PAC18A Series

Single-Phase Thyristor Power Regulator

Instruction Manual

Thank you for purchasing a Shimaden PAC18A Series Single-Phase Thyristor Power Regulator.
After making sure the product fits the desired description, you should carefully read the instructions and get a good understanding of the contents before attempting to operate the equipment.

Request

The instruction manual should be kept in a handy place where the end user can refer to it when necessary.

Preface

The instruction manual has been prepared for those involved in setup, wiring, operation or routine maintenance of PAC18A Series equipment.
The manual provides information concerning mounting, wiring and precautions when working with PAC18A Series equipment.
You should therefore keep it in a handy place to refer to when operating and handling the equipment.
Be sure to observe all precautions and adhere to the procedures provided in the manual.
Safety rules, precautions concerning equipment damage, additional instructions and notes are written based on the following headings.

◎Matters that could result in injury or death if instructions are not followed.

⚠WARNING

◎Matters that could result in equipment damage if instructions are not followed.

⚠CAUTION

◎additional instructions and notes

Note

⚠WARNING

PAC18A Series instrument is designed to control heater power, etc., used by industrial equipment. It should not be used for nuclear power generation, traffic control, communications or medical equipment. You should either take appropriate safety measures or avoid using for control that could have a serious effect on human life. The manufacturer shall not be liable for an accident that results if used without taking appropriate safety measures.

⚠WARNING

1. The power regulator should be used so the terminal elements in the control box, etc., are not touched by human beings.
2. The power regulator should not be used as a switch.
   Even if output is zero, power is present in the capacitors and resistors of the output circuit, and could result in accident involving human life or serious bodily injury due to electrical shock.
3. Radiation fins and chassis become extremely hot. Never touch the radiation fins or chassis. Doing so could result in burn injury.
4. Do not supply power when wiring. Doing so could result in electrical shock.
5. Do not touch terminal elements or other charged parts while conducting electricity. Also, do not introduce foreign objects or matter into the equipment.
   If a foreign object or matter accidentally gets inside, be sure to turn off the power and make sure all is safe before introducing tools or your hands.

⚠CAUTION

If there is danger of damage to any peripheral device or equipment due to failure of the power regulator, you should take appropriate safety measures such as mounting a rapid fuse or overcurrent circuit breaker.

⚠CAUTION

1. Concerning the ⚠ alert symbol on the power regulator's plate, a ⚠ alert symbol is printed on the label applied to the outer surface of the device.
   The symbol is provided to prompt you to employ special care not to touch the device because doing so could result in electrical shock if parts that conduct power are touched when power is present, or could result in burn injury if touched when hot, etc.
2. Provide a switch or breaker as a means of cutting off power for external power circuit connected to the power terminal of the device.
   Mount a switch or breaker near the controller where the operator can get to it easily and label it as an electrical breaker for the device.
3. Be sure to securely fasten conductor cable connections before using.
   Failure to do so could result in burning from overheating due to contact resistance.
4. Be sure power supply voltage and frequency do not exceed the rating.
5. Do not apply voltage/current other than rated input to the input terminal.
   Doing so could shorten the life of the product or result in equipment failure.
6. Voltage/current of load connected to the output terminal should not exceed the rating.
   Using voltage/current that exceeds the rating could shorten the life of the device by raising the temperature, and could result in equipment failure.
7. Be sure to mount the terminal cover that comes with the device after wiring.
8. The user should absolutely not modify or use the device in any way other than it was intended to be used.
9. To ensure safety and maintain the functions of this device, do not disassemble this device. If this device must be disassembled for replacement or repair, contact your dealer.
10. Be sure to observe the notes and precautions provided in the manual to use the device safely and maintain its reliability.

Note: Shimaden shall bear no responsibility, monetarily or otherwise, for accident or damages caused by failure to observe warnings, notes and precautions contained in the instruction manual.

SHIMADEN CO., LTD.

MPA018A-E01-D
May. 2023

Contents

1. Introduction

1-1. Preliminary check

The equipment has undergone sufficient quality control inspections, but you should check the specification code, inspect the equipment and confirm you have all the accessories to make sure nothing is missing or damaged.
Compare the specification code on the case with the following to make sure it is the product you ordered.

1-1-1. Specifications code check

Make sure the product you have received matches the specifications of your order. If you have any questions, feel free to contact your nearest Shimaden agent.

Code selection table

Item	Code	Specifications				Pattern 1	Pattern 2
1. Series	PAC18A	Single-Phase Thyristor Power Regulator				○ Can be changed after purchase	Can be changed after purchase
2. Control type		P0-	Phase control / phase angle proportional output				
		P1-	Phase control / voltage proportional output				
		P3-	Phase control / voltage square (electric power) proportional output				
		C1-	Cycle calculation zero voltage switching control				
		P2-	Phase control / current feedback *Output current detection / alarm output function (optional)			–	
3. Control input		3	Voltage: 1 – 5 V DC, input resistance: 200kΩ, contact: common			○	○
		4	Current: 4 – 20 mA DC, receiving impedance: 100kΩ, contact: common				
		6	Voltage: 0 – 10 V DC, input resistance: 200kΩ, contact: common				
4. Current capacity		020-	20A			○	○
		030-	30A				
		045-	45A				
		060-	60A				
		080-	80A				
		100-	100A				
5. Current detection / alarm output function (optional) * When P2- (Phase control / current feedback) is selected,'Without'cannot be selected.		0	Without			○	–
		1	With	Overcurrent protection, current limit function, alarm output function (power failure / overcurrent / heater break / hardware error)			Required
6. Additional function			0	Without		–	–
7. Remarks				0	Without	○	○
				9	With		

Pattern 1: No current feedback
Pattern 2: Current feedback
○: Can be selected when purchasing
–: Cannot be selected when purchasing

1-1-2. Accessories check

Instruction manual: 1

⚠CAUTION

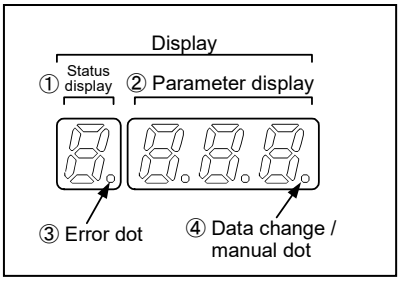
In the event you want to inquire about a product defect, missing accessory or other matter, please contact your nearest Shimaden agent.

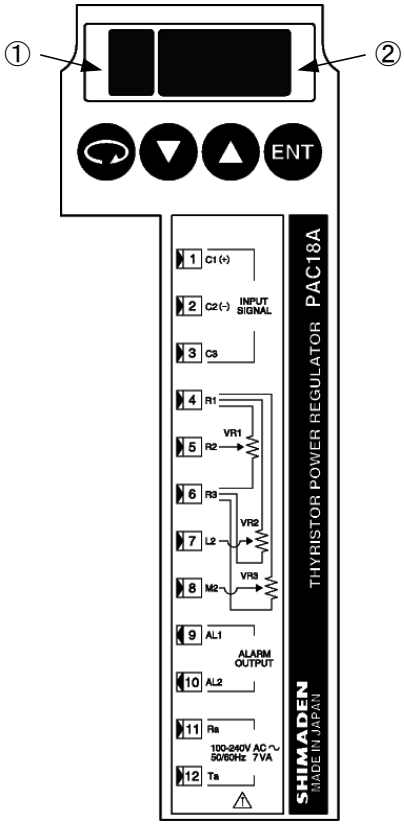
1-2. Precautions when using

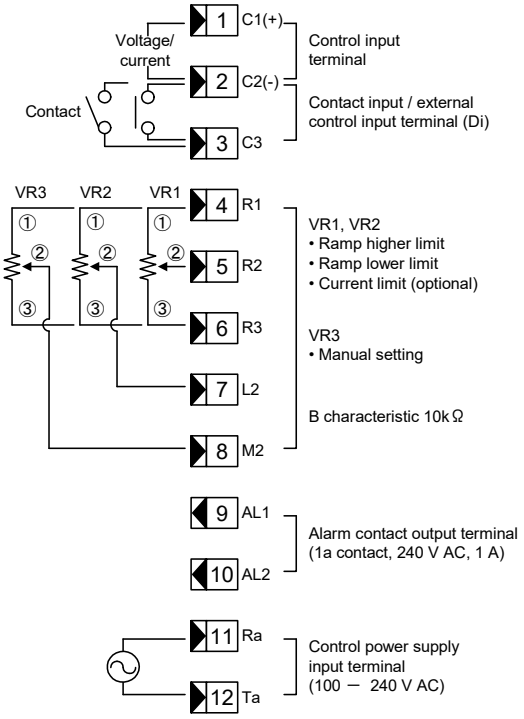
Do not operate the front panel keys with hard or pointed objects. Always press the keys lightly with the tips of your fingers.
To clean, wipe lightly with a dry cloth. Do not use solvents such as thinner.

2. Panel part names and control terminals

2-1. Name and function of display and key operation sections







Display

① Status display (red, 1 digit): Displays symbols that indicate status of various parameters.
If "Output monitor" is displayed, an alarm is displayed when an error occurs.
② Parameter display (green, 3 digits): Displays parameter symbols and data.
③ Error dot: Flashes when an error occurs.
(Status display section dot, red)
④ Data modification / manual dot: Flashes when data is modified or manual operation is selected.
(Parameter display section dot, green)

Key switches

Parameter key: Key for switching screens of each screen group.
Pressing and holding for 2 seconds switches monitor screen group ⟷ user parameter screen group.
Pressing and holding for 2 seconds switches from initial settings screen group / manual output screen group ⟶ monitor screen group.

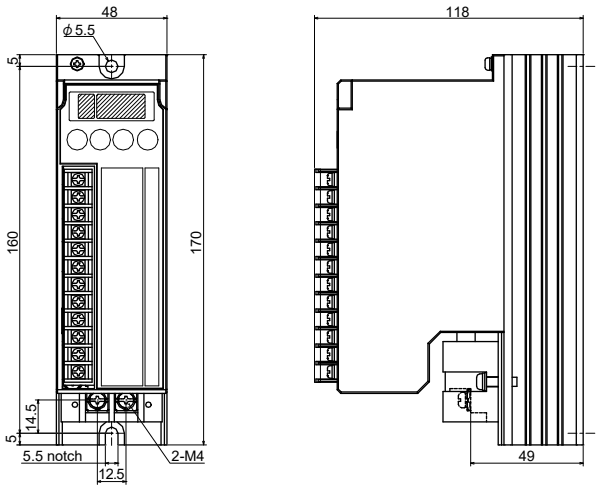
Down key: Key that decrements numbers and changes mode of various parameter setting screens.

Up key: Key that increments numbers and changes mode of various parameter setting screens.
Pressing and holding for 5 seconds switches from monitor screen group ⟶ initial setting screen group.

ENT Enter key: Key for executing settings on the various parameter screens.
Setting data registration key for various parameter setting screens.
Pressing and holding for 2 seconds switches from monitor screen group ⟶ manual output screen group.

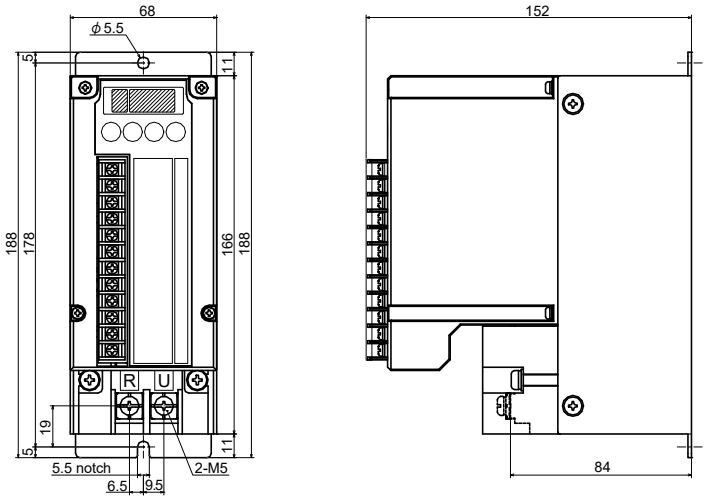
3. External dimensions / terminal dimensions / weight

20/30A Weight: Approx. 0.8 kg



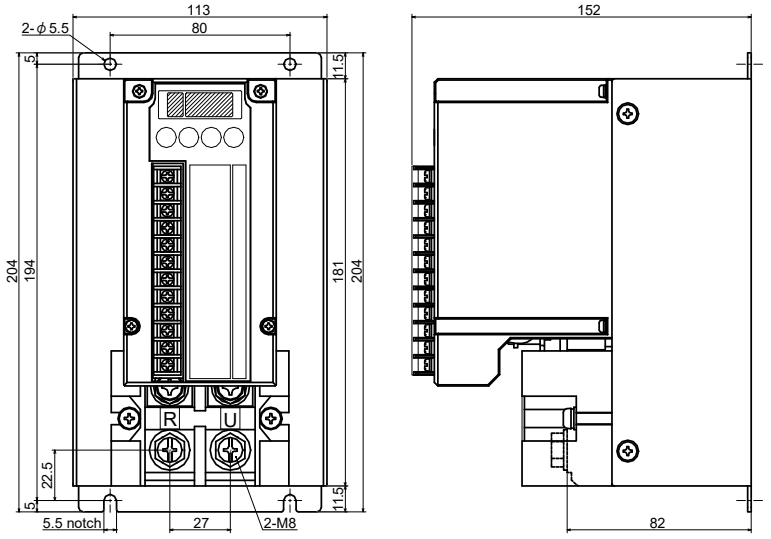
Unit: mm

45/60A Weight: Approx. 1.8 kg



Unit: mm

80/100A Weight: Approx. 3.0 kg



Unit: mm

4. Setup location

The device is designed to be used under the following conditions. Observe the following environmental conditions when using:

1) Indoor use
2) Elevation: Max. 2000 m (see '15-2. Ambient temperature, elevation and load current.')
3) Temperature range: -10 − 55°C (see '15-2. Ambient temperature, elevation and load current.')
4) Humidity range: Max. 90% RH Must be no dew condensation.
5) Overvoltage category: II
6) Pollution class: 2 (IEC 60664)

⚠ CAUTION

Do not use in the following locations. Doing so could lead to equipment failure, damage or fire.

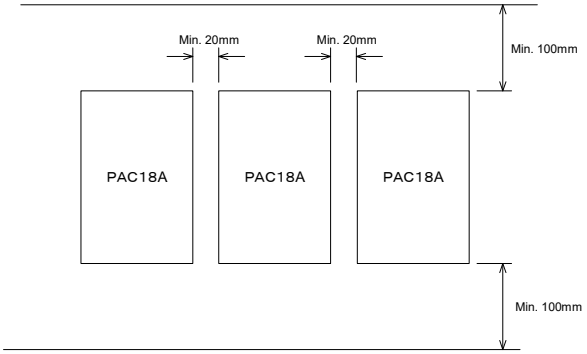
- Places exposed to flammable or corrosive gases, oil mist, or excessive dust that could cause insulation to deteriorate
- Places subject to vibration or impact
- Places exposed to water dripping or direct sunlight
- Places directly exposed to air from heater or air conditioner
- Places where maintenance cannot be performed safely

5. Mounting

Fasten to control panel, wall, rack, etc., when using. To ensure safety, arrange so that people cannot easily come into contact with the equipment.
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 current capacity.

5-1. Mounting method and clearance

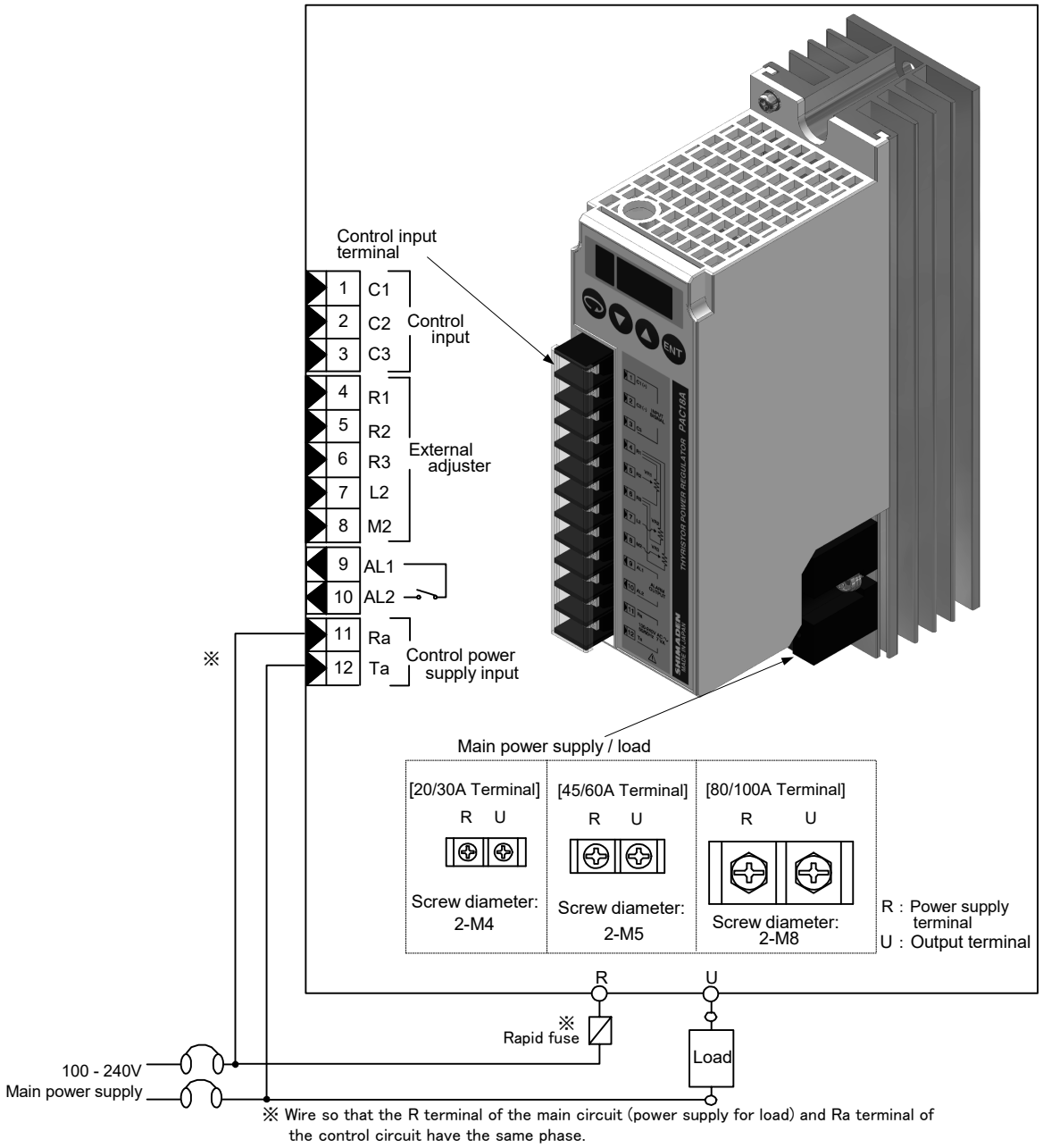
Provide the clearance shown in the figure.



⚠ CAUTION

Be careful not to damage the cable by touching the heat sink or pinching the wires.
In some cases, doing so could result in fire.
Use a cable that is capable of withstanding at least 105°C.

6. Terminal arrangement and wiring example



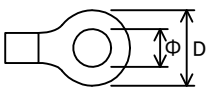
7. Power supply and load wiring

7-1. Wiring

Wire while referring to the figure above. If using a rapid fuse, place at entrance to main power supply (R terminal).
Remove the terminal block cover to connect wires to the terminal block.
Loosen the fastening screws mounted on the device and wire.

7-2. Power supply and load wiring

PAC18A employs 2-terminal wiring. M4 screws are used for the R and U terminals of 20/30A, M5 for 45/60A and M8 for 80/100A.
Use the proper terminal and securely fasten the screws.



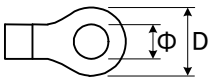
	Current capacity		
	20A/30A	45A/60A	80A/100A
Φ (mm)	Min. 4	Min. 5	Min. 8
D (mm)	Max. 10	Max. 13	Max. 14
Screws	M4	M5	M8
Fastening torque (N·m)	1.2−1.4	2.0−2.4	5.5−6.6

Use wiring of material that matches current capacity for R and U terminals.

8. Control input signal wiring

M3 screws are used for control signal terminals.
Use the proper terminal and securely fasten the screws.
Use wiring that conforms to crimping terminals.

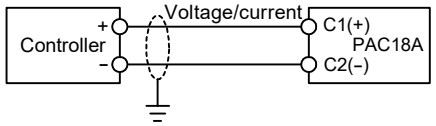
Control terminal	
Φ mm	Min. 3.0
D mm	Max. 6.2
Screws	M3
Fastening torque (N•m)	0.5－0.75



Control signal from the controller (4 – 20 mA, 1 – 5 V, 0 – 10 V, contact, etc.) enters the control input signal terminals (C1, C2, C3).
Be careful of the polarity and make sure noise from strong electric circuits does not get into the wiring.
Countermeasure against lightning surge will be required for signal line over 30m.

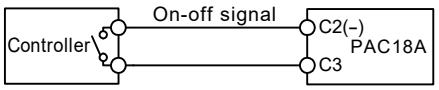
8-1. 1-to-1 connection with controller

Connection with voltage/current output controller
Adjust controller output with control signal of the PAC18A.



In the case of 1-to-1 connection, connect the positive controller output terminal (+) to C1 and the negative terminal (–) to C2 as shown in the figure above.

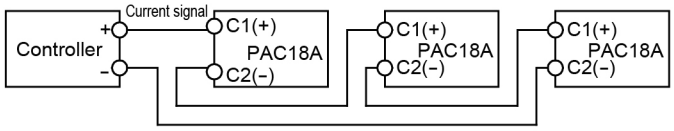
Connection with contact output controller



If connecting with on-off signal, connect between C2 and C3 terminals.

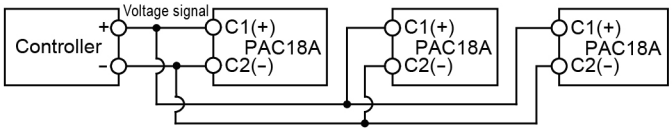
8-2. Multiple units connected to a single controller

Current input connection diagram



In the case of current input type, wire control input signals in series. Input resistance for the PAC18A is 100Ω, so if load resistance tolerance for a 4 – 20 mA output controller is 600Ω, you can connect up to 6 units.

Voltage input connection diagram



In the case of voltage input type, wire control signals in parallel. Input resistance for the PAC18A is 200kΩ, so if maximum load current for a 0 – 10 V output controller is 2 mA, you can connect up to 40 units.

9. Precautions when turning on the power

9-1. Power supply voltage

Power supply voltage for control should be from 100 to 240V.
If voltage in excess of the rating is applied, internal components could be damaged. You should therefore be careful of the power supply voltage.
Refer to '6. Terminal arrangement and wiring example' to connect power supply and load, control power supply. Connect so that main power supply (R terminal) and control power (Ra terminal) phase are the same.
The equipment will not operate if the phases are reversed.

9-2. Power supply frequency

Power supply frequency should be 50/60 Hz.
Power supply frequency is automatically determined, but the device cannot handle sudden frequency change.
Before switching frequency, turn off the device's power.
Changing power supply frequency with the power on could result in malfunction and result in 100% output.

10. Alarm function

The alarm function consists of power failure, overcurrent, hardware error, heater break and input error.
If an equipment error occurs, an alarm is output externally and is displayed on the front display (status display).
In addition to input error, you can select key sequence '1-2 – 1-5' for each alarm.
When an error occurs and the key sequence '0-0. Output monitor (basic screen)' is displayed, an alarm code is displayed on the front display (status display), and if any other screen is displayed, the error dot on the front display (status display) flashes.

⚠ CAUTION

When an alarm occurs, turn off the power, remove the cause, and then turn the power back on.

Alarms

Alarm types	Alarm display	Conditions	Alarm output	Corresponding action
(1) Power failure (Power error)	"P"	Power supply frequency is outside the range of 40Hz - 70Hz, or is unstable.	Available	Stops output. Output is automatically reset if alarm conditions are eliminated.
(2) Overcurrent (Current error) (optional)	"C"	Output current has exceeded 130% of rating.	Available	Stops output. Turn off the power, remove the cause, and then turn the power back on.
(3) Hardware error (optional)	"h"	Output current flows when output is 0%.	Available	Stops output. If a hardware error alarm occurs when a load is connected, repair is required.
(4) Heater break (optional)	"H"	Heater deterioration or break has been detected.	Available (can be disabled by Di function)	Control continues.
(5) Input error	"I "	Control input has exceeded the range of -10 to 110%.	Not available	

*If multiple alarm causes occur at once, display is as follows:

→ "P" → "C" → "h" → "H" → "I "

The following alarm function contents are indicated:

10-1. Power failure (Power error)

A power failure alarm occurs when power supply frequency exceeds the 40 – 70 Hz range or power supply frequency is unstable.
Output stops when an alarm occurs. The front display (status display) displays P and the parameter display displays Stb.
When the source of the error has been eliminated, the P, Stb alarm display goes off and output is automatically restored.
When a power failure is output to optional alarm contact output (AL), set key sequence '1-2. Power failure alarm.'
If the power is instantaneously interrupted, you can select whether or not to conduct output slow-up for a short period of time following restoration by key sequence '2-7. Power supply instantaneous stop handling function.'
Malfunction could however result from instantaneous interruption even if "output slow-up" is set.

10-2. Overcurrent (Current error) (current detection / alarm output function [optional])

An overcurrent alarm occurs for the built-in current detection circuit when the output current value exceeds 130% of the rating.
Output stops when an alarm occurs. The front display (status display) displays C and the parameter display displays Stb.
When the source of the error has been eliminated, the C, Stb alarm display goes off and output is automatically restored.
When an overcurrent alarm is output to alarm contact output (AL), set key sequence '1-3. Overcurrent alarm.'

10-3. Hardware error (current detection / alarm output function [optional])

A hardware error alarm occurs when a thyristor error occurs (current continues to flow even if the thyristor device shorts and control input is 0%).
Output stops when an alarm occurs. The front display (status display) displays h and the parameter display displays Stb.
When the source of the error has been eliminated, the h, Stb alarm display goes off and output is automatically restored.
When a hardware error alarm is output to alarm contact output (AL), set key sequence '1-4. Hardware error alarm.'

⚠CAUTION

Avoid conducting electricity with no load. If a hardware error alarm occurs even if a load is connected, repair is required.
Contact your nearest Shimaden agent.

10-4. Heater break (current detection / alarm output function [optional]

Function that detects load heater break. A heater break alarm occurs when the current drops below the preset heater break alarm current value.
Output continues when an alarm occurs. The front display (status display) displays H.
When a heater break alarm is output to alarm contact output (AL), set key sequence '1-5. Heater break alarm.'
If alarm cannot be output because of unstable operation when booting, etc., you can disable HB alarm output by key sequence '2-2. Di function selection.'

NOTE: As for heater break detection point, heater break standard values are set based on power supply voltage or output operation amount implemented by key sequence '3-3. Heater break judgment standard setting.'
If the power supply voltage or output operation amount at that point in time is other than the set condition, operation may deviate from the preset values for heater break alarm operation.

10-5. Input error

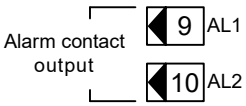
An input error alarm occurs if control input is less than -10% or over 110% of the setting range. In the case of 0 – 10 V DC, however, control input less than 0% cannot be detected, so less than -10% input error alarm does not occur.
Output continues even if an alarm occurs. You cannot output input error alarm to an alarm contact output destination (AL).
Alarm display i is displayed on the front display (status display).
Key sequence '0-0. Output monitor (basic screen)' display does not display less than 0% or more than 100%.
Key sequence '0-2. Control input' display displays 0.0 or LLL if control input is less than -10%, and output becomes ramp lower limit value. If 110% is exceeded, HHH is displayed, and output becomes ramp higher limit value (display differs according to type of control input).
You can set so input error is not displayed by key sequence '2-6. Input error display setting.'

10-6. Alarm output (current detection / alarm output function [optional])

You can use contact output (relay a contact, 240V AC / 1 A) as a function to notify alarm occurrence.
Output is on when in alarm status.
You can select whether to output an alarm for each type of alarm. (Multiple selections possible)

Alarm output type and terminal layout

Terminal block No.	Terminal symbol	Alarm	Output type
9	AL1	ALARM OUTPUT	Contact output (relay a contact)
10	AL2		



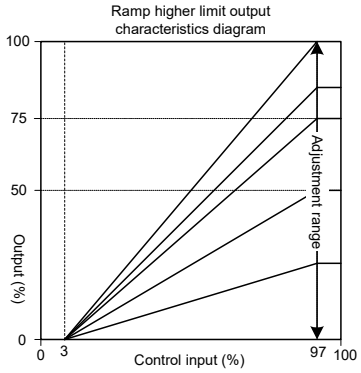
11. Various adjustment functions

11-1. Ramp higher limit (high power)

Output is set to ramp higher limit (high power) by key sequence '1-7. Ramp higher limit selection' or key input allocation is set by key sequence '1-8. Ramp higher limit setting' (range: 0.1 - 100%).
Because with ramp higher limit, maximum output is adjusted by control input signal being 100%, output ramp of the PAC18A is adjusted according to the control input signal.

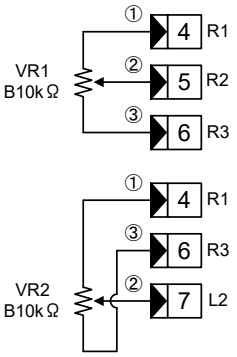
11-1-1. Ramp higher limit according to external adjuster

Adjustment location is allocated to VR1 or VR2 by '1-7. Ramp higher limit selection.'
If allocated to VR1, connect external adjuster B characteristics 10kΩ (VR) to terminal block No. 4-5-6.
Ramp higher limit adjustment and ramp lower limit adjustment cannot be allocated to the same external adjuster VR.



External adjuster terminal block layout

Allocation	Terminal block No.	Terminal symbol	Adjuster No.
VR1	4	R1	①
	5	R2	②
	6	R3	③
VR2	4	R1	①
	7	L2	②
	6	R3	③



Ramp higher limit setting range: 0.1 - 100%

External adjuster error table 1

VR1/VR2		Ramp higher limit output value
①	Break	100%
②	Break	0%
③	Break	0%

Note: Output becomes ramp lower limit value if output is less than 3% of control input.
Output becomes ramp higher limit value if output is at least 97% of control input.

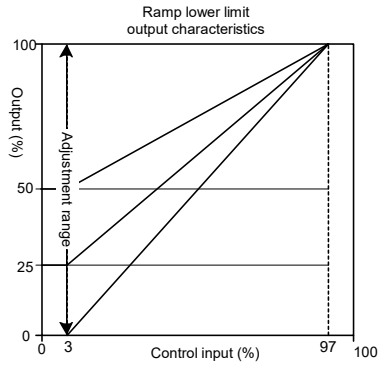
Note: Operation would become as given in External adjuster error table 1 if the external adjuster were broken.

11-2. Ramp lower limit (low power)

Set adjustment source by key sequence '1-6. Ramp lower limit setting.'
With the ramp lower limit function, output can be adjusted from 0 to 99.9% when control input signal is 0%.
Used when you want output even when control input is 0%.
Because minimum output is adjusted, output ramp of the PAC18A relative to the control input signal is changed.

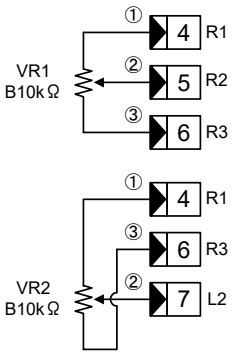
11-2-1. Ramp lower limit according to external adjuster

Adjustment location is allocated to VR1 or VR2 by key sequence '1-6. Ramp lower limit setting.'
If allocated to VR2, connect external adjuster B characteristics 10kΩ (VR) to terminal block No. 4-7-6.
Ramp higher limit adjustment and ramp lower limit adjustment cannot be allocated to the same external adjuster VR.



External adjuster terminal block layout

Allocation	Terminal block No.	Terminal symbol	Adjuster No.
VR1	4	R1	①
	5	R2	②
	6	R3	③
VR2	4	R1	①
	7	L2	②
	6	R3	③



Ramp lower limit setting range: 0.0 – 99.9%

External adjuster error table 2

VR1/VR2		Ramp lower limit output value
①	Break	100%
②	Break	0%
③	Break	0%

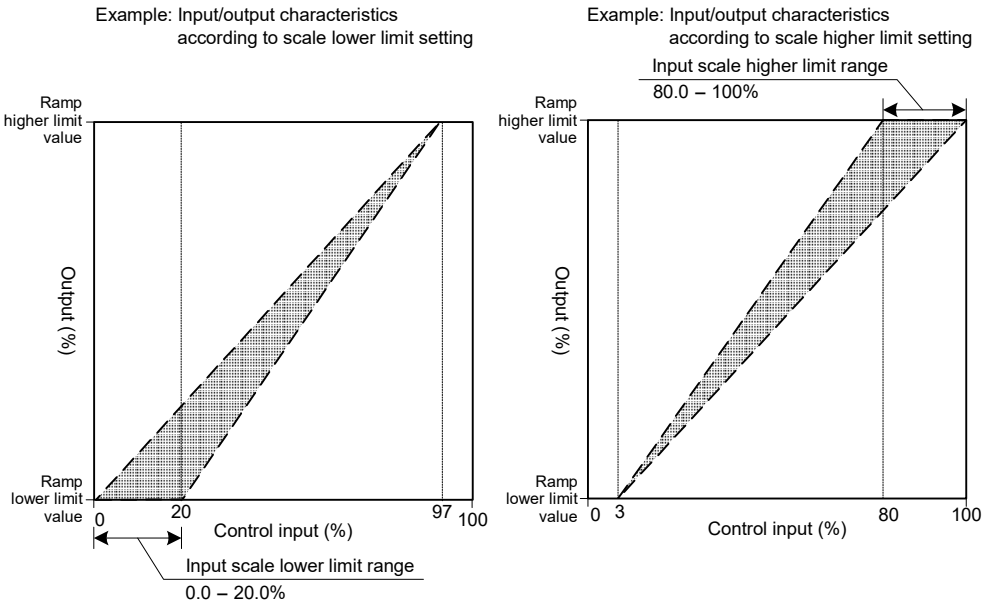
Note: Output becomes ramp lower limit value if output is less than 3% of control input.
Output becomes ramp higher limit value if output is at least 97% of control input.

Note: Output is changed by percentage of change of key sequence '1-9. Slow-up' and '1-10. Slow-down' when settings of key sequence '1-6. Ramp lower limit setting' or ramp adjustment by external adjuster.

Note: Operation would become as given in External adjuster error table 2 if the external adjuster were broken.

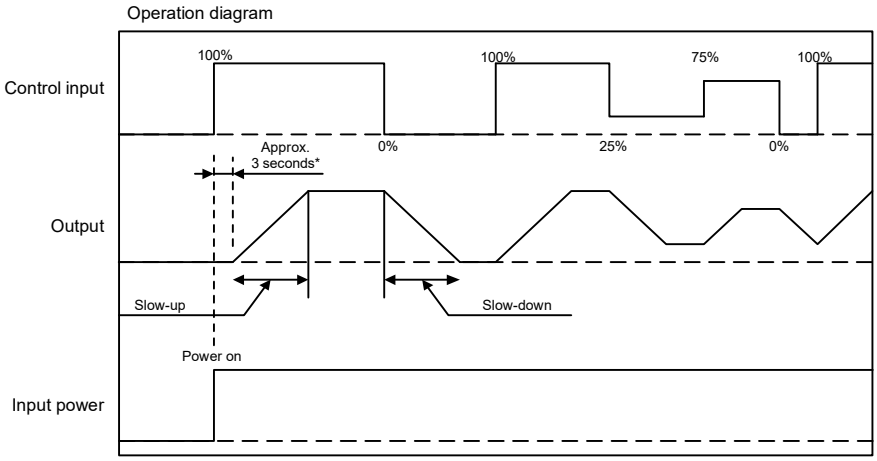
11-3. Input scaling

You can set key sequence ‘1-13. Control input scale lower limit setting’ and ‘1-14. Control input scale higher limit setting.’
Setting below the lower limit value makes output 0% and setting above the higher limit value makes output 100%.



11-4. Variation limit (slow-up / slow-down time)

The variation limit function delays PAC18A output response according to control input signal or sudden change of setting.
Function for suppressing excessive variation of load voltage, load current or suppressing load of electrical equipment.
Slow-up / slow-down time is the time required for output to go from 0% to 100%. You can set from 0.0 to 99.9 seconds by key sequence ‘1-9. Slow-up’ and ‘1-10. Slow-down.’
The longer the time is set, the slower output response is. Adjust time according to characteristics of load used.
The factory setting is approximately 1 second, but the overcurrent protection function could be triggered according to load conditions.
Output is changed by variation limit during ramp adjustment by external adjuster or by setting change of key sequence ‘1-6. Ramp lower limit setting’ and ‘1-8. Ramp higher limit setting.’



Variation limit slow-up setting range: 0.0 – 99.9 seconds
Variation limit slow-down setting range: 0.0 – 99.9 seconds

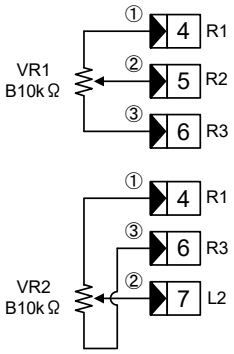
*The variation limit function produces an approximately 3 seconds delay when power is turned on.

11-5. Current limit: Phase control only (current detection / alarm output function [optional])

Function for limiting output current to within 0 – 120% of the device's rated current. Limits current and protects the load if using loads with large inrush current such as pure metal heaters or lamp heaters.
The device detects output current by built-in CT, and because output is controlled each cycle of the power supply frequency, a difference in actual output and target output may develop. Sudden change in load while conducting power therefore cannot be handled in some cases.
If using external current limit setting device B characteristic 10kΩ (VR), allocate by key sequence '1-11. Current limit' (current is limited to 0 – 100% of rated current if allocated to VR).
If load of inrush current is large, set the slow-up time longer.

External adjuster terminal block layout

Allocation	Terminal block No.	Terminal symbol	Adjuster No.
VR1	4	R1	①
	5	R2	②
	6	R3	③
VR2	4	R1	①
	7	L2	②
	6	R3	③



External adjuster error table 3

VR1/VR2		Output
①	Break	100%
②	Break	0%
③	Break	0%

Note
- The current limit function is not activated for cycle calculation zero voltage switching control.
- Reduces output power the amount that load rate exceeds 100% (limits current to limit value by lowering output voltage).
- If the current limit setting device is broken while allocated to external current limit setting device (VR) by key sequence '1-11. Current limit' setting, operation is as given in External adjuster error table 3.
- If current limit value is 0 – 10%, the equipment operates but will operate outside guaranteed precision.

11-6. Contact input / external control input (Di)

Making the C2 and C3 terminals open-circuited/short-circuited triggers the function allocated to key sequence '2-2. Di function selection.'
However, if [Con] is allocated to key sequence '2-1. Control input type selection,' contact input will be given priority.
To modify the settings of Di function selection, please make it open-circuited between the terminal C2 and C3 first.

11-6-1. Contact input

Select key sequence '2-1. Control input type selection' [Con].
If the C2 and C3 terminals are shorted, output is 100% regardless of control input; if they are not shorted, output is 0%.
The equipment can be turned on/off from outside. Ramp higher limit and ramp lower limit are enabled.
If input signal (voltage/current) is not applied, an input-error message is displayed. To close the message, set the key sequence '2-6. Input error display setting' to "[oFF]."
You can switch to '3. Manual output screen group' during contact input.
key sequence '2-2. Di function selection' is not displayed.

11-6-2. External control input

11-6-2-1. Manual output (by external adjuster)

Select key sequence '2-1. Control input type selection' [LCnt]. Select [mAn] by key sequence '2-2. Di function selection.'
Shorting the C2 and C3 terminals enables manual operation by manual setting device using VR3, regardless of control input.
When manual output is "on" (C2 and C3 terminals shorted), you cannot switch to '3. Manual output screen group.'
When manual output is "off" (C2 and C3 terminals not shorted), you can switch to '3. Manual output screen group.'

11-6-2-2. Standby

Select key sequence '2-1. Control input type selection' [LCnt]. Select [Stb] by key sequence '2-2. Di function selection.'
When the C2 and C3 terminals are shorted, output is 0% (standby status), regardless of control input.
To cancel standby, remove the short between the C2 and C3 terminals.
You cannot switch to '3. Manual output screen group' during standby.

Note: "Standby" refers to the following state:
Output is 0%.
The status display flashes on the screen prior to standby.
Alarm output maintains the same status prior to standby.

11-6-2-3. HB alarm output disable

Select key sequence '2-1. Control input type selection' [LCnt]. Select [HboF] by key sequence '2-2. Di function selection.'
Shorting the C2 and C3 terminals disables HB alarm output only (off). The alarm is not output even if it is triggered. Other alarms are however output if triggered.
HB alarm output is enabled if the C2 and C3 terminals are not shorted.

12. Manual operation

The device is equipped with two modes of automatic operation by control input and manual operation (hereinafter referred to as “manual operation”): one by manual setting device and the other by key operation.
If performing manual operation or deciding output characteristics by test operation, you can control output manually.
Operation is set to automatic operation when shipped from the factory. When the power is turned on, the device is therefore controlled by control input.

12-1. Manual operation

With manual operation, the desired operation amount is controlled manually.
Manual operation includes key operation and operation by external adjuster VR3.
During manual operation, the first manual dot of data display for the manual output screen group flashes.

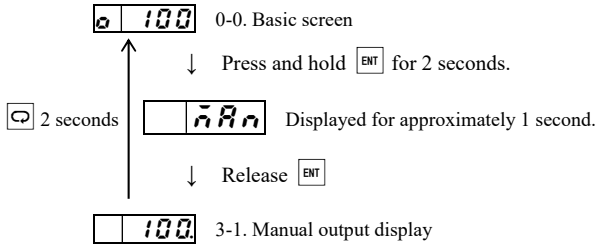
Note: If you set to [Stb] by key sequence ‘2-2. Di function selection’ and short the C2 and C3 terminals, you cannot switch to manual operation by key operation.
If you set to [mAn] by key sequence ‘2-2. Di function selection’ and short the C2 and C3 terminals, you cannot switch to manual operation by key operation.
Manual operation cannot be conducted if you select contact 2-position control input [Con] by key sequence ‘2-1. Control input type selection.’

Note: Since output is limited when the current limit function is operating, although the amount of manual operation by key is indicated in the manual operation output display, it may differ from the actual output value.

Note: Ramp lower limit setting, ramp higher limit setting, scale lower limit setting and scale higher limit setting are disabled during manual operation.

1) Manual operation by key

Press and hold [ENT] on the basic screen for at least 2 seconds.



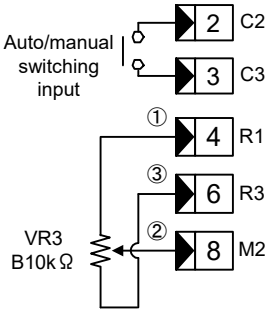
Output is up by [▲], and down by [▼].

Manual operation can be conducted by key sequence ‘3-1. Manual output display.’

2) Manual operation by external adjuster VR3 (if [mAn] is selected by key sequence ‘2-1. Di function selection’)
Shorting the C2 and C3 terminals selects external adjuster VR3.
In this case, the manual operation screen group can no longer be selected by key operation.

Manual power adjuster terminal block layout

Allocation	Terminal block No.	Terminal symbol	Adjuster No.
	2	C2	
	3	C3	
VR3	4	R1	①
	8	M2	②
	6	R3	③



External adjuster error table 4

VR3		Output
①	Break	100%
②	Break	0%
③	Break	0%

Note: Operation would become as given in External adjuster error table 4 if the external adjuster were broken.

Note: When operation is switched from control input to manual operation by key, manual operation is set from the output values before switching.
If switched from manual operation by key to control input operation, operation is executed by control input values immediately after switching (output values are not carried over).

Note: During manual operation (using VR3), an input-error message is displayed. To disable the display setting in manual operation (VR3), set the key sequence ‘2-6. Input error display setting’ to “[oFF].”

Due to the current limit function, actual output phase angle may not increase even if manual output is increased by the external adjuster VR3.

13. Heater break alarm function

13-1. Heater break alarm function (current detection / alarm output function [optional])

The heater break alarm is a function whereby an alarm is given to let you know when the heater is broken. The function is effective for preventing product defects and negative impact of insufficient power.

Note: Heater break alarm detection precision may be reduced if power supply voltage and output operation amount are modified as soon as key sequence '3-3 Hearter break judgement standard setting' is set.

13-1-1. Operation overview

In ordinary operating condition, measure the current of the steady heater by key sequence '3-3. Heater break judgment standard setting' and use as standard value.

Next input the current value reduction rate relative to the standard value (heater break alarm point) setting by key sequence '1-12. Heater break alarm current.' The heater break alarm determines heater break when the value is below the preset vale for at least 5 seconds and the alarm H is displayed on the front display (status display). Control operation continues unchanged.

If alarm cannot be output because of unstable operation when booting, etc., you can disable HB alarm output by '2-2. Di function selection.'

When the alarm is output, it is canceled as soon as heater current recovers, and the H display in the front display (status display) is also canceled.

If self-hold is required, an external self-hold circuit must be constructed.

13-1-2. Setting method

1) Preparation before setting

Switch to r-SEt of key sequence '3-3. Heater break judgment standard setting' of the manual operation screen (data change dot flashes).

Energize the heater near the actual condition of output for the device to sufficiently stabilize the temperature of the heater (load current at this time should however be about 25% of the rated current).

2) Heater current value setting

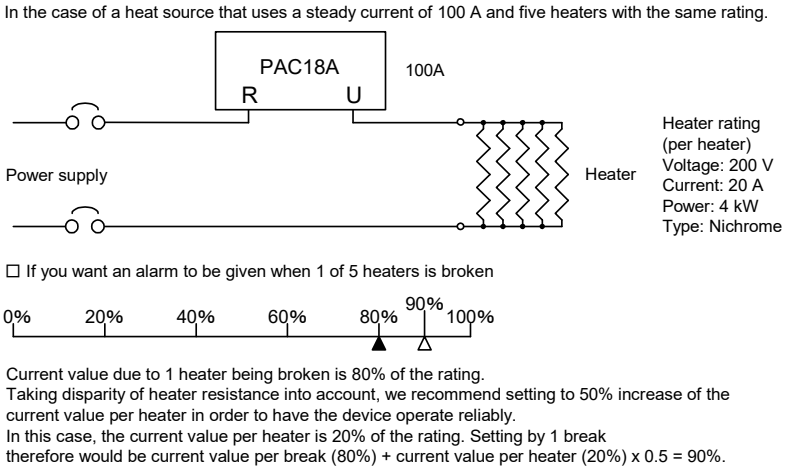
When heater temperature stabilizes, press ENT and import the heater current value (standard value) (data change dot stops flashing).

3) Heater break alarm point setting (HB alarm trigger point setting)

Set current value for heater break within the range of 0 – 100% by key sequence '1-12. Heater break alarm current' (alarm however is not triggered if heater break alarm current is set to 0%).

Example 1: Detecting break for 1 of 5 heaters used

Current percentage for 1 break is 4/5 x 100 = 80%; set to about 90% between that and 100% current when operating normally.



Current value due to 1 heater being broken is 80% of the rating.
Taking disparity of heater resistance into account, we recommend setting to 50% increase of the current value per heater in order to have the device operate reliably.
In this case, the current value per heater is 20% of the rating. Setting by 1 break therefore would be current value per break (80%) + current value per heater (20%) x 0.5 = 90%.

Example 2: If using 1 heater

Set to 50% between 0% current when broken and 100% when operating normally.

13-1-3. Precautions when setting

1) When setting standard current value of heater by key sequence '3-3. Heater break judgment standard setting,' conduct output of the device at maximum output within the output range for actual service conditions. If set outside the output range actually used or when output is small (load current is less than 25% of the rated current), the impact of detection error could increase and result in malfunction.

2) Set heater break alarm point lower than usual by key sequence '1-12. Heater break alarm current.'

Depending on the type of load, detection precision may drop and result in malfunction.

Even in the case of constant resistance heaters, resistance value may vary according to heater temperature in some cases. In some cases, it may be difficult to differentiate between that resistance value variation and resistance value variation due to 1 of several heaters being broken.

If there are many heaters (5 or more), if you set lower than the calculation value (value between 1 break and when normal), you may not be able to detect break of 1 of several heaters, but this is effective for preventing malfunction of heater break alarms.

3) A load with variable resistance (large temperature coefficient) can be controlled as an applicable heater, but the heater break may not be detected correctly due to the large changes in resistance value against heat generation. When connecting a variable resistance load, the current value during operation may be higher or lower than the steady heater current value measured in advance in the key sequence "3-3. Setting the heater break judgment criteria". In such a case, it will be required to set a heater break alarm in consideration of the current change during operation to avoid false alarm.

Example: Using 2 heaters. If heater resistance is large when starting and current when starting is 70% of the heater current for ordinary operation, set lower than 70% of the current when it drops. Because current when starting is 70% and 50% when 1 heater is broken, if you set to 60% between the two, you can detect break 1 of 2 heaters in most cases.

4) In the case of light loads of less than 15% of the rated heater current, heater break may not be able to be detected.

With transformer loads, current detection precision may drop.

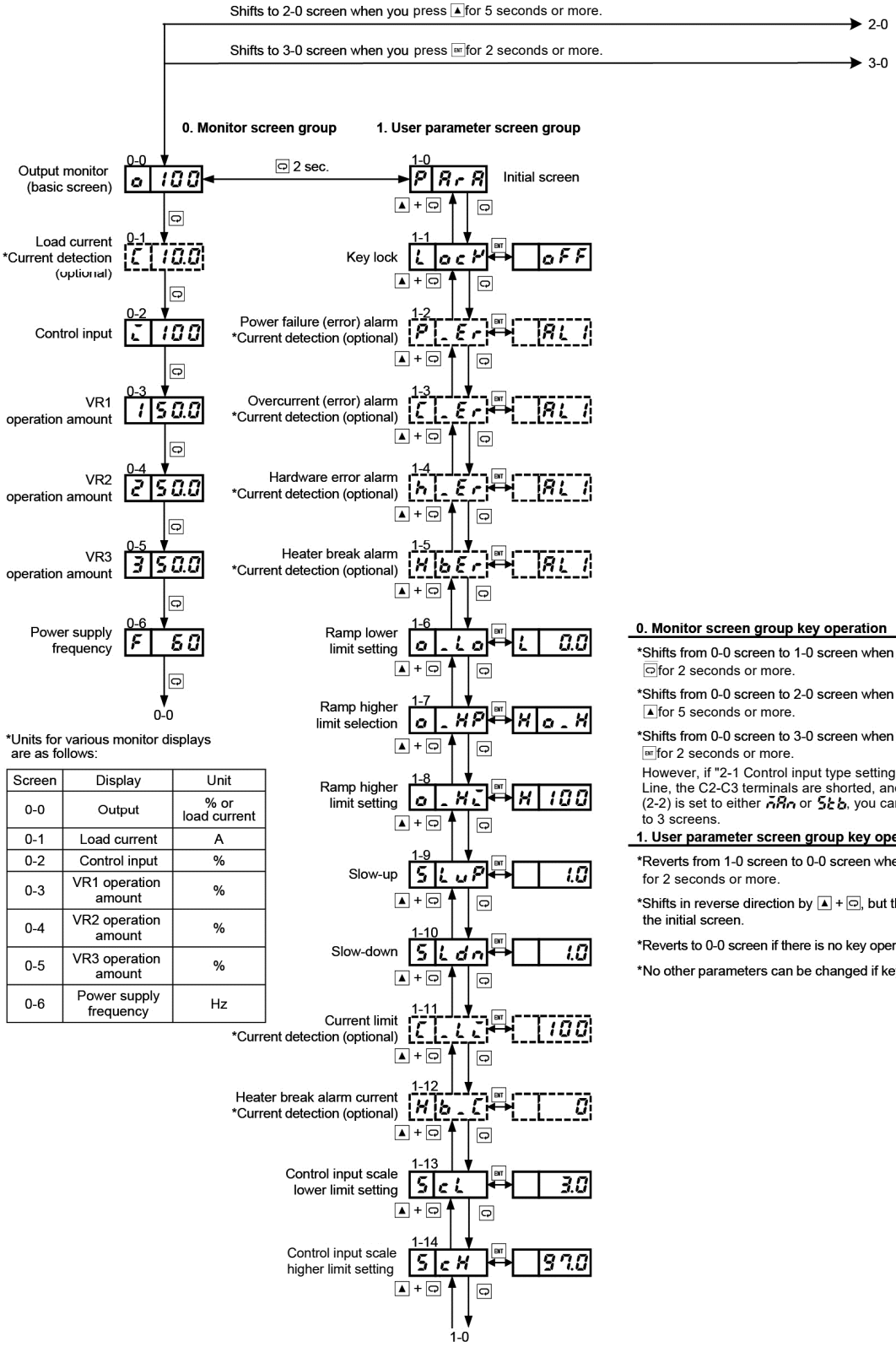
If using with light load (less than 30% of rated load) or transformer load to prevent malfunction, use 50% for the heater break alarm point setting of key sequence '1-12. Heater break alarm current' as the standard.

5) In order to prevent malfunction, the heater break alarm will not be triggered if output phase angle is less than 15%.

14. Key sequence

14-1. Screen sequence

Standard screens are indicated by ☐ and optional screens are indicated by ⋯⋯.
Optional screens may not be displayed depending on the product specifications.



*Units for various monitor displays are as follows:

Screen	Display	Unit
0-0	Output	% or load current
0-1	Load current	A
0-2	Control input	%
0-3	VR1 operation amount	%
0-4	VR2 operation amount	%
0-5	VR3 operation amount	%
0-6	Power supply frequency	Hz

0. Monitor screen group key operation

*Shifts from 0-0 screen to 1-0 screen when you press ⟲ for 2 seconds or more.

*Shifts from 0-0 screen to 2-0 screen when you press ▲ for 5 seconds or more.

*Shifts from 0-0 screen to 3-0 screen when you press ENT for 2 seconds or more.
However, if "2-1 Control input type setting" is set to Line, the C2-C3 terminals are shorted, and Di function (2-2) is set to either rAn or Stb, you cannot switch to 3 screens.

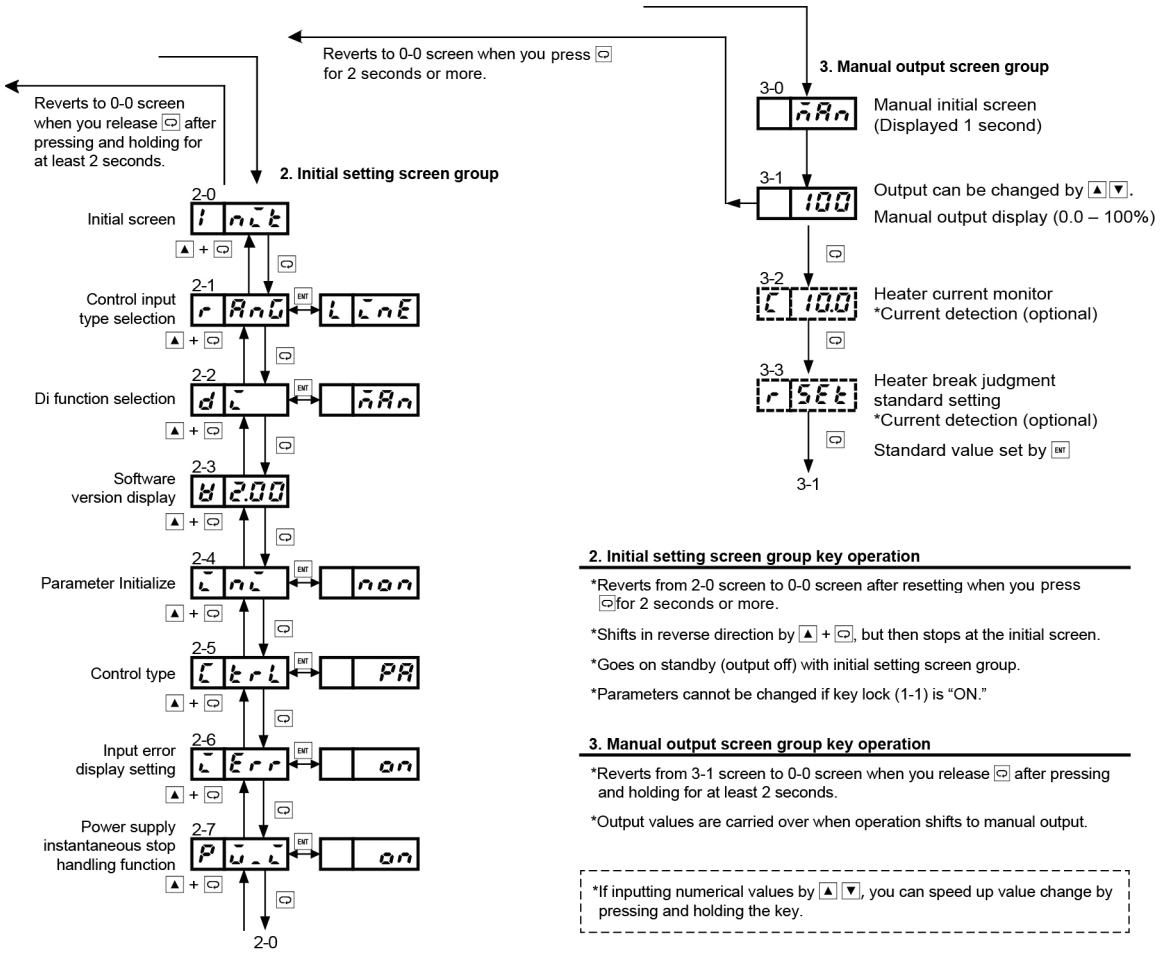
1. User parameter screen group key operation

*Reverts from 1-0 screen to 0-0 screen when you press ⟲ for 2 seconds or more.

*Shifts in reverse direction by ▲ + ⟲, but then stops at the initial screen.

*Reverts to 0-0 screen if there is no key operation for 3 minutes.

*No other parameters can be changed if key lock (1-1) is "ON."



2. Initial setting screen group key operation

*Reverts from 2-0 screen to 0-0 screen after resetting when you press ↺ for 2 seconds or more.

*Shifts in reverse direction by ▲ + ↺, but then stops at the initial screen.

*Goes on standby (output off) with initial setting screen group.

*Parameters cannot be changed if key lock (1-1) is "ON."

3. Manual output screen group key operation

*Reverts from 3-1 screen to 0-0 screen when you release ↺ after pressing and holding for at least 2 seconds.

*Output values are carried over when operation shifts to manual output.

*If inputting numerical values by ▲ ▼, you can speed up value change by pressing and holding the key.

Standard screens are indicated by [ ] and optional screens are indicated by [ ].
Optional screens may not be displayed depending on the product specifications.

Screen display when power is turned on

Screen display when power is turned on is as follows.

Power on
↓ Approx. 0.5 seconds
P 18A
↓ Approx. 0.5 seconds
PA Control type display
↓ Approx. 0.5 seconds
20A Current capacity display
↓ Approx. 0.5 seconds
0.0 Displays '0-0. Output monitor screen.'

14-2. Monitor screen group

Screen group that displays data such as voltage, current and input values of various loads.

The following information icons are used here to facilitate explanation.

AL	Setting/display enable when optionally equipped with current detection
Range	Setting range
Init.	Initial value

0-0. Output monitor (basic screen)

Basic screen for the device.
Displays current output.
When phase control (phase angle proportional control) is selected:
Output phase angle (%)
When phase control (voltage proportional control) is selected:
Output voltage (%)
When phase control (current feedback) is selected:
Output current (A)
When phase control (voltage square [electric power] proportional control) is selected:
Output power (%)
When cycle calculation zero voltage switching control is selected:
Output operation amount (%)

Switches from this screen to various parameter groups for checking/setting various parameter settings.

100 Setting range: 0.0 – 100
(Fractional digits below decimal point not displayed for 100% or 100A)

- Switches to subsequent screen → '0-1.'
- Pressing and holding 2 seconds switches to user parameter group → '1-0.'
- Pressing and holding 5 seconds switches to initial setting screen group → '2-0.'
- Pressing and holding 5 seconds switches to manual output screen group → '3-0.'

Note 1
Alarm contents are sometimes displayed for status display (one-digit red LED).
For details, see '10. Alarm function.'

0-1. Load current (current detection [optional]) Unit: A

Displays load current value. Displayed when optional current detection is selected.

C 10.0 AL

In the case of phase control, effective value; in the case of cycle calculation zero voltage switching control, mean value of effective value for 1 second.
Displays C - - - if less than 5% of rated current.

0-2. Control input Unit: %

Displays control input value.

C 100

0.0 or LLL is displayed if control input is less than -10%; HHH is displayed if 110% is exceeded. Differs according to type of control input.
If Con is selected by key sequence '2-1. Control input type selection,' - - - is displayed and no numerical value is displayed.

Range -10.0 – 110
(fractional digits below decimal point not displayed for 100% and more)

0-3. VR1 operation amount Unit: %

Output amount can be manually changed by connecting an external adjuster. Operation amount of the external adjuster is displayed in the range of 0 – 100%. Set either key sequence '1-6. Ramp lower limit setting,' '1-8. Ramp higher limit setting' or '1-11. Current limit.'

1 50.0

Range 0.0 – 100
(fractional digits below decimal point not displayed for 100%)

0-4. VR2 operation amount Unit: %

Output amount can be manually changed by connecting an external adjuster. Operation amount of the external adjuster is displayed in the range of 0 – 100%. Set either key sequence '1-6. Ramp lower limit setting,' '1-8. Ramp higher limit setting' or '1-11. Current limit.'

2 50.0

Range 0.0 – 100
(fractional digits below decimal point not displayed for 100%)

0-5. VR3 operation amount Unit: %

Output amount can be manually changed by connecting an external adjuster. Operation amount of the external adjuster is displayed in the range of 0 – 100%. VR3 is used for manual operation.

3 50.0

Range 0.0 – 100
(fractional digits below decimal point not displayed for 100%)

0-6. Power supply frequency Unit: Hz

Displays power supply frequency.
Power supply frequency is automatically determined, but sudden frequency change cannot be handled. Before switching frequency, turn off the device's power. Changing power supply frequency with the power on could cause temporary malfunction and result in 100% output.

F 60

Range 40 – 70

- Switches to '0-0. Initial screen.'

14-3. User parameter screen group

The user can modify the control operation parameters.
You can obtain safer, more reliable control characteristics by various type of alarm output settings and settings such as overcurrent limit.

Pressing and holding [⟲] for 2 seconds switches from key sequence '0-0. Output monitor (basic screen)' to the user parameter screen group.

Parameter change by [▼] [▲]

Selection entered by [ENT]

1-0. Initial screen

PArA

Displays the initial screen of the user parameter screen group.
Switch to this screen when returning to the basic screen from the user parameter screen group.

[⟲] switches to subsequent screen to key sequence '1-1. Key lock.'

1-1. Key lock

Limits operation of parameters screens.

LocK bFF: All parameters can be modified.

on: Parameters other than key lock cannot be modified.

Range oFF, on Init. oFF

1-2. Power failure (error) alarm (current detection [optional])

Sets whether or not to output an alarm when a power failure occurs.

P_Er AL 1: Allocated to alarm output 1

non: Alarm not output

Range AL 1, non Init. AL 1

1-3. Overcurrent (error) alarm (current detection [optional])

Sets whether or not to output an alarm when overcurrent protection circuit is triggered.

C_Er AL 1: Allocated to alarm output 1

non: Alarm not output

Range AL 1, non Init. AL 1

1-4. Hardware error alarm (current detection [optional])

Sets whether or not to output an alarm when thyristor failure or circuit error occurs.

h_Er AL 1: Allocated to alarm output 1

non: Alarm not output

Range AL 1, non Init. AL 1

1-5. Heater break alarm (current detection [optional])

Sets whether or not to output an alarm when heater break occurs.

HbEr

AL 1: Allocated to alarm output 1

non: Alarm not output

Range AL 1, non Init. AL 1

1-6. Ramp lower limit setting Unit: %

Sets allocation of output gradient lower limit (base power).

o_Lo L 0.0: Key input allocation

L VR 1: Allocated to VR1 (below 0.0)

L VR2: Allocated to VR2

Range 0.0 – 99.9, L VR 1, L VR2 Init. 0.0

Note 1

Both ramp lower limit and ramp higher limit cannot be allocated to VR1 or VR2 at the same time.
If one VR has been selected, the other is automatically selected as well. (Example: If ramp lower limit is set for VR1, only VR2 can be selected to set ramp higher limit by VR.)
To change while higher or lower limit is selected, first cancel VR allocation and then change.
(VR cannot be selected while using key sequence '1-11. Current limit.'
To allocate to ramp lower limit, cancel allocation of VR of key sequence '1-11. Current limit')

Note 2

Ramp lower limit cannot be set higher than ramp higher limit. (Key setting and VR setting)

1-7. Ramp higher limit selection

Sets allocation of ramp higher limit of output (high power).

o_HP H o_H: Allocated to ramp higher limit only

H VR 1: Allocated to VR1 x ramp higher limit setting

H VR2: Allocated to VR2 x ramp higher limit setting

Range Ho_H, HVR 1, HVR2 Init. Ho_H

Note 1

Both ramp lower limit and ramp higher limit cannot be allocated to VR1 or VR2 at the same time.
If one VR has been selected, the other is automatically selected as well. (Example: If ramp higher limit is set for VR1, only VR2 can be selected to set ramp lower limit by VR.)
To change while higher or lower limit is selected, first cancel VR allocation and then change.
(VR cannot be selected while using key sequence '1-11. Current limit.'
To allocate to ramp higher limit, cancel allocation of VR of key sequence '1-11. Current limit').

Note 2

For VR setting, ramp higher limit has priority if ramp higher limit is lower than ramp lower limit.

Note 3

If allocating to VR1 or VR2, ramp higher limit is ramp higher limit setting value (%) of VR setting value (%) x key sequence '1-8. Ramp higher limit setting' If set by VR only, set key sequence '1-8. Ramp higher limit setting' to 100%.

1-8. Ramp higher limit setting Unit: %

Sets ramp higher limit value of output (high power).

o_HL H 100

Range 0.1 – 100 (fractional digits below decimal point not displayed for 100%) Init. 100

Note 1

Ramp higher limit value cannot be set lower than ramp lower limit value.

1-9. Variation limit slow-up Unit: Seconds

Current may change precipitously if amount of output varies dramatically while the power is on. Slow-up is provided to play the role of suppressing this ramp.

SLuP 1.0

The setting value is the time required for output to increase from 0 to 100%.

Range 0.0 – 99.9 Init. 1.0

1-10. Variation limit slow-down Unit: Seconds

Slow-down is provided to play the role of slowly reducing output.

SLdn 1.0

The setting value is the time required for output to decrease from 100 to 0%.

Range 0.0 – 99.9 Init. 1.0

1-11. Current limit (current detection [optional]) Unit: %

The current limiter limits output current value to 120% of rated current. Sets allocation of the function. Lower the display from 0% by key when allocating to VR. (If allocating to VR, current limit is 0 – 100% of rated current.)

This screen is not displayed for cycle calculation zero voltage switching control.

CLLC 100: Key input allocation (AL)

Vr1: Allocated to VR1 (below 0%)

Vr2: Allocated to VR 2

Range 0 – 120, Vr 1, Vr2 Init. 100

Note

VR currently being used cannot be selected by key sequence '1-6. Ramp lower limit setting' and key sequence '1-7. Ramp higher limit selection.' If allocated to current limit, cancel VR allocation of key sequence '1-6. Ramp lower limit setting' or key sequence '1-7. Ramp higher limit selection.'

1-12. Heater break alarm current (current detection [optional]) Unit: %

The value produced by alarm for heater break is set by percentage display relative to value set by '3-3. Heater break judgment standard setting.' Alarm however does not occur if heater break alarm current is set to 0%. (AL)

Hb_C 0

Range 0 – 100 Init. 0

1-13. Control input scale lower limit setting Unit: %

Sets control input scale lower limit value.

ScL 3.0

Range 0.0 – 20.0 Init. 3.0

1-14. Control input scale higher limit setting Unit: %

Sets control input scale lower limit value.

ScH 97.0

Range 80.0 – 100 Init. 97.0

To key sequence '1-0. Initial screen' by ⟲

14-4. Initial setting screen group

Group of screens for setting operation conditions for the device. Must be set in advance.

Pressing and holding ▲ for at least 5 seconds from key sequence '0-0. Output monitor (basic screen)' switches to the initial setting screen group. Output is stopped (output OFF).

To exit the initial setting screen group, press and hold ⟲ from '2-0. Initial screen' for at least 2 seconds and then release. After rebooting, switches to monitor screen group.

Parameter change by ▼ ▲

Selection entered by ENT

2-0. Initial screen

Initial screen for initial setting screen group.

Switch to this screen when returning to the basic screen.

InIt

⟲ switches to subsequent screen (key sequence '2-1. Control input type selection').

Pressing and holding ⟲ for at least 2 seconds and then releasing switches to monitor screen group after rebooting, and then to key sequence '0-0. Output monitor (basic screen)' (however returns to screen when power is turned on).

2-1. Control input type selection

Selects type of control input for the device.

rAnG LinE: Voltage/current input

Con: Contact 2-position control input

Range LinE, Con Init. LinE

2-2. Di function selection

Select/set according to usage objective of external control input (Di).

If Con is selected by key sequence '2-1. Control input type selection,' this screen is not displayed.

dI nAn: Manual output (by external adjuster)

Stb: Standby

HboF: HB alarm output disable

Range nAn, Stb, HboF Init. nAn

Di function setting range table

	C2-C3 open-circuited	C2-C3 short-circuited
nAn	Control input operation (HB alarm output enabled)	Manual output by VR3
Stb		Standby
HboF		Control input operation (HB alarm output disabled)

* When the C2 and C3 terminals are shorted in Stb setting, output is 0% (standby status), regardless of control input. To cancel standby, remove the short between the C2 and C3 terminals.

When the C2 and C3 terminals are shorted in nAn Stb setting, you cannot switch to '3. Manual output screen group.'

To switch to '3. Manual output screen group,' remove the short between the C2 and C3 terminals.

2-3. Software version display

Displays software version of the device.

U2.00 Version is set to version 2.00 in this display.

2-4. Parameter initialize

Resets initial settings screen group and user parameter group to default settings.

When dFLt is displayed, executed by ENT (device reboots after reset is executed).

Because control type becomes PA after reset is executed, reset '2-5. Control type.'

ini

non: No initialize

dFLt: Initialize

Range non, dFLt Init. non

2-5. Control type

Sets control type.

ctrL

PA: Phase control / phase angle proportional

PA-U: Phase control / voltage proportional

CFb: Phase control / current feedback

PA-J: Phase control / electric power proportional

ZC: Zero voltage switching

Range PA, PA-U, CFb, PA-J, ZC Init. By product specifications code

Note

Current feedback cannot be selected for equipment not equipped with current limit / alarm output function (optional).

2-6. Input error display setting

Selects whether or not to display an input error when control input is less than 10% or exceeds 110%.

iErr

on: Displays input error.

oFF: Does not display input error.

Range on, oFF Init. on

2-7. Power supply instantaneous stop handling function

Sets whether or not to conduct slow-up operation when operation is restored after equipment stops running when power supply is interrupted instantaneously.

Unlike the preset time of key sequence '1-9. Slow-up,' slow-up time is 160 msec (50 Hz).

PU_i

on: Enable

oFF: Disable

Range on, oFF Init. on

Switches to '2-0. Initial screen.'

14-5. Manual output screen group

With manual operation, the desired operation amount is controlled manually. With the heater break alarm function, there is an operation to set load current of the heater to serve as the judgment standard.

3-0. Manual initial screen

Pressing and holding ENT for at least 2 seconds switches from key sequence '0-0. Output monitor (basic screen)' to manual output.

If you switch to manual output by key sequence '0-0. Output monitor (basic screen),' the value of the immediately preceding control input is carried over. If reverting to the '0-0. Output monitor (basic screen)' from manual output, output is in accordance with control input values at that time.

0100 0-0. Basic screen

↓ ENT Press and hold for 2 seconds.

mAn Displayed approx. 1 second

3-1. Manual output display Unit: %

Manual output display screen.

100: Displays manual output values.

Setting range: 0.0 - 100

Output is 100% for this display.

(Fractional digits below decimal point not displayed for 100%)

When you switch to manual output, the immediately preceding control input value is carried over.

Output can be changed by ▼ ▲ key

↻ key switches to '3-2. Heater current monitor' C 10.0.

Pressing and holding the ↻ key for 2 seconds reverts to basic screen 0100.

Range 0.0 – 100

3-2. Heater current monitor (current detection [optional]) Unit: A

Displays heater current.

Heater current for manual output.

AL

C 10.0

In the case of phase control, effective value; in the case of cycle calculation zero voltage switching control, mean value of effective value for 1 second.

3-3. Heater break judgment standard setting (current detection [optional])

Sets break judgment standard for heater break.

Sets usual state by manual output and uses it as the standard for determining heater break.

AL

With the judgment standard as 100%, set an actual operation alarm by key sequence '1-12. Heater break alarm current.'

rSEt: Displays heater resistance setting screen (data stored by ENT).

↻

100: Reverts to key sequence '3-1. Manual output display.'

↻ ↻ Press and hold for 2 seconds.

Reverts to key sequence '0-0. Output monitor (basic screen).'

0100

15. Characteristics

15-1. Current capacity and heat value

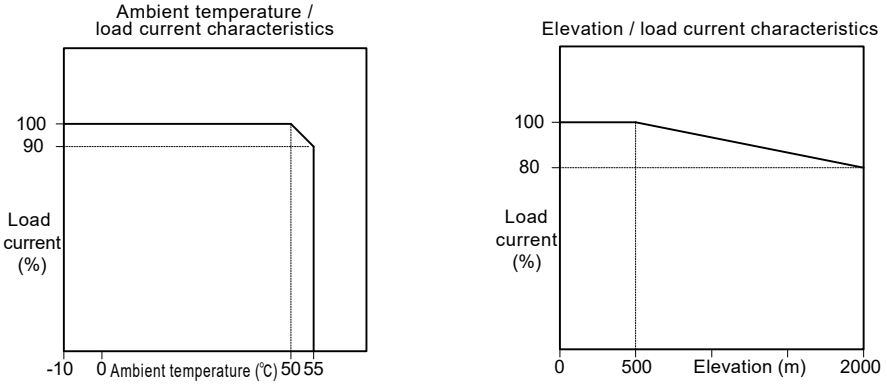
Voltage drop to thyristor device (0.9 – 1.3 V) is produced by current flowing to the thyristor. Voltage between thyristor device and accumulation of current (W) turn into Joule heat, resulting in rise in temperature of the thyristor device. Take heat dissipation and ventilation into account.

Internal heat value (Conversion formula for calorific value : 860kcal = 1000W)

Current capacity	20A	30A	45A	60A	80A	100A
Heat value	22W	36W	47W	65W	77W	96W

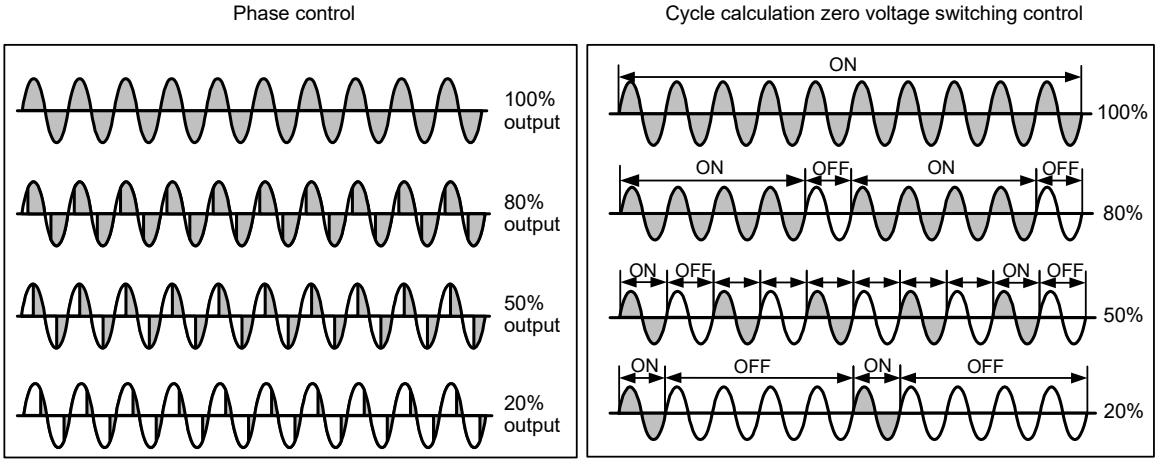
15-2. Ambient temperature, elevation and load current

Rated current of the device assumes an environment where ambient temperature does not rise above 55°C. If ambient temperature exceeds 50°C, reduce load current as shown in the figure.



15-3. Features and output waveform of control type

The device includes phase control and cycle calculation zero voltage switching control types. You can have the control type changed by specifying when ordering. You can set it by key sequence '2-5. Control type.'
Features and output waveform of phase control and cycle calculation zero voltage switching control are as follows:



Control type / Output	Phase control	Cycle calculation zero voltage switching control
Harmonics disturbance	Possibility of occurring	No
Flicker	No	Possibility of occurring
Applicable load	Resistance load Inductive load (transformer primary control)	Resistance load
Power factor	Poor	Good
Features	Smooth, thorough control	No harmonic noise produced

15-4. Control types and 5 types of output characteristics

This device enables you to switch your control type selection (2 types) according to load characteristics to either phase control by key operation (phase angle proportional output, voltage proportional output, voltage square [electric power] proportional output, current feedback [4 modes] or cycle calculation zero voltage switching control function [1 mode]).
Switching to current feedback can be done by selecting "Current feedback in control method" and "Current detection / alarm output function" when you place an order.

Control type

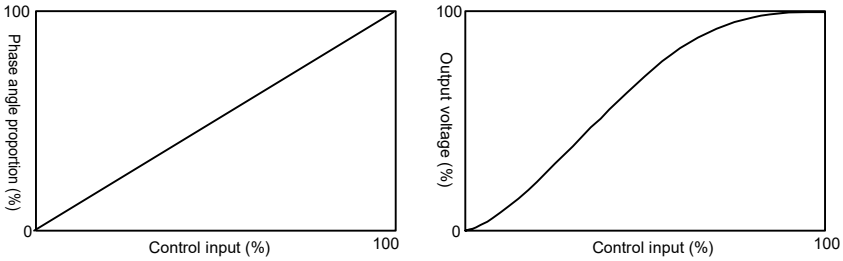
Parameter symbol	Control type
PA	Phase control / phase angle proportional output
PA-V	Phase control / voltage proportional output
CFb	phase control / current feedback *When current detection /alarm output function (optional) is added
PA-W	Phase control / voltage square (electric power) proportional output
ZC	Cycle calculation zero voltage switching control

*Remarks: Parameter symbols are displayed in the display section when power is turned on (when setting control type), depending on what type of control is selected.

15-4-1. Phase control / phase angle proportional output PA

You can obtain phase angle output proportional to control input signal.
This function enables finer output control than cycle output control.
You should use the current limit function and variation limit function in combination for load with significant inrush current.

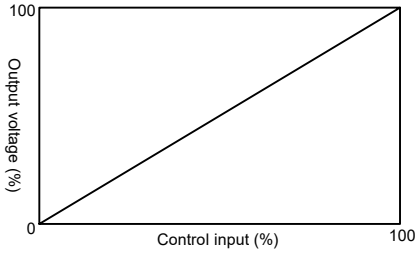
Phase control / phase angle proportional output (PA)



15-4-2. Phase control / voltage proportional output PA-V

You can obtain output voltage proportional to control input signal.
The current limit function is necessary for large inrush current loads.
You should use the current limit function and variation limit function in combination for load with significant inrush current.

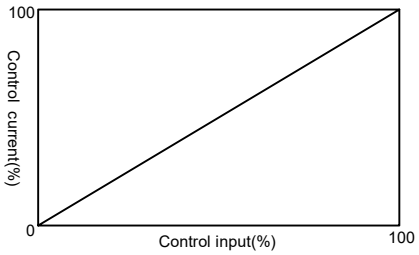
Phase control / voltage proportional output (PA-V)



15-4-3. Phase control / current feedback CFb

You can obtain output current proportional to control input signal.
If control input is constant, output current is kept constant even if load or power supply voltage fluctuate.

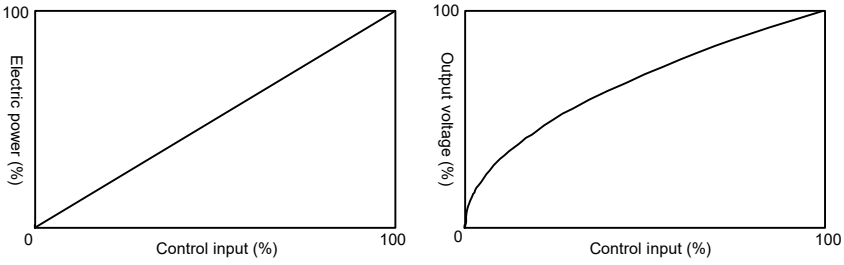
Phase control / constant current output (current feedback)



15-4-4. Phase control / voltage square (electric power) proportional output PA-W

You can obtain voltage square output proportional to control input signal. Because power relative to constant resistance is proportional to voltage squared, you can obtain power according to control signal using constant resistance heaters such as nichrome or iron-chrome.
Use the current limit function and variation limit function in combination for load with significant inrush current.

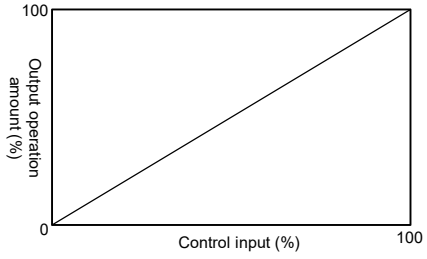
Phase control / voltage square proportional output (PA-W)



15-4-5. Cycle calculation zero voltage switching ZC

You can obtain cycle output proportional to control input.
Not as much noise is produced as with phase angle control.
Current limit is disabled.

Cycle calculation zero voltage switching (ZC)



16. Noise countermeasures

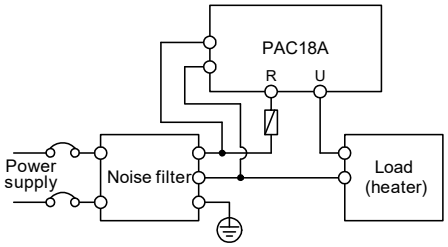
With phase control, part of the power supply sine wave is dropped. This produces distortion in the sine wave if power supply impedance is high. Also, because power supply is switched each half cycle, switching noise is produced. The power supply distortion and noise may affect other equipment.
In the case of cycle calculation zero voltage switching, an extremely small amount of noise is produced compared with phase control due to switching near the zero cross point of the power supply.
Because some noise is produced by switching large current, however, you should use a noise filter if necessary.
Also, if power supply impedance is high, the power supply may flicker in synch with ON/OFF of the thyristor.

16-1. 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.

Equipment current capacity	Noise filter models
20A	NF2020C-SDG
30A	NF2030C-SDG
45A	NF2050C-SDG
60A	NF2060C-SDG
80A	NF2080C-SDG
100A	NF2100C-SDG

Noise filter connection diagram

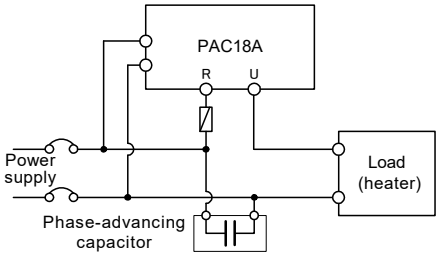


For information on noise filters, contact your nearest Shimaden agent.

16-2. Improvement of power supply waveform by phase-advancing capacitor

It is effective to connect a phase-advancing capacitor to the main power supply for the device and load to ameliorate power supply distortion (high harmonic wave) due to thyristor phase control by enhancing power factor.
1 μF capacitor should be effective for current capacity 1 A.
This is a very simple method, but you should take the following precautions.
(1) High harmonic wave current flows into the capacitor, so pay attention to the rated current of the capacitor and watch out for temperature rise.
(2) The capacitor may cause resonation with inductance of the power supply line resulting in high harmonic wave voltage; check the power supply waveform.

Phase-advancing capacitor connection diagram



*We recommend the Panasonic N2 low voltage phase-advancing capacitor.

17. Precautions when using transformer load

Transformer usage objective

1) To match voltage when heater voltage differs from power supply voltage.
2) When it is necessary to insulate the heater circuit from the power supply.
3) To raise ground voltage resistance using a compound transformer when ground insulation deteriorates like vacuum equipment.

17-1. Control type

Transformer load can be used for phase control.
A transformer load cannot be used for cycle calculation zero voltage switching control.

17-2. Transformer magnetic flux density

Excessive current flows when the magnetic circuit becomes saturated when using the transformer (load is limited to transformer winding resistance) and could destroy the thyristor. With thyristor control, the thyristor is switched (OFF/ON) each half cycle. If the load becomes heavy, the output waveform tends to become unbalanced and saturated. You should therefore design the system so that magnetic flux density is lower than that of a conventional transformer.

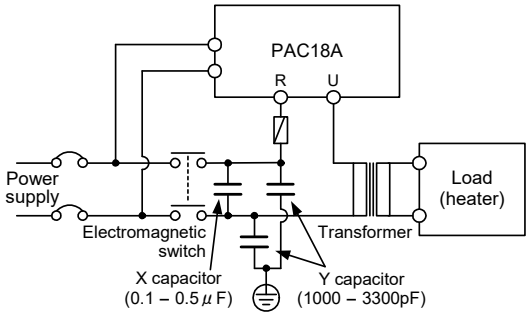
⚠ CAUTION

The applicable transformer is as follows:
Applicable transformer: Isolation transformer (double wound transformer)
Inapplicable single phase transformer: Single wound transformer (slide transformer, etc.)
The secondary side of applicable transformers must, however, be connected to resistance load (power factor 0.8 – 1.0).

Do not connect any equipment between the device and transformer.
Cut off the power supply before replacing the tap of the transformer.

17-3. If using electromagnetic switch (contactor)

If using an electromagnetic switch (contactor) for a circuit connected to the transformer (inductive load), malfunction could result from contact bounce. If so, you should either use the prescribed noise filter, or connect an X capacitor (0.1 – 0.5 μF) between the R and U power supply side terminals of the thyristor, or a Y capacitor (1000 – 3300 pF) between the R and U power supply side terminals and the ground to absorb the noise.



17-4. Rapid fuse usage

We recommend a rapid fuse to protect the thyristor device from excessive current produced when using a transformer due to high frequency wave noise or load trouble, etc.
See '19-1. Rapid fuse (sold separately).'

17-5. Prohibition of operating without load

Before conducting operation whereby a load cannot be connected such as test operation, disconnect the transformer wiring and connect a dummy load such as an electric heater or light bulb. Do not operate the device without a transformer load.
Do not switch loads while the device is powered. Operating without a load may damage the thyristor device.
Note: If using a single heater and it becomes broken, then the device would be operating without a load.

18. Fuse / heater break alarm function

18-1. Rapid fuse (sold separately)

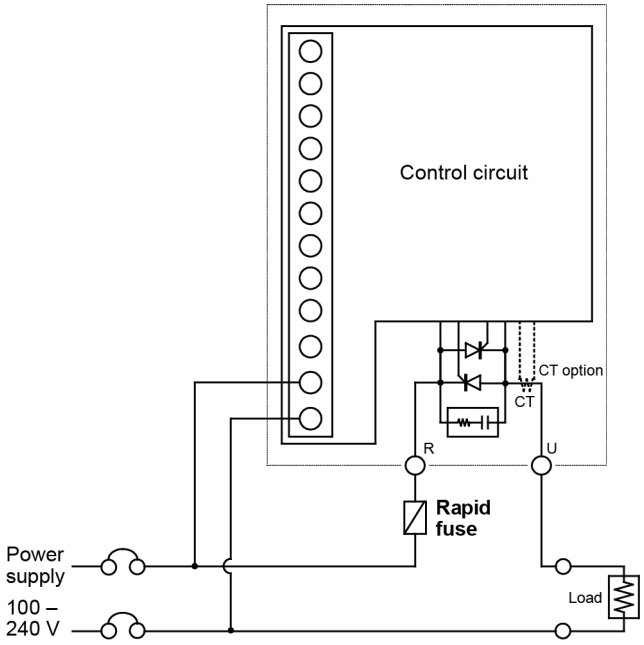
You can externally mount a rapid fuse to protect the thyristor device. It is possible to protect the thyristor device from malfunction when using a transformer or load short while energized.

Recommended rapid fuses

	Current capacity	Model
Rapid fuse	20 / 30A	QSF006
	45 / 60A	QSF007
	80 / 100A	QSF008
Fuse holder	20 – 60A	QSH002
	80 / 100A	QSH003
Rapid fuse and fuse holder set	20 / 30A	QSF01F
	45 / 60A	QSF01G
	80 / 100A	QSF01H

For information on rapid fuses, contact your nearest Shimaden agent.

Connection diagram



⚠ CAUTION

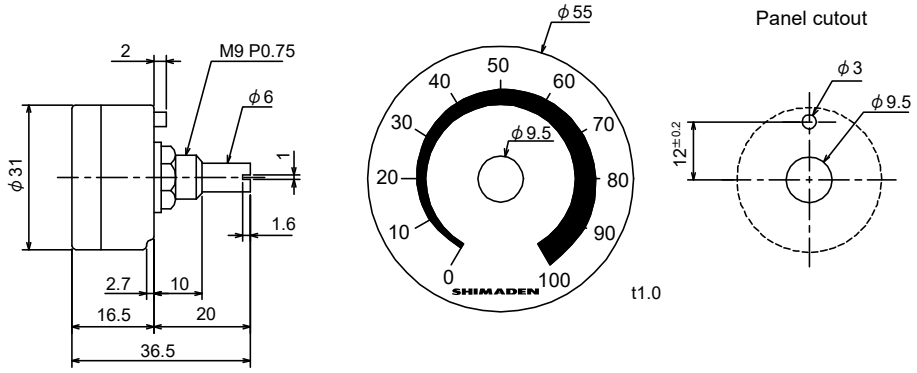
Cut off the device's power supply before replacing the rapid fuse.

19. Accessories (sold separately)

19-1. External adjuster

- Type : QSV003
- Specifications : Characteristics/resistance value: B 10kΩ
  Lead: Vinyl lead, 1 m, M3 crimp terminal
  Scale plate / knob: 1 each provided

• External dimensions and panel cutout (unit: mm)

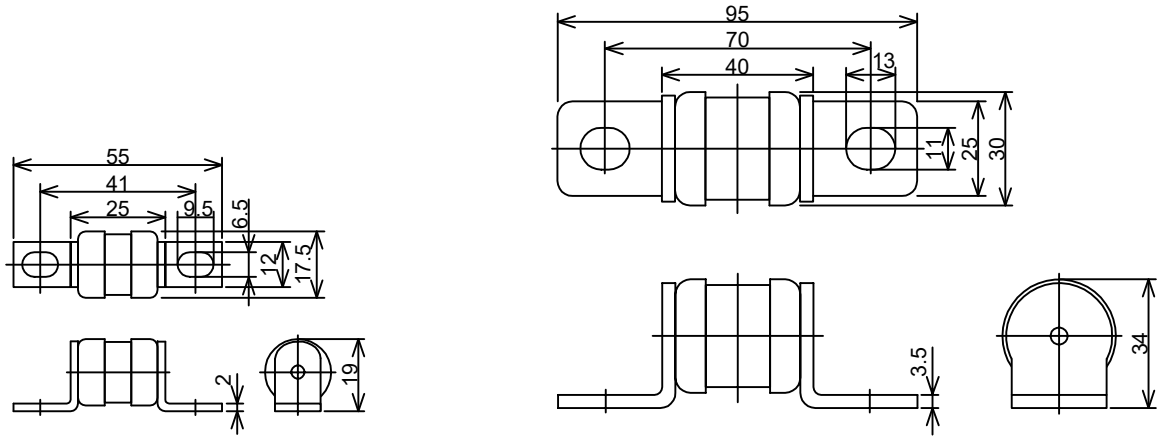


19-2. External rapid fuse

20/30A (Model: QSF006)
45/60A (Model: QSF007)

80/100A (Model: QSF008)

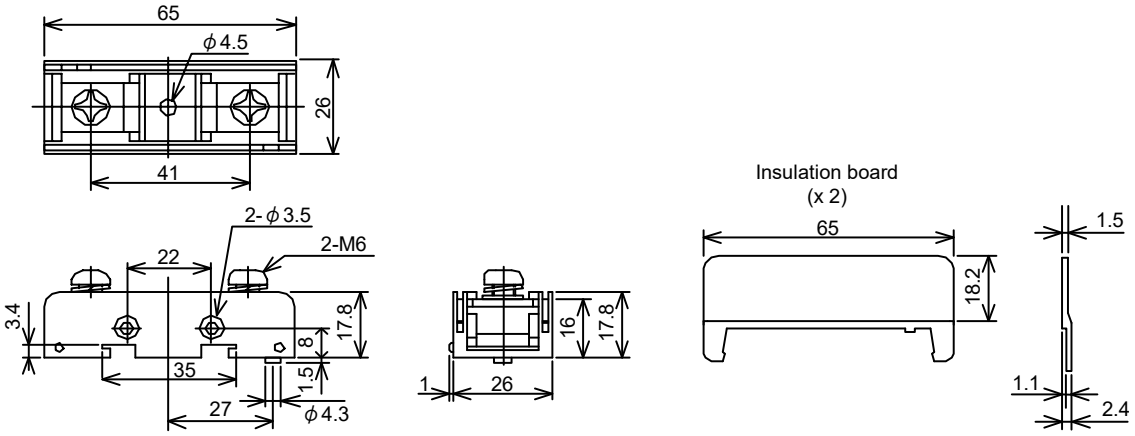
• External dimensions (unit: mm)



19-3. Fuse holder

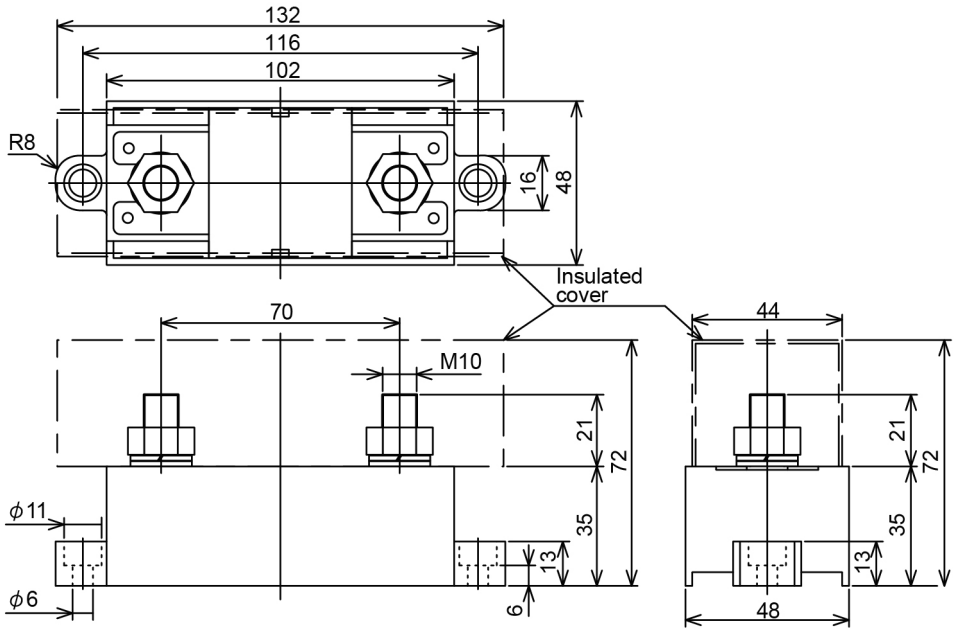
20/30A, 45/60A (Model: QSH002)

• External dimensions (unit: mm)



80/100A (Model: QSH003)

• External dimensions (unit: mm)



20. Troubleshooting

If a problem occurs while using the equipment, check it by using the following chart and contact your nearest Shimaden agent.

	Problem	Place to inspect	Measures to take
1	No output.	1) Panel LED does not light.	Check power. If power is not supplied, check out the power supply side. If power is supplied, the device may be broken.
		2) h is lit in the alarm code display at the front display (status display).	There could be something wrong with the circuit or the thyristor may have shorted.
		3) C is lit in the alarm code display at the front display (status display).	Excessive current may have been produced for some reason. For pure metal heater or transformer load, set longer slow-up time. If the alarm lights again, turn the power off, set ramp higher to 0% and then turn the power back on. If no longer lit, there might be a problem on the load side. You should therefore check the load side. If lit, there may be internal failure of the device.
		4) Is the control input signal present?	Check the level by measuring between input terminals with a VOM, etc. If the control input signal is not present, check the signal supply source such as the controller. (Linear control input [voltage/current control input]: Between C1 and C2 terminals; contact 2-position control: Between C2 and C3 terminals) If a normal signal is present, check settings of and connection with external adjusters. If the connections and settings are correct, the device may be faulty.
		5) Output limit is functioning.	Check ramp higher limit setting and current limiter setting. Check the value of the parameter setting screen and whether the external adjuster (VR) to which the function is allocated has been turned down.
2	Output continues as is.	1) h is lit in the alarm code display at the front display (status display).	The thyristor may be shorted/faulty or the circuit may be shorted.
		2) Is the load circuit open?	If the load circuit is open, the panel meter or tester will indicate high voltage. Check the load circuit.
		3) Ramp lower limit setting is high.	The minimum value for output is not set to zero for ramp lower limit function. Check the value of the parameter setting screen and position of the external adjuster (VR) to which the ramp lower limit is allocated. Check VR position on monitor screen VR1 – VR2.
3	Maximum output has dropped.	1) Check various output adjustment settings.	Check parameter setting (Ramp higher limit selection, Ramp higher limit setting, Variation limit slow-up, Current limit, Control input scale higher limit setting) values and external adjusters (VR). Set to '100%' and monitor output.
		2) Check control input signal.	Check if the control input signal is 100%.
		3) Check the load current value.	Check current limit setting, set to 100% and check output and load current. If load current is at the maximum rated current, the current limit function is functioning. The load exceeds the rating of the device.
		4) Check the measuring instrument used for the measurement.	The reading may vary according to the type of meter. Be sure to use actual value type (True RMS) or moving-iron meter. If measuring voltage with a conventional digital or analog tester, the mean value is shown as the actual value conversion, which could result in significant pointing error. (In the case of a 200 V power supply, pointing error may be as much as 43 V.)
4	External fuse blows.	1) Are load capacity and device capacity appropriate?	If load rate is 100% or more, turn output down.
		2) If inrush current from pure metal heater, etc., produces a large load.	Set slow-up time longer. If this doesn't help, replace the device with one with a larger rated current.
		3) If using a transformer.	Set slow-up time longer. Also lighten load relative to transformer capacity. If malfunction due to noise is possible, either use a noise filter or connect a capacitor (at least 250V AC, 0.1 μF) between terminals R and U.

21. Common specifications

□ Type : PAC18A
□ Control element configuration : Thyristor x 2 inverse-parallel connection
□ Main/control power supply : 100 – 240V AC, 7VA (main/control power supply used by same phase)
□ Power supply waveform : Sine wave
□ Voltage fluctuation tolerance : Max. ±10% of rated voltage
□ Rated frequency : 50/60Hz automatic recognition (operation range: 40 – 70Hz)
□ Current capacity : Specify any of 6 types (20A, 30A, 45A, 60A, 80A, 100A)
□ Minimum load current : 0.6A
□ Control output range : Min. 0 – 97% (200V/50Hz power supply)
□ Applicable load : Resistance load or inductive load (transformer primary control: phase control only)
□ Control type : The following types of control can be set.
Px-: Phase control (selected when placing order), phase angle proportional output (P0-),
voltage proportional output (P1-),
current feedback (when optional current detection / alarm output function added) (P2-),
voltage square (electric power) proportional output (P3-)
C1-: Cycle calculation zero voltage switching control
□ Cooling : Self cooling
□ Protection : 1) Overcurrent protection function (current detection [optional]), output stops at approx. 130% of rated current
2) External rapid fuse (sold separately)

□ Control input : Selection of any one of 3 types
(current 4 – 20mA DC [receiving impedance 100Ω] or voltage 1 – 5V, 0 – 10V DC [input resistance 200kΩ])
Contact 2-position control (on/off control)
□ Standard functions
• Output adjustment function : Ramp setting (higher: 0.1 – 100%, lower: 0.0 – 99.9%)
Slow-up time / slow-down time (0.0 - 99.9 sec)
Input scaling (lower: 0.0 – 20.0%, lower: 80.0 – 100%)
Manual operation (0.0 – 100%)
• External adjustment function : Connecting external adjuster (sold separately) enables ramp setting (higher/lower) and
manual operation adjustment (max. 3)
□ Additional functions (options)
Output current detection / alarm output function: By built-in current sensor (CT)
• Current limit function : Phase control only supported
Limits load current (initial value: 100% of rated current)
0 – 100% of rated current set by external adjuster (current limiter) or 0 – 120% of rated current set by
front panel key operation
• Overcurrent alarm : Overcurrent protection function (output stops at approx. 130% of rated current)
• Hardware error alarm : Detects thyristor device error and outputs alarm.
• Heater break alarm : Detects heater break or deterioration and outputs alarm.
Heater break judgment 0 – 100%
*Heater break alarm judgment precision may be reduced in the case of variable resistance heaters
• Alarm output : 1 point, 1a contact, 240V AC 1A, insulated from system
Power failure, overcurrent, hardware error, heater break selection; alarm contact output;
redundant setting possible
□ External control input function : Manual operation
Standby (output OFF)
HB alarm output disable

□ Separately sold goods

- External adjuster : (Model: QSV003) B characteristics, 10kΩ, 3 lines
- External rapid fuse / fuse holder : Protects thyristor and power equipment from load short, etc. (For model, see '19. Fuse / heater break alarm function.')
- Noise filter : Model

  20A: NF2020C-SDG
  30A: NF2030C-SDG
  45A: NF2050C-SDG
  60A: NF2060C-SDG
  80A: NF2080C-SDG
  100A: NF2100C-SDG

□ General specifications

- Operation ambient temperature range : -10 – 55°C (current must be reduced for 50°C or higher)
- Operation ambient humidity range : 90% RH or lower (no dew condensation)
- Storage temperature : -20 – 65°C
- Internal heat value :

Current capacity	20A	30A	45A	60A	80A	100A
Heat value	22W	36W	47W	65W	77W	96W

- Safety standards : Safety IEC61010-1, EN61010-1
  EN IEC 61010-2-030
  : EMC EN61326-1
  The specified noise filter (sold separately) must be used.
- Insulation resistance
  Between control power supply terminal and control input terminal : 500V DC, 20 MΩ min.
  Between main power supply terminals and chassis : 500V DC, 20 MΩ min.
- Dielectric strength
  Between control power supply terminal and control input terminal : 2300V AC, 1 minute
  Between main power terminal and chassis : 2000V AC, 1 minute
- Plastic case material : Polycarbonate
- External dimensions/weight : 20/30A: 48 (W) × 118 (D) × 170 (H), approx. 0.8 kg
  45/60A: 68 (W) × 152 (D) × 188 (H), approx. 1.8 kg
  80/100A: 113 (W) × 152 (D) × 204 (H), approx. 3.0 kg
- Terminal cover : Standard attached

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

Temperature and Humidity Control Specialists

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