turned off. 2. When over-current cut-off circuit has functioned, never resupply power without checking load side and putting it in order so as not to destroy thyristor element. 3. Once over-current cut-off circuit has functioned, turn off power, check, and take remedial measure. Then, wait five or more minutes before resupplying power.
When alarm is output due to stoppage of cooling fan, [FAN] monitor lamp lights.	Is there foreign matter in cooling fan? After proper measure is taken, resupply power and make sure that fan revolves. 180A, 240A, 300A, 450A and 600A types
When alarm is output due to burning out of rapid fuse, [FUSE] monitor lamp lights.	Check load side, find cause of burning of rapid fuse, and take remedial measure. Then, replace it with new rapid fuse. Refer to page 21 for details on how to replace the rapid fuse.

16-2 Inspection in case of trouble

Problem	Possible Causes	Remedy
Output is not produced.	1. Are voltages of power supply terminals (R, S, T) normal? 2. Has alarm functioned (monitor lamp lit)? • Has over-current cut-off circuit functioned? • Have any of cooling fans stopped? • Has rapid fuse burnt out? 3. Are signals from controller normal? 4. Is output adjuster (power VR) set at 0?	If 1~4 are normal, control board or thyristor element may have problem and either of them should be replaced. 2: Refer to 16-1 'Inspection and remedial measure when alarm is output'.
Output keeps being produced.	1. Are input signals normal? 2. Output does not decrease when output adjuster (power VR) is turned toward 0% (counterclockwise).	In case 1 is normal and 2 is the case, malfunctioning of control board or accidental conducting of thyristor element is considered to be cause and either should be replaced.
Alarm is output frequently.	1. Is there short on load side? 2. Has load side insulation failed? 3. Does load side capacity exceed rating? 4. Is phase order of power source correct? (Is red power lamp lit?)	1 and 2: Check and repair load side. 3: Change power capacitor to one which corresponds to load capacity. 4: Correct phase order.
Output is out of balance.	1. Are voltages across power terminals (R, S, T) normal? 2. Is phase order of power source correct? 3. Is part (one phase) of load side broken?	If 1~3 are normal, control board or thyristor element may have problem and either should be replaced.

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