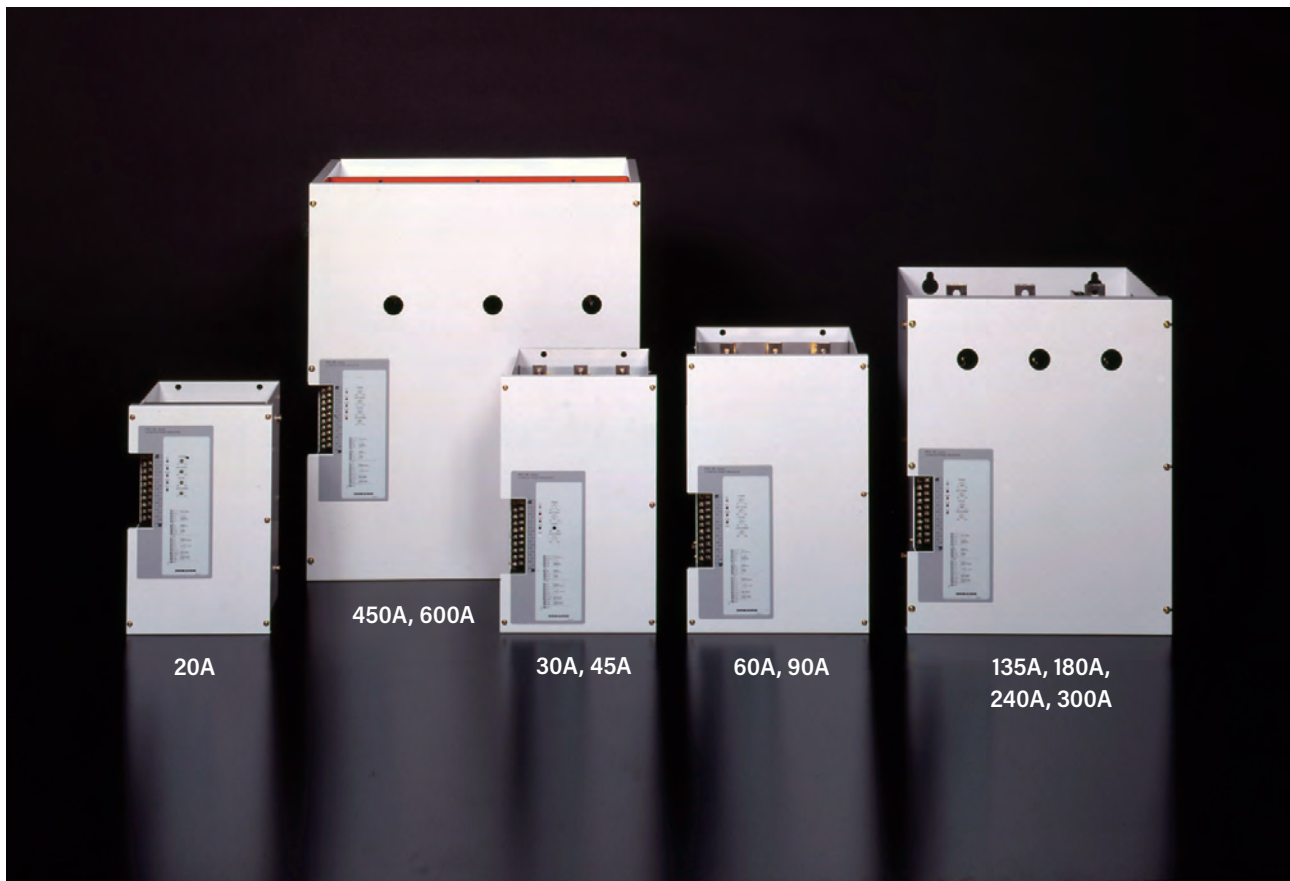


°C

Series PAC36P

%RH

THYRISTOR THREE PHASE POWER REGULATOR



BASIC FEATURES

- Wide application with variety of functions*
- Suitable for air conditioning, electric, furnace, dryer, bio engineering, food industry, chemical industry, plastic formation and control of heat source applications.*
- Power Supply: 200–240V or 380–440V AC*
- 6 toxic substances, which are subject to RoHS directive supported, are contained. However, the amount of toxic substances contained does not exceed standardized values.*

FUNCTION

Standard Function	
Electronic over current protect function:	Protects thyristor element by shutting off the over current detected by a load current monitoring CT.
Constant voltage characteristics by means of voltage feedback:	Stable output provided by the voltage control function and easy operation achieved by the linear characteristics of control input and output voltage.
Soft start function:	Setting suitable soft start time for the load.
Additional Function (option)	Stable output provided by the voltage control function and easy operation achieved
Automatic power adjusting function:	The suitable power for the control temperature is continuously controlled by a signal from the programmable controller, computer and adjuster. Applicable for soft control of the low range.
Constant-current control (Current feedback):	Applicable to controlling the pure metallic heater and the Kanthal Super heater.
Constant-power control (Power feedback):	Applicable to controlling the SiC and the carbon heater, and applicable to high stability controlling.
Power linear control (Voltage square feedback):	Applicable to precise controlling for Nichrome heater load with power linear characteristics of the control input / output voltage.
Current limiting function:	Applicable to loads with rush current on starting and continuous usage over current condition such as pure metallic, Tungsten and Molybdenum heaters.
Start up output limiting function:	Applicable to the rush current reduction and load protection on turning on the power supply.
Heater break alarm:	Alarm display and output in case of detecting the low power condition of the broken heater and heater defect.
Rapid fuse:	Perfect protection for the thyristor device and the power line from the over current of the short circuit and the grounding.
Power adjustment function:	Addition of various manual equipment used for adjusting ramp, base (residual output), manual and high / low.
Monitor and Alarm Output on the Trouble Situation	
Over-current protection:	[O.C] monitor lights and alarm output on
Fan stop (for models over 180A):	[FAN] monitor lights and alarm output on
Rapid fuse burnt out:	[FUSE] monitor lights and alarm output on
Heater break alarm:	[H / B] monitor lights and warning output on

SPECIFICATION

Control input and Rating:	Current input:	4–20mA / DC, Receiving impedance: 100Ω
	Voltage input:	1–5V / DC, Input impedance: 200kΩ min. 0–10V / DC, Input impedance: 200kΩ min.
	Contact signal:	Non-voltage contact signal
	Note:	Select external power (P) or (H) in the table of code Selection Item 7, (Output Adjusting Function)
Power Supply and Rating:	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
Control Mode:	Phase angle control system	
	Soft start:	Adjustable approx. 1–10 sec. (time for reaching 90%)
	Applicable load:	Resistive load (additional function selected according to characteristics) Inductive load (transformer primary side control)
	Output voltage control range:	0–98% minimum of input voltage
	Output stability (95% or less of output voltage):	Input fluctuation ± 2% or less when input fluctuation is ± 10%.
	Control element configuration:	Mixed antiparallel configuration of SCRs and diodes
Over-current Protection System:	Electronic type (gate signal breaking system) standard:	approx. 130% of rated current
	Rapid fuse type (optional):	130–150% of rated current
	Reset Electronic type:	Turn power OFF and reapply
	Rapid fuse:	Replace fuse.
Current Capacity and Cooling System:	20A, 30A, 45A, 60A, 90A, 135A:	Self-cooling system
	180A, 240A, 300A, 450A, 600A:	Forced air cooling system
Alarm Monitors and Rating:	Over-current:	[O.C] monitor lights. / AL1-AL2 conducting
	Fan stop:	[FAN] monitor lights. / AL1-AL2 conducting
	Fuse burnt out:	[FUSE] monitor lights./AL1-AL2 conducting
	Heater break:	[H / B] monitor 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:	90% RH max. with no condensation
Insulation Resistance:	Power terminal and chassis:	500V DC 20MΩ min.
	Input terminal and power terminal:	500V DC 20MΩ min.
Dielectric Strength:	Power terminals and chassis:	
	200–240V power supply:	2000V AC 1 minute
	380–440V power supply:	2500V AC 1 minute
Material / Finish:	Ordinary steel plate / paint coating (equivalent to N8.5 Munsell number)	
External Dimensions and Weight:	See external demension drawings.	
Terminal Cover:	Installed as standard equipment.	

Additional functions (option):	Power adjuster	
	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, High power:	0–100%
	Low power:	High power × Low power
	Constant-current control (current feedback) Applicable loads:	Pure metallic heaters, Super kanthal, etc.
	Constant-power control (power feedback) Applicable loads:	SiC, Carbon heaters
	Power linear control (voltage feedback) Applicable loads:	Nichrome heater
	Output limiting function: Current limit:	50–100% of rated current
	Start up output limiting:	0–60% output for 1–60sec.
	Rapid fuse:	With alarm output function
	Heater break alarm: function:	Setting at 0–100% of rated current Automatic power adjusting 50–100%

INTERNAL HEAT GENERATED

Internal heat generated by series PAC36P at maximum current operation is as follows. The heat decreases is proportional to the current decrease. Ventilation should be considered for the system.

Rating current (A)	20	30	45	60	90	135	180	240	300	450	600
Internal heat generated (W)	82	121	151	196	274	442	620	731	1040	1567	2000

Approx. 10% more heat is generated in case of using rapid fuse.

ORDERING INFORMATION

Item	Code	Specification				
Series	PAC36P	Thyristor three- phase power regulator				
CONTROL INPUT	3	1-5V DC, Input Impedance: 200kΩ / contact signal				
	4	4-20mA DC, Receiving Impedance: 100Ω / contact signal				
	6	0-10V DC, Input Impedance: 200kΩ / contact signal				
	9	Others (Please consult before ordering.)				
POWER SUPPLY	15-	200-220V				
	16-	220-240V				
	17-	380-400V				
	18-	400-440V				
CURRENT CAPACITY (KVA is a guideline for rated load capacity)	Code	Current capacity	200V-240V	Code	Current capacity	*400V-440V
	021	20A	6.9 to 8.3 kVA	022	20A	13.2 to 15.2 kVA
	031	30A	10.4 to 12.5 kVA	032	30A	19.7 to 22.9 kVA
	041	45A	15.6 to 18.7 kVA	042	45A	29.6 to 34.3 kVA
	061	60A	20.8 to 24.9 kVA	062	60A	39.5 to 45.7 kVA
	091	90A	31.2 to 37.4 kVA	092	90A	59.2 to 68.6 kVA
	131	135A	46.8 to 56.1 kVA	132	135A	88.9 to 102.9 kVA
	181	180A	62.4 to 74.8 kVA	182	180A	118.5 to 137.2 kVA
	241	240A	83.1 to 99.8 kVA	242	240A	158.0 to 182.9 kVA
	301	300A	103.9 to 124.7 kVA	302	300A	197.4 to 228.6 kVA
	*451	450A	155.9 to 187.1 kVA	452	450A	296.2 to 342.9 kVA
	*601	600A	207.8 to 249.4 kVA	602	600A	394.9 to 457.2 kVA
FEEDBACK FUNCTION	0	Constant voltage (standard feature) / Nichrome				
	1	Constant current / Platinum, carbon, salt bath, tungsten				
	2	Constant power / SiC/Carbon (Note)				
	3	Voltage Square-root / Nichrome				
OUTPUT CONTROL FUNCTIONS	0	None				
	1	Startup time output control limiting (0-60%, 1-60sec.)				
	2	Current limit (when saving continuously for more than 1 minute)				Not selectable when 1 or 2 is selected with the feedback function
	3	Startup time output control + Current limiting				
EXTERNAL POWER ADJUSTER	WHEN USED WITH VOLTAGE AND CURRENT OUTPUT CONTROLLER	N	None (Internal installation as standard)			
		P	External power adjuster			
		M	Manual power adjuster			
		B	Base power adjuster			
	WHEN USED WITH CONTACT OUTPUT	W	External power + Manual power			
		Y	External power + Base power			
		P	External power adjuster			
		H	High-Low power adjuster			
HEATER BREAK ALARM (constant resistance load)	0	Without				
	1	With (0-100% setting of rated current)				
RAPID FUSE	0	Without				
	1	With (See rapid fuse table.)				
AUTO POWER ADJUSTMENT FUNCTIONS	0	Without				
	4	4-20mA DC, Receiving Impedance: 100Ω				
	6	0-10V DC, Input Impedance: 200kΩ				
REMARKS	0	Without				
	9	With (Please consult before ordering.)				

- Please contact us when using other than the rated voltage.
- The 200V series/450A, 600A and 400V series/20 to 600A marked with * are treated as semi-standard products. Please contact us in advance for the delivery date.

(Note)

Since the heating elements of the variable resistance types (especially silicon carbide) have a high temperature coefficient, so the resistance value while heating will be significantly lower than in the room temperature range.

Therefore, if you need to obtain appropriate power over the entire temperature range, determine the current capacity using the values below.

The resistance ratio of silicon carbide heaters is approximately 1:3, so select a current capacity that is the square root of the resistance ratio $\sqrt{3} \approx 1.73$ times.

If the heater deteriorates, the resistance ratio may further increase, so we recommend selecting one with twice the resistance.

■ External adjuster

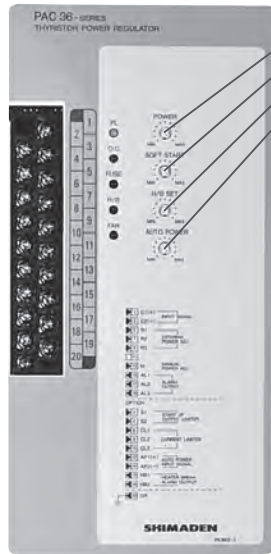
Code	Specification
QSV002	B10kΩ, knob, scale plate, 1m lead

■ RAPID FUSE (Option)

CURRENT CAPACITY	FUSE CAPACITY	PARTS NO.
20A	30A	QSF045
30A	40A	QSF026
45A	60A	QSF027
60A	100A	QSF046
90A	120A	QSF029
135A	200A	QSF042
180A	250A	QSF043
240A	350A	QSF047
300A	450A	QSF044
450A	600A	QSF034
600A	800A	QSF048

PANEL INFORMATION AND CONTROL TERMINALS

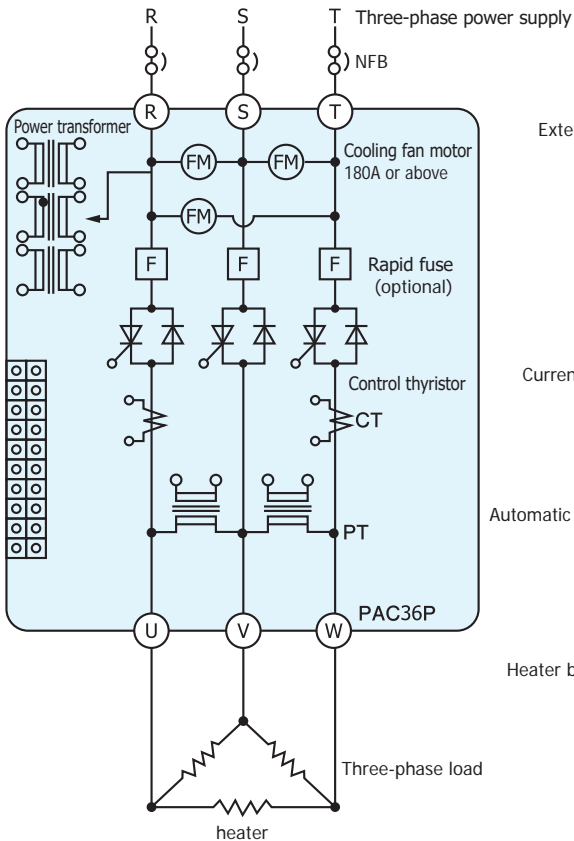
Terminal No.	Code	Terminal code
Upper terminal	1	C1 (+)
	3	C2 (-)
	5	R1
	7	R2
	9	R3
	11	—
	13	M
	15	AL1
	17	AL2
19	AL3	
Lower terminal	2	S1
	4	S2
	6	CL1
	8	CL2
	10	CL3
	12	AP1
	14	AP2
	16	HB1
	18	HB2
	20	G



- 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
 - : Green LED turns on at correct phase sequence.
 - : Red LED turns on at open / opposite phase sequence.
 - 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 start up time output control limiting
 - CL1-CL2-CL3.....: Current limiting adjuster
 - AP1-AP2: Automatic Power signal input
 - HB1-HB2.....: Heater break alarm output

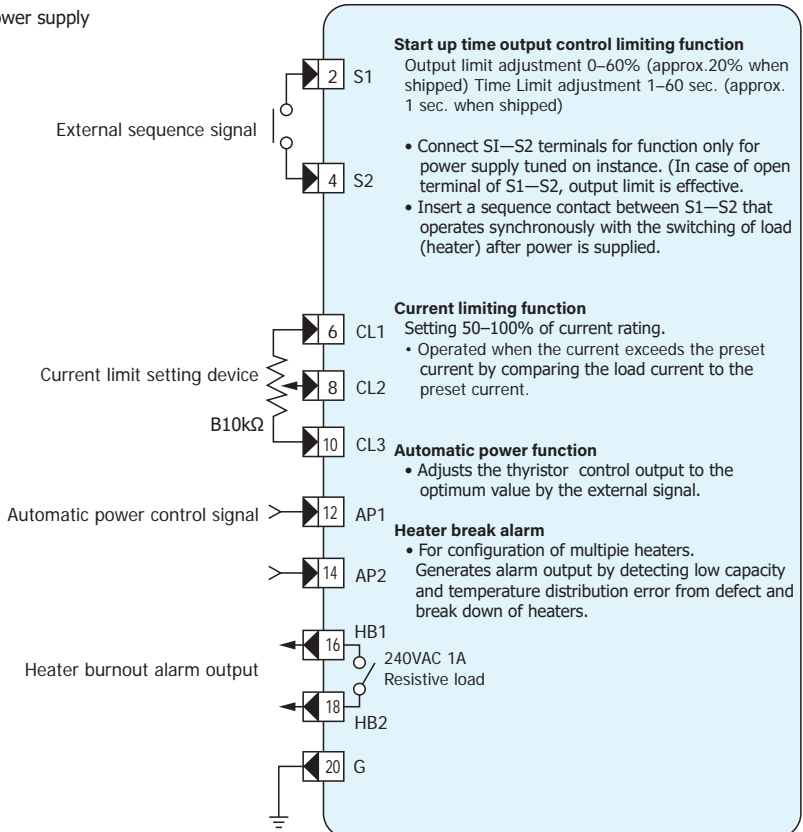
CIRCUIT BLOCK AND WIRING OF CONTROL TERMINAL

• Circuit Block



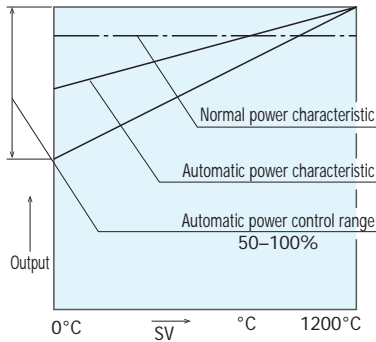
• Additional Function (Option) (Lower Terminal)

Additional function terminals (Lower Terminal) are manufacturer options and cannot be added after delivery. Please select after ordering.



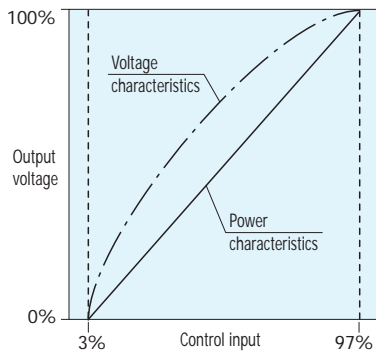
DRAWING OF ADDITIONAL FUNCTION CHARACTERISTIC

• Automatic Power Adjusting Function



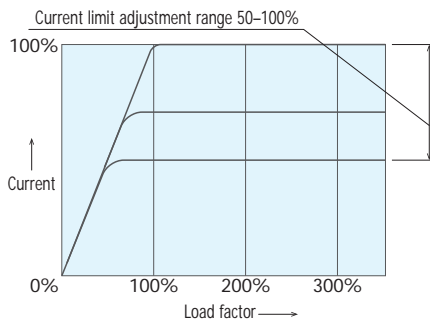
The maximum output (power) suitable for the set (SV) temperature is set steplessly by an external signal (program controller, computer, controller), and controllability over a wide area is improved.

• Power Linear Characteristics (Voltage Feedback)



This function outputs a power proportional to the control input and also has a constant voltage characteristic, so it can be applied to a nichrome heater to improve controllability. It becomes a power regulator proportional to the scale of the regulator for manual adjustment.

• Current Limiting Characteristics

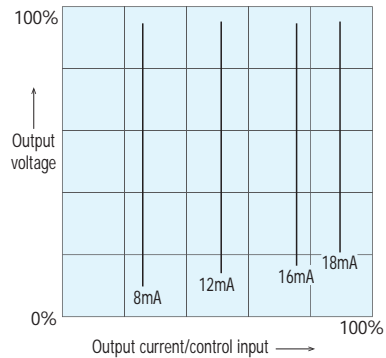


This function is a characteristic that limits the current value to the set value (50 to 100% of the rated value). Select this when controlling the heater such as platinum, molybdenum, tungsten, etc. where an initial inrush current occurs and the SiC heater control.

Note: With this characteristic, the power is reduced as the load is increased beyond the rating. (See table below)

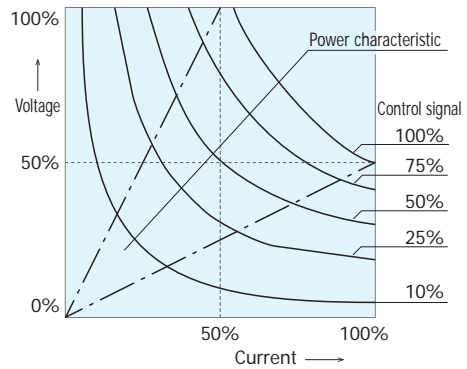
Load factor	100%	200%	300%	500%
Current	97%	100%	100%	100%
Voltage	97%	50%	33%	20%
Power	94%	50%	33%	20%

• Constant Current Characteristics (Current Feedback)



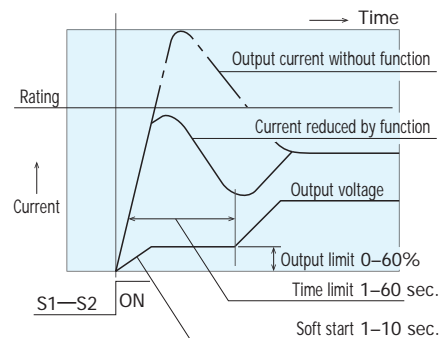
This function calculates and controls the current setting value given by the control signal and the current signal from the current transformer (built-in CT). If the control input is constant, the current is controlled to be constant even if load fluctuations and power supply fluctuations occur, making it suitable for controlling platinum, molybdenum, tungsten, Kanthal super, etc.

• Constant Power Characteristics (Power Feedback)



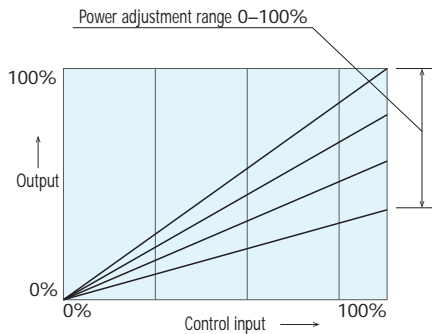
This function controls the electric power proportional to the control input, and its effect appears in the SiC heater control where the resistance value changes greatly depending on the temperature range. Controlling the electric power controls the amount of heat generated in a stable manner, and the controllability is further improved compared to the case of controlling only the voltage or current. When selecting this characteristic, it is necessary to allow some extra thyristor capacitance. The maximum power characteristics of the thyristor are in the range of rated current 50% × rated voltage 100% to rated current 100% × rated voltage 50% as shown in the figure above. Select the thyristor rating so that the heater load current used is 50% of the thyristor current shown in the above figure.

• Start up Output Limiting Characteristics



This characteristic is effective when controlling a load (platinum, molybdenum, tungsten, infrared lamp, etc.) that has an inrush current when the power is turned on or when the load is switched. It can also protect the load.

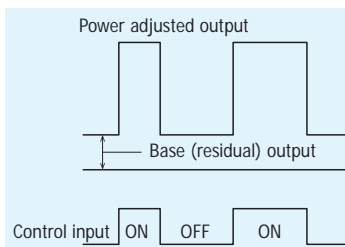
• Output Power



This function selects the external power when you want to operate it away from the main unit. It can be used to adjust the power to suit the set temperature, improve controllability, adjust the rising slope, and manually correct the load characteristics.

* When combined with a voltage/current input type controller, the internal power (with standard) can be used in the same way as above.

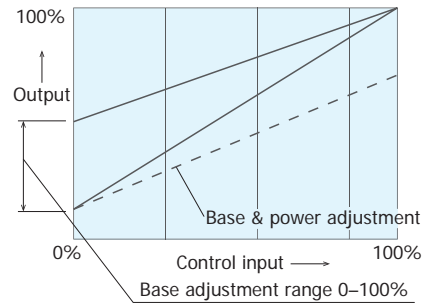
• High / Low Power Characteristics



In the case of contact signal input type, use low power to improve control and prevent inrush current due to load characteristics in combination with two-position controller or PID controller. High power can adjust the power in the range of 0 to 100% when the C1 and C2 terminals are short-circuited. The low power is the output value that is obtained by multiplying the low power adjustment value by the high power adjustment value when C1 and C2 terminals are released.

Example: When the high power value is 80% and the low power is 30%, the residual output is 24%.

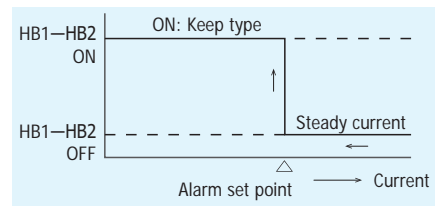
• Base (Residual) Power Characteristics



In general control, the output is set to 0% when the control input is 0%, but when the output limit function at startup is added, the control input continues for 0% of the time, and when the heater temperature falls, the control input is turned on again. When it increases to 100% etc., an appropriate current remains so that an overcurrent does not flow.

*The residual output can be adjusted in the range of 0 to 100%, so be careful to set it to the required value so that it does not become excessive.

• Heater Break Alarm Circuit



The load current is detected, the load current is compared with the alarm set point, and an alarm is output if the load current is below the set value.

The heater burnout alarm function calculates by voltage/current detection, and the detection sensitivity is about 10%.

*Reset: Power OFF

*Control output is output even during alarm operation.

CHARACTERISTICS OF HEATING ELEMENT

The heating element has the characteristics as shown in the table below.

Infrared lamp load requires start-up output limiting function.

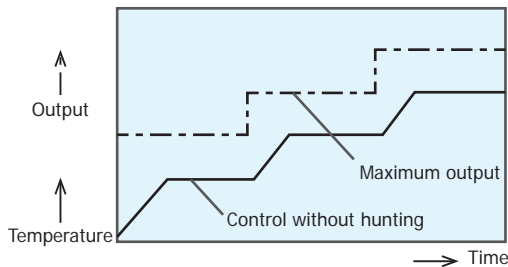
Loads with large thermal capacity such as Platinum, Molybdenum, Tungsten and Kanthal Super require the addition of a current limit function.

Classification	type	Maximum operating temperature	Resistance - temperature characteristics	Additional function
Constant resistance load	Alloy <ul style="list-style-type: none"> • Nichrome • Iron · chrome • Graphite • Kanthal A 	1100 °C (in the air) 1200 °C (in the air) 1330 °C (in the air)		<ul style="list-style-type: none"> □ It is a general feature. It is possible with standard specifications.
Variable resistance load	Pure metal <ul style="list-style-type: none"> • Tungsten • Molybdenum • Platinum • Kanthal Super 	2400 °C (In vacuum) 1800 °C (In vacuum) 1400 °C (In vacuum) 1700 °C (in the air)		<ul style="list-style-type: none"> □ Infrared lamp (tungsten) ... Start-up output limiting circuit □ Add a current limit function to limit inrush current to within the rating.
	Silicon carbide <ul style="list-style-type: none"> • Tecorandum • Siliconit • Elema 	1600 °C (in the air) 1600 °C (in the air) 1600 °C (in the air)		<ul style="list-style-type: none"> □ If the current capacity is doubled, standard specifications are possible □ If current limit function is added, it is possible with load capacity (Be careful when not using a transformer) Adjust to the terminal voltage of the load by using a transformer together.

The automatic power function is a power adjusting function that provides suitable control output to the thyristor by external equipment (programmable controller, computer or controller) and improves controlling ability continuously providing suitable power to the SV (Set Value)

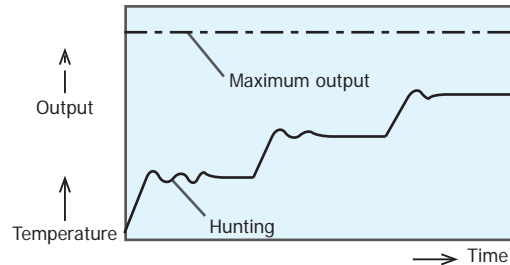
■Contstant value control

• Output with automatic power control function and result of control



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

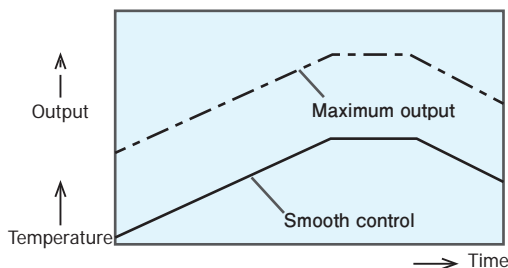
• Output without automatic power control function and result of control



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

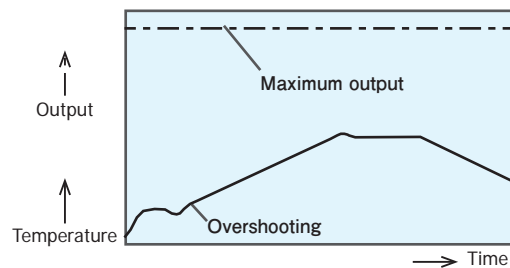
■Program Control

• 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.

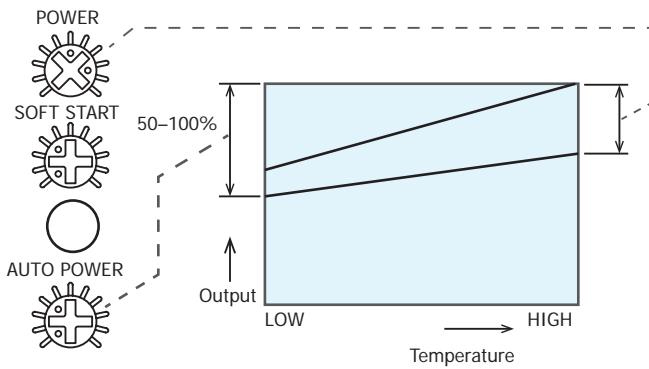
• Output with automatic power control function and result of control



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

EXAMPLE OF THE AUTOMATIC POWER FUNCTION

■Procedure for Automatic Power Adjusting Function

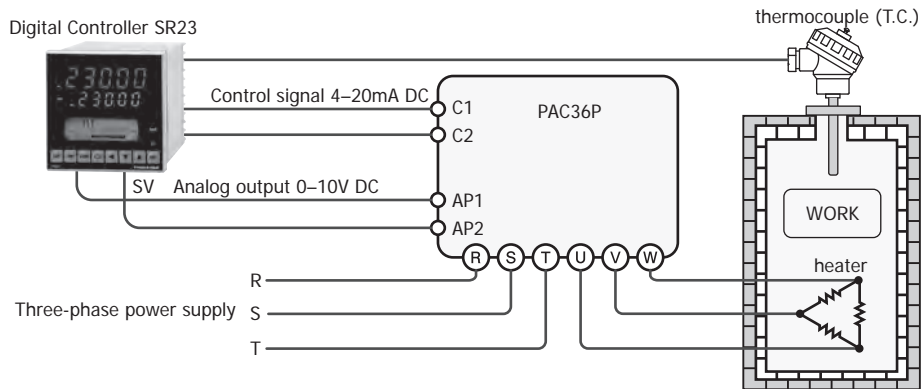


By setting output optimum to the low range set value on the [AUTO-POWER] adjuster, the output characteristic is designated to the line connecting automatic power adjusting value and the output at the maximum temperature. In case of adjusting maximum output, adjusters for internal power and external power are employed.

• Soft Control by Automatic Power Adjusting Function

In case of achieving small temperature stress such as bio industry and fine ceramic manufacturing, the automatic power adjustment is effective for precision control. The temperature control range expands for the same PID value in the PID control condition.

■Example of combination with Digital controller SR23A



When the SV analog output (4-20mA or 0-10V) of the SR23 Digital controller is input to the auto power terminals (AP1 and AP2) of the PAC36P, maximum power cramping, is set automatically by controller setting (SV) and the efficiency of control is improved. The combination plays another role; it effectively saves a total load when several thyristors are turned on simultaneously. AP1-AP2.

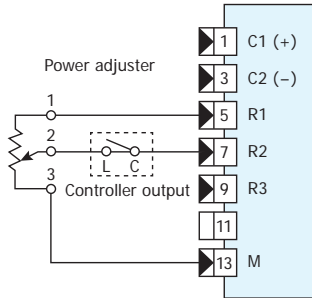
CIRCUIT BLOCK AND WIRING OF CONTROL TERMINAL

• Output Adjusting Function (Upper Terminal)

This function is available by connecting adjuster (rating B 10kΩ 1W), after delivery.

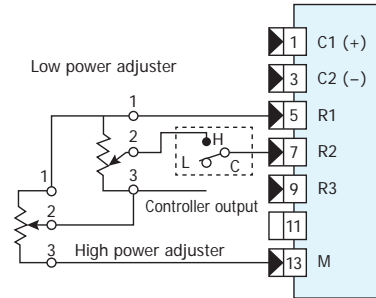
■Wiring with contact output controller

External power



- To adjust output of contact ON (Controller output contact C—L conducted).
- Conduct ON: 0–100%

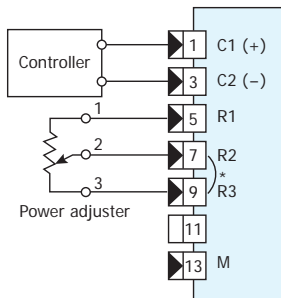
High / Low power



- To adjust maximum output for conducted (on) output contact C-L and to maintain non-conduct (off) (C-H conducted) output.
- High power: With C-L on 0–100%
- Low power: With C-H on High power x Low power

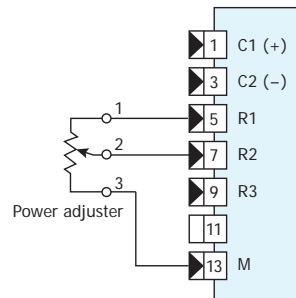
■Wiring with voltage / current output controller

External power



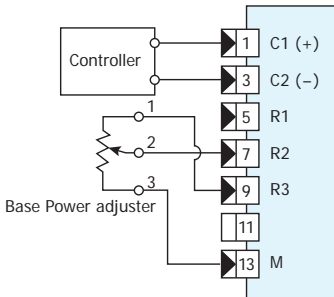
- Internal power adjuster as standard
- *When not using the power adjuster, short-circuit between R2 and R3. (Adjust with built-in power adjuster).
- Input of 100%: 0–100%

Manual power



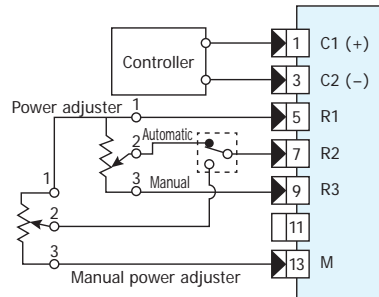
- To adjust power manually

Base (residual) power



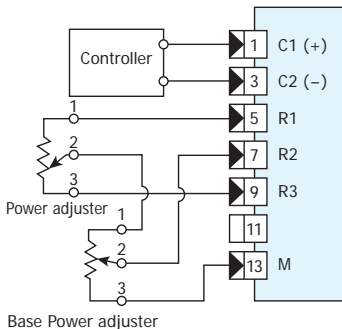
- To keep output steady when the control signal is at 0%.
- The maximum power is adjusted by internal power adjuster.
- Input of 0%: 0–100%

External power + Manual power (auto / manual)



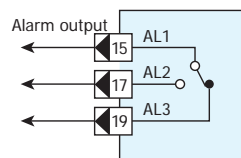
- External contact switches automatic / manual for power adjusting selection of automatic and manual operations.
- Please prepare the automatic / manual switch.

External power + Base (residual) power



- To adjust maximum output and to maintain some parts of output of 0% control signal.

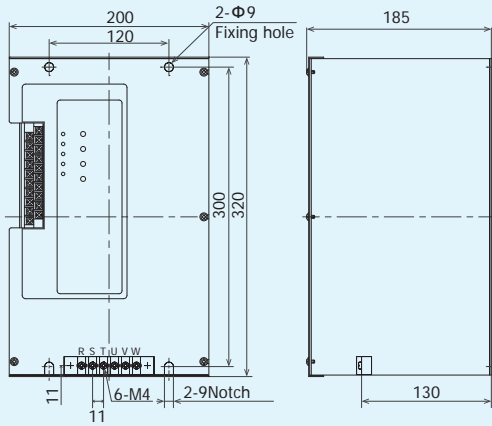
Alarm circuit



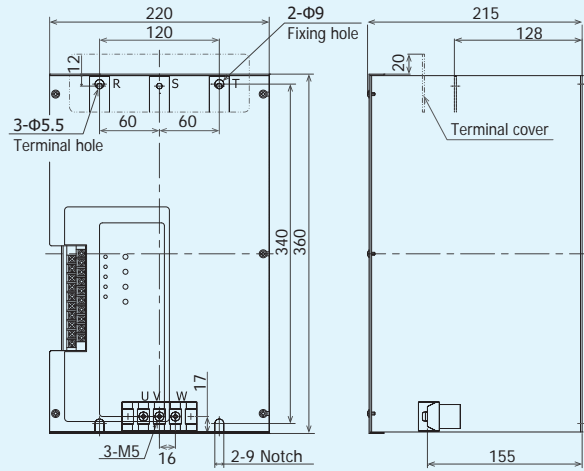
- Alarm output. Conduct between AL1 and AL2. Non conduct between AL1 and AL3.
- Operation Over-current protection circuit on operation. Fuse burnt out. Cooling fan stopped.

EXTERNAL DIMENSION, WEIGHT, MOUNTING

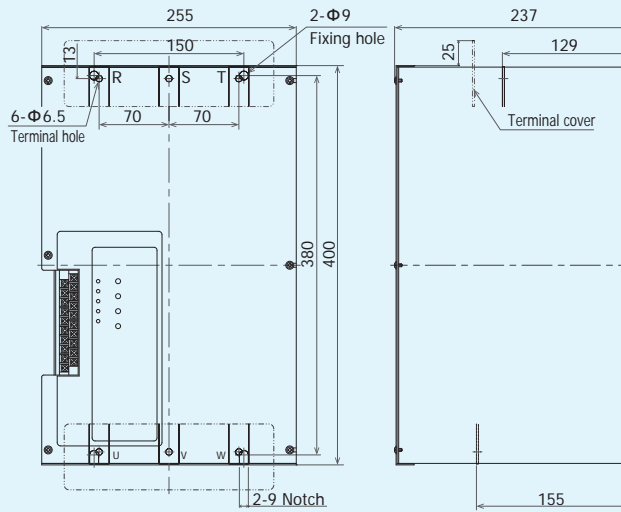
■ 20A Weight: approx. 9kg.



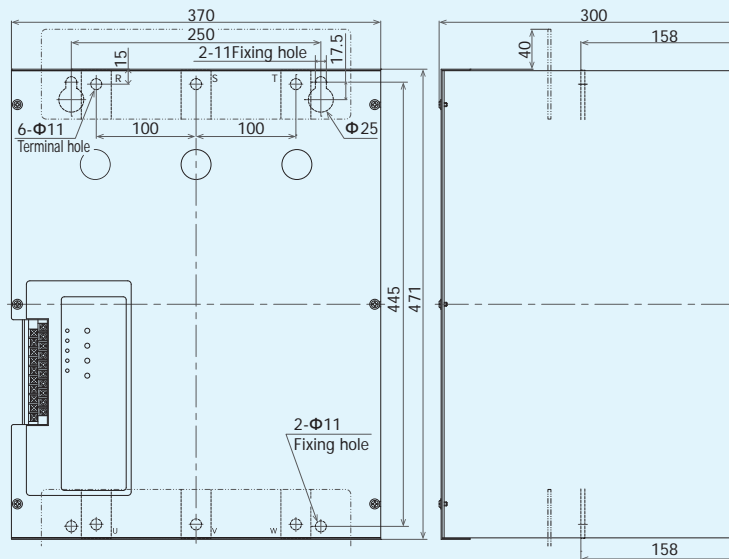
■ 30A / 45A Weight: approx. 12kg.



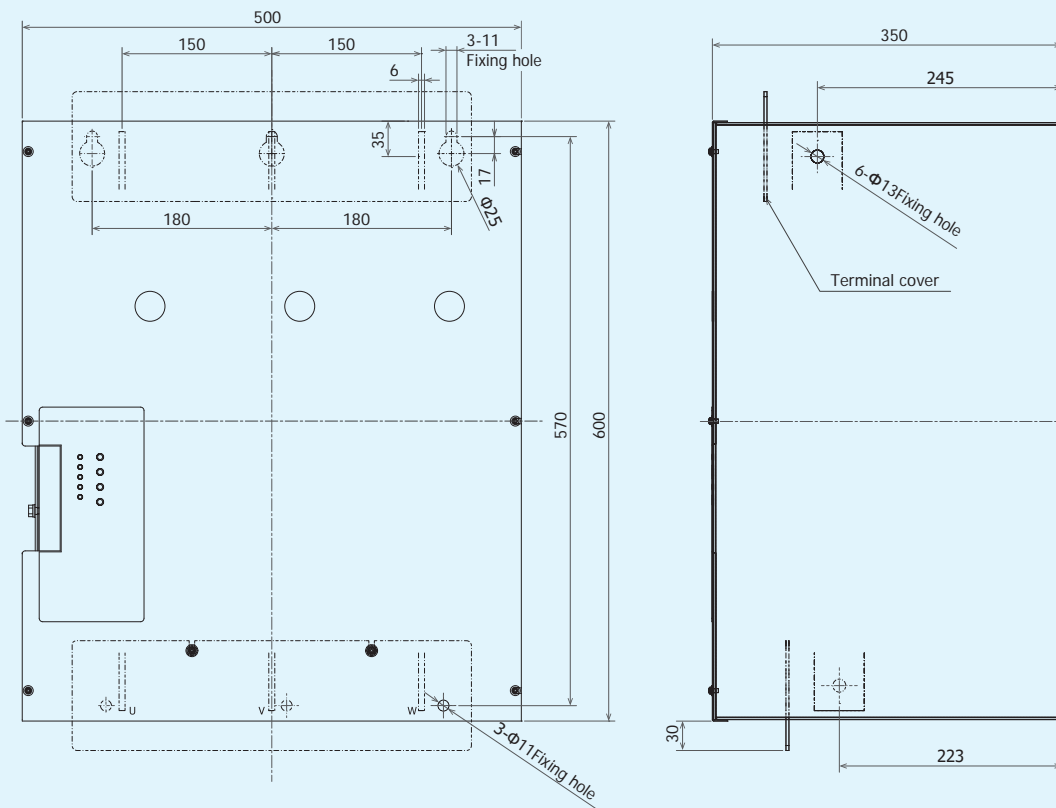
■ 60A / 90A Weight: approx. 16.5kg.



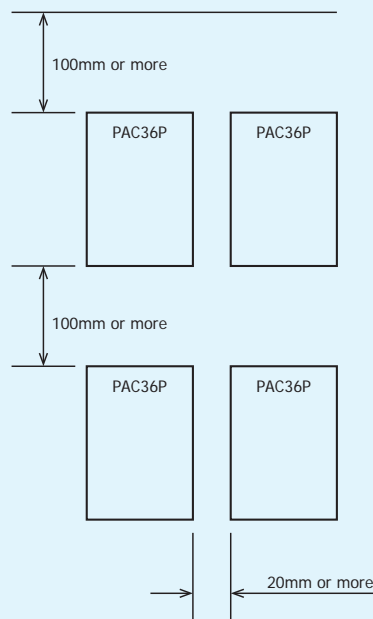
■ 135A / 180A / 240A / 300A Weight: approx. 36.0kg.



■ **450A / 600A** Weight: approx. 55kg.



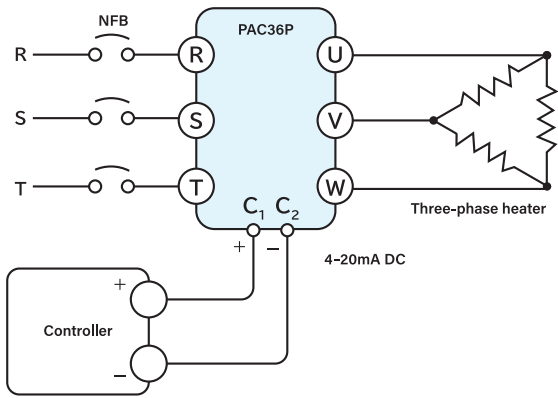
■ **Mounting diagram**



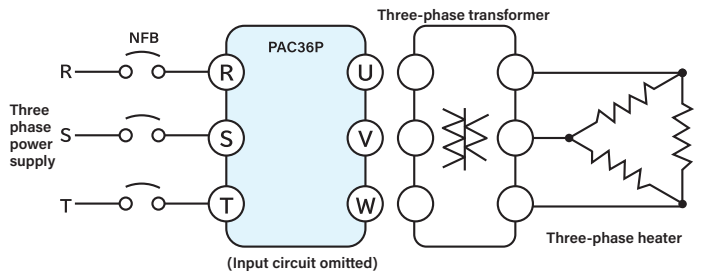
Unit: mm

APPLICATION EXAMPLES

•Application Connecting a Conventional Heater



•Application with Transformer



The aim of transformer
 • Isolates primary / secondary circuits.
 • Adjust to the terminal voltage of the load.

—Note for transformer design—

Generally, margin is set for magnetic flux density in application of switching controlling. The value of the magnetic flux density should be less than 8000 Gauss.

Avoid unbalance of load and rush current from magnetic saturation.

EXTERNAL POWER ADJUSTER

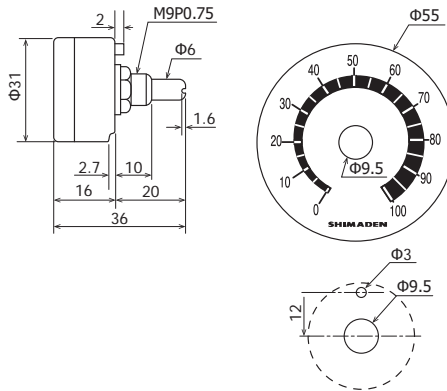
• Rating

Type: QSV002
 Characteristics / Resistance: B 10kΩ 1W
 M3.5 crimp terminal



• External dimensions and mounting method

Lead wire: With 1m vinyl lead
 Scale version/Knob.....with 1 each



• Names and scale

External power 0-100%
 Manual power 0-100%
 Base power 0-100%
 High/low power 0-100%
 Current limit setter (QSV004) ... 50-100%

NOISE COUNTERMEASURE

In a thyristor, especially in phase control, a part of the sine wave waveform of the power supply is cut out before use, which causes distortion of the power supply waveform when the power supply impedance is high. Also, since the power supply is switched every half cycle, switching noise is generated.

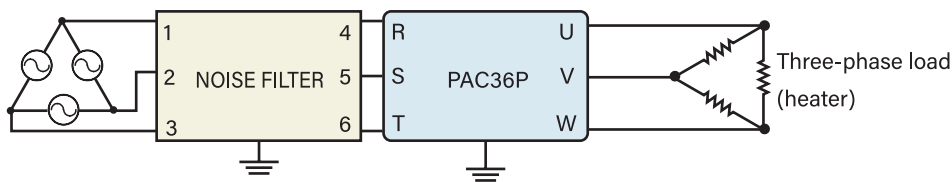
These power distortions and noise may affect other equipment, so use a noise filter if necessary.

How to use the noise filter: Three-phase three-wire

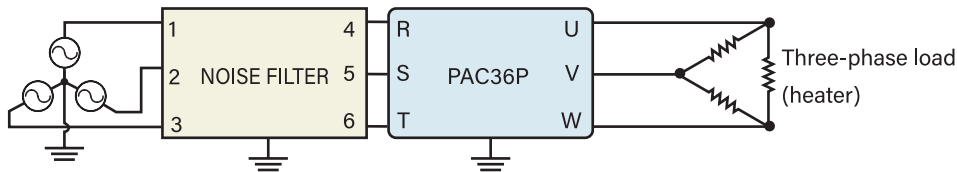
Note) Install the noise filter on the same metal plate as PAC36P and be sure to ground it.

Make the wiring between the noise filter and PAC36P as short as possible.

1) One-phase installed power supply (Delta connection)



2) Neutral point ground power supply (star connection)



■ Noise filter (sold separately)

The frequency component of the noise generated by the thyristor is distributed in the low place below a few MHz,

General-purpose general-purpose noise filters do not have sufficient noise attenuation effect.


Noise can be attenuated by using our designated noise filter.

This noise filter is dedicated to our thyristor power regulator.

CURRENT CAPACITY	Code
20A	NF3020C-SXJ
30A	NF3040C-SXK
45A	NF3050C-SXK
60A	NF3060C-SXK
90A	NF3100C-SXK

CURRENT CAPACITY	Code
135A	NF3150C-SXK
180A	NF3200C-SXK
240A	NF3300C-SXK
300A	NF3300C-SXK
450A	NF3500C-SXK
600A	NF3600C-SXK

■ The contents of this material are subject to change without notice.

 WARNING	<ul style="list-style-type: none">* Be sure to follow the instruction manual when operating this device.* This device is designed for industrial use to control temperature, humidity and other physical values. Avoid using it for control of devices upon which human life is dependent.* If the possibility of loss or damage to your system or property as a result of failure of any parts of the process exists, proper safety measures must be made before the instrument is put into use so as to prevent the occurrence of trouble.
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Head Office & Saitama Factory
ISO 9001/ISO14001 Certification Obtained

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