

PAC16 Series Thyristor Type Single Phase Power Regulator

Instruction Manual

Thank you for purchasing this Shimaden product. Please check that the delivered product is exactly what you ordered. Please do not begin operating this product before you carefully read this instruction manual and fully understand its contents.

Notice

Please ensure that this instruction manual is passed on to the final user of the instrument.

Preface

This instruction manual is meant for those who will be involved in wiring, installation, operation and routine maintenance of the PAC16 series. As it describes matters to be attended to in handling the instrument, its installation, wiring, functions and operating procedure, you are requested to keep this manual readily available and follow the instructions given in it when using the PAC power regulator.

Safety Rules

Matters regarding safety, potential damage to equipment and/or facilities, additional explanations and instructions are described under the following headings:

⚠ WARNING

- Ⓞ This heading indicates that failure to follow instructions could cause injury or even death.

⚠ CAUTION

- Ⓞ This heading indicates that failure to follow instructions could cause damage to equipment and/or facilities.

NOTE

- Ⓞ This heading indicates additional instructions and/or notes.

⚠ WARNING

The PAC16 series is designed for controlling the power of a heater or similar equipment used in general industrial facilities. This means that it must not be used in any way that might result in injury or fatality.

⚠ WARNING

- This instrument must be housed in a control box installed indoors to prevent charged parts from coming into accidental physical contact with personnel.
- Wiring should be carried out without energizing the instrument. Otherwise, an electric shock may result.
- Do not touch the radiation fin as its temperature rises to a very high level while power is on and immediately after power is turned off. If it is touched, serious burns may result.
- For the prevention of an electric shock, make sure that the earth terminal is grounded.
- Do not touch the terminals or other charged parts while power is on. Take care to allow no metal or other foreign matter to get into the product. If something gets in by mistake, remove it only after turning power off and confirming that conditions are safe.

⚠ CAUTION

Should there be any possibility of doing harm or damage to peripheral devices, equipment or products in the event of trouble of this instrument, you must take appropriate measures such as installing a quick-to-burn fuse, a current overage or an overheat prevention device before you start using the instrument.

⚠ CAUTION

- Line voltage, load current and source frequency should be within the rated ranges. If their ratings are exceeded, the life of the product may shorten or the product may malfunction.
- Do not apply voltage and current which are outside of their rated ranges to the input control terminals. Otherwise, the life of the product may shorten or the product may malfunction.

- Make sure to fasten the screws of the terminals upon completion of wiring. Insufficient fastening may cause overheating due to contact resistance, leading to accidental burning in the worst case.
- Once wiring is completed, make sure to install the terminal cover.
- Users are prohibited from remodeling the product or using it in an unauthorized manner.

Marks Used for the Product

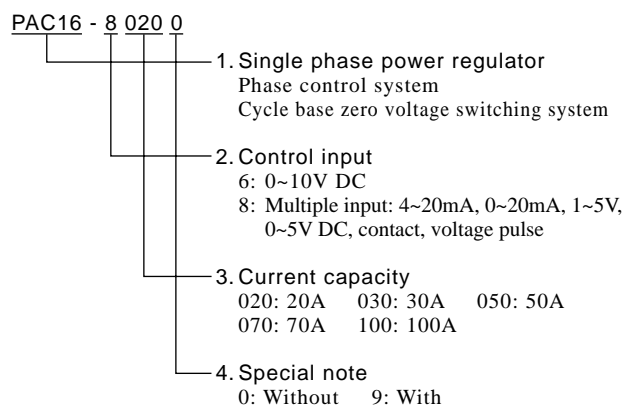
⚠ Alert Mark	Calls attention to high temperature or electric shock feared to be generated from the marked part.
⚠ Warning against high temperature	The temperature of a marked part will rise so high that a serious burn may result if touched. (Example: Radiation fin)
⚠ Warning against electric shock	The mark warns against touching a charged part while power is on, which may result in an electric shock.
⊕ Earth terminal	Make sure to ground so as to prevent an electric shock.

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1. Confirmation of Model Codes and Accessories

Checking prior to using the instrument and confirmation of model codes: Although the product was examined carefully to ensure quality, you are requested to check the model codes, the external appearance of the product and the attached item and confirm that there is not any error, damage or insufficiency.



ⓄAttached item: This instruction manual – 1 copy

* For other items available (to be purchased separately), see "9. Other Items Available" on page 6.

2. Notes on Use

- (1) Do not operate the keys on the front panel by using something hard or with a pointed end.
- (2) In cleaning, do not use a solvent such as thinner. Just wipe the product lightly with a piece of cloth.

3. Installation

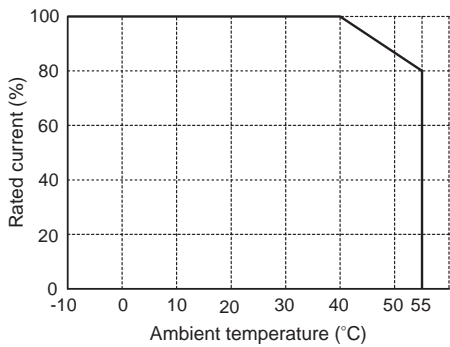
3-1. Installation Site (Environmental Conditions)

⚠ CAUTION

For the installation of the instrument, avoid those places as indicated below. Such places may cause trouble with the instrument, do damage to it or may even lead to a fire.

- (1) Where flammable gas, corrosive gas, salt, soot or particles that can deteriorate electrical insulation is generated or is abundant.
- (2) Where ambient humidity exceeds 90%RH.
- (3) Where highly intense vibration or impact is generated.
- (4) Where induction trouble, static electricity, magnetism or noise tends to be caused.
- (5) Where the instrument is exposed to dew drops or direct rays of the sun.
- (6) Rated current is at 100% in an ambient temperature range between 0 and 40°C. In case ambient temperature exceeds 40°C, reduce the load current as shown below. The operating temperature is 55°C maximum. The load current at 55°C should be 80% or less of the rated current.

Ambient Temperature and Load Current Characteristics Diagram



- (7) Where the elevation exceeds 2,000 m.

Note: Of the environmental conditions required for the instrument, the installation category is II and the pollution degree 2.

3-2. Mounting

⚠ CAUTION

The PAC16 series is designed to be housed in a panel placed indoors for use. You should not use it by simply putting it on a desk or in any other unfixated state. In such a position, it may fall and become damaged, leading to an electric shock or injury. Make sure to use the instrument properly housed in a panel. Care must be taken to prevent charged parts from coming into contact with a person accidentally.

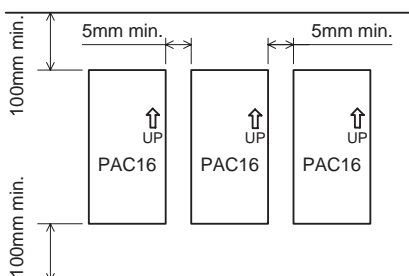
- Screw the instrument to the panel as shown in the diagram of mounting dimensions.
- In order to enhance the cooling effect, install the instrument vertically so that the display faces upward and the main circuit terminals face downward.



Make sure the pointed end of the arrow mark faces upward.

3-3. Intervals Required for Mounting

- In case two or more PAC16 power regulators are installed or it is installed side by side with other types of instruments, stick to the following interval sizes so as not to impair the effect of radiation.



unit: mm

The following table shows approximate internal heat values of the PAC16 series. While observing the abovementioned interval sizes for mounting and the environmental conditions stated in 3-1, give consideration to radiation and ventilation.

Current capacity	20A	30A	50A	70A	100A
Heat value	24W	40W	56W	79W	109W

3-4. External Sizes

unit: mm

Current capacity	Figure	W	D1	D2	P
20A	Figure 1	50	128	65	24
30A		60	154	92	28
50A		110	154	92	75
70A	Figure 2	110	154	92	75
100A		155	154	92	75

Figure 1. 20A, 30A, 50A

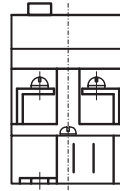
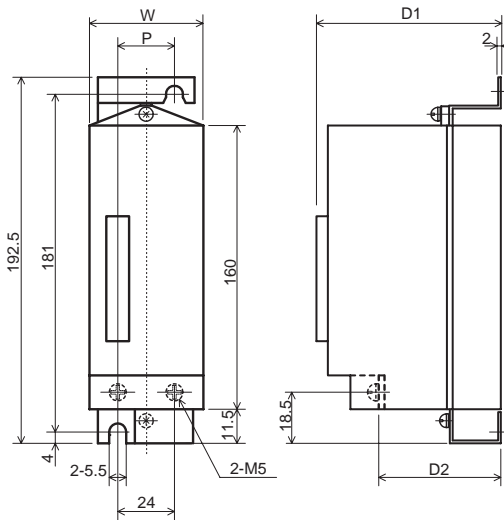
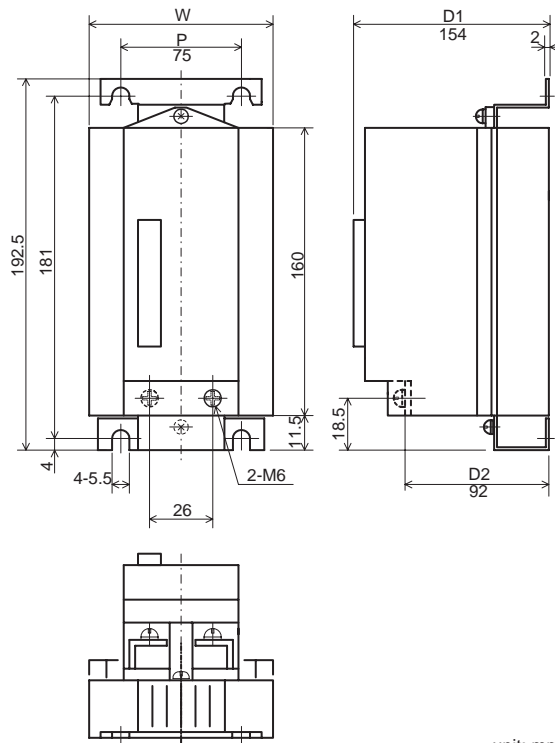
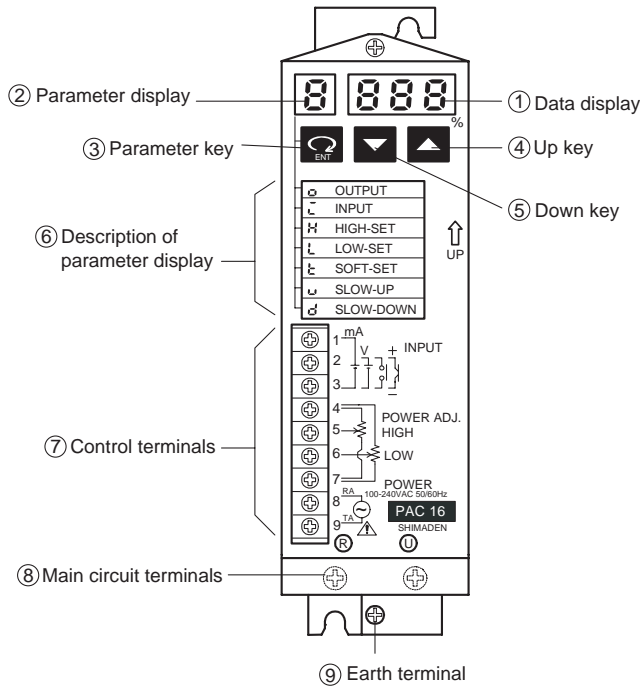


Figure 2. 70A, 100A



unit: mm

4. Names of Parts



Name	Description
① Data display	An input value, an output value and set data are displayed in figures.
② Parameter display	The type of a parameter is displayed.
③ Parameter key	Used to change s data display screen and to register set data when changed.
④ Up key	Used to increase or move data forward during setting.
⑤ Down key	Used to decrease or move date backward during setting.
⑥ Description of parameter display	What is shown on the parameter display is explained. (Example: OUTPUT)
⑦ Control terminals	For connection to control input circuit, power source and an external power adjuster (to be purchased separately).
⑧ Main circuit terminals	For connecting thyristor elements (built-in) to power source and load.
⑨ Earth terminal	For safety's sake, ground it with a grounding resistance of 100Ω or lower.

5. Wiring

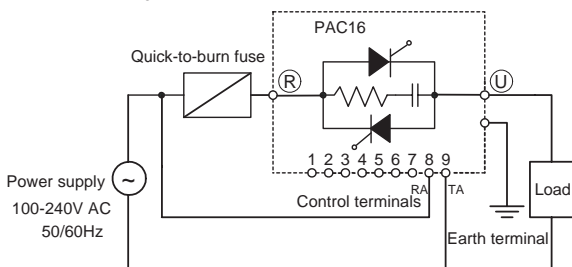
⚠ WARNING

- For the prevention of an electric shock, make sure to carry out wiring only after confirming that the instrument is not energized.
- Do not use the instrument without grounding the earth terminal. If you do, an electric shock might be caused.
- Once wiring is completed, do not touch terminals or other charged parts while the instrument is energized.

5-1. Wiring for Main Circuit Terminals and Control Power Terminals

- In wiring for the main circuit terminals, a cable with a sufficiently larger capacity than a load current has to be used.
- Main circuit terminal screws should be M5 for 20A to 50A and M6 for 70A and 100A. Use corresponding screws and fasten them firmly. (The clamping torque of M5 screw: Between 2.0 and 2.4 N·m) (The clamping torque of M6 screw: Between 2.5 and 3.0 N·m)
- The R and U terminals of the main circuit must be in phase respectively with the control power terminals 8 (RA) and 9 (TA). (Refer to the following connection diagram.)

Connection diagram for main circuit terminals and control power terminals

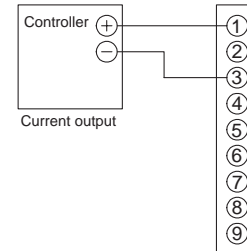


5-2. Wiring for Control Terminal

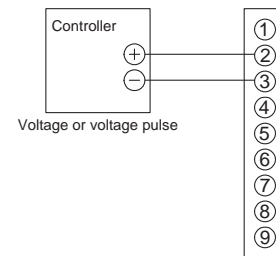
- M3 screws are used for control terminals and so you should use press-fit terminals of more than 3 mm in inside diameter and less than 6 mm in outside diameter. (Clamping torque=0.5~0.6 N·m)
- In wiring for the control terminals, pay close attention to the polarity, i.e., + and - of the terminals and take proper measures to block noise from a strong electric circuit.

(1) Wiring for control input signals

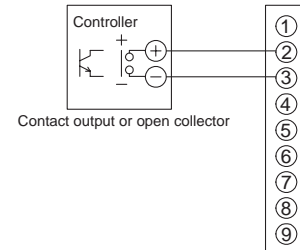
- In the case of current signals (4~20mA, 0~20mA: Receiving impedance 100Ω), connect a controller to the control terminals No. 1 (+) and No. 3 (-).



- In the case of voltage signals (1~5V, 0~5V: receiving impedance about 500kΩ) or voltage pulse signals (12V DC 3mA), connect a controller to the control terminals No. 2 (+) and No. 3 (-).

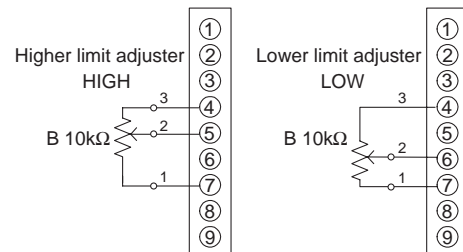


- In the case of contact signals (no-voltage) or open collector signals (Sink load: 5V DC 3mA), connect a controller to the control terminals No. 2 (+) and No. 3 (-). There is no polarity for contact signals.



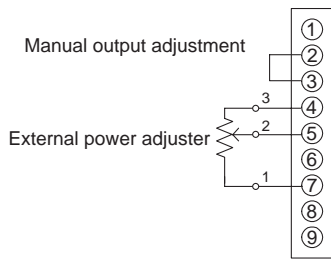
(2) Wiring in case external power adjusters (option) are connected and a higher limit and a lower limit are set:

- A value set for a power adjuster is shown correctly in the data display; the dial gives an approximate guideline.
- Connect the terminals Nos. 3, 2 and 1 of variable resistors respectively to the terminals Nos. 4, 5 and 7 of the higher limit adjuster and the terminals Nos. 4, 6 and 7 of the lower limit adjuster in the order stated.



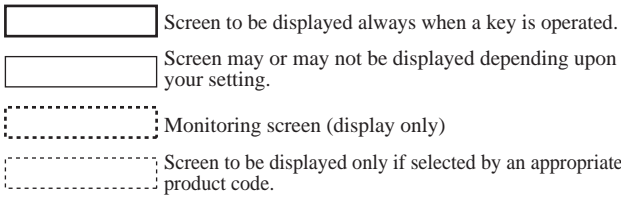
(3) Wiring in the case of manual output adjustment by the use of a power adjuster:

- Set the contact input in the instrument and short across the control terminals Nos. 2 and 3.
- Connecting a power adjuster to the control terminals Nos. 4, 5 and 7 enables you to adjust output manually. It is not possible to switch manual to/from auto by means of an external signal.



6. Description of Screens, Functions and Operation

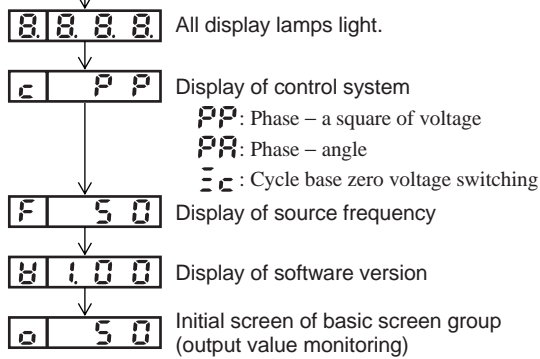
NOTE: The screens of the parameter display and the data display are classified as denoted by different frames shown below.



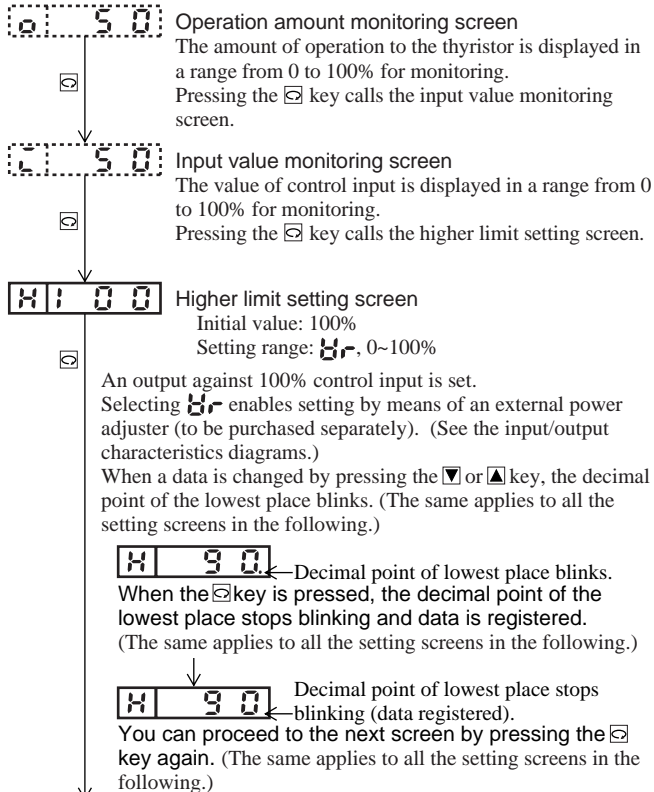
6-1. Initial Screen upon Applying Power

Upon applying power, the initial screen appears and screens change sequentially to the initial screen (the monitoring screen for the amount of operation) of the basic screen group as shown below.

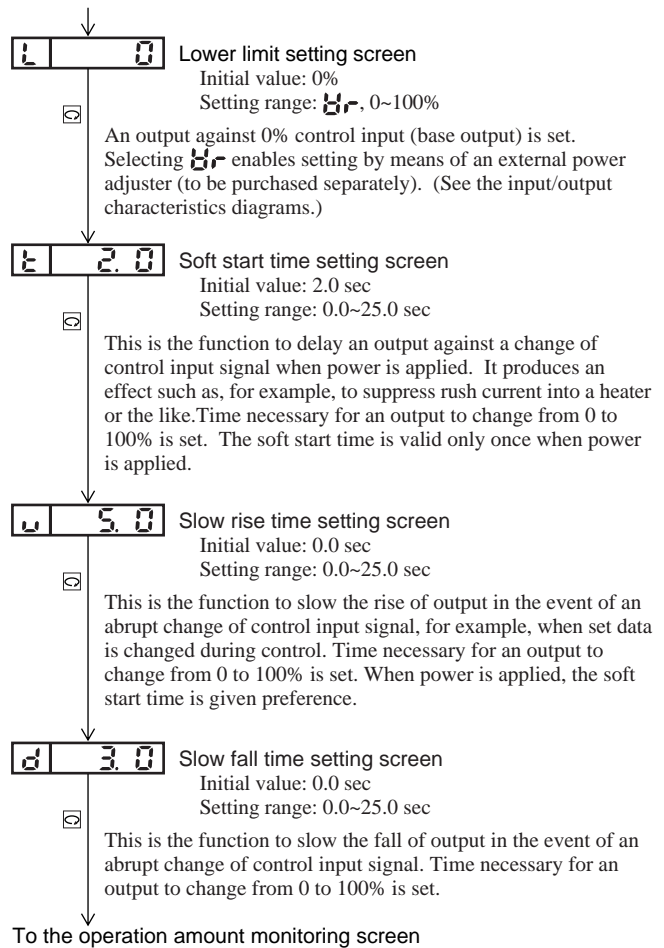
Power applied



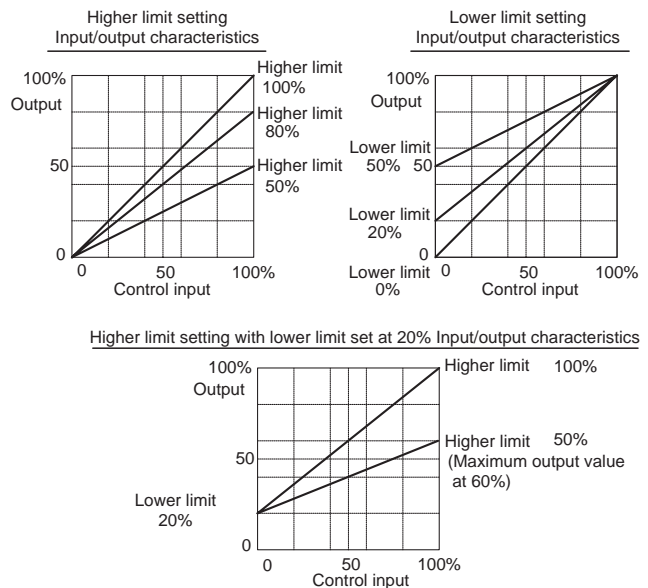
6-2. Basic Screen Group



To the Lower limit setting screen



6-3. Diagrams of Input/Output Characteristics When Higher and Lower Limits Are Set



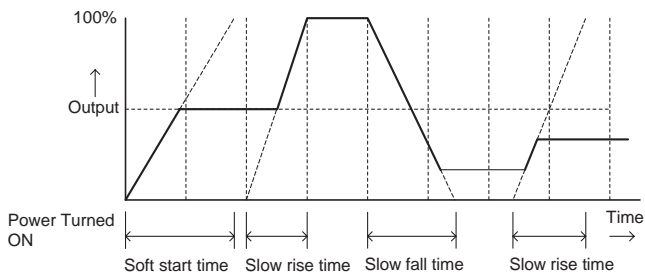
© In the lower limit setting, output is a value against a 0% control input, that is, the base output. A maximum output value in a higher limit setting is calculated by the following equation:

$$\text{Maximum output value (\%)} = (100 - \text{lower limit set value}) \times \text{higher limit set value} + \text{lower limit set value}$$

Example: In case 20% is set as a lower limit and 80% as a higher limit,
 Maximum output value = $(100 - 20) \times 80 + 20 = 84\%$

6-4. Soft Start/Slow Rise/Slow Fall Times

(1) Soft start, slow rise, and slow fall times are set respectively as the lengths of time taken for an output to change from 0% to 100%. Each ramping is fixed and actual travel time is in proportion to the amount of deviation.



(2) Although the soft start action is valid only once when power is applied, it is not carried out if the difference between input and output is zero when power is applied. In case the difference between input and output reaches zero (for instance, the input declines during a given soft start time), the action comes to an end even while the soft start is in action.

Note: The slow rise and the slow fall actions are meant for suppressing a sudden rise of input and an abrupt change of load voltage or load current. Please note, however, that they may affect control in certain control systems.

6-5. Setting Screen Group

When the key is pressed continuously for 3 seconds, the control system selection screen of the setting screen group appears. Likewise, pressing the key continuously for 3 seconds on a screen of the setting screen group calls back the operation amount monitoring screen of the basic screen group.

CAUTION

When you select or change a control system or an input code, power supply to the main circuit must be turned off.

Basic screen group

Press key for 3 seconds.
PP Control system selection screen
 Initial value: **PP**
 Display of control system
PP: Phase – a square of voltage
PR: Phase – angle
PC: Cycle base zero voltage switching

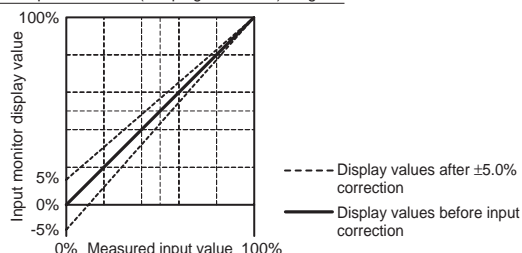
0 Input sampling cycle setting screen
 Initial value: 0
 Setting range: 0, 1~120 sec
 This screen is displayed when contact or voltage pulse is selected for input. Set 0 sec for two-position action or 1~120 sec for proportional action. A value to be set should be an integral multiple of a proportional cycle time of a controller.

NOTE: In case a controller in which the proportional cycle time is subject to change is used, a satisfactory result of control may not be attained.

A -2.0 Linear input correction screen
 Initial value: -2.0
 Setting range: -5.0~5.0%

This screen is displayed when current or voltage is selected. Difference (ramping) between a measured value of current or voltage input converted to 0 to 100% and an input monitor display value is corrected.

Linear input correction (ramping correction) diagram



To the Input type code selection screen

0 Input type code selection screen
 Initial value: 0
 Setting range: 0~5
0: 4~20mA **1**: 0~20mA
2: 1~5V **3**: 0~5V
4: Contact or open collector **5**: Voltage pulse
 This screen is not displayed when 0~10V is set for input. For multi-input, select correspondingly to an output specified for a controller.

00 External higher limit adjuster monitoring screen
 This monitors a set value when an external higher limit adjuster is connected. If not connected, an unfixed value is displayed.

0 External lower limit adjuster monitoring screen
 This monitors set values when an external lower limit regulator is connected. If not connected, an unfixed value is displayed.

To the control system selection screen

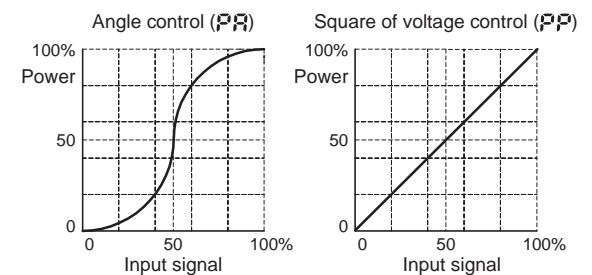
6-6. Control Systems

(1) Phase Control

This is the system to control output by repeating switching in a voltage area for each cycle.



Input/output characteristics in angle control and square of voltage control of phase control



- In the angle control, output voltage describes an S-shaped line against input signals.
- In the square of voltage control, current describes substantially a straight line against input signals (in the case of fixed resistive load.)

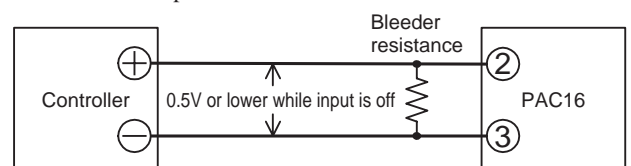
(2) Zero-voltage Switching Control

This is the system to control output by turning the thyristor on and off on a point close to 0V. As output is turned on and off nearly on a 0V point, less noise is generated compared to the phase control.



6-7. Input

- (1) When contact input is selected, the instrument is operated also with an open collector signal. In this case, the sink load is 5V DC 3mA and the residual voltage while control input is on is 0.8V or less.
- (2) For voltage pulse input, if there is substantial leakage current while the controller is off, connect a bleeder resistance across appropriate terminals of the controller or the terminals Nos. 2 and 3 of the PAC16 so that voltage can be 0.5V or lower while the control input into the PAC16 is off.



11. Specifications

- Model : PAC16
- Control system : Phase control system/cycle base zero voltage switching system
Selection and setting by key operation
- Control element configuration : SCR × 2 Anti-parallel connection
- Control output range : 0~98% or higher
- Applicable load : Resistive load
- Minimum load : 0.5A or higher
- Current capacity : 20A, 30A, 50A, 70A, 100A
- Power supply : Main power supply and control power supply from separate power sources. The former must be in phase with the latter.
: 100~240V AC ±10%
: 100~240V AC ±10%
: 50/60 Hz automatically discernible
- Main power supply
- Control power supply
- Source frequency
- Control input : Multi-input (to be selected and set out of the following 6 types:
Current: 4~20mA DC, 0~20mA DC (receiving impedance 100Ω)
Voltage: 1~5V DC, 0~5V DC (input impedance about 500kΩ)
Contact: No-voltage contact or open collector (load 5V 3mA, ON voltage 0.8V or lower)
Voltage pulse: Operating voltage range 3~16V DC (input impedance about 4kΩ)
: Voltage: 0~10V DC (input impedance about 370kΩ) to be designated when order is placed.
: Current, voltage 40ms/50Hz, 33.3ms/60Hz
Contact, voltage pulse 2 ms while in two-position action, 1~120 seconds variable while in proportional action
- Input sampling cycle
- Display : 7 segments red LED 1 (parameter display) + 3 digits (data display), height of character 10 mm
: Indication of amount of operation
: Control input value
: Set value for power adjuster (higher limit)
: Set value for base power adjuster (lower limit)
: Various parameters (See "Setting" below.)
- Digital display
- Contents
- Digital setting : By 3 keys (☐, ▼, ▲) on front panel
- Method of setting : ☐ Control system
- Parameters to be set : ⚡ Higher limit (ramping) setting 0~100%
: ⚡ Lower limit setting 0~100%
: ⚡ Soft start time 0.0~25.0 sec valid only upon applying power
: ⚡ Slow rise time 0.0~25.0 sec
: ⚡ Slow fall time 0.0~25.0 sec
: ⚡ Input type (current, voltage, contact, voltage pulse)
: ⚡ Input sampling cycle (0~120 sec), setting possible for contact and voltage pulse
Setting between 1 and 120 sec for proportional action (an integral multiple of proportional cycle of controller should be set.), 0 sec for two-position action
: ⚡ Linear input correction (ramping correction) -5.0 to 5.0% setting possible for current or voltage input.
- Optional items (to be purchased separately)
- Power adjuster : With variable resistor B 10kΩ, a knob, a dial and 1 m-long lead wire
For power (higher limit/ramping) adjustment, base power (lower limit) adjustment and usable for manual power adjustment but switching between auto and manual not possible
- Quick-to-burn fuse : To be attached externally, with fuse holder
- General Specifications
- Data storage : By non-volatile memory (EEPROM)
- Operating ambient temperature range : -10 to 55°C (For 40°C or higher temperature, refer to the diagram of ambient temperature/load current characteristics.)
- Operating ambient humidity range : 90% RH or lower (no dew condensation)
- Insulation resistance : Between power terminals and control terminals 500V DC 20MΩ or higher
: Between power terminals and ground terminal 500V DC 20MΩ or higher
: Between power terminals and control input terminals 1 min at 2300V AC
: Between power terminals and ground terminal 1 min at 1500V AC
- Dielectric strength
- External dimensions and weight : 20A: W50 × H192.5 × D128 mm, about 0.6kg
: 30A: W50 × H192.5 × D128 mm, about 0.7kg
: 50A: W60 × H192.5 × D154 mm, about 1.2kg
: 70A: W110 × H192.5 × D154 mm, about 1.8kg
: 100A: W155 × H192.5 × D154 mm, about 2.3kg

The contents of this manual are subject to change without notice.

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