Shimaden, Temperature and Humidity Control Specialists

°C
%RH
SHIMADEN

SHIMADEN Series PAC46
THYRISTOR THREE-PHASE POWER REGULATOR

BASIC FEATURES

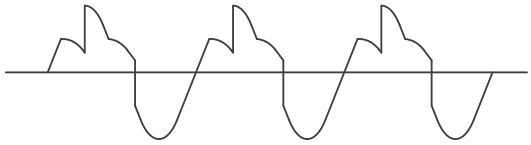
- *Reduced even harmonics with 6-arm control (thyristor pure inverse parallel)*
- *Approx. half the size and mass of the previous model (PAC36P)*
- *Separate European terminals facilitate wiring.*
- *Safety design prevents electric shock.*
- *Four types of high-precision feedback specifications*
- *Output limiting function*
- *Soft start function*
- *Automatic frequency determination*
- *Internal rapid fuse (optional)*
- *Output adjustment function*
- *Heater break alarm function (standard-equipped)*
- *Digital control input: 2 points*
- *Alarm output: 1 point*
- *Abnormal internal temperature alarm function*
- *Overcurrent protection function*
- *Indicator lamps for 4 types of errors*
- *Communication function (optional)*
- *RoHS directive supported*

FEATURES

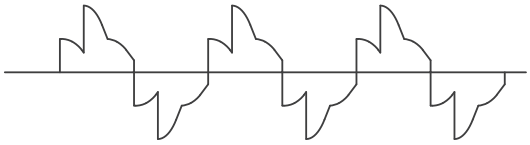
■ Six-arm control (thyristor pure inverse parallel) reduces even harmonics.

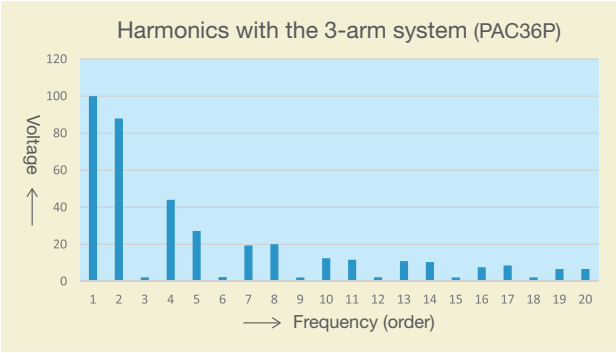
Voltage waveform is more symmetrical than the 3-arm system, so almost no even harmonics are generated. Bias magnetism is less likely to occur in the case of the transformer primary control, thereby enabling more compact transformers with enhanced efficiency.

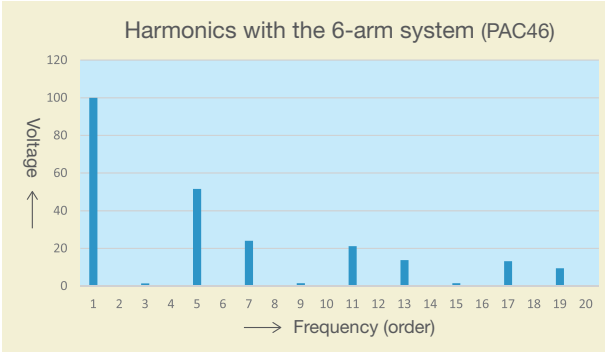
Output voltage waveform with the 3-arm system

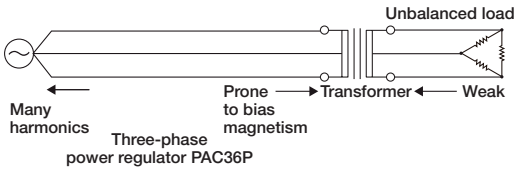


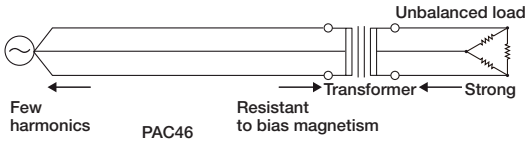
Output voltage waveform with the 6-arm system





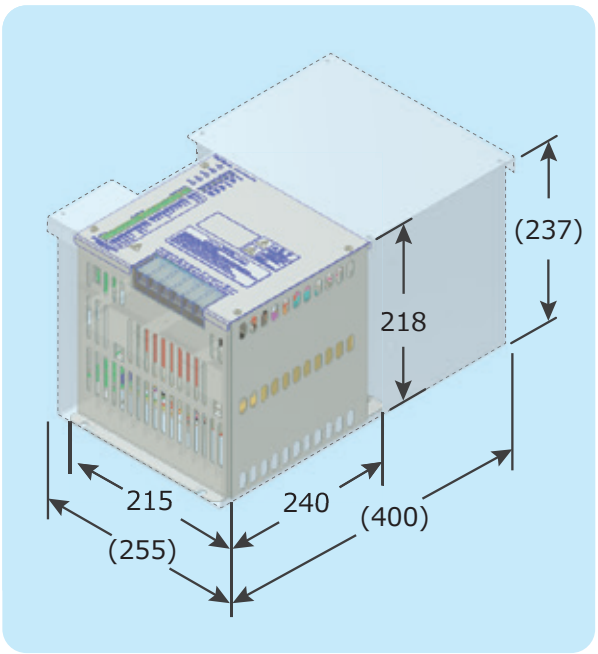






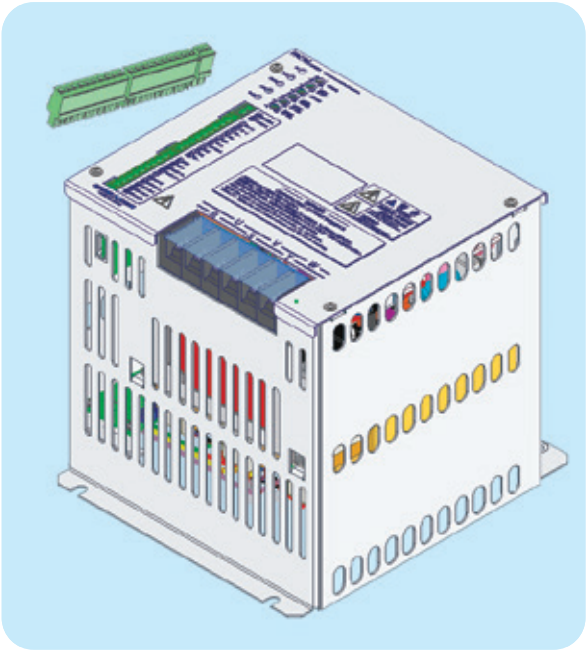
■ RoHS directive supported.

■ Size and mass of the main unit have been reduced to approximately half that of the previous model (PAC36P). [Example: 100 A type]

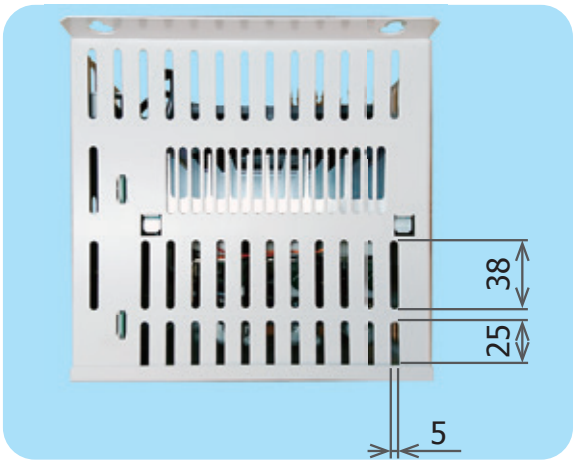


( ) indicates PAC36P.

■ Use of separate European terminals facilitates wiring.



■ The device is designed for safety; its structure is designed to prevent electric shock.



Vertical mounting (recommended) prevents fingers from getting inside if accidentally placed on top the device.

■ A variety of high-precision feedback specifications are available.

A wide selection of feedback specifications is available for the device.

You can choose from among four feedback specifications (voltage, current, power, and voltage square) according to load.

Use of a stable three-phase power supply* enables high control accuracy (±3%FS). It also enhances temperature control, saves space, requires less wiring, and contributes to lower total cost. (* Stable three-phase power supply: Sine wave within 0.5% distortion factor and ±0.05% frequency stability)

Optional communication function also allows the feedback specifications to be changed.

Feedback control is a function that detects the output voltage and current of the power regulator and controls them to maintain output proportional to control input.

The function can maintain stable output even if the supply voltage or load resistance fluctuates.

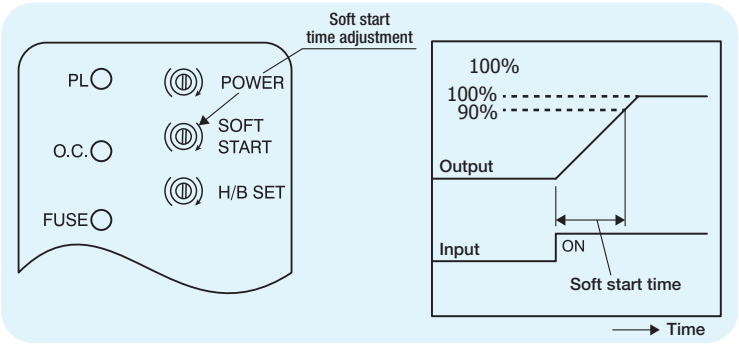
■ Output limiting function

- Current limiting (optional): The current limiting function allows you to limit the output current.
- Start-up output limiting (optional): The start-up output limiting function allows you to limit the output at start-up. (Enables time setting)

If you are measuring output voltage or current of the device, correct value will not be indicated by a rectifier type meter. Be sure to use an effective value meter.

■ Soft start function

Soft start time can be set to reduce rush current.



The characteristics such as those shown in the figure on the left can be realized for the change in the control signal and rise of output during power-up. The time it takes following the control signal to go from zero to 90% output can be adjusted in the range of approximately 1 to 30 seconds.

■ Automatic frequency determination

Automatic power frequency determination eliminates the need for 50/60 Hz switching.

■ Internal rapid fuse (optional)

■ Output adjustment function (See page 14 for a description of this function.)

- Internal power adjustment
- External power adjustment (optional)
- Manual power adjustment (optional)
- Base-power adjustment (optional)
- External/manual power adjustment (optional)
- External power adjustment/base-power adjustment (optional)
- Soft start time
- Automatic power adjustment (optional)

■ Heater break alarm function (standard-equipped)

The heater break alarm does not require an optional communication function, but it is required to detect heater resistance.
The approximate time for replacement is detected by heater resistance.
Under loads where resistance values fluctuate, detection accuracy may however be reduced.

■ Digital control input: 2 points

■ Alarm output: 1 point

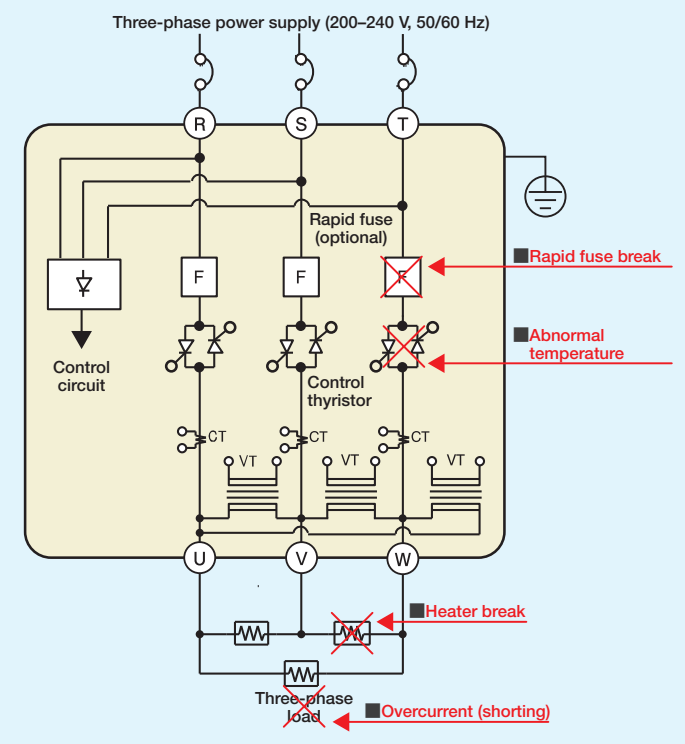
■ The abnormal internal temperature alarm function shuts off output when abnormal temperature is detected.

■ The overcurrent protection function shuts off output when approximately 110% of the rated current is detected.

■ Four types of errors are indicated by indicator lamps.

- Rapid fuse break alarm (optional)
- Overcurrent protection alarm
- Abnormal internal temperature alarm
- Heater break alarm

Monitor lamp lights when error occurs. (For details, see the instruction manual.)



- Rapid fuse break alarm (optional)

  If a rapid fuse breaks, output is shut off and the monitor lamp (FUSE) lights.

- Abnormal internal temperature alarm

  If an abnormal internal temperature is detected, output is shut off and the monitor lamp (O.H.) lights.

- Overcurrent protection alarm

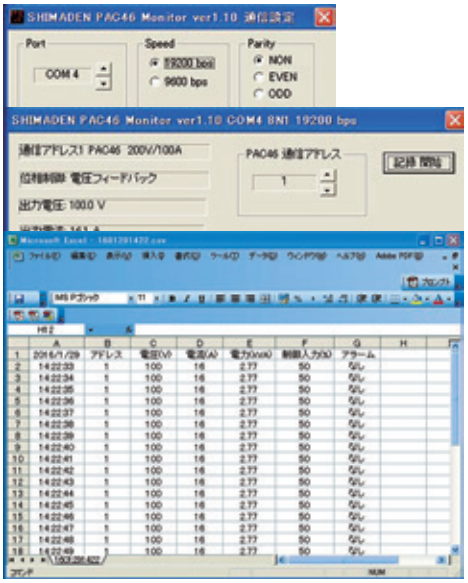
  If excessive current is detected, output is shut off and the monitor lamp (O.C.) lights.

- Heater break alarm

  If a heater break fault is detected, the monitor lamp (H/B) lights. Output continues in this case.

■ Communication (option)

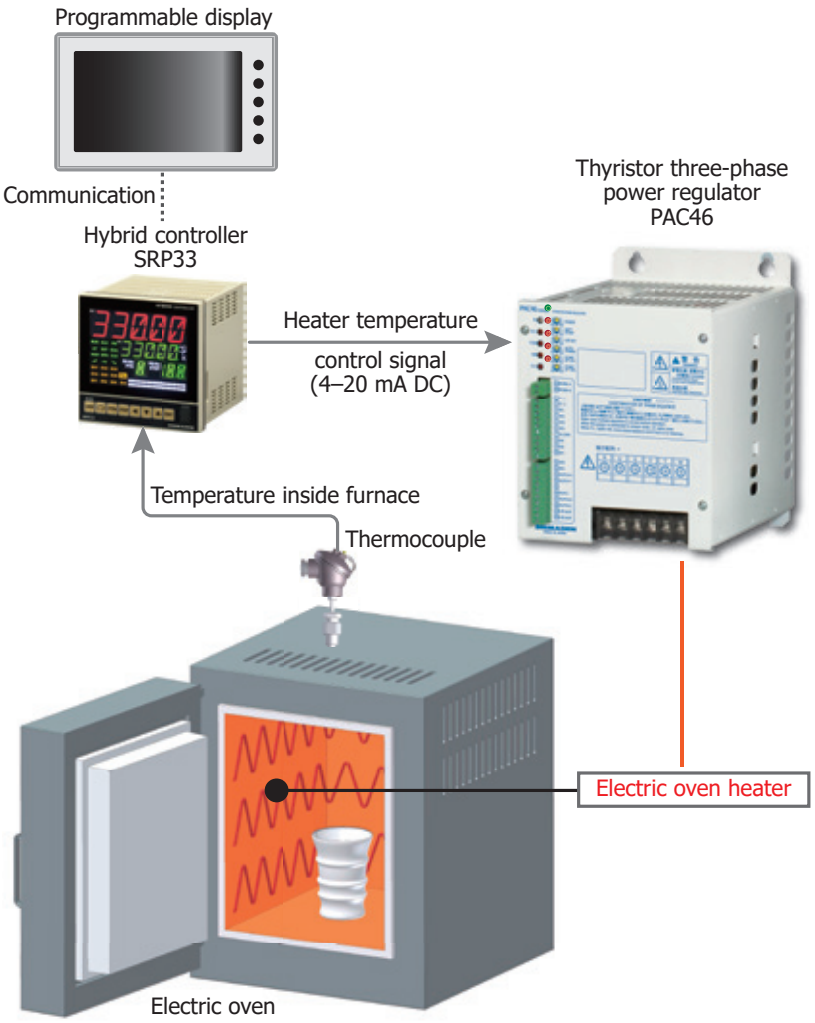
- Up to 31 PAC46 devices can communicate with a single PC.
  (May differ according to connection conditions)
- RS-485 specifications: Insulated from the system
- Communication protocol: Modbus RTU
- Data communications up to 19200 bps (9600/19200 bps selection)
- Free application software is available for PCs. Please download from our website and install.
- Recommended operating environment
  Supported operating systems: Windows 10, Windows 7 (Japanese version)
  Hard disk free space: Min. 1 MB
  Memory capacity: Windows recommended



Notes:

1. For details on communication function, see the item “Communication (optional)” on page 8 (specifications page) or the Communication Interface Instruction Manual (separate).
2. Windows 10 and Windows 7 are registered trademarks of Microsoft Corporation in the United States and other countries.

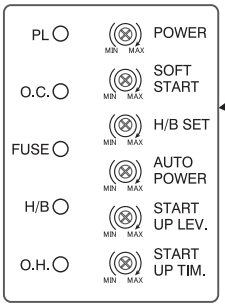
EXAMPLE OF USE



PANEL PART NAMES AND CONTROL TERMINALS

■ Trimmer regulators

POWER : Internal power adjustment
SOFT START : Soft start time adjustment
H/B SET : Heater break alarm setting
AUTO POWER : Automatic power adjustment*1
START UP LEV. : Start-up output limiting level adjustment*1
START UP TIM. : Start-up output limiting time adjustment*1



■ Monitor lamps

PL : Normal power supply: Lights green
Open phase/abnormal phase sequence/abnormal frequency: Lights red*2
O.C. : Lights to indicate overcurrent protection alarm
FUSE : Lights to indicate rapid fuse break alarm*1
H/B : Lights to indicate heater break alarm
O.H. : Lights to indicate abnormal internal temperature alarm

*1 Optional functions
*2 Abnormal frequency is defined as that of power supply outside the approximate range of 44–65 Hz.

Control terminal numbers and symbols

No.	Symbols	Function overview	Remarks
21	RS485-A	RS-485 communication input and output (+)	Available If selecting communication function as the control system
22	RS485-B	RS-485 communication input and output (-)	

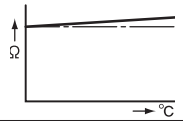
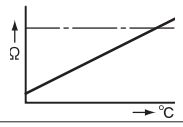
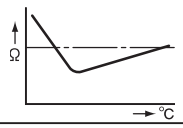
1	C (+)	Control signal input (+)		If not using a power regulator, short VR1 and VR+.
2	C (–)	Control signal input (-)		
3	VR–	Connection terminals of external power regulator for VR1	Connection terminals of base-power/manual power regulator for VR2	
		Red (1)	Red (1)	
4	VR1	White (2)	---	
5	VR2	---	White (2)	
6	VR+	Black (3)	Black (3)	
7	DI-COM	DI-COM and DI1: Base-power/manual power adjustment switching DI-COM and DI2: Synchronization signal for start-up output limiting		
8	DI1			
9	DI2			
10	VR–	Connection terminal of current limit setter for VR3: Red (1)		Optional

11	VR3	Connection terminal of current limit setter for VR3: White (2)	Optional
12	VR+	Connection terminal of current limit setter for VR3: Black (3)	
13	AUTO-P+	Automatic power adjustment signal input (+)	Optional
14	AUTO-P—	Automatic power adjustment signal input (-)	
15			
16	ALM-C	Output alarm for overcurrent protection/abnormal internal temperature/fuse break (optional)	
17	ALM-N.O.		
18	ALM-N.C.		
19	H/B ALM	Output heater break alarm	
20	H/B ALM		

Note: Use wires from 28 to 12 AWG stripped 7.0 mm.

The heating element has characteristics such as those given in the following table. For infrared lamp loads, the start-up output limiting function is required.

For loads such as platinum, molybdenum, tungsten, and Kanthal Super with large heat capacities, current limiting function is required.

	Classification	Type	Max. service temperature	Resistance-temperature characteristics	Additional function
Fixed resistive load	Alloy	● Nichrome ● Iron-chrome ● Graphite ● Kanthal A	1100°C* 1200°C* 1330°C*		☐ These are general characteristics. Supported with standard specs.
Variable resistive load	Pure metal	● Tungsten ● Molybdenum ● Platinum ● Kanthal Super	2400°C† 1800°C† 1400°C† 1700°C*		☐ Infrared lamp (tungsten) requires a circuit for start-up output limiting. ☐ A current limiting function is added to keep rush current within rating.
	Silicon carbide	● Tecorundum ● Siliconit ● Erema	1600°C* 1600°C* 1600°C*		☐ Supported with standard specs if double current capacity is selected. ☐ With the addition of a current limiting function, you do not need to double current capacity. (caution required when not used with transformer) ☐ Use with transformers to match the load terminal voltage.

* In the atmosphere † In a vacuum

INTERNAL HEAT VALUE/MOUNTING CLEARANCE DIAGRAM

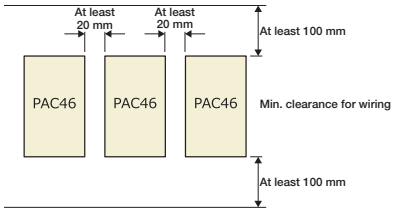
Internal heat value for the PAC46 series with the rated current is as follows.

Voltage is produced between terminals by current flowing to the thyristor. Voltage between terminals multiplied by current (W) turns into Joule heat, resulting in rise in temperature of the thyristor element. Take heat dissipation and ventilation into account. (Heat value conversion formula: 860 kcal = 1000 W)

Rated current (A) / Heat value (W)	20	30	50	75	100	150	200	300	500	600
Internal heat value w/o rapid fuse	89	128	179	262	345	517	684	1057	1687	2020
Internal heat value w/ rapid fuse	97	140	201	297	391	581	775	1208	1847	2208

■ Ambient temperature and load current

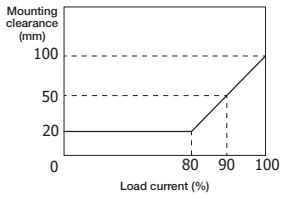
Fasten to control panel, wall, rack, etc., when using. To ensure safety, arrange so that people cannot easily come into contact with the device.
Be sure to mount so air cannot flow between the device and the mounting surface. Air vents or other holes on the mounting surface can cause internal heat generation and functional damage.
Be sure to mount vertically to allow heat to dissipate. Provide at least 100 mm of clearance above and below the device.
If the device has to be mounted horizontally, operate at no higher than 50% of the rated current.

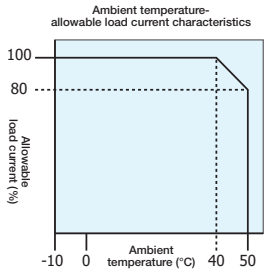


● Mounting clearance and load current

If installing more than one unit, provide clearance between devices for wiring (at least 100 mm) and take measures to minimize the impact of heat from the lower unit.
If there is less than 100 mm of clearance, reduce load current as shown in the figure.

(Precautions)
Rated current of the device assumes an environment where ambient temperature does not rise above 50°C.
If ambient temperature exceeds 40°C, reduce load current as shown in the figure.





SPECIFICATIONS

■ Product type	: Thyristor three-phase power regulator (PAC46)
■ Control input and ratings	
• Current input	: 4–20 mA DC/Receiving impedance: 100Ω
• Voltage input	: 1–5 V DC/Min. input resistance: approx. 300kΩ 0–10 V DC/ Min. input resistance: approx. 220kΩ
■ Supply voltage and ratings	
• 200 V system	: 200–240 V AC ± 10% (50/60 Hz)
• 400 V system	: 380–440 V AC ± 10% (50/60 Hz)
■ Current capacity	: 20 A, 30 A, 50 A, 75 A, 100 A, 150 A, 200 A, 300 A, 500 A, 600 A
■ Control system	: Phase control system
■ Soft start time	: Approximate adjustable range: 1–30 sec. (time it takes to go from zero to 90% output)
■ Applicable load	: Resistive load, inductive load (transformer primary control)
■ Min. load	: 20 A: 0.4 A, 30 A: 0.5 A, 50 A: 0.5 A, 75 A: 0.5 A, 100 A: 1.0 A, 150 A: 1.0 A, 200 A: 2.0 A, 300 A: 2.0 A, 500 A: 2.0 A, 600 A: 2.0 A
■ Output voltage control range	: 0–98% of input voltage or above
■ Output stability	: Input variation ±10% results in output variation within a ±2% range. (95% or below output voltage)
■ Output accuracy	: Support 4 types of feedback; Control output accuracy of ±3.0%FS possible (when output is 10–90%; three-phase average)
■ Control element configuration	: SCR × 6, pure inverse-parallel connection (6-arm system)
■ Overcurrent protection system	
• Electronic gate breaking function	: Approx. 110% of rated current (when the crest factor is 2 or below)
• Rapid fuse (optional)	: Approx. 117–133% of rated current
■ Cooling system	
• Natural air	: 20 A, 30 A
• Forced air cooling system	: 50–600 A
■ Alarm monitors	
• Overcurrent	: LED [O.C] lights/(ALM-C)–(ALM-NO) continuity (when overcurrent protection is performed)
• Fuse break	: LED [FUSE] lights/(ALM-C)–(ALM-NO) continuity (when rapid fuse breaks)
• Abnormal internal temperature	: LED [O.H.] lights/(ALM-C)–(ALM-NO) continuity (when abnormal radiator temperature is detected)
• Heater break	: LED [H/B] lights/(H/B ALM)–(H/B ALM) continuity (when heater break alarm is output)
■ Power lamp	
• Output contact rating	: 240 V AC, 1 A/resistive load
• Normal power supply	: Green LED lit
• Open phase/abnormal phase sequence/abnormal frequency	: Red LED lit (when power frequency is outside the approximate range of 44–65 Hz)
■ Standard functions	
• Control system	: Selectable from the following: ◆Phase control/voltage feedback ◆Phase control/current feedback (applicable loads: pure metal, Kanthal Super, etc.) ◆Phase control/power feedback (applicable loads: silicon carbide, carbon, etc.) ◆Phase control/voltage square feedback (applicable loads: nichrome, etc.) ◆Communication function (The factory default control system is voltage feedback. RS-485 communication allows the feedback system to be changed.) Note: Output increases as the control input exceeds 3%.
• Output adjustment function	: Internal power adjustment: 0–100%
• Digital control input (DI)	: Input 2 points: Non-voltage contact or open collector can be used (max. 5 V, 0.88 mA). DI1: Base-power/manual power adjustment switching DI2: Synchronization signal for start-up output limiting.
• Heater break alarm function	: If a heater break is detected, alarm H/B is output (H/B ALM).
Setting range	: 10–100% (accuracy guarantee not applicable below 30%)
Setting accuracy	: Within ±5% (when set to 30% or above)
Action	: Alarm signal output
Output during action	: The control output is maintained.
Alarm output reset	: Reset as the heater condition returns to normal.
Voltage variation tolerance	: Within ±10%
• Alarm output (ALM)	: 1 point; Contact 1c; 240 V AC, 1 A; Insulated from the system; Alarms against overcurrent and abnormal internal temperature

■ Optional functions

• Output limiting function

Current limiting : Limiting to 50–100% of rated current (via external current limit setter for VR3)

Start-up output limiting : Limiting to 0–60% output for 1–60 sec.

• Output adjustment function

Use with voltage/current output type controller : External power adjustment: 0–100% (with 100% input)
Manual power adjustment: 0–100%
Base-power adjustment: 0–100% (with 0% input)
External power adjustment + manual power adjustment: 0–100%
External power adjustment + base-power adjustment: 0–100%

Use with contact output type controller : External power adjustment: 0–100% (with contact ON)
High/low power adjustment: 0–100%

• Rapid fuse : Alarm output for fuse break (ALM).

• Automatic power adjustment function : 25–100%, non-insulated from the control input

• Communication (optional) : Available if selecting communication function as the control system

RS-485 specifications : Insulated from the system

Communication protocol : Modbus RTU

Communication rate : Selectable from 9600/19200 bps

Parity : Selectable from EVEN/NON/ODD

Stop bit : 1 bit

Readable parameters : Control system, output voltage value*/current value*/power value*, heater resistance value*, interphase output voltage values, phase output current values, alarm action status, control signal input value, adjustment trimmer values, VR input values, DI input values, control input scale lower limit value, automatic power adjustment (optional) control input value
* average of values for each phase

Settable parameters : Control system, control signal input value, adjustment trimmer values, VR input values, DI input values, alarm output values, operation status ON/OFF, communication memory mode setting, parameter reset, control input scale lower limit value, automatic power adjustment (optional) control input value

For details, see separate PAC46 Series Communication Interface Instruction Manual.

■ Operating environment

• Ambient temperature range : -10–50°C (load current reduction required at 40°C or above)

• Ambient humidity range : 90%RH or below (no dew condensation)

■ Applicable standards : RoHS directive supported

■ Insulation resistance

Power terminal and grounding terminal clearance : 500 V DC, 20MΩ or above

Power terminal and control input terminal clearance : 500 V DC, 20MΩ or above

■ Dielectric strength

Power terminal and grounding terminal clearance : 200–240 V: 2000 V AC, 1 min.
380–440 V: 2500 V AC, 1 min.

Power terminal and control input terminal clearance : 200–240 V: 2000 V AC, 1 min.
380–440 V: 2500 V AC, 1 min.

■ Power consumption :

	200–240 V	380–440 V
20 A, 30 A	18 VA or below (for 200 V)	11 VA or below (for 380 V)
50 A, 75 A, 100 A	33 VA or below (for 200 V)	22 VA or below (for 380 V)
150 A, 200 A, 300 A	40 VA or below (for 200 V)	30 VA or below (for 380 V)
500 A, 600 A	80 VA or below (for 200 V)	55 VA or below (for 380 V)

■ Material/finish : Normal steel plate/paint finish (Munsell N8.5 equivalent)

■ External dimensions : See the External Dimensions Diagram and Mass on page 21.

■ Mass :

	200–240 V	380–440 V
20 A, 30 A	Approx. 5.0 kg	Approx. 7.5 kg
50 A, 75 A, 100 A	Approx. 6.0 kg	Approx. 10.0 kg
150 A, 200 A, 300 A	Approx. 15.0 kg	Approx. 20.0 kg
500 A, 600 A	Approx. 42.0 kg	Approx. 50.0 kg

■ Accessories : Instruction Manual (this brochure): 1 copy
Separate connection terminals: 2 long terminals and 1 short terminal (Short terminal is contained if selecting code CM (communication function) as the control system.)
Jumper wire: 1 wire

ORDERING INFORMATION

ITEM	CODE	SPECIFICATIONS
1. Series	PAC46	Thyristor three-phase power regulator
2. Control input	3	1 to 5V DC Input resistance: Approx. 300kΩ or above
	4	4 to 20mA DC Receiving impedance: 100Ω
	6	0 to 10V DC Input resistance: Approx. 220kΩ or above
3. Supply voltage (*1)	20 -	200V AC
	22 -	220V AC
	24 -	240V AC
	38 -	380V AC
	40 -	400V AC
	44 -	440V AC

4. Current capacity		Supply voltage: 200 to 240 V				Supply voltage: 380 to 440 V		
		Code	Current capacity	Applicable load capacity		Code	Current capacity	Applicable load capacity
		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
		051	50A	17.3 to 20.8 kVA		052	50A	32.9 to 38.1 kVA
		071	75A	26.0 to 31.2 kVA		072	75A	49.4 to 57.2 kVA
		101	100A	34.6 to 41.6 kVA		102	100A	65.8 to 76.2 kVA
		151	150A	52.0 to 62.4 kVA		152	150A	98.7 to 114.3 kVA
		201	200A	69.3 to 83.1 kVA		202	200A	131.6 to 152.4 kVA
		301	300A	103.9 to 124.7 kVA		302	300A	197.4 to 228.6 kVA
	†1	501	500A	173.2 to 207.8 kVA		502	500A	329.1 to 381.0 kVA
	†1	601	600A	207.8 to 249.4 kVA		602	600A	394.9 to 457.2 kVA

5. Control system (6-arm phase control)		P0	Phase control/voltage feedback
		P1	Phase control/current feedback
		P2	Phase control/power feedback (*2)
		P3	Phase control/voltage square feedback
	†2	CM	Communication function (The factory default setting is voltage feedback.) (*3)

6. Output limiting function	0	Without	
	1	Start-up output limiting: Limiting to 0 to 60% output for 1 to 60 sec.	
	2	Current limiting: Limiting to 50 to 100% of rated current (via external setter for VR3)	w/ QSV006 × 1
	3	Start-up output limiting + current limiting (code 1 + code 2)	w/ QSV006 × 1

7. Output adjustment function		N	Without (adjustment via standard-equipped internal power regulator)	
	Selectable when used with voltage/current output type controller	P	External power adjustment	w/ QSV005 × 1
		M	Manual power adjustment	w/ QSV005 × 1
		B	Base (residual)-power adjustment	w/ QSV005 × 1
		W	External power adjustment + manual power adjustment	w/ QSV005 × 2
		Y	External power adjustment + base-power adjustment	w/ QSV005 × 2
	Selectable when used with contact output type controller	C	External power adjustment	w/ QSV005 × 1
		H	High/low power adjustment	w/ QSV005 × 2

8. Rapid fuse	0	Without
	1	With Fuse break alarm output available

9. Automatic power adjustment function (non-insulated from the control input)	0	Without
	4	4 to 20 mA DC Receiving impedance: 100Ω
	6	0 to 10 V DC Input resistance: Approx. 220kΩ or above

10. Remarks	0	Without
	9	With

Notes:

*1 For use beyond the rated voltage, please make an inquiry.

*2 Variable resistance heating elements such as silicon carbide (SiC) heaters have a high negative temperature coefficient (their resistance greatly affected by temperature). During a temperature rise, their resistance falls far below that within the ordinary temperature range, leading to inadequate power. Maintaining output power within an appropriate range at every temperature requires the device's current capacity to be multiplied by a square root of the heating element's resistance ratio. To give an example, the approximate resistance ratio of SiC heaters is 1:3, a square root of which is √3, or approx. 1.73. The required current capacity when using those heaters is thus 1.73 times the original capacity. However, since heater deterioration may further widen the ratio, a current capacity even higher than the abovementioned must be selected. As for use of SiC heaters, we recommend about double the original capacity.

*3 See separate PAC46 Series Communication Interface Instruction Manual.

†1 Current capacity 500/600 A for 200 V system and 20–600 A for 400 V system are quasi-standard specifications. For delivery times, please inquire in advance.

†2 When selecting communication function, RS-485 communication allows the feedback system to be changed.

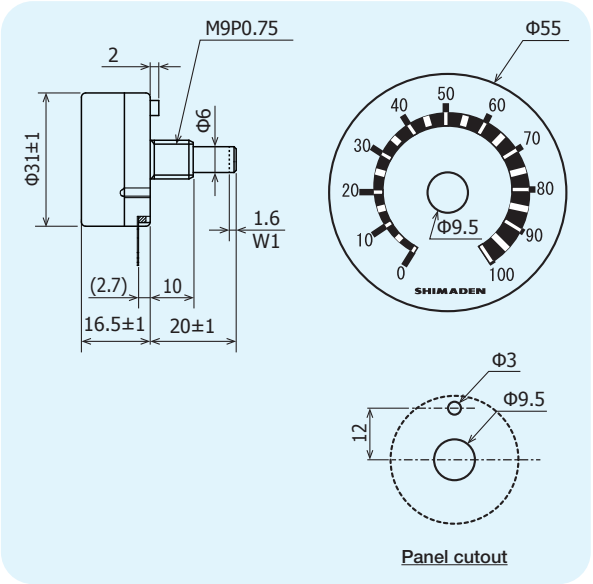
ITEMS SOLD SEPARATELY

■ External Power Adjuster

Name	Model
External power adjuster	QSV005
Current limit setter	QSV006

● Specifications: Potentiometer: RV30YN 20S/
Characteristics and resistance: B10kΩ
Lead wire: 1 m vinyl coated wire/
Wire-end treatment: Half-stripped
Scale plate: Single knob

● External dimensions and panel cutout diagram



● Name and scale

External power adjuster	(QSV005)	0–100%
Manual power adjuster	(QSV005)	0–100%
Base-power adjuster	(QSV005)	0–100%
High/low power adjuster	(QSV005)	0–100%
Current limit setter	(QSV006)	50–100%

■ Rapid fuse

PAC46 current capacity	Rated load capacity (200–240 V)	Rated load capacity (380–440 V)	Mounted fuse capacity	Fuse model (in-house)
20 A	6.9–8.3 kVA	13.2–15.2 kVA	25 A	QSF018
30 A	10.4–12.5 kVA	19.7–22.9 kVA	40 A	QSF009
50 A	17.3–20.8 kVA	32.9–38.1 kVA	63 A	QSF016
75 A	26.0–31.2 kVA	49.4–57.2 kVA	100 A	QSF010
100 A	34.6–41.6 kVA	65.8–76.2 kVA	125 A	QSF017
150 A	52.0–62.4 kVA	98.7–114.3 kVA	200 A	QSF019
200 A	69.3–83.1 kVA	131.6–152.4 kVA	250 A	QSF012
300 A	103.9–124.7 kVA	197.4–228.6 kVA	350 A	QSF013
500 A	173.2–207.8 kVA	329.1–381.0 kVA	630 A	QSF020
600 A	207.8–249.4 kVA	394.9–457.2 kVA	710 A	QSF049

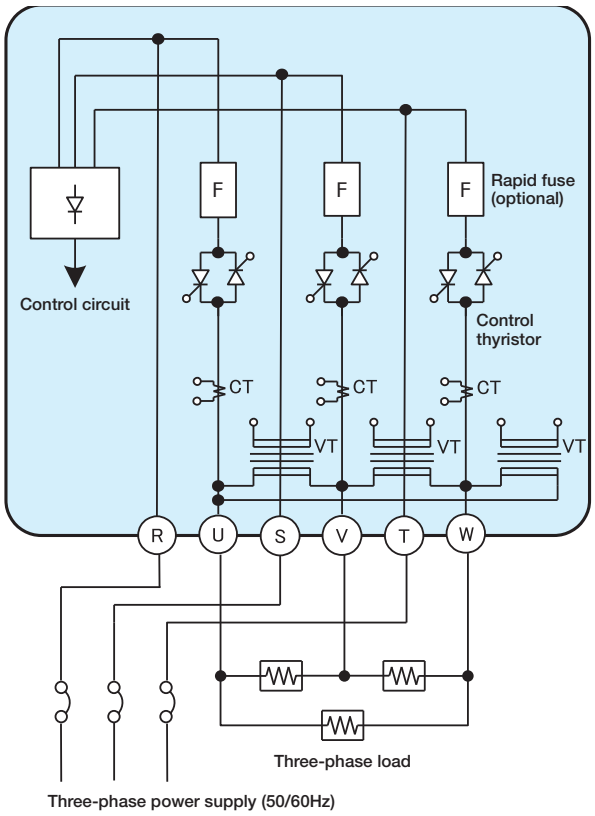
Note: Rated load capacity is calculated as below:
Rated load capacity (three-phase) = √3 × Rated input voltage × Output current

■ Noise filters

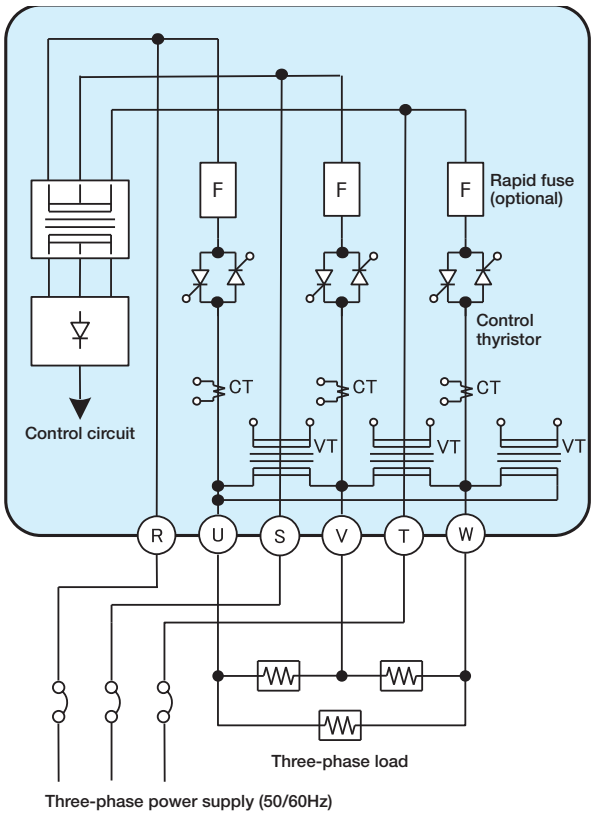
PAC46 current capacity	Noise filter capacity	Model
20 A	20 A	NF3020C-SXJ
30 A	40 A	NF3040C-SXK
50 A	50 A	NF3050C-SXK
75 A	100 A	NF3100C-SXK
100 A	100 A	NF3100C-SXK
150 A	150 A	NF3150C-SXK
200 A	200 A	NF3200C-SXK
300 A	300 A	NF3300C-SXK
500 A	500 A	NF3500C-SXK
600 A	600 A	NF3600C-SXK

CIRCUIT BLOCK DIAGRAM AND WIRING EXAMPLE

■ Supply voltage: 200–240 V AC

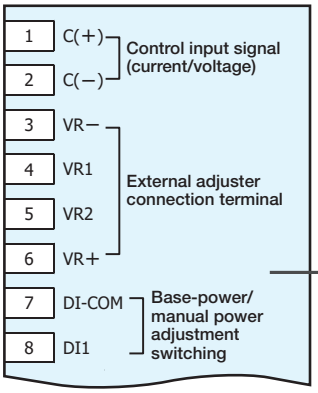


■ Supply voltage: 380–440 V AC



■ Wiring example

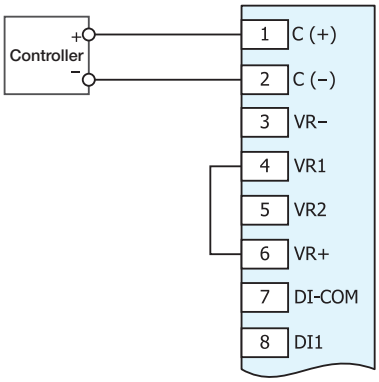
● Wiring for control input signal



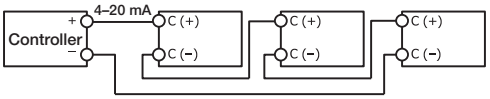
Control signal from the controller (4–20 mA/1–5 V/0–10 V) is input to the control signal terminals C (+) and C (-). When wiring, be careful of the polarity and take measures to ensure noise from strong electric circuits does not get into the wiring.

Connection between 7 (DI-COM) and 8 (DI1)	VR2 function
Open-circuited	Base-power adjustment
Short-circuited	Manual power adjustment

1. Connection of device (4–20 mA input) with 4–20 mA output type controller

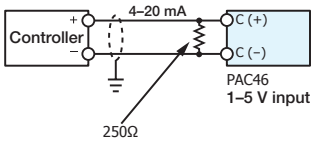


If connecting multiple units, connect in series as shown in the following figure.
Input resistance for the device (4–20 mA input) is 100Ω, so if load resistance tolerance for the controller is 600Ω, you can connect up to 6 units.

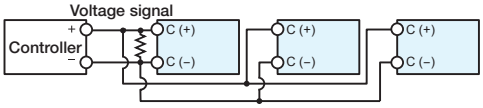


2. Connection of device (1–5 V input) with 4–20 mA output type controller

When connecting a 4–20 mA output type controller and the device (1–5 V input), connect a 250Ω resistor in parallel with the input terminals of the device.



If connecting multiple units, connect in parallel as shown in the following figure.



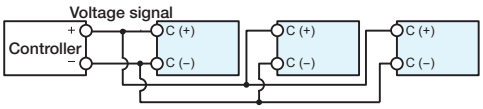
In the case of voltage input type controller, wire so that control signal flows in parallel through devices.

3. Connection of device (0–10 V input) with 0–10 V output type controller

The device specification is also 0–10 V input in this case.

Because of the high input resistance, be sure to use a double-core shielded wire and single-point ground to prevent the impact of noise.

Connect the positive (+) terminal of the controller to the C (+) input terminal of the device, and the negative (-) terminal of the controller to the C (-) input terminal of the device. If connecting multiple units, connect in parallel as shown in the following figure. It is not necessary to mount a resistor.



If maximum load current for the 0–10 V controller is 2 mA, since input resistance for PAC46 is 220kΩ, you can connect up to 44 units.

4. Connection with contact output type controller

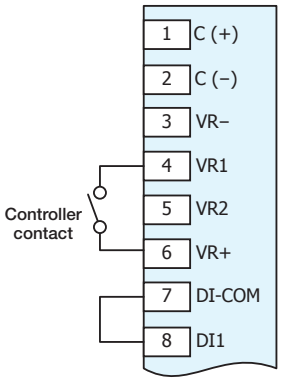
When connecting to a contact output type controller, short circuit terminals 7 (DI-COM) and 8 (DI1).

Do not connect anything to the input terminals 1 (C (+)) and 2 (C (-)) of the device. Opening the 4 (VR1) terminal shuts off the output.

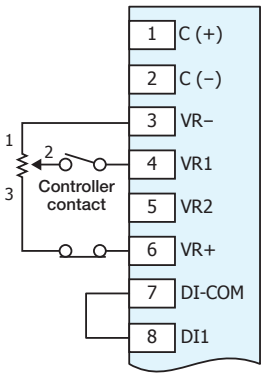
Connecting a contact output type controller applies to two-position, proportional and PID types.

The wiring has no polarity and wiring resistance can be anything up to 10Ω. You should however avoid wiring together with strong circuits.

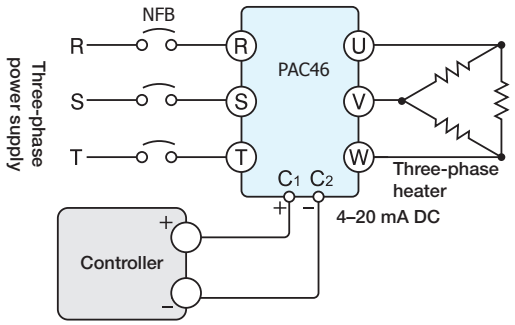
● 0–100% switching



● Connection of external power adjuster



■ Direct connection of general heater



■ Use with transformer

Precautions when using transformer

When to use a transformer:

1) Heater voltage differs from power supply voltage.
2) It is necessary to insulate the heater circuit from the power supply.
3) Ground insulation deteriorates like with vacuum equipment.

1. Transformer flux density

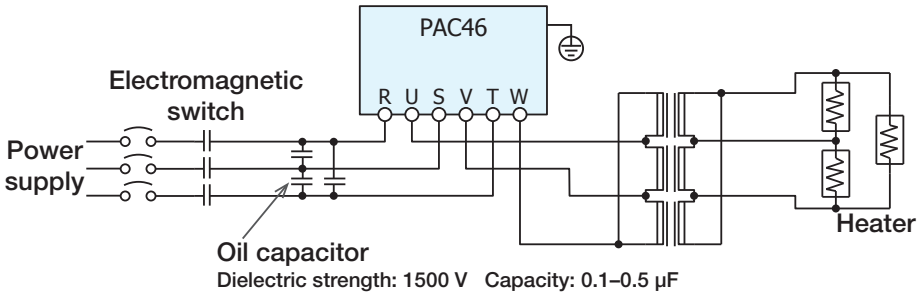
If the iron core of the transformer becomes magnetically saturated, excessive current flow can damage the device.
During operation, switching takes place in each cycle of supply voltage. If the load becomes too heavy, the iron core of the transformer tends to become magnetically saturated. You should therefore design the system so that magnetic flux density is lower than that of a conventional power transformer.

2. Use of insulated transformer

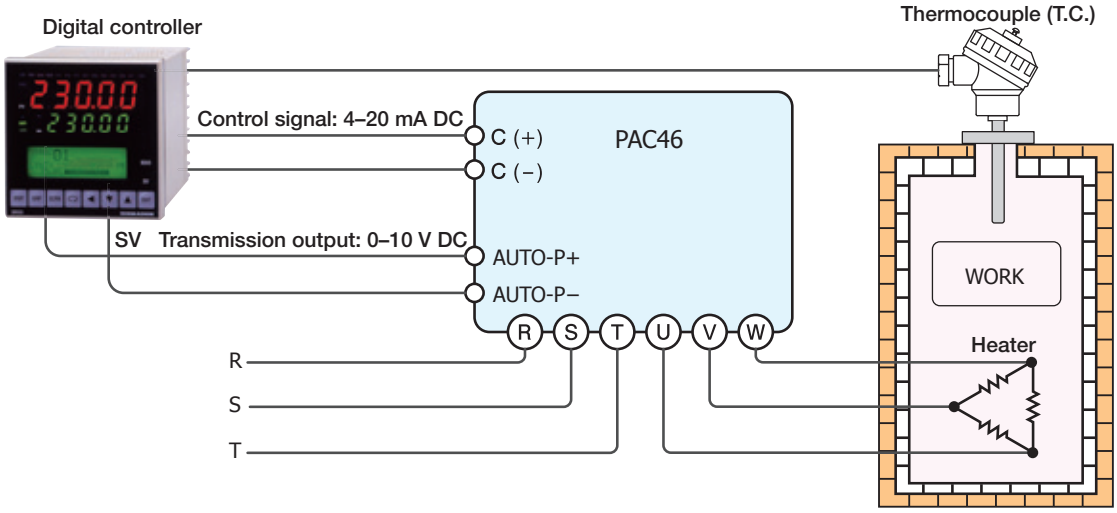
If the heater is structurally prone to ground faults or if the ground dielectric strength drops like with vacuum equipment, use an insulated transformer to protect the device and its power supply.

3. Precautions when using electromagnetic switch

Using an electromagnetic switch for a circuit connected to the transformer could result in malfunction due to noise when the contact is opened and closed. In this case, connect a capacitor to the power side of the device to absorb the noise as shown below.



■ Example of use with controller

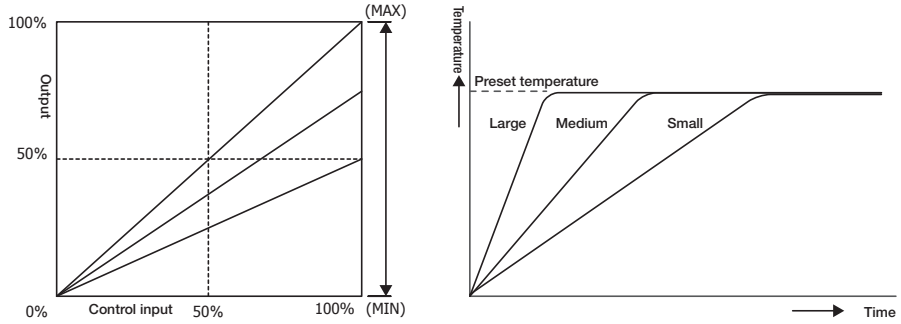


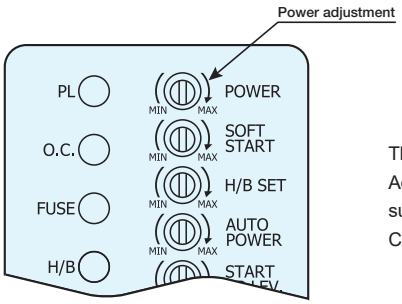
When the set value (SV) transmission output (4–20 mA or 0–10 V) of the controller is introduced to the PAC46 terminals for automatic power adjustment (AUTO-P+)–(AUTO-P-), the maximum power (ramp) is automatically set to facilitate control. Another effect is that when multiple thyristors are turned on at the same time, power peaks can be saved to avoid placing a load on power equipment.

FUNCTIONS

■ Output adjustment function

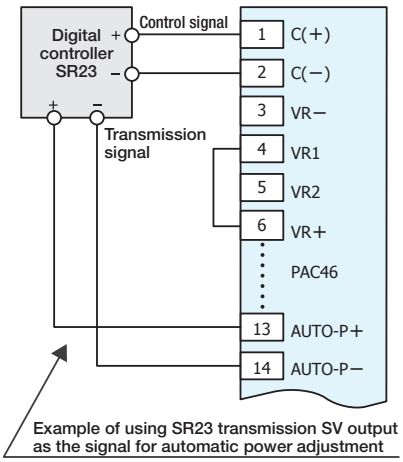
1. Power adjustment



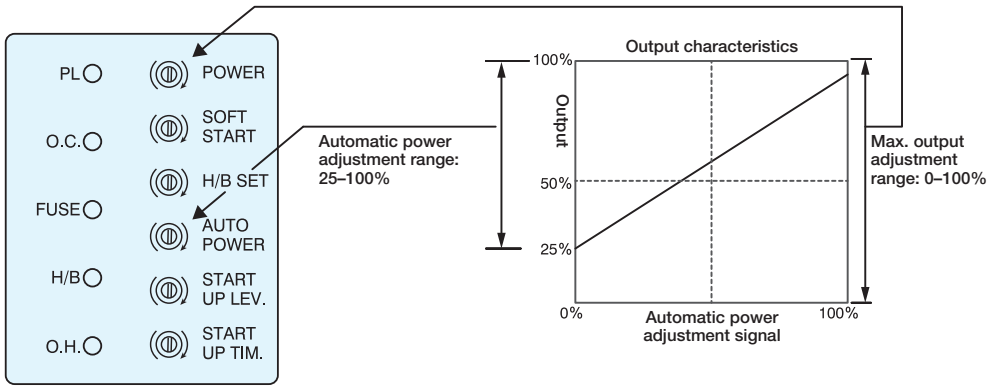


The power adjustment knob controls the output value of the PAC46 from 0% to 100%. (Upper left)
Adjusting output in this way allows the user to set the temperature for temperature control devices such as the heater.
Convergence time differs according to the power adjustment knob setting value. (Upper right)

2. Automatic power adjustment (optional)

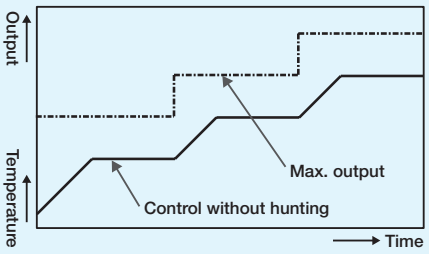


The automatic power adjustment function automatically adjusts the maximum output using external signals (such as a controller/PLC) for optimum control.
By setting the maximum output power that is optimal for the set temperature from the controller, you can improve control accuracy without the temperature change rate being greater than necessary.



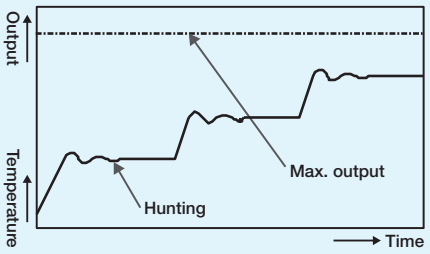
The automatic power adjustment function enables maximum power output to be adjusted together with the target value by external signal (from program controller, computer or other controllers) to eliminate overshoot and realize optimum control.

● Output and control results with automatic power adjustment



Maximum output also varies with the target value, eliminating overshoot and providing optimum control.

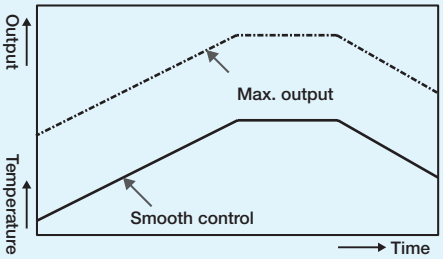
● Output and control results without automatic power adjustment



Over-shooting and hunting may occur due to excessive power at low temperatures.

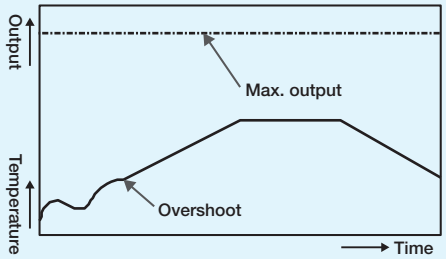
Program control comparison: Program control prevents overshoot during start-up and can handle exceptionally low temperature ramps.

● Output and control results with automatic power adjustment



Offers smooth program adjustment with no overshoot during start-up.

● Output and control results without automatic power adjustment

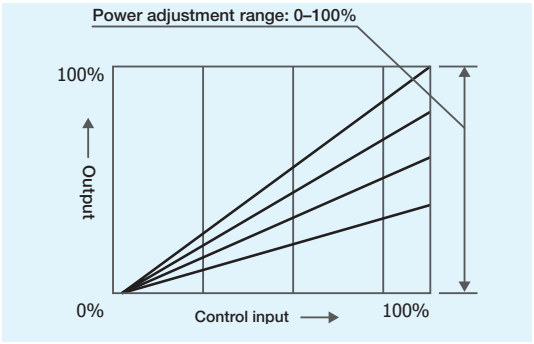


Starting output may be excessive, resulting in overshoot and poor control characteristics at low temperatures.

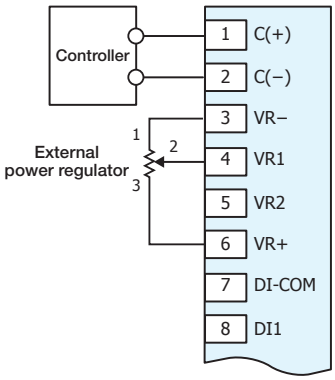
3. External power adjustment

External power adjustment is used to adjust the output of the device from remote locations. To use this function, select external power adjustment when ordering. External power adjustment can be used to adjust the power to the desired temperature to enhance control, to adjust the climb ramp, and to manually correct the load characteristics.

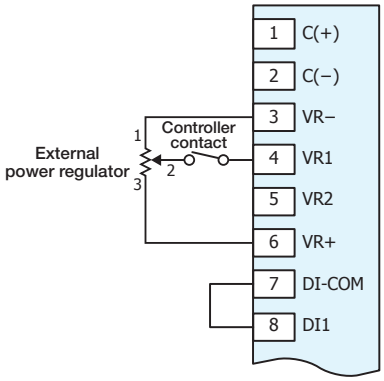
Note: Internal power adjustment (standard feature) can be used in the same way as described above when combined with a voltage/current input type controller. Internal power adjustment can be used to adjust the power to the desired temperature to enhance control, to adjust the climb ramp, and to manually correct the load characteristics. An external adjuster (B10kΩ) can be connected to the terminal to add external adjustment function after delivery.



■ Use with voltage/current output type controller



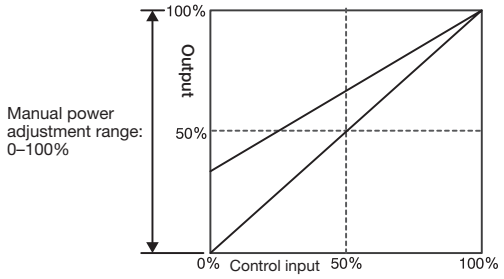
■ Use with contact signal output type controller

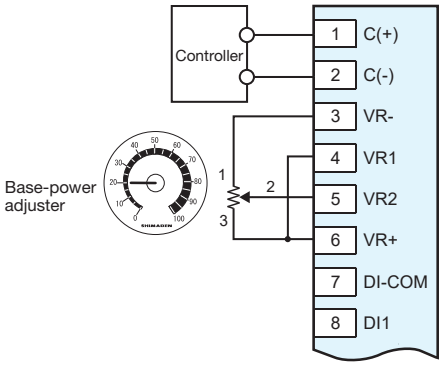


If not using an external power adjuster short circuit 4 (VR1) to 6 (VR+).

4. Base power adjustment

The base-power adjustment is generally used to retain output even when the control signal is 0%.



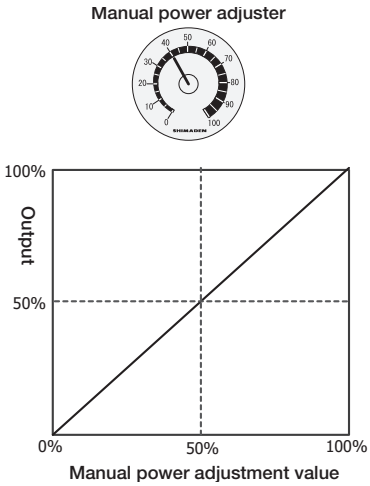


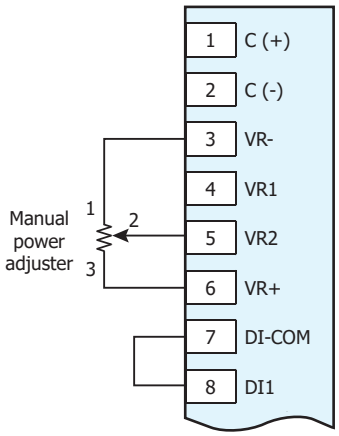
5. Manual power adjustment

Switched to and from adjustment using the control input, manual power adjustment is typically used when adjusting output without using the control input (automatic), when adjusting test operation, or when selecting manually set output by an external signal. Examples of toggling automatic (control input) and manual and how to adjust are provided below.

Set up external contacts to toggle between automatic and manual operation modes, automatic power adjustment and manual power adjustment.

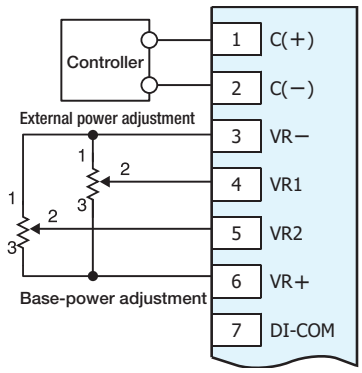
■ Adjustment without controller

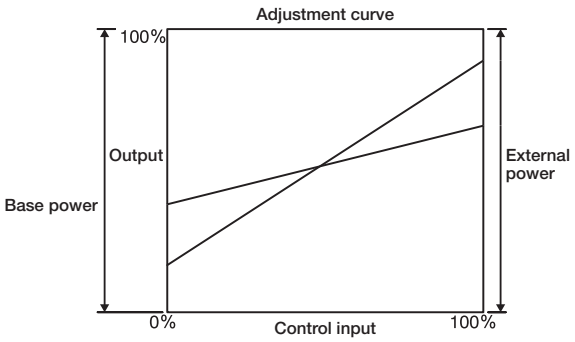




6. External power adjustment and base-power adjustment (when used with voltage/current output type controller)

This configuration facilitates control and adjusts to load characteristics by adjusting maximum output and allowing a certain degree of minimum output to remain.





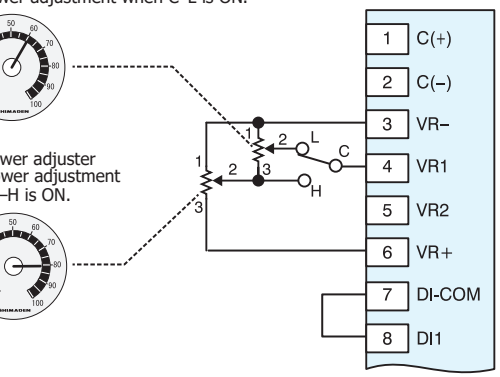
7. High/low power adjustment

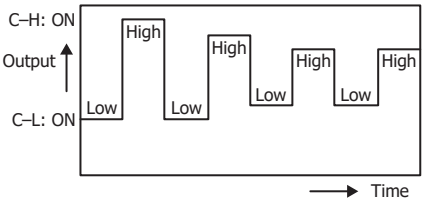
Consisting of contact signals, high/low power adjustment adjusts output (high power) for contact short circuit and output (low

power) when contact is open to facilitate control.
It is also used when heater characteristics demand a constant flow of current.

■ Low power adjuster
Low power adjustment when C–L is ON.

■ High power adjuster
High power adjustment
when C–H is ON.





■ High power adjustment:

The output for C-H short circuit can be adjusted from 0% to 100%.
Adjust to the best output for the set temperature.

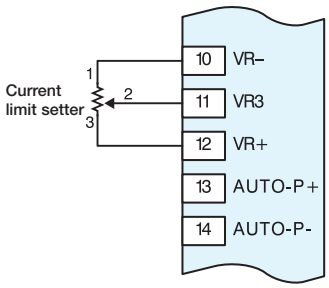
■ Low power adjustment:

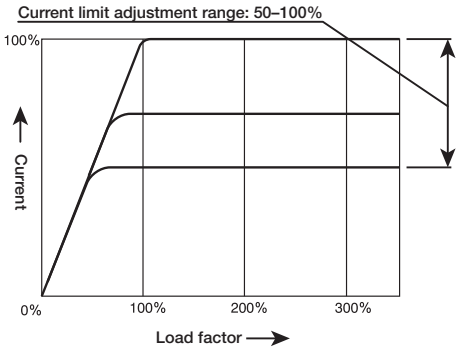
Residual power adjustment for C-L short circuit.
The scale of the adjuster is between 0% and 100%, but the following formula determines the residual power.
Residual output = (high power) x (low power).

Example: In the case where high power is 70% and low power is 40%: Residual output = 70% x 40% = 28%.

8. Current limiting (optional)

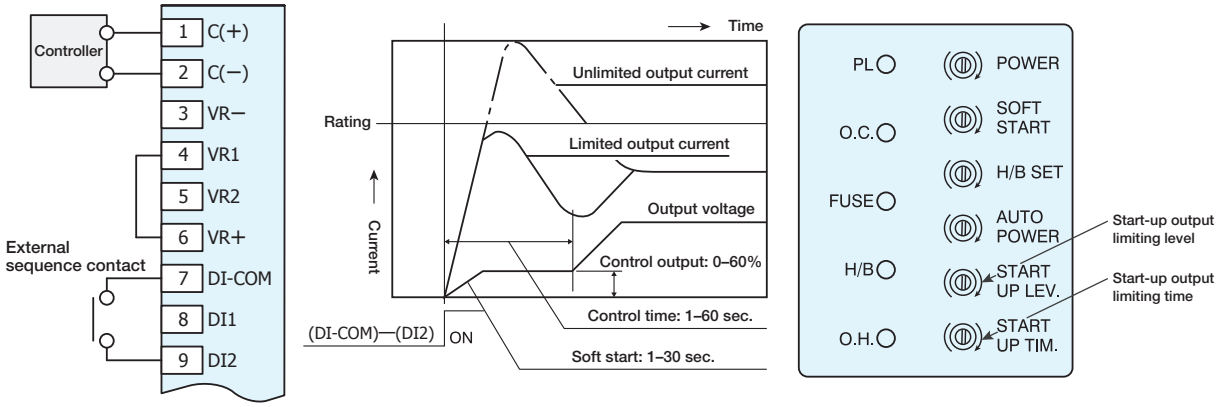
Function for limiting output current to within 50–100% of current capacity.
Connect a current limit setter with a 50% to 100% scale to the (VR-)–(VR3)–(VR+) terminals as shown below.





9. Start-up output limiting (optional)

There are two ways to use this circuit: limit the output at power-up or in sync with an external sequence.



■ To limit the output during power-up

Leave the (DI-COM)–(DI2) terminals short-circuited.

■ To limit the output by synchronizing with an external signal

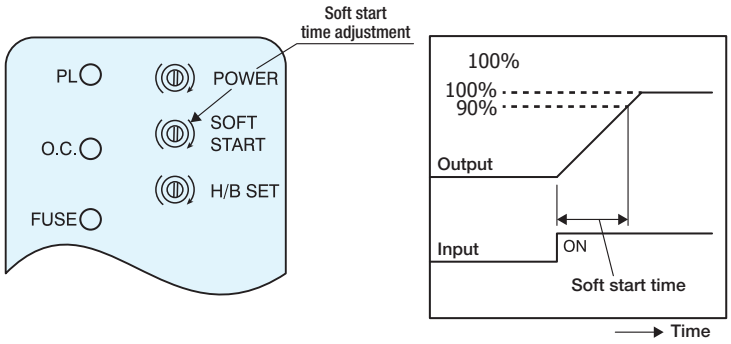
Connect the (DI-COM)–(DI2) terminals to an external signal.

Output remains limited while the (DI-COM)–(DI2) terminals are open.

10. Soft start time

The characteristics shown in the figure below can be obtained for change in the control signal and output rise during power-up.

The time it takes for output to go from zero to 90% following the rise of the control signal can be adjusted in the range of approximately 1 to 30 seconds.

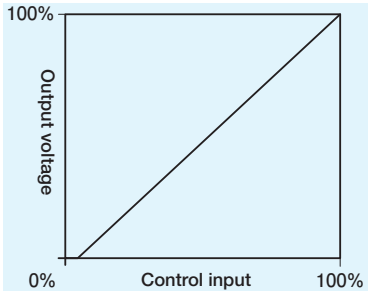


CONTROL SYSTEM AND OUTPUT LIMITING FUNCTION

A variety of feedback control systems is available for the device (voltage, current, power, voltage square).
Feedback control is a function that detects the output voltage and current of the power regulator and regulates them to maintain output proportional to control input.
The function can maintain stable output even if the supply voltage or load resistance fluctuates.
The output limiting function includes current limiting and start-up output limiting.
The correct measurement value will not be indicated by a rectifier type meter if you are measuring device output voltage or current.
Be sure to use an effective value meter.

1. Phase control/Voltage feedback

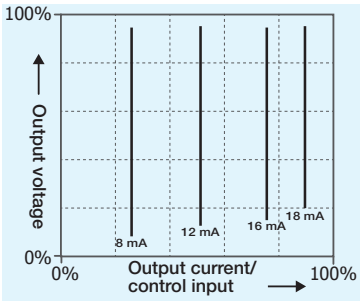
Voltage feedback control regulates the output so that the output voltage is proportional to the control input.
If control input is constant, output voltage is kept constant even if load or power supply fluctuates.
For example, if the supply voltage is 200 V and the control input is 80%, the output voltage is regulated at 160 V. Voltage feedback characteristic allows the control input and output voltage to be linear to each other, as shown in the characteristic diagram. Output is also controlled by a voltage controller so secondary voltage fluctuation is minimal even if primary voltage fluctuates, making it suitable for precise control at less than 2% of the primary side range of fluctuation (less than 0.2 V with 10 V fluctuation).



Voltage feedback control regulates the average of the three-phase load voltage.
The voltage of each phase cannot be controlled separately.

2. Phase control/Current feedback

Current feedback control regulates the output so that the output current is proportional to the control input. If control input is constant, output current is kept constant even if load or power supply fluctuates. For example, if the current capacity is 100 A and the control input is 80%, the output current is regulated at 80 A.
This control characteristic is based on a calculation using the current setting value provided by the control signal and the current signal from the current transformer (internal CT). If the control input is constant, the current is controlled consistently even if load or current fluctuates, making it suitable for controlling platinum, molybdenum, tungsten, Kanthal Super, etc.



The following heaters are effectively operated with this constant current control.

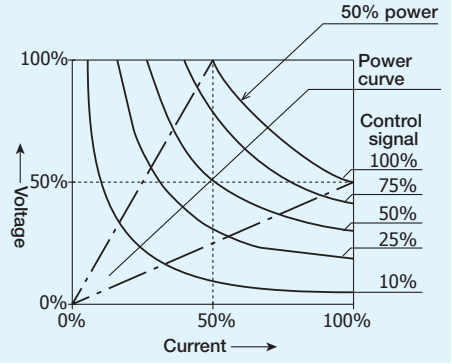
- □ Heater in which rush current flows: platinum, molybdenum, Kanthal Super
- □ Heater with significant current variation: carbon, salt bath
- □ Heater that requires stable electrolytic current: plating

Current feedback control regulates the average of the three-phase load current.
The current of each phase cannot be controlled separately.

3. Phase control/Power feedback

Power feedback control regulates the output so that the product of output voltage and current is proportional to the control input.
If control input is constant, output power is kept constant even if load or power supply fluctuates.
For example, if supply voltage is 200 V, current capacity is 100 A, and control input is 80%, the output power is regulated to the following value:

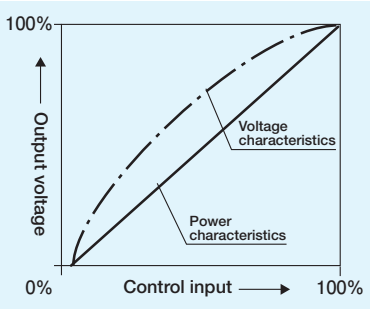
$\sqrt{3} \times 200\ V \times 100\ A / 2 \times 0.80 \fallingdotseq 13.9\ (kVA)$



Power feedback control regulates the electric power consumption of the load (3-phase total power: √3 x average of 3-phase load voltage values x average of 3-phase load current values).
The power of each phase cannot be controlled separately.

4. Phase control/Voltage square feedback

Voltage square feedback control regulates the output so that the square of output voltage is proportional to the control input.
For loads with low resistance temperature characteristics such as nichrome heaters, the control signal is proportional to the output power, which facilitates control.



□ Control signal and output power are linear to facilitate control.
□ Power percentage can be adjusted to match the regulator scale for manual adjustment.
□ Power formula

$P = V \times I$
$P = V \times V / R \leftarrow$ Constant
$\therefore P \propto V^2$ ... (Description: P is proportional to V^2.)

[P = power, V = voltage, I = current, R = resistance]

Voltage square feedback control regulates the square of the average of the three-phase load voltage.
Each phase cannot be controlled separately.

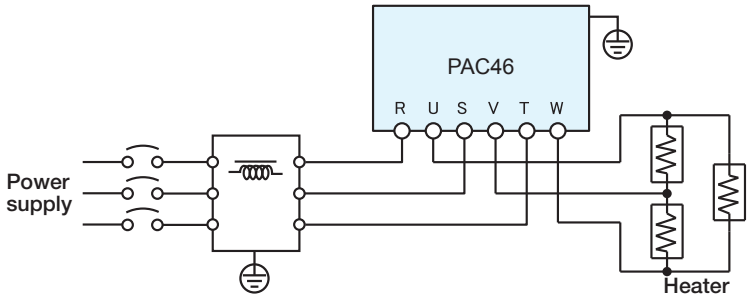
NOISE COUNTERMEASURES

Especially with phase control for thyristors, part of the power supply sine wave is dropped. This produces distortion in the sine wave if power supply impedance is high. Also, because power supply is switched each half cycle, switching noise is produced.
The power supply distortion and noise may affect other equipment. Use a noise filter if necessary.

■ Noise filter (sold separately)

The frequency of noise produced by the thyristor is distributed in a place below several megahertz, and the noise dampening effect of common commercially available noise filters is insufficient.
Using noise filters specified by Shimaden can dampen this noise.
This noise filter is specially designed for our thyristor power regulators.

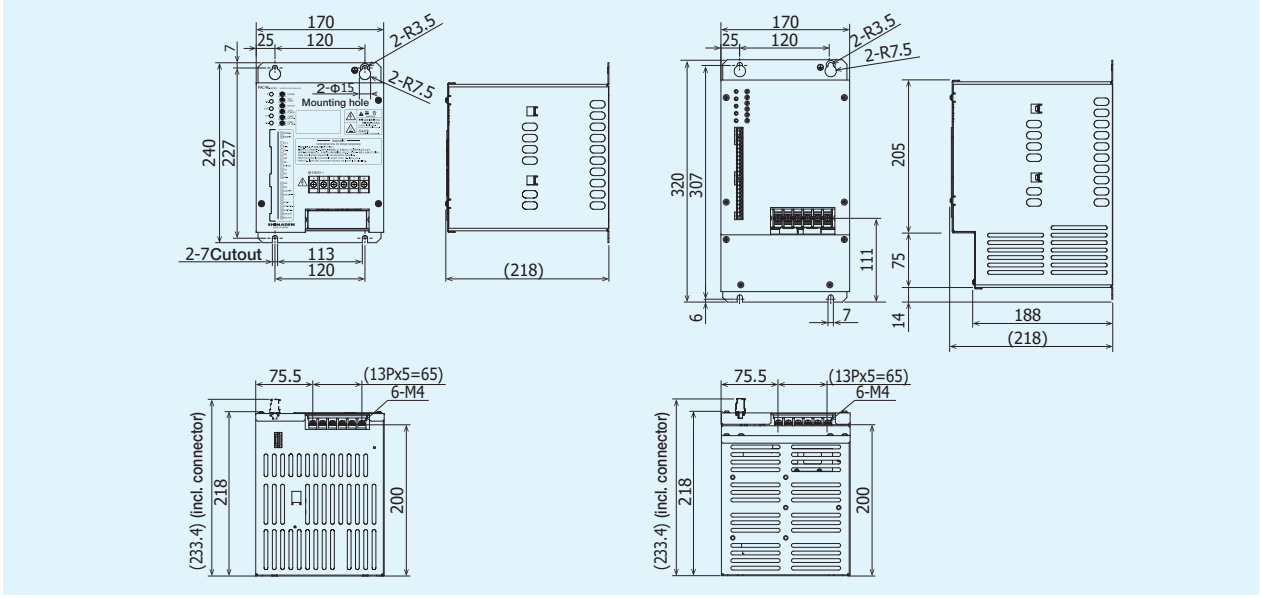
PAC46 current capacity	Model
20 A	NF3020C-SXJ
30 A	NF3040C-SXK
50 A	NF3050C-SXK
75 A	NF3100C-SXK
100 A	
150 A	NF3150C-SXK
200 A	NF3200C-SXK
300 A	NF3300C-SXK
500 A	NF3500C-SXK
600 A	NF3600C-SXK



EXTERNAL DIMENSIONS DIAGRAM AND MASS

■ 20 A, 30 A

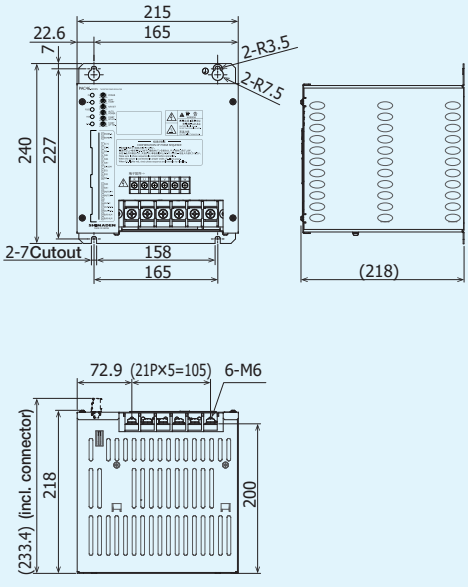
200–240 V/Mass: Approx. 5.0 kg



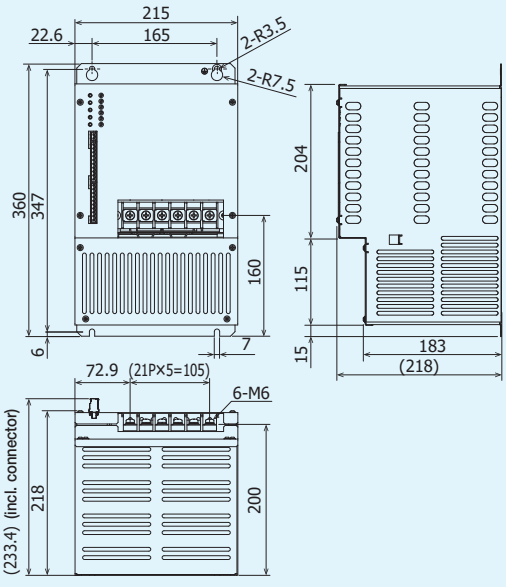
380–440 V/Mass: Approx. 7.5 kg

■ 50 A, 75 A, 100 A

200–240 V/Mass: Approx. 6.0 kg



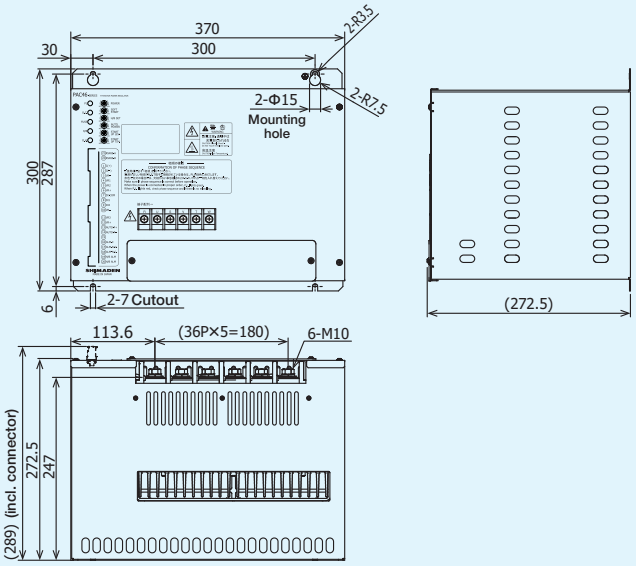
380–440 V/Mass: Approx. 10.0 kg



■ 150 A, 200 A, 300 A (200–240 V, 380–440 V)

200–240 V/Mass: Approx. 15.0 kg

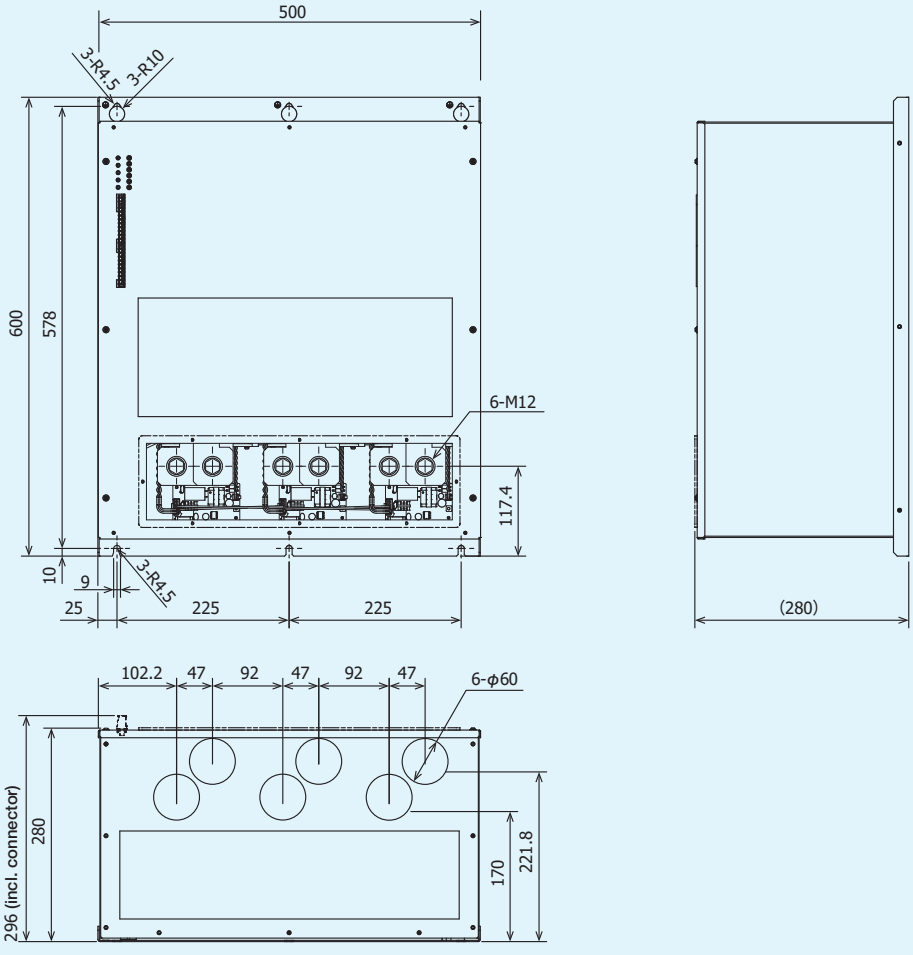
380–440 V/Mass: Approx. 20.0 kg



■ 500 A, 600 A (200–240 V, 380–440 V)

200–240 V/Mass: Approx. 42.0 kg

380–440 V/Mass: Approx. 50.0 kg



(Unit: mm)

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

WARNING	* 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.

Head Office & Saitama Factory
ISO 9001/ISO14001 Certification Obtained

Temperature and Humidity Control Specialists

SHIMADEN CO., LTD.

Head Office: 2-30-10 Kitamachi, Nerima-ku, Tokyo 179-0081 Japan
Phone: +81-3-3931-7891 Fax: +81-3-3931-3089
E-MAIL: exp-dept@shimaden.co.jp URL: https://www.shimaden.co.jp

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