Part No. Z1-002-292, IB002743
Nov. 2005

OPERATION MANUAL

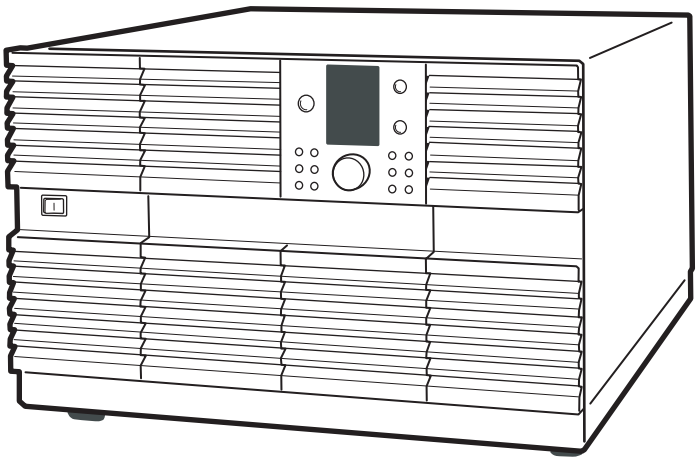
Regulated DC Power Supply

PAM series 2kW model

PAM40-50
PAM80-25
PAM160-12
PAM320-6

PAM series 4kW model

PAM40-100
PAM80-50
PAM160-25
PAM320-12



KIKUSUI

Use of Operation Manual

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

If you find any incorrectly arranged or missing pages in this manual, they will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the “Kikusui Part No.” given on the over.

This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

⚠ Safety Symbols

For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Understand the meanings of the symbols and observe the instructions they indicate (the choice of symbols used depends on the products).

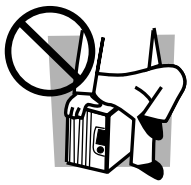
	Indicates that a high voltage (over 1,000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.
DANGER	Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
	Shows that the act indicated is prohibited.
	Is placed before the sign “DANGER,” “WARNING,” or “CAUTION” to emphasize these. When this symbol is marked on the product, see the relevant sections in this manual.
	Indicates a protective conductor terminal.
	Indicates a chassis(frame) terminal.

⚠ Safety Precautions

The following safety precautions must be observed to avoid fire hazard, electrical shock, accidents, and other failures. Keep them in mind and make sure that all of them are observed properly.

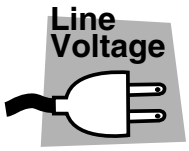
Users

- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If it is handled by disqualified personnel, personal injury may result. Be sure to handle it under supervision of qualified personnel (those who have electrical knowledge.)
- This product is not designed or manufactured for general home or consumer use.



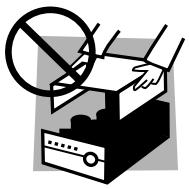
Purposes of use

- Do not use the product for purposes other than those described in the operation manual.



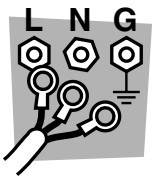
Input power

- Use the product with the specified input power voltage.
- For applying power, use the AC power cord provided.



Cover

- There are parts inside the product which may cause physical hazards. Do not remove the external cover.



Installation

- When installing products be sure to observe "Precautions for Installation" described in this manual.
- To avoid electrical shock, connect the protective ground terminal to electrical ground (safety ground).
- When applying power to the products from a switchboard, be sure work is performed by a qualified and licensed electrician or is conducted under the direction of such a person.

Relocation

- Turn off the power switch and then disconnect all cables when relocating the product.
- Use two or more persons when relocating the product which weights more than 20 kg. The weight of the products can be found on the rear panel of the product and/or in this operation manual.
- Use extra precautions such as using more people when relocating into or out of present locations including inclines or steps.
- Be sure the operation manual be included when the product is relocated.

Operation

- Before starting operations, inspect for abnormalities affecting the input power voltage. Examine the exterior of the AC power cord. Cut off the power supply before performing these inspections.
- If any abnormality or failure is detected in the products, stop using it immediately. Disconnect the AC power cord from the switchboard. Be careful not to allow the product to be used before it is completely repaired.
- For output wiring or load cables, use connection cables with larger current capacity.
- Do not disassemble or modify the product. If it must be modified, contact Kikusui distributor/agent.

Maintenance and checking

- To avoid electrical shock, be absolutely sure to stop applying power before performing maintenance or checking.
- Do not remove the cover when performing maintenance or checking.
- To maintain performance and safe operation of the product, it is recommended that periodic maintenance, checking, cleaning, and calibration be performed.

Service

- Internal service is to be done by Kikusui service engineers. If the product must be adjusted or repaired, contact Kikusui distributor/agent.

Arrangement of this manual

This Operation Manual is made up of the following sections.

Preface

Provides a brief descriptions of the PAM series and specifies its features.

Chapter1 Setup

Describes the necessary procedure from unpacking to preparation before use.

Chapter2 Precautions and Preparations for Use

This chapter contains essential descriptions that must be understood by the user. This chapter must be read thoroughly before operation is begun.

Chapter3 Basic Operation

This chapter describes the power supply, the protective circuits, and basic front panel operations.

Chapter4 Applied Operation

This chapter describes the remote sensing, the analog remote control, and remote monitoring.

Chapter5 Names and Functions of Controls

Provides an outline of the switches and terminals on the panels, including their names and functions.

Read this chapter to learn the meanings of the alert marks ⚠ indicated on the panels of the unit.

Chapter6 Maintenance

This chapter describes unit maintenance and calibration, as well as the proper procedures for handling unit malfunctions.

Chapter7 Specifications

This chapter provides the electrical and mechanical specifications for the PAM series, as well as a list of accessories.

Appendix

Explains how to check the ROM version.

Contents

Chapter 4 Applied Operation

Chapter 5 Names and Functions of Controls

Chapter 6 Maintenance

Chapter 7 Specifications

Preface

About this manual

This Operation Manual describes the PAM series, including the specific types named below.

PAM series 2kW model

- PAM40-50
- PAM80-25
- PAM160-12
- PAM320-6

PAM series 4kW model

- PAM40-100
- PAM80-50
- PAM160-25
- PAM320-12

Outline of the PAM series

Models in the PAM series are regulated DC power supplies that automatically shift between constant voltage and constant current, based on a switching regulating method.

Feature

- The switching regulating method used in the series realizes high efficiency minimal heat generation, and lightweight.
- The external voltage or resistor enables you to remotely control output voltages and currents.
- When used together with models in the Kikusui's power supply controller PIA4800 series, which have GPIB and RS-232C interfaces, the PAM series permits systematization of various devices, such as automatic testers.
- 4kW model permits you to run up to three same rating models in parallel by using the parallel operation option (factory option).

Chapter 1 Setup

Describes the necessary procedure from unpacking to preparation before use.

1.1 Checking at unpacking

When you unpack the product, make sure that you have all the parts and that none have been damaged during transportation.

For models with factory-installed optional equipment, check to verify that all necessary optional equipment is included and that any required accessories are included with the optional equipment.

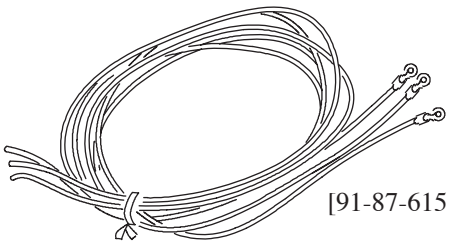
Table 1-1 shows the common accessories for each PAM series model.

For details concerning models featuring GPIB/TP-BUS interface options, see Fig. 1-4 through Fig. 1-6. For models featuring optional parallel operation, see also Fig. 1-7 and Fig. 1-8.

If any part is damaged or missing, contact Kikusui distributor/agent.

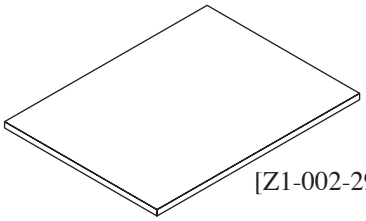
NOTE

- We recommend that all packing materials be saved, in case the product needs to be transported at a later date.



[91-87-6151]

☐ Power cords (3 pcs., 14mm^2, 3m)
(Insulation sleeve color:
green, white, black 1 pc. each)



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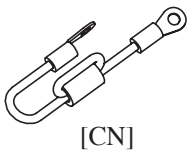
☐ Operation Manual (1 copy)

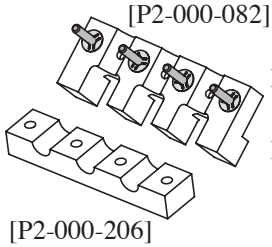


[CN]

Fastening screw (1 pc.)
[M3-001-111]

☐ Chassis connecting cable (1 pc.)

[P2-000-082]

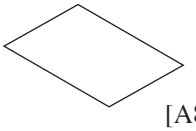


Fastening screws (4 pcs.)
[M3-002-181]

Push nuts (4 pcs.)
[M8-500-003]

[P2-000-206]

☐ Clamper (1 pair)



This sticker is included with the PAM series 4 kW model.
Attach it to a visible part of the product.

[A8-000-003]

☐ Weight sticker (1 pc.)

Fig.1-1 The common accessories for each PAM series model

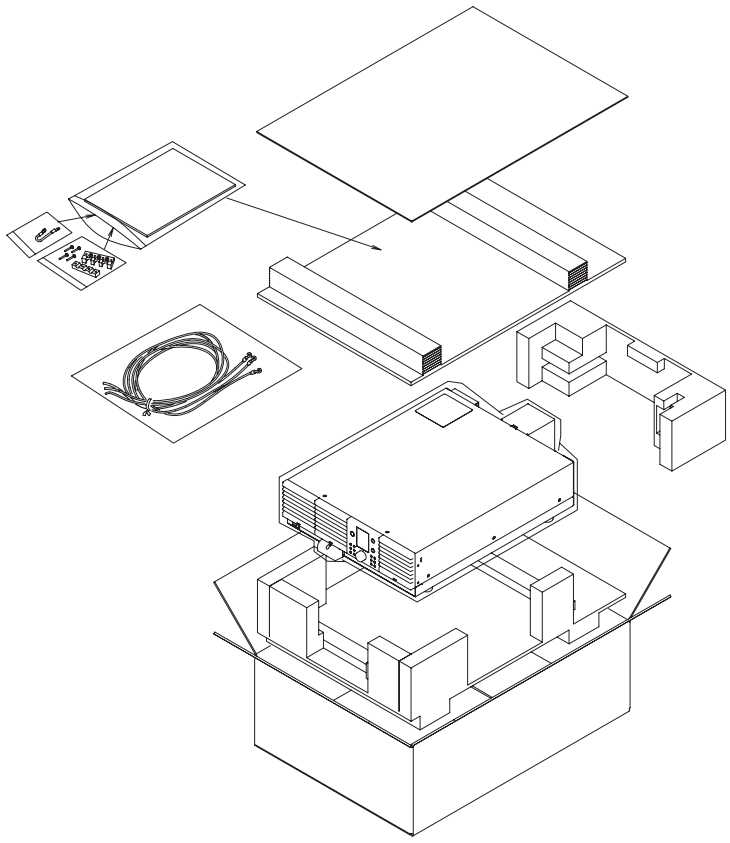


Fig. 1-2 Unpacking for PAM 2kW series

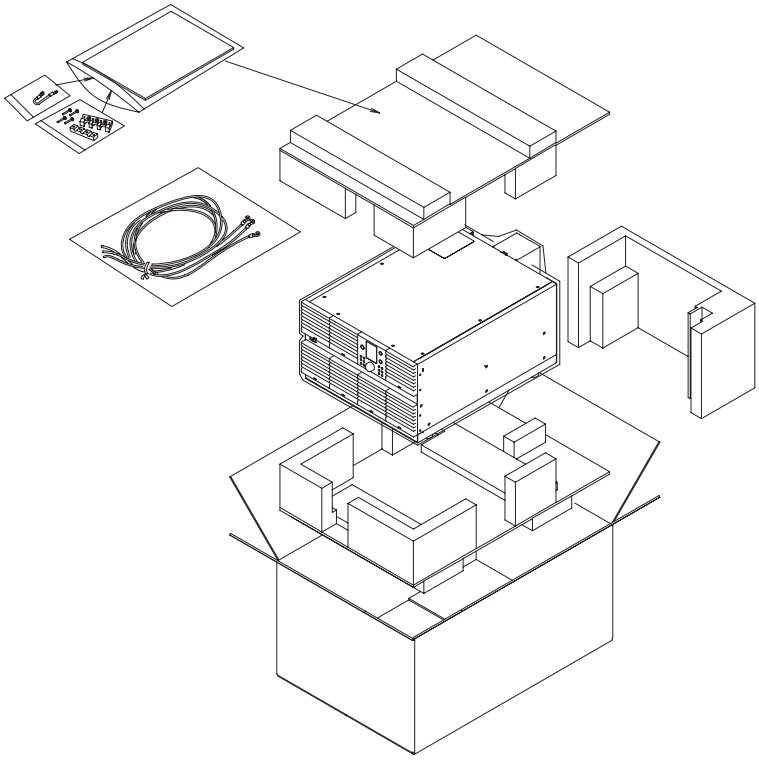


Fig. 1-3 Unpacking for PAM 4kW series

Checking at unpacking(cont'd)

Checking models with the GPIB/TP-BUS interface options

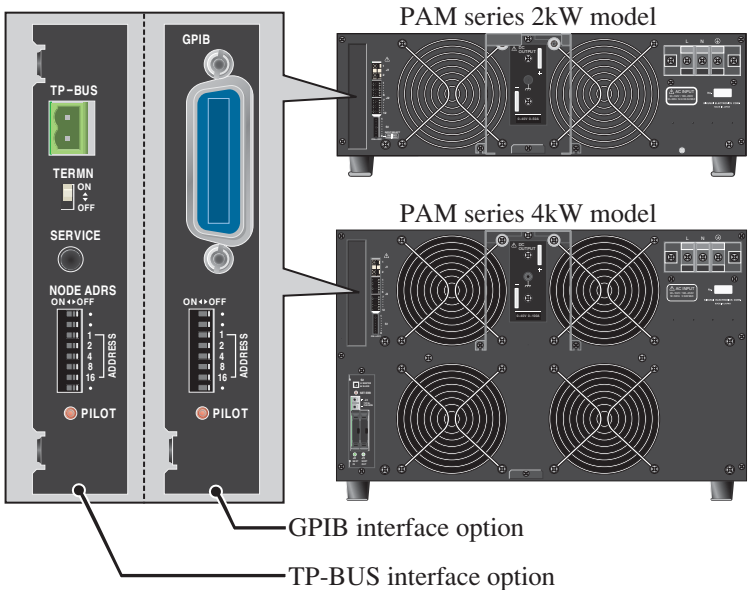
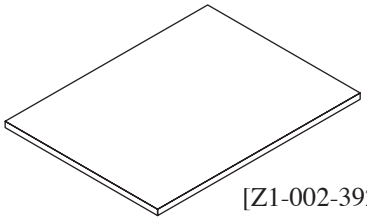
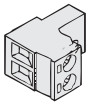


Fig. 1-4 Location at which the GPIB/TP-BUS interface option is installed



☐ Interface option operation manual (1 copy)

Fig. 1-5 Accessory for the GPIB interface option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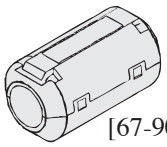
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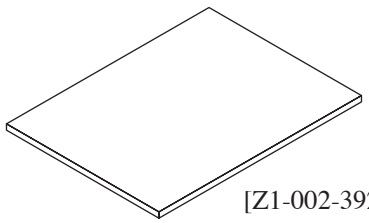


☐ TP-BUS connector (1 pc.) ☐ Core for TP-BUS (1 pc.) ☐ Interface option operation manual (1copy)

Fig. 1-6 Accessories for the TP-BUS interface option

NOTE

- The Operation Manual is common to both the GPIB and TP-BUS interface options.

Checking models with the optional parallel operation (4kW model only)

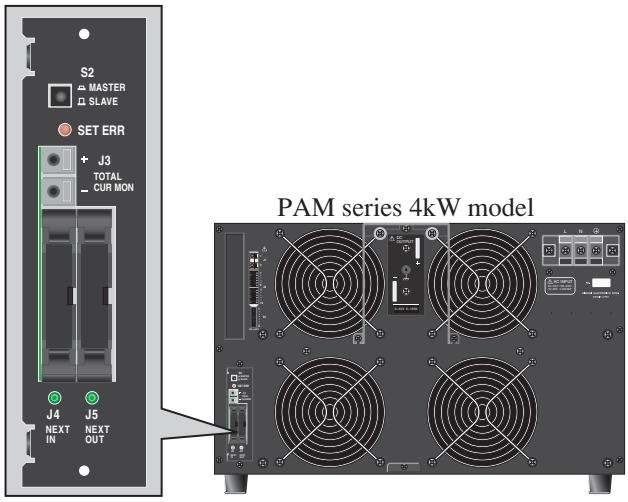
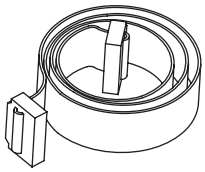
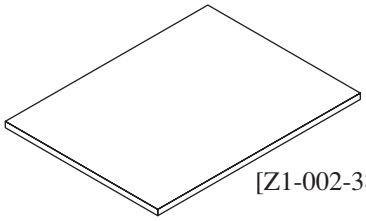


Fig. 1-7 Location at which the optional parallel operation installed



[83-22-6290]



[Z1-002-382]

☐ Signal connection cable for parallel operation(1pc., 1.3m)

☐ Optional Parallel Operation Manual(1copy)

Fig. 1-8 Accessories for the optional parallel operation

1.2 Precautions for installation

Be sure to observe the following precautions when installing the power supply.

■ Do not use the power supply in a flammable atmosphere.

To prevent explosion or fire, do not use the power supply near alcohol, thinner, or other combustible materials, or in an atmosphere containing such vapors.

■ Avoid locations where the power supply is exposed to high temperatures or direct sunlight.

Do not locate the power supply near a heater or in areas subject to drastic temperature changes.

Operating temperature range: 0°C to 50°C

Storage temperature range: -10°C to +60°C

■ Avoid humid environments.

Do not locate the power supply in a high-humidity environment—near a boiler, humidifier, or water supply.

Operating humidity range: 20% to 80% RH

(no dew condensation is allowed)

Storage humidity range: 90% RH or less

(no dew condensation is allowed)

Condensation may occur even within the operating humidity range. In that case, do not start using the power supply until the location is completely dry.

■ Do not place the power supply in a corrosive atmosphere.

Do not install the power supply in a corrosive atmosphere or one containing sulfuric acid mist or the like. This may cause corrosion of various conductors and imperfect contact with connectors, leading to malfunction and failure, or in the worst case, a fire.

■ Do not locate the power supply in a dusty environment.

Dirt and dust in the power supply may cause electrical shock or fire.

■ Do not use the power supply where ventilation is poor.

The power supply employs a forced air cooling system. Air is taken in from intake ports located on the power supply's sides and front, and is exhausted from the rear. Prepare sufficient space around the power supply so that the intake ports and exhaust port are always completely unobstructed. Otherwise, heat may accumulate in the power supply, resulting in fire.

■ Do not place any object on the power supply.

Particularly a heavy one, as doing so could result in a malfunction.

■ Do not place the power supply on a tilted surface or in a location subject to vibrations.

If placed on a non-level surface or in a location subject to vibration, the power supply may fall, resulting in damage and injury.

■ Do not use the power supply in locations affected by strong magnetic or electric fields.

Operation in a location subject to magnetic or electric fields may cause the power supply to malfunction, resulting in electrical shock or fire.

■ Do not use the power supply in locations where highly-sensitive measuring instruments or receivers are nearby.

Such instruments may be affected by the noise generated by the power supply.

1.3 Precautions for moving

When moving or transporting the power supply to an installation site, observe the following precautions.

■ Turn the POWER switch off.

Moving the power supply with the power on may result in electrical shock or damage.

■ Turn off the switch on the switchboard, and remove all wirings connected.

Moving the power supply with cables connected may break the cables or cause the power supply to fall, resulting in injury.

■ For transportation, use the special packing material for the power supply.

Transport the power supply in its original package to prevent vibration and falls, which may damage the power supply. If you require packing material, contact Kikusui distributor/agent.

1.4 Input power

PAM series 2kW model

This unit has two input voltage ranges to be selected by the user - a 100 V line (90 V to 132 V AC) and a 200 V line (180 V to 250 V AC).

The unit is factory-set to the 100 V line.

If the S1 switch 8 on the rear panel is OFF, the line used is 100 V. If it is ON, the line used is 200 V line.

See Fig. 1-9.

⚠ CAUTION

- When changing the settings for the input-voltage range, first turn the POWER switch OFF.
- Select the correct input voltage range. If the POWER switch is turned on with the incorrect range selected, the following conditions may arise, resulting in malfunctions.

Input voltage range selected	Input voltage	POWER switch	Unit condition
100 V line	200 V line	ON	A protective circuit (abnormal input voltage) is activated, indicating "ALARM" on the front display panel.
200 V line	100 V line	ON	The front display panel lights. While the unit may function, it may not operate correctly. No "ALARM" indication is displayed.

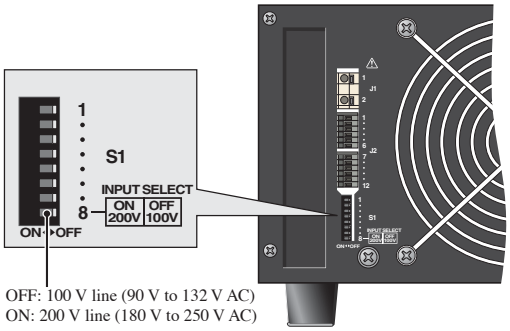


Fig. 1-9 Selecting an input voltage range (PAM series 2kW model only)

PAM series 4kW model

Exclusive to the 200 V line (180 V to 250 V AC).

With the PAM series 4 kW model, the settings for S1 Switch No. 8 are ineffective (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).

1.5 Connecting the AC power cord

Connecting procedure of PAM series side

⚠ WARNING

- To avoid electric shock, first connect the cable to the AC input terminal board before connecting it to the switchboard.
- To ensure safety, use only the accompanying input power cord (14 mm^2, 3m). Do not use any other cords. This cord keeps the distance between the unit and the switches on the switchboard to within 3 meters to allow smooth switch operation in an emergency.

⚠ CAUTION

- Inside the unit, protective circuits including input fuses are connected in order to meet the input terminal rating. Confirm that the insulated suleeve color of crimping terminal are connected to the AC input terminals (L, N, and ⏚(GND)).

1. Remove the terminal cover from the AC INPUT terminal.
2. Connect the supplied AC power cord to the AC input terminal board as shown in Fig. 1-10.

   The figure illustrates the connection of the 2kW model. The same steps apply to the 4 kW model.
3. Hold the cord in the accompanying clamper and secure to the panel with four fastening screws.
4. Install the AC INPUT terminal cover.

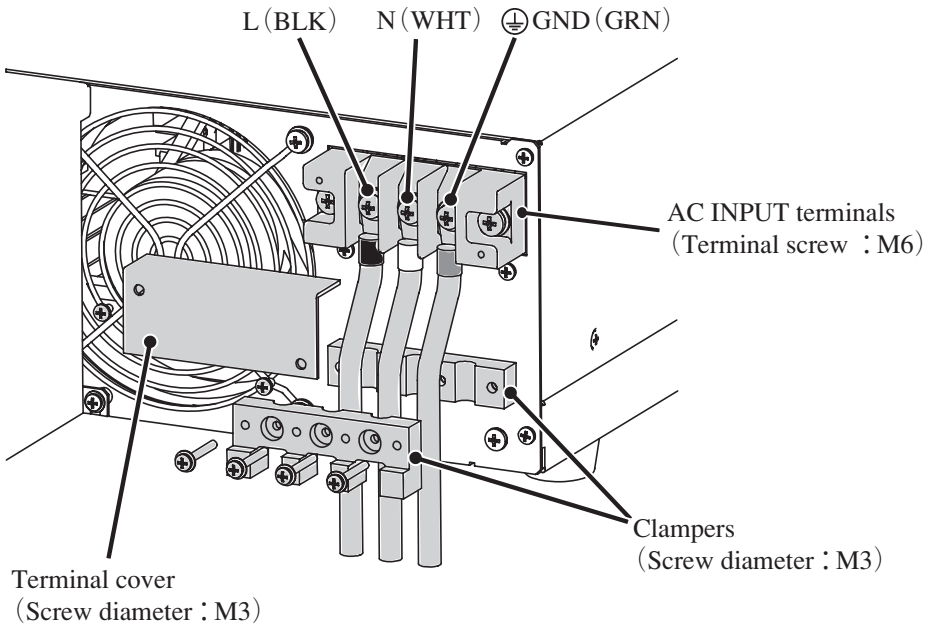


Fig. 1-10 Connecting the AC power cord (PAM series 2 kW model)

Connecting the AC power cord(Cont'd)

Connecting procedure of switchboard side

1. Attach crimp terminals to the wires of the AC power cord of switchboard side.

⚠ CAUTION
- Check the terminal screw on the switchboard, and crimp a terminal on each wire end suitable for the said terminal screw. (This connection must be performed by qualified personnel.)

2. Turn off the switch on the switchboard.
3. Connect the AC power cord to the switchboard.

   Confirm that the specified polarity of AC input terminals are connected to the switchboard.

1.6 Grounding

⚠ WARNING
- Not grounding the power supply creates danger of electric shock.
- Connect the ground terminal to an electrical ground (safety ground)

⚠ CAUTION
- Not performing adequate grounding work on the power supply results in malfunction or the production of large noises from the power supply

Securely connect the GND line (identified by the green insulation sleeve on the clamp terminal of the AC INPUT terminal) on the input power cord to the ground terminal on the switchboard.

Chapter 2 Precautions and Preparations for Use

This chapter contains essential descriptions that must be understood by the user. This chapter must be read thoroughly before operation is begun.

2.1 Inrush current

A inrush current may flow about 100 Apeak when the POWER switch is turned on. If you are planning to use several sets of the unit in a system, and to turn on the POWER switches at the same time, check that the AC switchboard or the switchboard is of sufficient capacity.

⚠CAUTION • Keep 10 seconds or longer interval between ON and OFF of the POWER switch. Repeated ON/OFF at a shorter interval may cause a break in the inrush current limiting resistor and shorten the service lives of the input fuse and power switch.

2.2 Negative voltage and current

When the OUTPUT switch is OFF, the load may be subjected to a slight reverse current due to a reversed polar voltage of about 0.1V to 0.2 V occurring in the outputs.

If a short circuit is likely on the output, be aware that a slight reverse current of a low percentage of the rated current may occur.

The voltmeter displays and the ampere meter displays only positive values. Thus, no negative voltages and currents are displayed (the value “0 V” or “0 A” is displayed instead).

2.3 Load

Note that the output may become unstable when one of the following loads is connected.

2.3.1 When load current has peaks or is pulse-shaped

The current meter on the power supply indicates only mean values. Even when the indicated value is less than the preset current value, therefore, a peak may exceed the preset current value. In such a case, the power supply is instantaneously put into constant-current operation mode, and the output voltage drops accordingly. If you look carefully, you will see the constant current (CC) indicator light up dimly.

For such a load, a larger value should be preset for the constant current, or the current capacity should be increased.

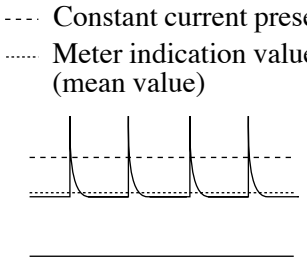


Fig.2-1 Load current with a peak

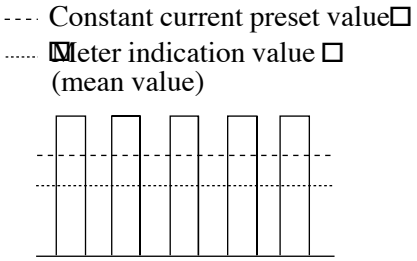


Fig. 2-2 Pulsing load current

2.3.2 When a load generates a reverse current to the power supply

The PAM series is unable to absorb a reverse current from a load. Therefore, if a power-regenerative load, such as an inverter, converter, or transformer that tends to regenerate power to the power supply, is connected, the output voltage may increase, resulting in unstable output.

To handle this type of load, connect a resistor (R_D) to bypass reverse currents, as illustrated in Fig. 2-3. Note that, if such a resistor is used, the current capacity for the load decreases by Irp.

⚠ CAUTION • Select R_D with sufficient rated power. Use of a resistor with insufficient rated power may burn R_D.

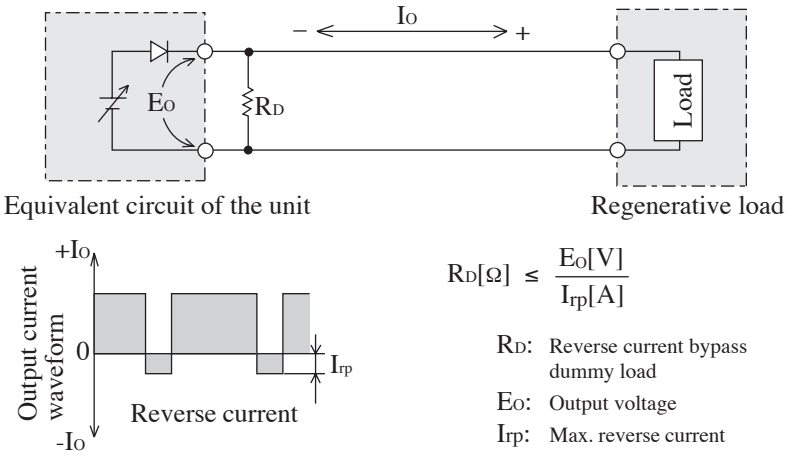


Fig. 2-3 Countermeasure against a power-regenerative load

2.3.3 In case of load with accumulated energy, such as batteries

Connecting a load with accumulated energy, such as a battery, to the output of the unit may cause a current to flow from the load through the internal circuit. Such currents may damage the internal components of the unit, and reduce the life of the load.

As a remedy, connect a reverse-current-prevention diode DRP between the unit and the load as shown in Fig. 2-4.

⚠ CAUTION
- To protect the power supply and the load, select DRP that meets the following requirements:
  1. Reverse-voltage tolerance is at least two times the rated output voltage of the power supply.
  2. Forward current capacity is three to ten times the rated output current of the power supply.
  3. A diode with small loss
- Be sure to take account of heat generation from DRP. DRP may burn unless adequately dissipated.
- The remote sensing function cannot be used.

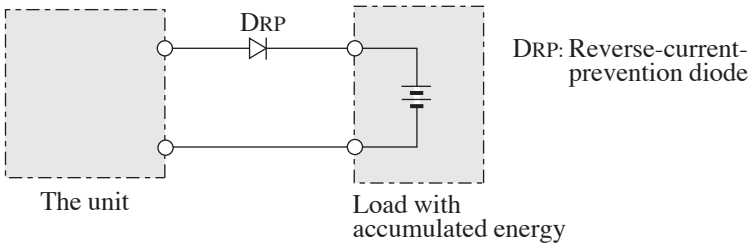


Fig. 2-4 Countermeasure against a load with accumulated energy

2.4 Constant-voltage and constant-current power supplies

The PAM series is capable of both constant voltage and constant current operation. The following describes these operation.

The ideal constant-voltage power supply has zero output impedance at all frequencies and maintains a definite constant output voltage with respect to variations in load current. The ideal constant-current power supply has infinite output impedance at all frequencies and compensates for load resistance variation by changing the voltage to maintain a constant output current.

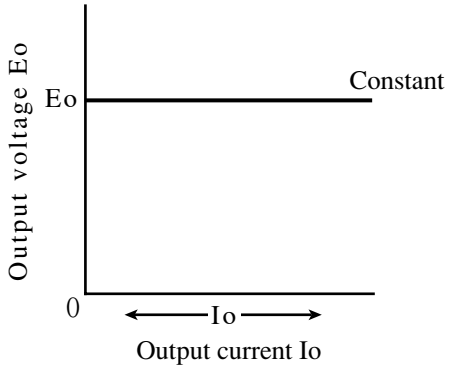


Fig.2-5 Ideal Constant-Voltage Power Supply

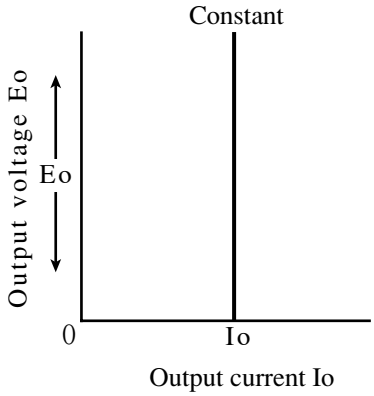


Fig.2-6 Ideal Constant-Current Power Supply

However, the output impedance of an actual constant-voltage or constant-current power supply is neither zero nor infinite, and they have a definite frequency response. In addition, maximum voltage or maximum current constraints on output are a factor, leaving these power supplies unable to maintain constant voltage or current with respect to all changes in load current or load resistance. The following describes the relationship between the basic operations in constant voltage (CV) and constant current (CC) modes and limit setting of the unit.

The following description assumes a power supply with a DC output of 100 V and 10 A (maximum rated output voltage of 100 V, maximum rated output current of 10 A) as a model.

A resistive load of 10 Ω is connected to the output terminals of the power supply and the output current limit is set to 5 A. In this condition, output voltage is raised gradually from 0 V. In this case, the power supply operates in the constant voltage (CV) mode. The output current increases as the output voltage increases, and when the output voltage reaches 50 V (that is, the output current has reached 5 A), the output voltage no longer increases beyond 50 V even if you attempt to raise it. This is because the output current is limited to the 5 A set at the beginning of operations, causing the power supply to switch to the constant current (CC) operation mode. In this way, the power supply automatically moves from the constant-voltage to constant-current operation to prevent an overcurrent from flowing. (The point at which the operation modes switch is called the "crossover point"). If the current limit is raised in this condition, the power supply returns to the previous constant voltage

operation, allowing you to increase the output voltage further. If the current limit is increased from 5 A to 9 A in Fig. 2-7, a voltage of up to 90 V can be output.

Next, let's assume a case in which a load resistance of 4 Ω is used. The output current limit is regarded as the rated maximum output current. When you increase the output voltage from 0 V, the output current reaches the power supply's maximum current rating when the output voltage reaches 40 V; the power supply cannot output a voltage above 40 V with the maximum current flowing. This is its limit, even though the power supply is not yet generating half its output capacity in terms of power. If you wish to increase the output voltage further, the initial unit needs to be replaced by a model having larger current capacity. Particularly for loads into which a transient peak current flows, the current must be set such that its peak does not reach (or exceed) the current limit. If the unit enters constant-current operation mode even when the current is set within the rated output current, the current capacity needs to be raised.

Next, we consider a case of using a load resistance of 25 Ω. In this case, when the output current limit is set to 4 A or more, the power supply is capable of outputting voltages from 0 V to the rated maximum output voltage while in constant-voltage operation mode. In this load condition, the output voltage limit is the rated maximum output voltage (for these conditions) and the output current is gradually increased from 0 A. At this time, the power supply is operating in the constant-current (CC) operation mode. The power supply increases the output voltage in order to source the current setting. When the output voltage reaches the supply's maximum rated output of 100 V, no more current can be sourced to this load, regardless of the current setting. To continue applying a current under these conditions, you must use a model compatible with higher voltage outputs. Particularly for loads where a transient surge voltage is generated, the voltage must be set so that the surge voltage does not reach (or exceed) the voltage limit.

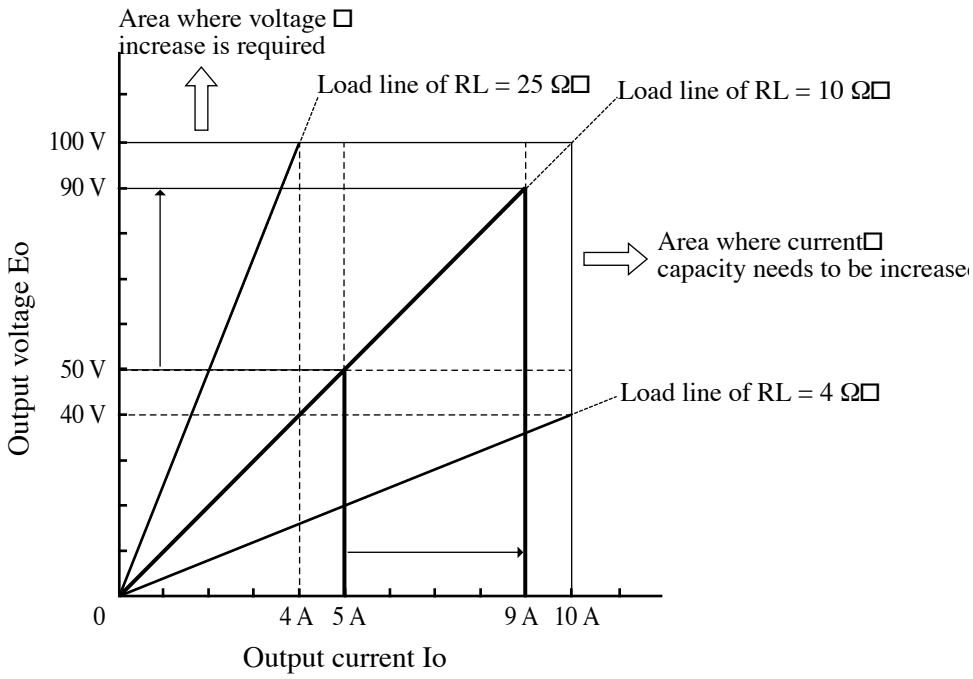


Fig. 2-7 Constant Voltage Operation and Constant Current Operation

2.5 Alarm

The PAM series has the following protective circuits. Once a protective circuit is activated, the output is cut off, and an ALARM LED on the front panel lights up. The alarm(ALM) signal is output to terminal 4 of the J2 terminal board. See Fig. 2-8 and Fig. 2-9.

Whenever a protective function is activated, identify and remove the cause. Then, on the control panel, press the ALARM RESET switch or reclose the POWER switch to turn OFF the alarm. Where there is an input-voltage abnormality, however, simply reclose the POWER switch. When the POWER switch is reclosed and the OUTPUT switch is ON, the output will be ON as the alarm is released. Until the cause of the alarm is removed, the protective function will reactivate, turning the output OFF.

For details concerning the procedure to be followed when the ALARM LED lights, see "6.4 Malfunctions and Causes"

Protective circuits

- **OVP (Overvoltage protection)**

  Activates when the output exceeds the voltage preset as an overvoltage (OVP trip point).

  Preset range: 20 % to 110 % of the rated output voltage.

  When the OVP circuit generates an alarm, “OVP” appears on the voltmeter display. If the output voltage exceeds the OVP trip point as the dial on the operation block is being turned, the preset output voltage may appear on the voltmeter (the SET switch on the operation block lights).

- **OHP (Overheat protection)**

  Activates when the temperature of the unit’s internal heat sink rises to abnormal levels under certain conditions, including the following:

  The unit is used in an environment above its operating ambient temperature.

  The inlet or outlet is choked.

  The fan motor is stopped by a foreign object.

  When the OHP circuit issues an alarm, “OHP” appears on the voltmeter display. Once the internal temperature returns to a normal level, the “OHP” message is no longer displayed. However, the ALARM LED remains lit until the alarm is turned OFF.

- **Abnormal input voltage**

  In PAM series 2kW model, activates when a voltage on the 200 V line is input by mistake to the AC IN terminal while the 100 V range is selected.

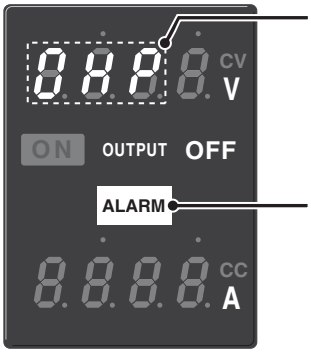
  For the input voltage range, see "1.4 Input power"

- **Abnormal sensing**

  Activates when there is an abnormal sensing voltage. One of the causes is a reversed polarity connection of the sensing cable.

- **Internal unit abnormality**

  Activates in the event of a failure or abnormal action involving an internal unit.



In the case of an OVP or OHP alarm, the ALARM LED lights, and the voltmeter displays "OVP" (*1) or "OHP". In the case of other alarms, only the ALARM LED lights.

ALARM LED

*1: See the "OVP" section on the preceding page.

Fig. 2-8 ALARM indication (OHP)

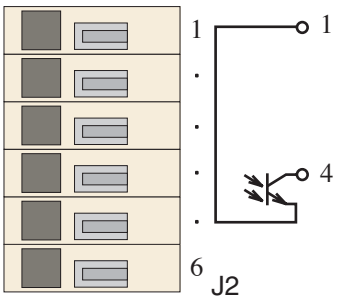


Fig. 2-9 ALARM output

⚠ WARNING • Mishandling of J2 terminal board may lead to electric shock. Before wiring to the alarm signal terminal, see "4.1.1 J1 and J2 terminal boards"

The alarm output signal is insulated from other terminals with an open collector-type photocoupler.

All other status outputs (CV MODE of terminal 2 and CC MODE of terminal 3) are also insulated from each other. However, note that the COM line (STAT COM of terminal 1) is used for all status outputs and the alarm output signal. For more information, see "4.4.1 External monitor for operating mode".

2.6 Grounding the output terminal

The output terminals of this unit are insulated from protective conductor terminal. When the GND line of the input power cord is connected to the ground terminal on the switchboard, the unit's chassis assumes a grounding potential, as shown in Fig. 2-10. Cables and loads connected to the output terminals (including the sensing terminal J1) must be insulated from the chassis with at least the isolation voltage of the unit (*1, also see Table 2-1). Terminals 5 through 12 on the J2 terminal board on the rear panel (analog remote control and output monitor terminal) will have nearly equal potential on the circuit as the - (neg.) output terminal of the unit. Accordingly, cables and devices connected to these terminals must be insulated with at least the isolation voltage of the unit.

The output terminal is floating. The shadowed area must be insulated from the chassis with at least the isolation voltage of the unit.

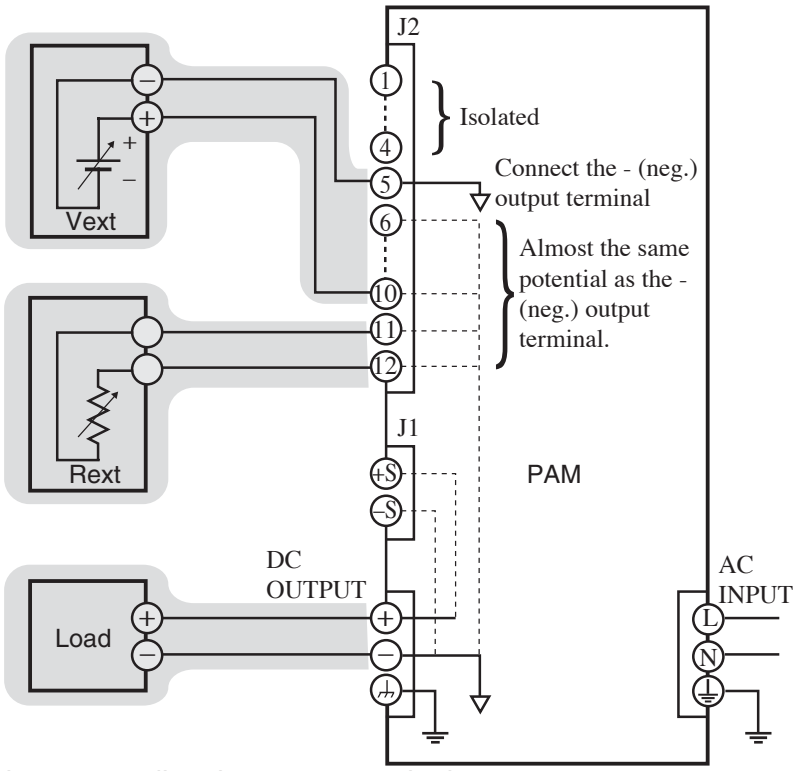


Fig. 2-10 Without grounding the output terminal

Table2-1 Isolation voltage value

	PAM series 2 kW model		PAM series 4 kW model	
	PAM40-50 PAM80-25	PAM160-12 PAM320-6	PAM40-100 PAM80-50	PAM160-25 PAM320-12
Isolation Voltage	± 250 V	± 500 V	± 250 V	± 500 V

DESCRIPTION *1Isolation voltage: The maximum external voltage that may be applied between an output terminal on the power supply and protective conductor terminal (chassis).

The procedure for grounding the output terminal is illustrated below.

Fig. 2-11 illustrates a connection of the + (pos.) output terminal to the chassis terminal. In this case, the + (pos.) output terminal is at grounding potential. For this reason, cables and loads connected to output terminals (including the sensing terminal J1) need to be insulated from the chassis with at least the maximum unit output voltage. The same applies to cables and devices connected to terminals 5 through 12 on the J2 terminal board.

When the - (neg.) output terminal is connected to the chassis terminal, the - (neg.) output terminal is at grounding potential. As in the preceding case, cables and loads connected to the output terminal must be insulated from the chassis with at least the maximum unit output voltage. Cables and devices connected to terminals 5 through 12 are at almost the same potential as the chassis. However, they need to be insulated from the + (pos.) output terminal with at least the maximum unit output voltage.

The +(pos.) output terminal is at grounding potentioal. The shadowed area must be insulated from the chassis with at least the maximum unit output voltage.

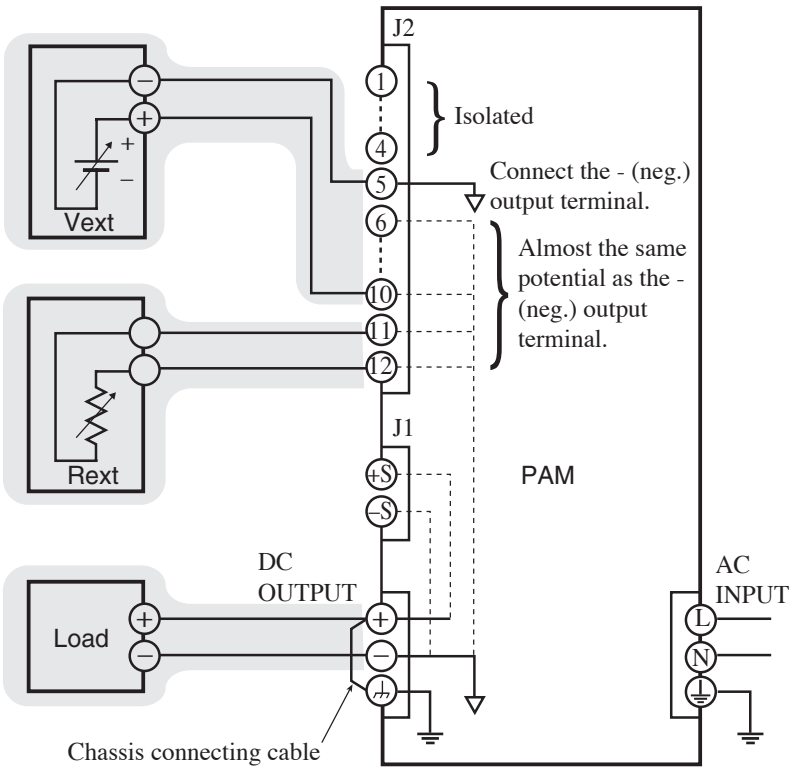


Fig. 2-11 Grounding the + (pos.) terminals

In conclusion, if there is no need to float the output terminals, ensure safety by connecting either of the output terminals to the chassis terminal.

⚠WARNING

- When grounding the output terminal, make connections securely using the accompanying shassis connecting cable.
- Even if the output terminal is grounded, it is necessary to insulate the output terminals (including the sensing terminal J1) and terminals 5 through 12 on the control terminal board with at least the isolation voltage of the unit.

Grounding the output terminal(Cont'd)

Incomplete connection of the shassis connecting cable may result in electric shock and output short-circuits unless full insulation is provided with at least the isolation voltage of the unit.

If no cable with the rated voltage is available, ensure the necessary withstand voltage through measures such as installing a cable in an insulating tube that can withstand the unit insulation voltage or more.

- When remote-controlling the unit using an external voltage source (Vext), float Vext outputs instead of grounding them (floating). As in the example shown in Fig. 2-11, grounding Vext outputs may lead to output short-circuits.

3

Chapter 3 Basic Operation

This chapter describes the power supply, the protective circuits, and basic front panel operations.

3.1 Turning on the power

⚠ CAUTION

- Before turning the POWER switch ON, be sure to check the input voltage range and S1 switch settings on the rear panel. In particular, incorrect settings for No.8 of S1 switch (selection of an input power voltage) may lead to malfunctions. (Only PAM series 2kW model)
- Keep 10 seconds or longer interval between ON and OFF of the POWER switch. Repeated ON/OFF at a shorter interval may cause inrush current and shorten the service lives of the input fuse and power switch.

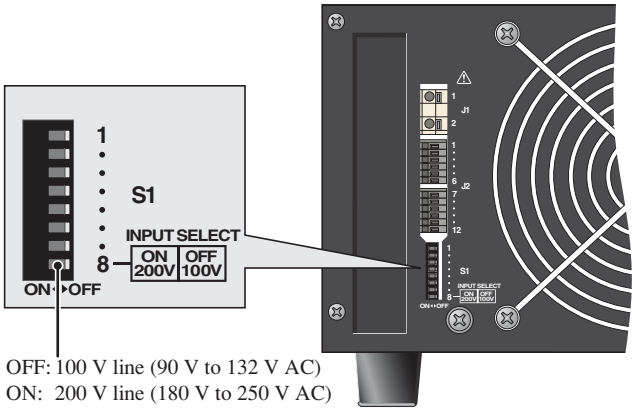


Fig.3-1 Setting a rear panel before turning the POWER switch ON (Only PAM series 2kW model)

Table3-1 Functions of S1 switches

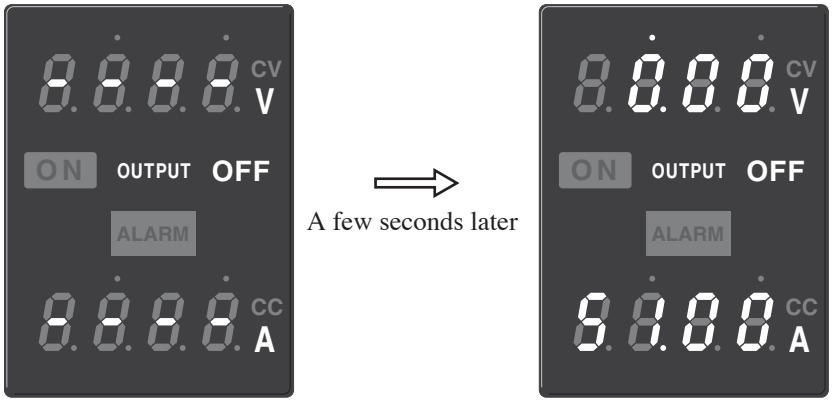
Switch No	Description	ON	OFF
1	Mode selection for output voltage control with an external resistor	10 kΩ → 0 OUT mode	10 kΩ → MAX OUT mode
2	Selection of program sources for output voltage control	External resistor	Voltage
3	Mode selection for output current control with an external resistor	10 kΩ → 0 OUT mode	10 kΩ → MAX OUT mode
4	Selection of program sources for output current control	External resistor	Voltage
5	Selection of remote control	Remote control	Local control
6	Mode selection for OUTPUT ON/OFF	Close ON mode	Close OFF mode
7	Selection of remote sensing	Remote sensing	Local sensing
8	Selection of input voltage (*1)	200 V	100 V

NOTE *1The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).

For more information on each switch, see the following:
Switches 1 through 5:"4.3.1 Output control with analog signal"
Switch 6: "4.3.2 Output ON/OFF control with an external contact"
Switch 7: "4.2 Remote sensing"
Switch 8: "1.4 Input power"

Turning on the power procedure

1. Check that the POWER switch is turned off.
2. Check that the OUTPUT switch is turned off.
   The OUTPUT switch is ON when it is down, and OFF when it is up.
3. Check the S1 switch settings on the rear panel. Fig. 3-1 and Table 3-1
   Since we are not performing analog remote control or remote sensing in this procedure, turn off switches 1 through 7.
4. Make sure the AC power cord is connected properly.
5. Turn on the POWER switch.
6. The voltmeter and ampere meter display "_ _ _ _" for a few seconds. See Fig. 3-2
7. A few seconds later, the unit is ready for output settings.



The steps above set the unit to start.

Right after the power is turned on waiting for output settings

Fig. 3-2 Display for power input (PAM40-50)

3.2 Basic operations

This section explains how to set the output and OVP (Overvoltage Protection) trip point. It also describes how to use this unit as a constant-voltage power supply or constant-current power supply.

3.2.1 Setting the output

Here, the PAM40-50 is used to illustrate how to set the output. The output will be set to 20.10 V and 30.05 A in this example.

Fig. 3-3 shows the display when power is turned on with device settings set to factory defaults.

The unit saves the output value set just before the POWER switch is turned off. It also stores the ON/OFF status of the LOCK switch. The next time the POWER switch is turned on, the unit is reset to the same output value and the ON/OFF status of the LOCK switch. Thus, you may see values different from those displayed in Fig. 3-3 for voltage, current, and ON/OFF status of the LOCK switch.

For information on factory settings, see Table 3-2.

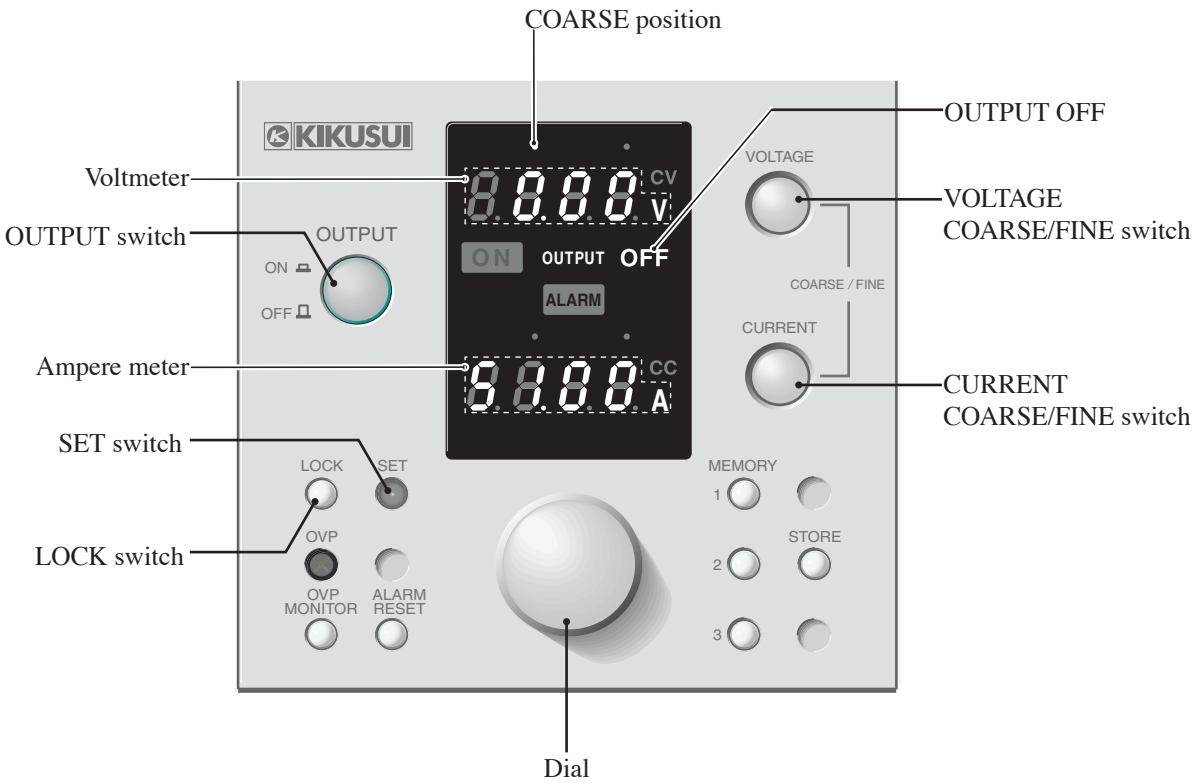


Fig. 3-3 Display and settings at power input (PAM40-50)

Table3-2 Factory settings

Front panel item	Settings
Output voltage setting value	0 V
Output current setting value	Maximum value
OUTPUT switch	OFF
LOCK switch	Light turned off (OFF)
OVP variable resistor	Clockwise to a full stop
Memory 1, 2 and 3	For three memory units (each output) Voltage: 0 V, Current: Maximum value

Item on the rear panel		Settings
S1 switches	1 through 7	OFF
	8	OFF

COARSE/FINE

When making settings for output voltage and output current on this unit, you may select COARSE or FINE.

The COARSE/FINE status is indicated by the two position LED located above the voltmeter and ampere meter. The left LED lights to indicate COARSE. The right LED lights to indicate FINE.

Table 3-3 shows the increments in which output can be set in COARSE or FINE mode.

Table3-3 output setting increment

		PAM series 2kW model				PAM series 4kW model			
		PAM 40-50	PAM 80-25	PAM 160-12	PAM 320-6	PAM 40-100	PAM 80-50	PAM 160-25	PAM 20-12
Voltage setting increment [V]	COARSE	1	1	10	10	1	1	10	10
	FINE	0.01	0.01	0.1	0.1	0.01	0.01	0.1	0.1
Current setting increment [A]	COARSE	1	1	1	0.1	10	1	1	1
	FINE	0.01	0.01	0.01	0.001	0.1	0.01	0.01	0.01

Setting PAM40-50 output to 20.10V and 30.05A

1. Check that the LOCK switch is OFF.
   If the switch is ON, no output settings can be made.
2. Check that the SET switch is ON.
   If it is OFF, the panel displays actual output values.
3. Check that "OUTPUT OFF" is lit on the display.

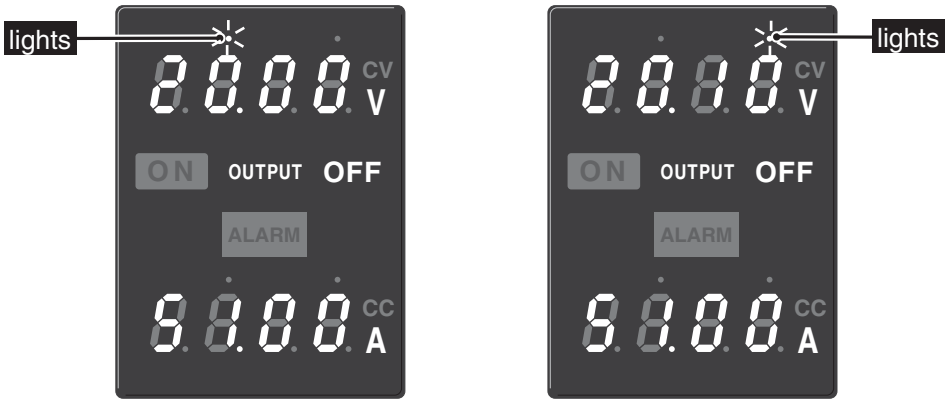
NOTE

- If the OUTPUT switch is turned ON, the SET switch, when lit, is automatically turned off, and the output values are displayed.
- If the dial is turned with the OUTPUT switch OFF, the SET switch, even when off, automatically lights to allow settings to be made.

4. On the voltmeter, check that the COARSE position is lit.
   If it is not lit, press VOLTAGE COARSE/FINE switch once.
5. The figure below the COARSE position changes as you turn the dial. Set the dial to "20." See Fig. 3-4
6. Press the VOLTAGE COARSE/FINE switch.
   On the voltmeter, the COARSE position is turned off, and the FINE position lights.
7. The figure below the FINE position changes as you turn the dial. Set the dial to "10."

NOTE

- Select between COARSE and FINE according to the amplitude of change.



COARSE position on the voltmeter FINE position on the voltmeter

Fig. 3-4 COARSE/FINE position on the voltmeter.

The steps above complete the voltage settings. To proceed to the current settings, go to Step 8.

8. Press the CURRENT COARSE/FINE switch.

   On the voltmeter, the FINE position is turned off. On the ampere meter, the COARSE position lights up. If it is not lit, press CURRENT COARSE/FINE switch once.

9. The figure below the COARSE position changes as you turn the dial. Set the dial to “30.”

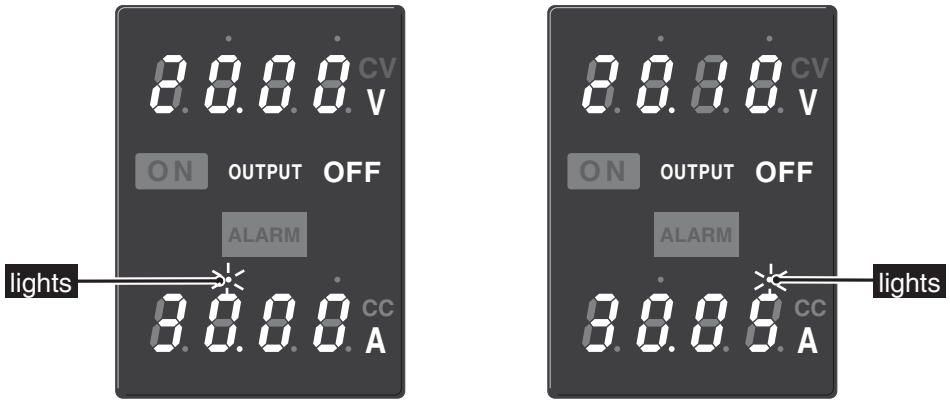
10. Press the CURRENT COARSE/FINE switch.

    On the ampere meter, the COARSE position is turned off. On the voltmeter, the FINE position lights up.

11. The figure below the FINE position changes as you turn the dial. Set the dial to “05.”

NOTE

- Select between COARSE and FINE according to the amplitude of change.



COARSE position on the ampere meter FINE position on the ampere meter

Fig. 3-5 COARSE/FINE position on the ampere meter

The steps above complete the current settings.

3.2.2 OVP (OverVoltage Protection) trip point presetting

The overvoltage protection (OVP) function protects a load from unexpectedly high voltage. If the OVP function is activated, the ALARM LED on the front panel lights up, and output is shut down. To release the alarm, press the ALARM RESET switch. In this case, lower the output voltage preset value. Otherwise, the OVP function is re-activated when the ALARM RESET switch is pressed.

⚠ CAUTION

- To protect the load, preset the OVP trip point for either operation mode.
- The OVP trip point is factory-preset to approx. 110% of the rated output voltage of the unit. When using the unit, preset to an OVP trip point suitable for the load.

NOTE

- When the unit is used as a constant-voltage power supply with the output current set to the low level, the OVP circuit may be activated due to a slight overshoot caused when the OUTPUT switch is turned ON. Set the OVP trip point to a value that does not activate the OVP function when the OUTPUT switch is turned ON at its maximum working voltage.
- During settings for the OVP trip point (the OVP MONITOR switch is pressed), the last digit place on the voltmeter is fixed to zero.

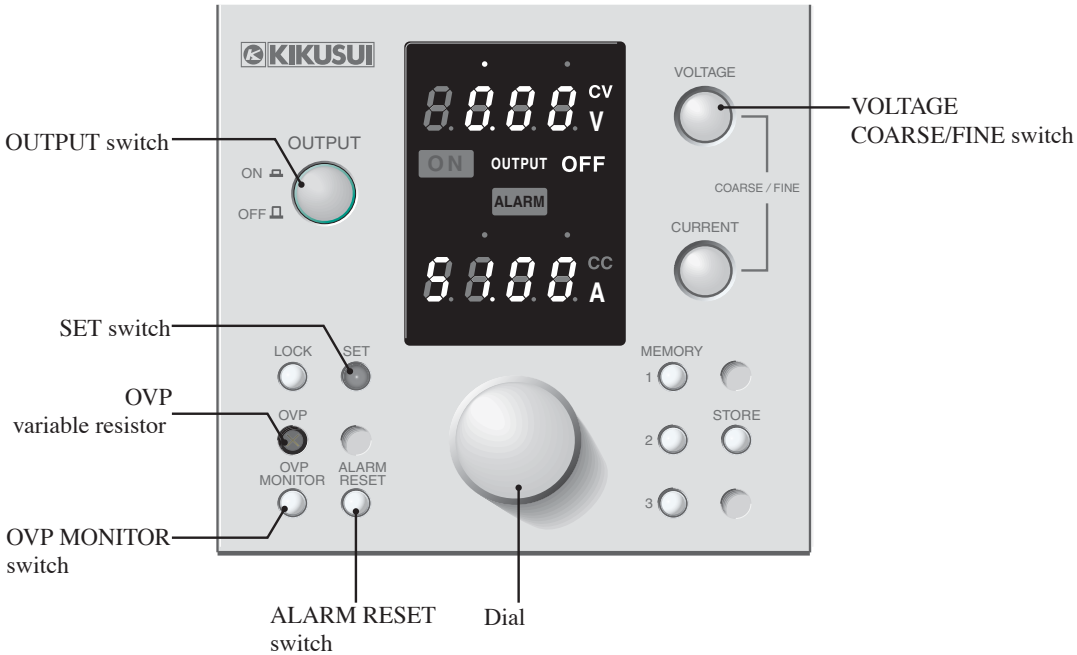


Fig. 3-6 Settings at OVP

Setting the OVP trip point

To protect the load from an overvoltage, after setting the OVP trip point, apply a voltage larger than the preset voltage between the unit's output terminals, and check that the OVP function works properly.

The OVP trip point can be set between 20 % to 110 % of the rated output voltage of the unit.

When the preset voltage is smaller than the rated output voltage of the unit, you can check the performance of the OVP function with the output voltage of the unit. However, if the preset voltage is larger than the rated output voltage, the output voltage of the unit does not permit verification of OVP performance. In this event, you can check the OVP function by externally applying a voltage larger than the preset voltage to the output terminal of the unit. The following describes how to set the OVP trip point below or above the rated output voltage of the unit:

■ Setting the OVP trip point below the rated output voltage of the unit

1. Check that no load is connected to the output terminal.

   Following settings for the OVP trip point, OVP operation needs to be checked by outputting a voltage. Thus, you must remove the load.

2. Check that the OUTPUT switch is OFF.

   The OUTPUT switch is ON when it is down, and OFF when it is up.

3. Turn the POWER switch ON.

4. Holding down the OVP MONITOR switch, turn the OVP variable resistor with a Phillips screwdriver. Set the OVP trip point.

   Settings are impossible because the last digit of the OVP trip point value is fixed at 0.

5. Use the VOLTAGE COARSE/FINE switch to select between COARSE and FINE.

6. Turing the dial, set the output voltage to a value well below the OVP voltage.

7. Press the SET switch to turn it OFF.

   When the SET switch is OFF, “0V” appears for the output voltage.

8. Turn the OUTPUT switch ON.

9. Slowly turn the dial clockwise. When the output voltage reaches the preset OVP voltage, check that ALARM LED lights and the outputs are turned OFF automatically.

   The voltmeter displays “OVP” or the current preset value of output voltage.

10. Turn the OUTPUT switch OFF.

11. Press the ALARM RESET switch.

    The ALARM LED light goes out.

12. Press the SET switch to turn it ON.

13. Turning the dial counterclockwise, set the output voltage to a value well below the OVP voltage.

The steps above complete the OVP trip point settings.

■ Setting the OVP trip point above the rated output voltage of the unit

1. As an external power supply for checking OVP performance, provide a power supply that meets the following conditions:

   Output voltage: Above the preset OVP output voltage, with variable outputs.

   Output current: At 5 % above the rated output current of the unit.

   No voltmeter is needed for the external power supply, because the external voltage can be displayed on the voltmeter of the unit.

2. Check that the POWER switches both on the unit and the external power supply are OFF.

3. As shown in Fig. 3-7, connect the external power supply to the unit's output terminal.

   For connections to the output terminal, see "3.3.2 Connecting to the output terminal"

⚠ CAUTION • Do not ground the unit's output terminal. Otherwise, the external power supply may short-circuit the output terminal. See Fig. 3-8.
When the unit's output terminal is not grounded, the external power supply will not short-circuit the output terminal.

---

4. Check that the OUTPUT switch is OFF.

   The OUTPUT switch is ON when it is down, and OFF when it is up.

5. Turn the unit's POWER switch ON.

6. Holding down the OVP MONITOR switch, turn the OVP variable resistor with a Phillips screwdriver. Set the OVP trip point.

   Settings are impossible because the last digit of the OVP trip point value is fixed at 0. The OVP trip point can be set at up to 110 % of the unit's rated output voltage.

7. Press the SET switch to turn it OFF

   The output voltage is displayed while the SET switch is OFF. The external voltage is thus displayed.

8. Turn the POWER switch of the external power supply ON.

9. Set the output voltage of the external power supply to a voltage below the OVP trip point.

   The output voltage of the unit may be set to any value below the OVP preset voltage.

10. Turn the unit's OUTPUT switch ON.

⚠ CAUTION • A voltage externally applied to the unit's output terminal must not exceed 110% of the preset OVP value. A voltage exceeding the value may cause damage to the unit.

---

11. By slowly increasing the output voltage of the external power supply, check that the ALARM LED lights and the outputs are turned OFF, as soon as the applied voltage reaches the preset OVP voltage.

    At this point, the voltmeter displays “OVP” or the current preset output voltage value.

12. Turn the unit’s OUTPUT switch OFF.

13. Press the ALARM RESET switch.

    The ALARM LED light goes out.

14. Turn the POWER switch on the external power supply ON.

15. Disconnect the external power supply.

The steps above complete the OVP trip point settings.

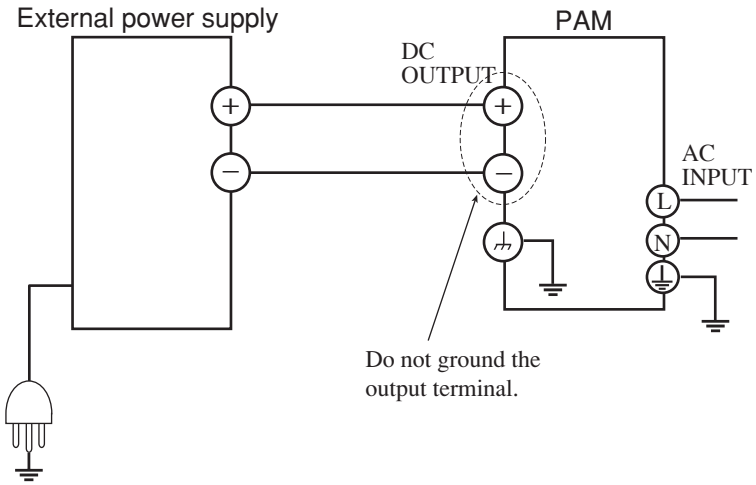


Fig. 3-7 Connection of the external power supply

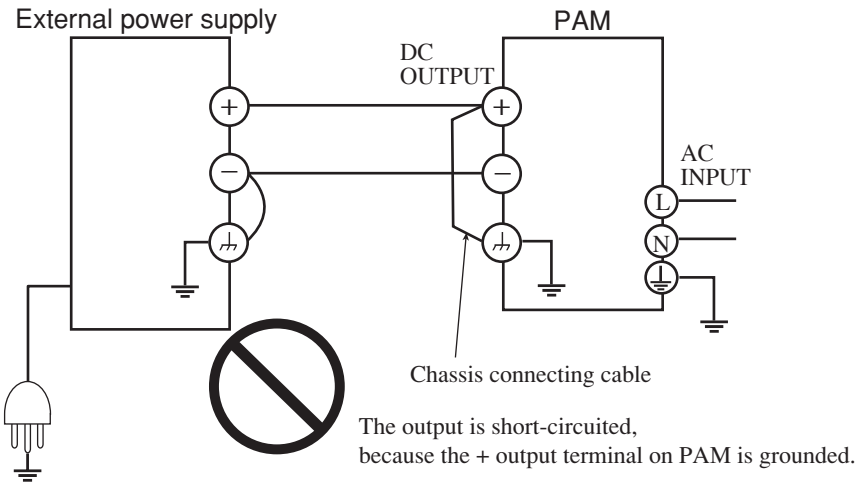


Fig. 3-8 An example of output short-circuiting

3.2.3 Using as a constant voltage power supply

To use the unit as a constant-voltage power supply, take the following steps:

1. Check that the POWER switch is OFF.
2. Check that the OUTPUT switch is OFF.
   The OUTPUT switch is OFF when it is down and ON when it is up.
3. Connect a load to the output terminal.
   For load connection, see "3.3 Connecting load"
4. Turn the POWER switch ON.
5. Check that “OUTPUT OFF” is lit on the display.
6. Check that the SET switch is lit.
7. Use the CURRENT COARSE/FINE switch to select between COARSE and FINE.
8. Turning the dial, set a current to be applied to the load.
   The value set here is the maximum current.
9. Pressing the VOLTAGE COARSE/FINE switch, select between COARSE and FINE.
10. Turning the dial, set a desired voltage.
11. Turn the OUTPUT switch ON.
12. A voltage is output to the output terminal.
    CV LED lights.

NOTE

- When the unit is used as a constant-voltage power supply, the unit shifts to constant-current operation once the maximum current set in Step 8 is exceeded due to load fluctuation. CC LED lights when the unit operates at constant current.

3.2.4 Using as a constant current power supply

To use the unit as a constant-current power supply, take the following steps:

1. Check that the POWER switch is OFF.
2. Check that the OUTPUT switch is OFF.
   The OUTPUT switch is OFF when it is down and ON when it is up.
3. Connect a load to the output terminal.
   For load connection, see "3.3 Connecting load"
4. Turn the POWER switch ON.
5. Check that “OUTPUT OFF” is lit on the display.
6. Check that the SET switch is lit.
7. Use the VOLTAGE COARSE/FINE switch to select between COARSE and FINE.
8. Turning the dial, set a voltage to be applied to the load.
   The value set here is the maximum voltage.
9. Pressing the CURRENT COARSE/FINE switch, select between COARSE and FINE.
10. Turning the dial, set a desired current.
11. Turn the OUTPUT switch ON.
12. A current is output to the output terminal.
    CC LED lights.

NOTE

- When the unit is used as a constant-current power supply, the unit shifts to constant-voltage operation once the maximum voltage set in Step 8 is exceeded due to load fluctuation. CV LED lights when the unit operates at constant voltage.
- When the unit is operating near an output short-circuit, a hissing sound may be heard from inside the unit. This sound does not indicate problems.

3.3 Connecting load

This section describes the cables (load cables) connecting the unit and a load and the proper procedure for connecting loads to the output terminals.

3.3.1 load cables

⚠WARNING • For load cables, use cables that have sufficient current capacity with respect to the rated output current of the unit and that have sufficient withstand voltage with respect to the isolation voltage of the unit.

Current capacity of load cables

Load cables must be rated to carry the maximum rated output current of the unit. If their current rating exceeds the maximum rated output current, they will carry the maximum current even if a load is short circuited.

The allowable current of a wire is determined by the maximum allowable temperature of the cable insulation, which in turn is governed by a current-caused resistance loss, ambient temperature, and thermal resistance to the outside. The allowable currents in Table 3-4 show the capacity of current flowing through a heat-resistant PVC wire (single wire) having a maximum allowable temperature of 60 °C when the wire is stretched horizontally in the air at an ambient temperature of 30 °C. If the condition is such that PVC wires with lower heat-resistant temperature are used, ambient temperature reaches more than 30 °C, or the wires are bundled, resulting in low heat radiation, the current capacity needs to be reduced.

Based on this consideration, it is better to make heat radiation as great as possible to let a larger current flow, as long as wires having the same heat-resistant temperature are used. For measures against noise in the load cables, installing the + (pos.) and - (neg.) output lines side by side or bundling them together is more effective against unnecessary noise. The Kikusui-recommended currents shown in Table 3-4 are allowable current values that have been reduced in consideration of potential bundling of load cables. Use these values as a guideline when installing load wires.

Because wires have resistance, voltage drop in wires becomes greater as the wire becomes longer or the current becomes larger. This causes the voltage applied at the load end to be smaller. The PAM series power supplies have a sensing function that compensates for this voltage drop. Compensation of up to approximately 1 V is available for a single line. If voltage drop exceeds this level, wires having a greater sectional area should be used.

Table3-4 Nominal Cross-sectional Areas of Cables and Allowable Currents

Nominal cross-sectional area[mm^2]	AWG	(Reference cross-sectional area) [mm^2]	Allowable current*1 [A1 (Ta=30˚C)	Current recommended by Kikusui [A]
2	14	(2.08)	27	10
3.5	12	(3.31)	37	-
5.5	10	(5.26)	49	20
8	8	(8.37)	61	30
14	5	(13.3)	88	50
22	3	(21.15)	115	80
30	2	(33.62)	139	-
38	1	(42.41)	162	100
50	1/0	(53.49)	190	-
60	2/0	(67.43)	217	-
80	3/0	(85.01)	257	200
100	4/0	(107.2)	298	-
125	-	-	344	-
150	-	-	395	300
200	-	-	469	-

*1. Excerpts from Japanese laws related electrical equipment

Withstand voltage of load cables

For load cables, use cable with a higher voltage rating than the isolation voltage of the unit. For more information, see "2.6 Grounding the output terminal".

3.3.2 Connecting to the output terminal

Models that the rated output current is 25 A or less have two output terminals, located on the front and rear. The output terminal on the front is used as an auxiliary terminal.

This terminal may not perform ideally, as may be required.

To operate the unit under normal conditions, connect the chassis terminal to the - (neg.) output terminal or to the + (pos.) output terminal, using the accompanying chassis connecting cable. For more information on the chassis terminal, see "2.6 Grounding the output terminal"

Using the DC OUTPUT terminal on the rear

⚠WARNING • Models equipped with an auxiliary output terminal have a cover provided for the terminal. Even when no load is connected to the auxiliary output terminal, install the cover on the terminal when the unit is in use to ensure safety. For installation of the auxiliary output terminal cover, see Fig. 3-15

Fig. 3-9 to Fig. 3-13 which are seen in the following procedures show examples of the 2kW model. See Fig. 3-9 to Fig. 3-13 for the 4kW model also. Connection to the output terminal is the same as the 2kW model.

1. Turn the POWER switch OFF.
2. Remove the DC OUTPUT terminal cover. See Fig. 3-9.

   Skip 3 of Fig. 3-9 for the PAM40-50 or PAM40-100 user. The acrylic cover is not attached for those models.
3. Using the accompanying chassis connecting cable, connect the chassis terminal to the - (neg.) or the + (pos.) output terminal. See Fig. 3-10.

   To connect to the output terminal, use the accompanying screws.
4. Install a crimping terminal on the load cable.

   The DC OUTPUT terminal has 9-mm holes and M4 holes for connecting a load cable. For the 9-mm hole, use an M6 or M8 screw. Use a crimping terminal compatible with the screw used.
5. Connect the load cable to the DC OUTPUT terminal. See Fig. 3-11 or Fig. 3-12.
6. Check that the load cable is connected securely.
7. Install the DC OUTPUT terminal cover. See Fig. 3-13.

   Skip 2 of Fig. 3-13 for the PAM40-50 or PAM40-100 user. The acrylic cover is not attached for those models.

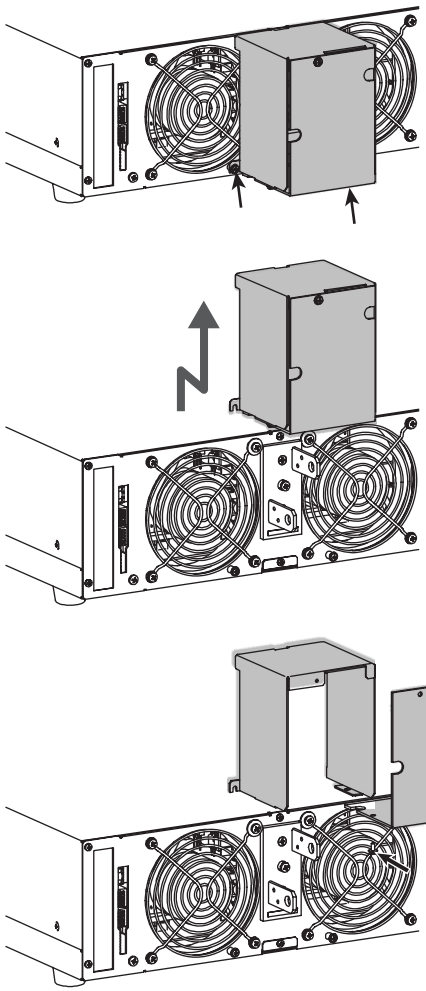


Fig. 3-9 Remove the DC OUTPUT terminal cover (PAM series 2kW model)

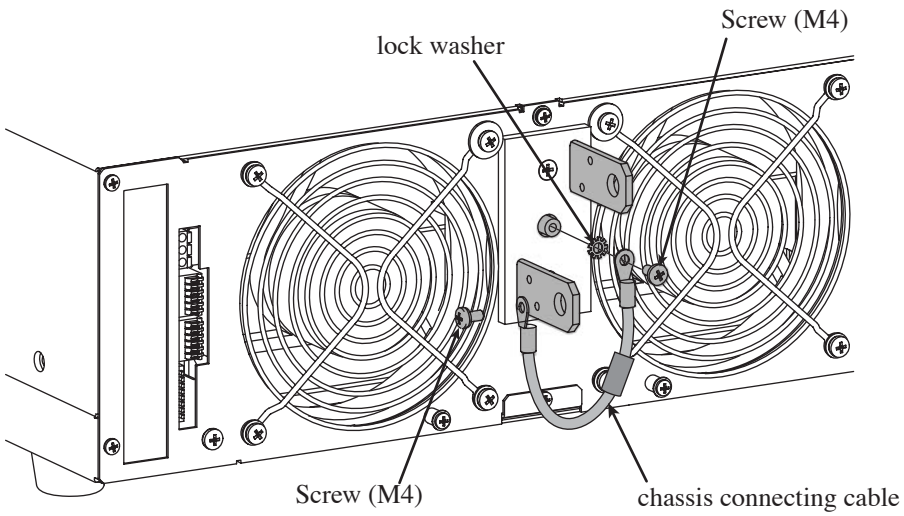


Fig. 3-10 Connection of chassis connecting cable (PAM series 2kW model)

Using the DC OUTPUT terminal on the rear(Con't)

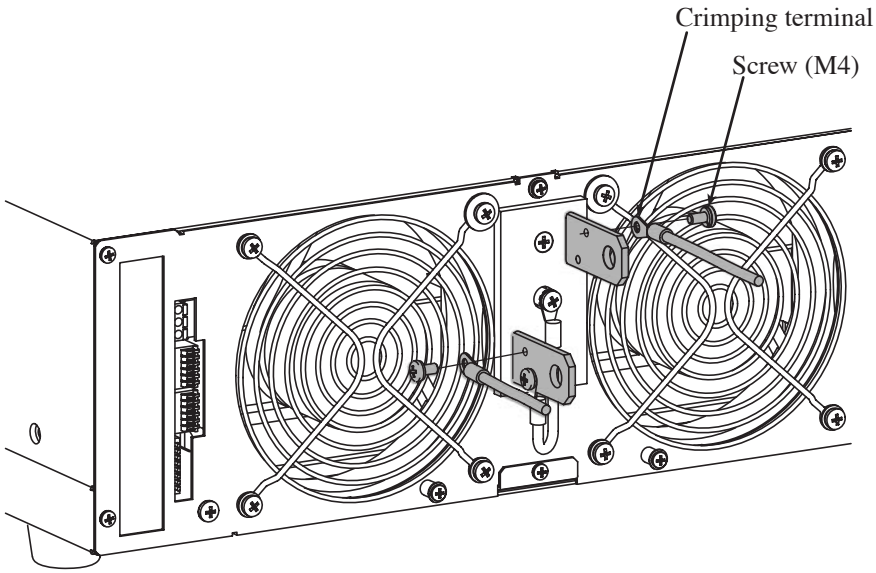


Fig. 3-11 Connection by M4 screw (PAM series 2kW model)

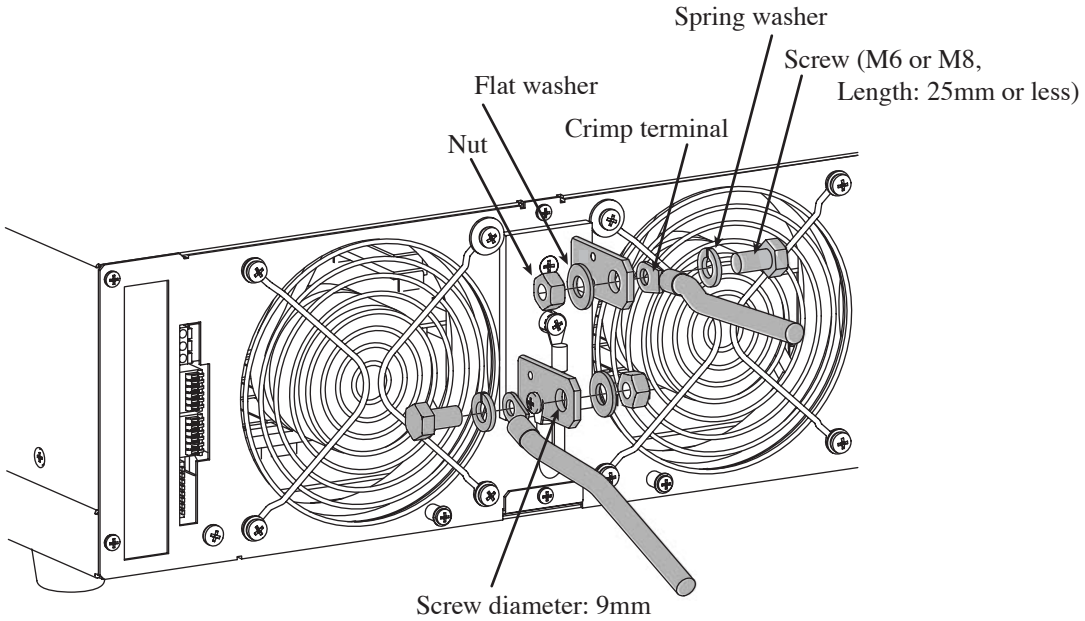


Fig. 3-12 Connection by M6 or M8 screw
(PAM series 2kW model)

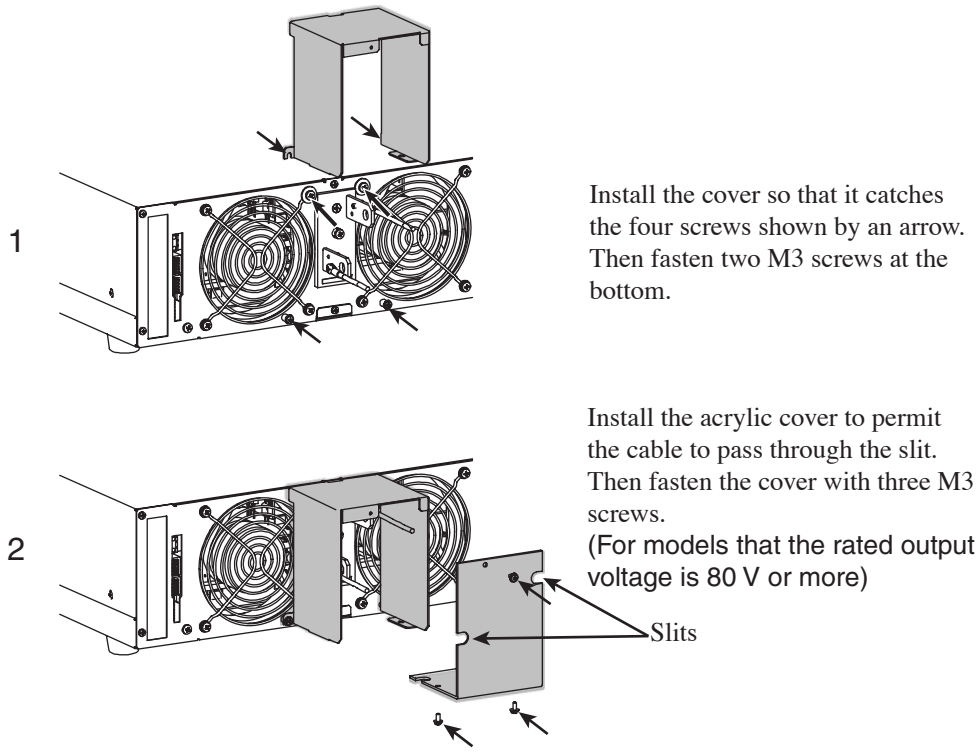


Fig. 3-13 Mounting the DC OUTPUT terminal cover (PAM series 2kW model)

Using the auxiliary output terminal on the front

NOTE

- Models that the rated output current is 50 A or more have no auxiliary output terminal.

In general, to connect a load to the auxiliary output terminal, connect the chassis terminal to the - (neg.) or + (pos.) output terminal. For information on connections, see Fig. 3-10.

1. Turn the POWER switch OFF.
2. Install a crimping terminal on the load cable.

   The auxiliary output terminal has a diameter of 6 mm. Use a compatible crimping terminal.
3. Remove the auxiliary output terminal cover. See Fig. 3-15.

   Fig. 3-15 shows an example of the 2kW model. See Fig. 3-15 for the 4kW model also. Putting on and taking off the auxiliary output terminal cover are the same as the 2kW model.
4. Connect the load cable to the auxiliary output terminal. See Fig. 3-14.
5. Install the auxiliary output terminal cover.

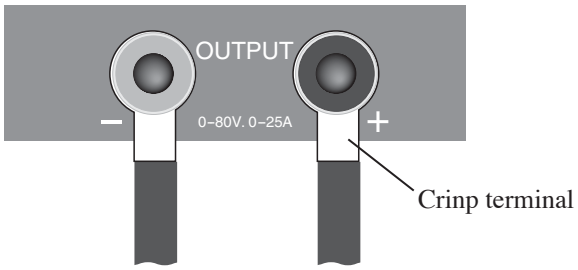


Fig. 3-14 Connecting to the auxiliary output terminal on the front panel

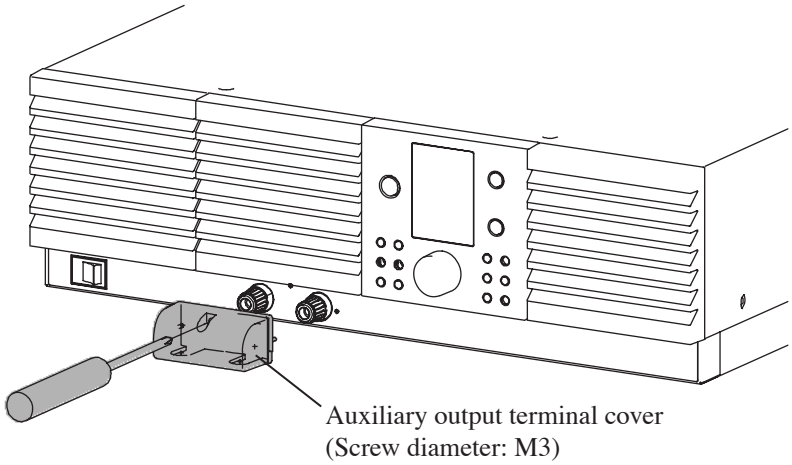


Fig. 3-15 Removing and reinstalling the auxiliary output terminal cover (PAM series 2kW model)

3.4 Memory function

The unit stores up to three preset values for output voltage and current. You can recall them whenever necessary.

Storing preset values

The preset values for present outputs are stored in memory. Make output settings before starting memory operations.

1. Press the STORE switch.

   The MEMORY 1, 2, and 3 switches light.

2. From the above three switches, select and press the one with which you want to store values.

   Only the switch you press remains lit. The preset values for output voltage and current are stored in the memory unit with the selected number.

NOTE

- To exit STORE mode, turn the dial, or press the STORE switch again. Or do nothing for about three seconds to automatically exit STORE mode.
- Memory operations are not possible when the LOCK switch is ON.

Recalling preset values

⚠ CAUTION

- If a preset value is recalled from memory with the OUTPUT switch ON, the recalled preset value is output. Thus, note that, if the wrong memory number is selected, the load may be subjected to excessive power levels. For unused memory units, we recommend presetting a voltage and current low enough to protect the load.

1. Press the MEMORY switch with which you want to recall values.
2. The switch you have pressed lights up, and the stored voltage and current are set.

NOTE

- To turn the MEMORY switch OFF, turn the dial.
- If a preset value is recalled from memory with the OUTPUT switch ON, outputs may start about 1.5 second later than usual.
- When the MEMORY switch is pressed with the OUTPUT switch OFF, the SET switch (if currently off) automatically lights to display the recalled preset values.

3.5 LOCK function

A LOCK function is provided to avoid altering preset output values by mistake. When the LOCK switch lights, the dial and some switches on the front panel associated with output settings and the memory function stop working. See Fig. 3-16.

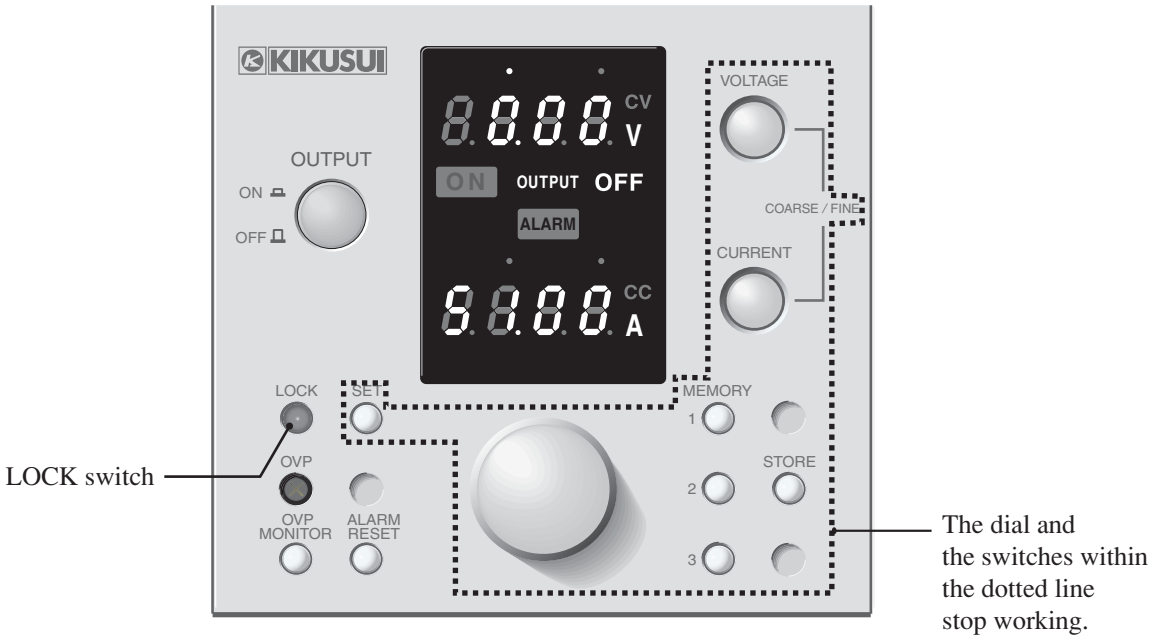


Fig. 3-16 The dial and switches that stop working when the LOCK switch lights up

Chapter 4 Applied Operation

This chapter describes the remote sensing, the analog remote control, and remote monitoring.

4.1 General description

The unit permits the following applied operations. The J1 and J2 terminal boards are used to perform these operations, along with the S1 switch.

- Remote sensing
- Output control by analog signal
- Output ON/OFF control by external contact
- Remote monitoring (Operation mode, Output voltage and Output current)

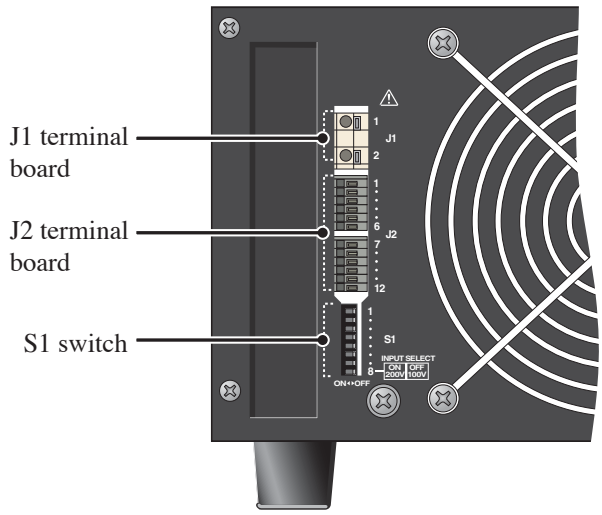


Fig.4-1 J1,J2 terminal boards and S1 switch (PAM series 2kW model)

4.1.1 J1 and J2 terminal boards

This section describes the cable connections required to use the J1 and J2 terminal boards. It also gives some important precautions.

■ Terminal arrangement

Table 4-1 and Table 4-2 respectively show the terminal arrangement on the J1 and J2 terminal boards.

Table4-1 Arrangement on the J1 terminal board

Terminal No.	Signal name	Description
1	+S	Positive input during remote sensing
2	-S	Negative input during remote sensing

Table4-2 Arrangement on the J2 terminal board

Terminal No.	Signal name	Description		
1	STAT COM	Common line for status output Photocoupler emitter input		An open-collector-type photocoupler used to insulate from other terminals.
2	CV MODE	Status output	Low level during operation at constant voltage. Photocoupler collector output.	
3	CC MODE		Low level during operation at constant current. Photocoupler collector output.	
4	ALM		Low level during operation of the protective circuit Photocoupler collector output.	
5	ANLG COM	Common line for output monitor Common line for remote control input		Connected to the - (neg.) output of the unit.
6	OUTPUT ON/OFF	Remote control input	Output ON/OFF control input with an external contact.	Almost the same potential as the - (neg.) output of the unit.
7	V MON	Output monitor	Monitor output of output voltage.	
8	I MON		Monitor output of output current.	
9	CV R CONT	Remote control input	Output voltage control input with an external resistor.	
10	CV V/R CONT		Output voltage control input with an external resistor. Output voltage control input with an external voltage.	
11	CC R CONT		Output current control input with an external resistor.	
12	CC V/R CONT		Output current control input with an external resistor. Output current control input with an external voltage.	

J1 and J2 terminal boards (Con't)

■ Wires and tools required for connection

1. Wires

Table4-3

	For J1 terminal board	For J2 terminal board
Single wire	ϕ 0.4 to ϕ 1.2 (AWG26 to 16)	ϕ 0.32 to ϕ 0.65 (AWG28 to 22)
Twisted wire	0.3mm^2 to 1.25mm^2 (AWG22 to 16) (Bare wire diameter: ϕ 0.18 or more)	0.08mm^2 to 0.32mm^2 (AWG28 to 22)

2.Screwdriver

Axis diameter: ϕ 3

End width: 2.6 mm

3. Wire stripper

One suitable for the wires described above

J1 and J2 terminal boards connecting procedure

⚠WARNING • Never attempt to connect wires to the J1 terminal board while the POWER switch turned on. This may result in electric shock or damage to the internal circuitry.

1. Turn off the POWER switch.
2. Use a wire stripper to remove the covering from each wire over a distance of 10 mm.

   Use of the strip gauge on the top of the unit, allows you to remove the required amount of covering from a wire.
3. Insert wires into terminal boards as shown in Fig. 4-2.

⚠WARNING • The potential of terminal 5 to terminal 12 of J2 terminal board is nearly the same as that of the - (neg.) output terminals of the unit. If part of the wire extending off a terminal board makes contact with the chassis, electric shock or internal circuit breakage may be caused. Insert wires into the terminals in such a way that bare parts are not exposed.

4. Remove the screwdriver from the terminal, and pull the wire gently to ensure that it is securely inserted.

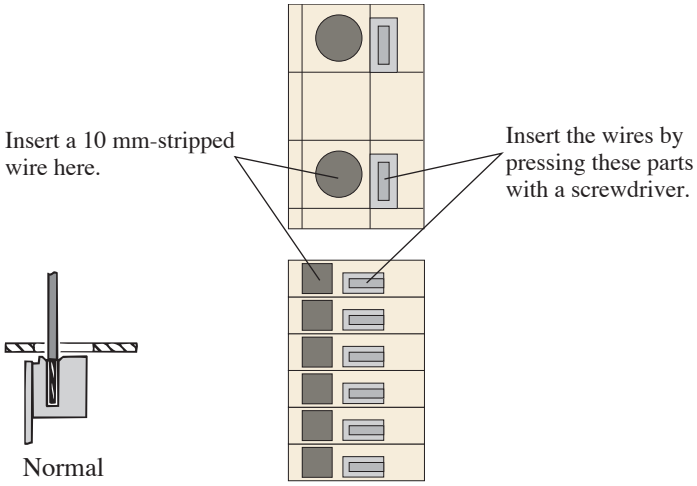
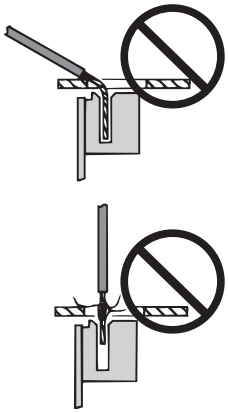


Fig. 4-2 Connection to J1 and J2 terminal boards



The wire makes contact with the chassis. Remove the covering from each wire over a distance of 10 mm.

Part of the wire extending off a terminal board makes contact with the chassis, Insert twisted wires into terminal boards.

Fig. 4-3 Improper connection

4.1.2 S1 switches

Table 4-4 shows the function of each S1 switch.

Table4-4 Function of S1 switches

Switch No.	Description	ON	OFF
1	Mode selection for output voltage control with an external resistor	10 kΩ → 0 OUT mode	10 kΩ → MAX OUT mode
2	Selection of program sources for output voltage control	External resistor	Voltage
3	Mode selection for output current control with an external resistor	10 kΩ → 0 OUT mode	10 kΩ → MAX OUT mode
4	Selection of program sources for output current control	External resistor	Voltage
5	Selection of remote control	Remote control	Local control
6	Mode selection for OUTPUT ON/OFF	Close ON mode	Close OFF mode
7	Selection of remote sensing	Remote sensing	Local sensing
8	Selection of input voltage (*1)	200 V	100 V

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).

For the function of the No.8 of S1 switch, see "1.4 Input power".

4.2 Remote sensing

The remote sensing function is intended to reduce the influence of voltage drops affected by the load cable resistance, to keep the output voltage stable at the load terminal. The PAM series' remote sensing function is capable of compensating for up to approximately 1V for a single line. Select load cables with sufficient current capacity so that a voltage drop in the load cables does not exceed the compensation voltage.

To perform remote sensing, an electrolytic capacitor is needed at the sensing point (load terminal).

NOTE

- A voltage drop that can be compensated for is approximately 1 V for a single line. When remote sensing is carried out at the rated output voltage, the unit's output is limited by the maximum voltage. Thus, in the event of a voltage drop of 0.6 V (double lines) or greater, the rated output voltage cannot be compensated for at the load ends. In this case, use wires with larger sectional areas to reduce the voltage drop below 0.6 V (double lines).

Sensing wire connecting procedure

⚠ WARNING

- Never attempt to connect wires to the J1 terminal board while the POWER switch turned on. This may result in electric shock or damage to the internal circuitry.

1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. Set the S1 switches as shown in Table 4-5.
4. As shown in Fig. 4-4, connect a sensing cable between the J1 terminal board and the load end.

   To reduce output ripple voltages caused by inductive effects, use a two-core shielded cable for wiring. Connect the shield to the - (neg.) terminal.

   If a shielded wire is not available, use the + (pos.) and the - (neg.) cables after fully twisting them.

⚠ WARNING

- For sensing wires, use cable with a higher voltage rating than the isolation voltage of the unit. For more information, see "2.6 Grounding the output terminal".
  Protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

Sensing wire connecting procedure (Cont'd)

⚠ CAUTION
- If the sensing wire is disconnected, the output voltage at the load terminals cannot be stabilized, and excessive voltage may be applied to the load. Use crimp terminals for securely connections.
- To turn on/off the power supplied to a load using a mechanical switch, provide additional switches between the sensing wires as shown in Fig. 4-5; turn on/off the power and remote sensing function simultaneously.

5. Connect an electrolytic capacitor (C) with a capacity of approx. 0.1 μF to 100 μF across the load terminals.

⚠ CAUTION
- Use a capacitor (C) whose withstand voltage is 120 % or more of the unit's rated output voltage.

NOTE
- If the length of wiring to a load extends to 3 m or more, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation. In such cases, the capacitor (C) prevents oscillation.
- If the load current changes suddenly to pulse form, the output voltage may increase due to effects from the inductance components of the wiring. In such cases, the capacitor (C) also prevents variations in output.
- Twisting the load cable reduces inductive effects and stabilizes operations.

6. Recheck that the connections of terminal and setting of switches.

⚠ CAUTION
- After using remote sensing, disconnect the sensing wires and turn OFF the No. 7 of S1 switch.
- Never attempt to turn ON/OFF the No.7 of S1 switch while the POWER switch turned on.

Table4-5 Setting S1 switches for remote sensing

Switch No.	Setting	Description
1	OFF/ON	No effect when Switch 5 is OFF. Depends on settings for each control mode when Switch 5 is ON.
2	OFF/ON	
3	OFF/ON	
4	OFF/ON	
5	OFF/ON	OFF when not using output control with an analog signal.
6	OFF/ON	OFF when not using OUTPUT ON/OFF control.
7	ON	Selects remote sensing.
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V).)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).

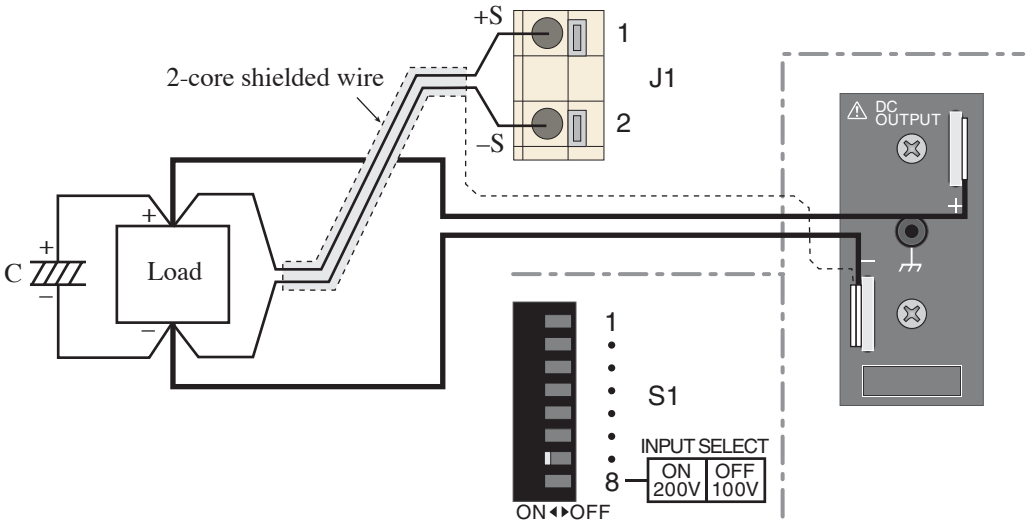


Fig. 4-4 Remote sensing connection

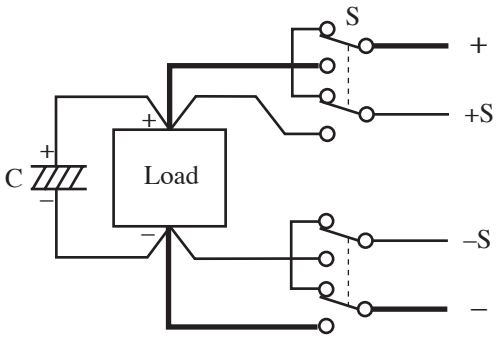


Fig. 4-5 Power ON/OFF using mechanical switches

4.3 Analog remote control

It is possible to remotely control the unit's output voltage and current using analog signals. Output ON/OFF operation by means of external contact points is also possible.

⚠WARNING • Incorrect handling of the J2 terminal board may cause electric shock or accidents due to short circuit of the output. When using remote control, always follow the procedures for each corresponding control method.

4.3.1 Output control with analog signal

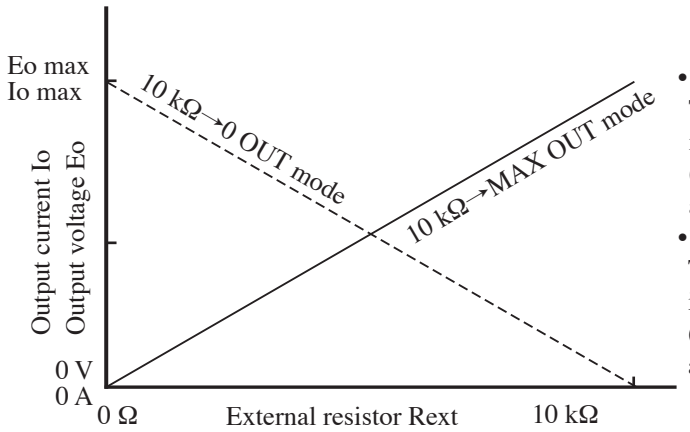
■ Remote control of both output voltage and output current

You can select between voltage and resistor as an analog signal for remote control of the output voltage and current. Four combinations are available for control, as shown below:

Table4-6 Control combinations
(both output voltage and output curtent)

Combination	Control source for output voltage	Control source for output current	Connection and setting
Control 1 (CV:V, CC:R)	Voltage	Resistor	See Page 4-12
Control 2 (CV:V, CC:V)	Voltage	Voltage	See Page 4-14
Control 3 (CV:R, CC:V)	Resistor	Voltage	See Page 4-16
Control 4 (CV:R, CC:R)	Resistor	Resistor	See Page 4-18

When controlling the output voltage and current using a resistor (in control methods other than those indicated in Table 4-6, Control 2), you can select between two control modes, as follows:



•10 kΩ→MAXOUT mode
The output voltage or current increases with increasing resistance. (0 to rated output voltage or current at 0 Ω to about 10 kΩ)
•10kΩ→0 OUT mode
The output voltage or current increases with decreasing resistance. (0 to rated output voltage or current at about 10 kΩ to 0 Ω)

Fig. 4-6 10kΩ → MAX OUT mode and 10kΩ → 0 OUT mode

■ Remote control of either output voltage or output current

This unit does not have a function to allow analog remote control of the output voltage or the output current alone. However, either the output voltage or the output current alone may be temporarily remote-controlled by replacing the resistor in the control source with a jumper cable.

When using a jumper cable, the external resistance becomes almost 0 Ω. For this reason, it is necessary to change the resistance control mode from 10 kΩ to 0 Ω OUT. Thus, where voltage or current is not remote-controlled, set to the rated output.

Table4-7 Control combination
(either output voltage or output current alone)

Combination	Control source for output voltage	Control source for output current	Connection and setting
Control 5 (CV:V, CC:Irtg)	Voltage	Jumper (0 Ω)	See Page 4-20
Control 6 (CV:R, CC:Irtg)	Resistor	Jumper (0 Ω)	See Page 4-22
Control 7 (CV:Ertg, CC:V)	Jumper (0 Ω)	Voltage	See Page 4-24
Control 8 (CV:Ertg, CC:R)	Jumper (0 Ω)	Resistor	See Page 4-26

Connecting and setting procedure

⚠WARNING

- Never attempt to connect wires to the J2 terminal board while the POWER switch turned on. This may result in electric shock or damage to the internal circuitry.
- The potential of terminal 5 to terminal 12 of J2 terminal board is nearly the same as that of the - (neg.) output terminals of the unit. If part of the wire extending off a terminal board makes contact with the chassis, electric shock or internal circuit breakage may be caused. Insert wires into the terminals in such a way that bare parts are not exposed.

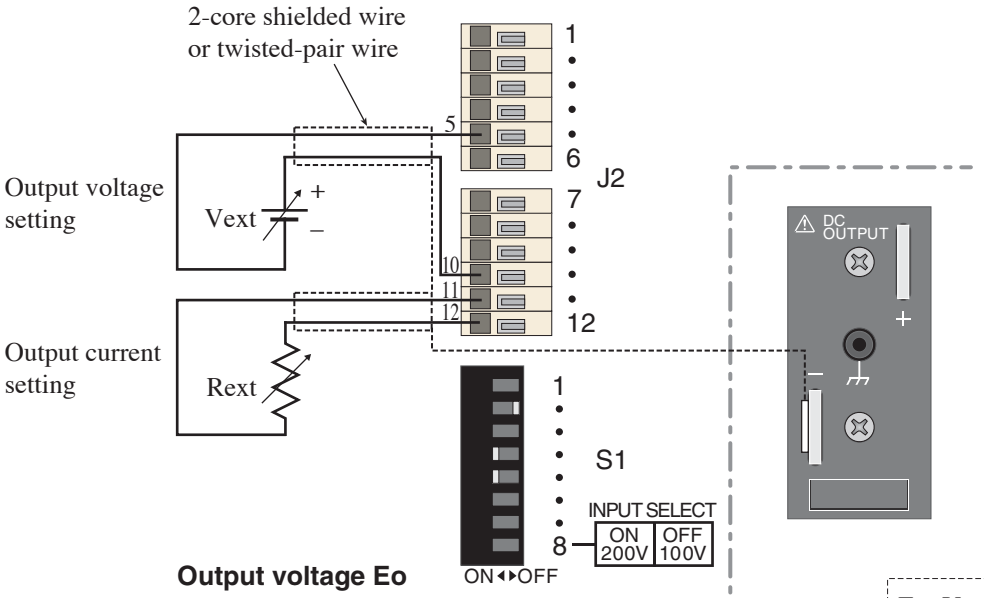
1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. From Table 4-6 and Table 4-7, select the desired control method.
4. Set the S1 switches and connect the control source according to the settings and connections for each control method shown in the following pages.
5. Recheck the terminal-board connections and switch settings.

Control 1 (CV:V, CC:R), connection and setting

Table4-8 Setting S1 switches for Control 1

Switch No.	Settings	Description
1	OFF/ON	No effects on Control 1
2	OFF	Selects voltage as control source for output voltage
3	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
4	ON	Selects resistor as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

$$Eo \approx \frac{Ertg \cdot Vext}{10} \quad [V]$$

$0 \leq Vext \leq 10.5[V]$

Ertg : Rated output voltage [V]

Output current Io

10 kΩ → MAX OUT mode

$$Io \approx \frac{Irtg \cdot Rext}{10000} \quad [A]$$

10 kΩ → 0 OUT mode

$$Io \approx \frac{10000 - Rext}{10000} \cdot Irtg \quad [A]$$

$Rext \leq 10000 \ [\Omega]$

Irtg : Rated output current [A]

For Vext and Rext, set the voltage and resistance values well above the minimum level.

Fig. 4-7 Connection for Control 1

⚠ WARNING

- Insulate the external voltage source (Vext), an external resistance (Rext) and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- Watch the polarity of Vext. Connection at incorrect polarity may damage the unit.
- If Vext is disconnected, an unexpected voltage may be supplied by external noise. Connect Vext securely to the J2 terminal board.
- Do not apply a reverse voltage or a voltage of 10.5V or greater between terminal 5 and terminal 10 of the J2 terminal board. Doing so will damage the unit.
- In the 10k Ω → MAX OUT mode, if Rext is disconnected, an excessively large current can flow to the load. Connect Rext securely to the J2 terminal board. If there is any danger of Rext being cut off and the circuit opened, use the 10k Ω → 0 OUT mode.
- To use a fixed resistor for Rext and to control it with a switch, select a closed short-circuit or continuous switch.

NOTE

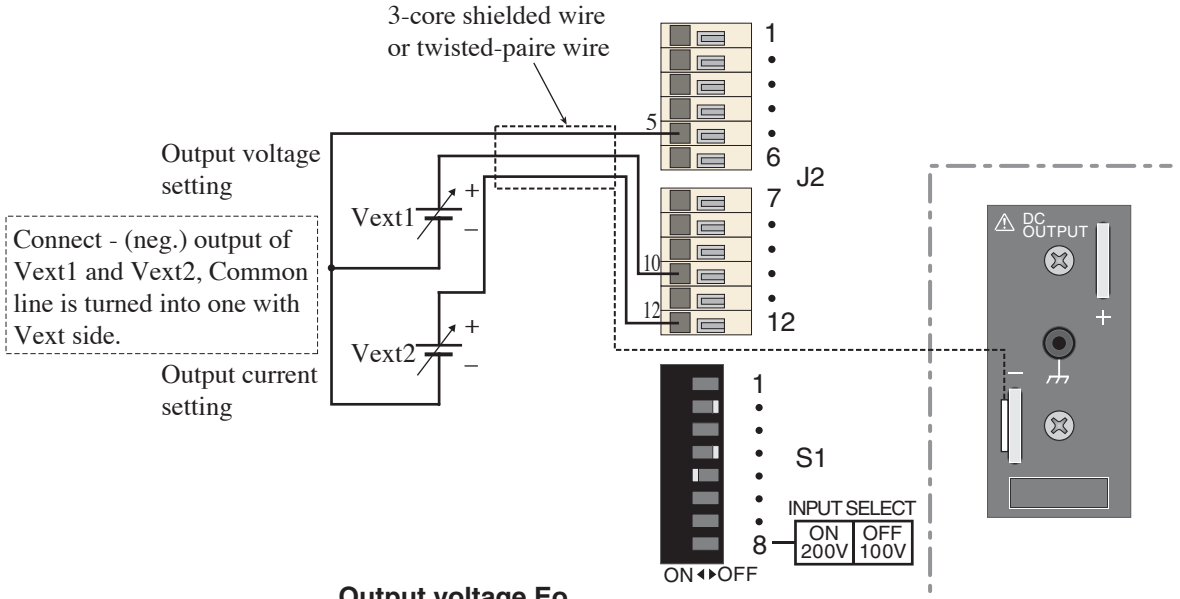
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Vext and J2 terminal board and between Rext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
  For information on connecting the shield to the Vext side, see Page 4-28 "When you wish to connect the shield to Vext"
- The input impedance between terminal 5 and terminal 10 of the J2 terminal board is approximately 10 kΩ.
- For Vext, use a voltage source of low noise and good stability. Noise in Vext is multiplied by the amplification degree of the unit and appears in the unit's output. Thus, output ripple noise may not meet the unit's specifications.
- For Rext, use a 1/2 W or larger resistor that has a good temperature coefficient and minimal aging effects, such as a metal film resistor or wire-wound resistor.
- Fig. 4-7 shows the general relationship between Vext and the output voltage Eo and between Rext and output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Vext and Rext values (Io applied to the 10 kΩ → 0 OUT mode).

Control 2 (CV:V, CC:V), connection and setting

Table4-9 Setting S1 switches for Control 2

Switch No.	Settings	Description
1	OFF/ON	No effects on Control 2
2	OFF	Selects voltage as control source for output voltage
3	OFF/ON	No effects on Control 2
4	OFF	Selects voltage as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

$$Eo \approx \frac{Ertg \cdot Vext1}{10} [V]$$

$0 \leq Vext1 \leq 10.5[V]$

Ertg : Rated output voltage [V]

Output current Io

$$Io \approx \frac{Irtg \cdot Vext2}{10} [A]$$

$0 \leq Vext\ 2 \leq 10.5[V]$

Irtg : Rated output current [A]

For Vext1 and Vext2, set the voltage value well above the minimum level.

Fig. 4-8 Connection for Control 2

⚠ WARNING

- Insulate the external voltage source (Vext), an external resistance (Rext) and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- Watch the polarity of Vext. Connection at incorrect polarity may damage the unit.
- If Vext is disconnected, an unexpected voltage may be supplied by external noise. Connect Vext securely to the J2 terminal board.
- Do not apply a reverse voltage or a voltage of 10.5V or greater between terminal 5 and terminal 10 and between terminal 5 and terminal 12 of the J2 terminal board. Doing so will damage the unit.

NOTE

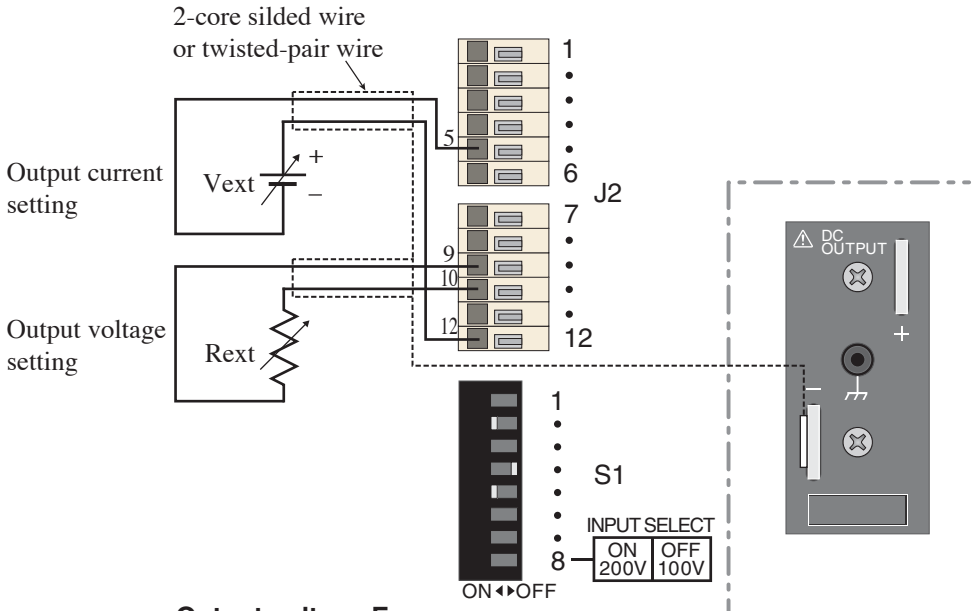
- To reduce the effects of noise on output, use a 3-core shielded wire or a twisted-pair wire to connect betreen Vext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
  For information on connecting the shield to the Vext side, see Page 4-28 "When you wish to connect the shield to Vext"
- The input impedance between terminal 5 and terminal 10 and between terminal 5 and terminal 12 of the J2 terminal board is approximately 10 kΩ.
- For Vext, use a voltage source of low noise and good stability. Noise in Vext is multiplied by the amplification degree of the unit and appears in the unit's output. Thus, output ripple noise may not meet the unit's specifications.
- Fig. 4-8 shows the general relationship between Vext1 and the output voltage Eo and between Vext2 and the output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Vext1 and Vext2 values.

Control 3 (CV:R, CC:V), connection and setting

Table4-10 Setting S1 switches for Control 3

Switch No.	Settings	Description
1	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
2	ON	Selects resistor as control source for output voltage
3	OFF/ON	No effects on Control 3
4	OFF	Selects voltage as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

10 kΩ → MAX OUT mode

$$Eo \approx \frac{Ertg \cdot Rext}{10000} [V]$$

10 kΩ → 0 OUT mode

$$Eo \approx \frac{10000 - Rext}{10000} \cdot Ertg [V]$$

Rext ≤ 10000 [Ω]

Ertg : Rated output voltage [V]

Output current Io

$$Io \approx \frac{Irtg \cdot Vext}{10} [A]$$

0 ≤ Vext ≤ 10.5[V]

Irtg : Rated output current [A]

For Vext and Rext, set the voltage and resistance values well above the minimum level.

Fig. 4-9 Connection for Control 3

⚠ WARNING

- Insulate the external voltage source (Vext), an external resistance (Rext) and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- Watch the polarity of Vext. Connection at incorrect polarity may damage the unit.
- If Vext is disconnected, an unexpected voltage may be supplied by external noise. Connect Vext securely to the J2 terminal board.
- Do not apply a reverse voltage or a voltage of 10.5V or greater between terminal 5 and terminal 10 of the J2 terminal board. Doing so will damage the unit.
- In the 10 kΩ → MAX OUT mode, if Rext is disconnected, an excessively large current can flow to the load. Connect Rext securely to the J2 terminal board. If there is any danger of Rext being cut off and the circuit opened, use the 10 kΩ → 0 OUT mode.
- To use a fixed resistor for Rext and to control it with a switch, select a closed short-circuit or continuous switch.

NOTE

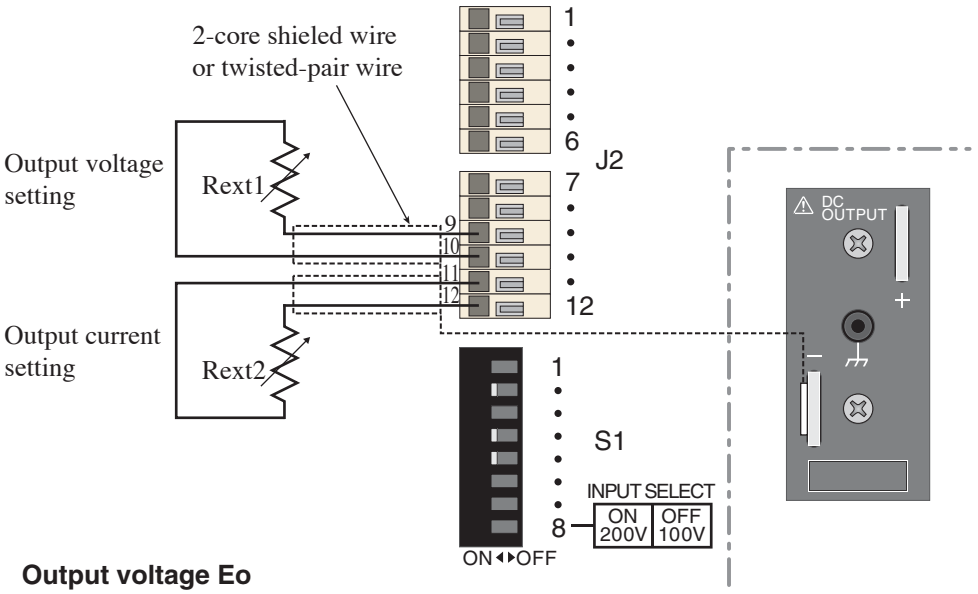
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Vext and J2 terminal board and between Rext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
  For information on connecting the shield to the Vext side, see Page 4-28 "When you wish to connect the shield to Vext"
- The input impedance between terminal 5 and terminal 12 of the J2 terminal board is approximately 10 kΩ.
- For Vext, use a voltage source of low noise and good stability. Noise in Vext is multiplied by the amplification degree of the unit and appears in the unit's output. Thus, output ripple noise may not meet the unit's specifications.
- For Rext, use a 1/2 W or larger resistor that has a good temperature coefficient and minimal aging effects, such as a metal film resistor or wire-wound resistor.
- Fig. 4-9 shows the general relationship between Vext and the output current Io and between Rext and output voltage Eo. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Vext and Rext values (Eo applied to the 10 kΩ → 0 OUT mode).

Control 4 (CV:R, CC:R), connection and setting

Table4-11 Setting S1 switches for Control 4

Switch No.	Settings	Description
1	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
2	ON	Selects resistor as control source for output voltage
3	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
4	ON	Selects resistor as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

10 kΩ → MAX OUT mode

$$Eo \approx \frac{Ertg \cdot Rext1}{10000} [V]$$

10 kΩ → 0 OUT mode

$$Eo \approx \frac{10000 - Rext1}{10000} \cdot Ertg[V]$$

Rext1 ≤ 10000 [Ω]

Ertg : Rated output voltage [V]

Output current Io

10 kΩ → MAX OUTmode

$$Io \approx \frac{Irtg \cdot Rext2}{10000} [A]$$

10 kΩ → 0 OUT mode

$$Io \approx \frac{10000 - Rext2}{10000} \cdot Irtg [A]$$

Rext2 ≤ 10000 [Ω]

Irtg : Rated output current[A]

For Vext and Rext, set the voltage and resistance values well above the minimum level.

Fig. 4-10 Connection for Control 4

⚠ WARNING

- Insulate the external resistance (Rext) and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- In the 10 kΩ → MAX OUT mode, if Rext is disconnected, an excessively large current can flow or excessively large voltage can output to the load. Connect Rext securely to the J2 terminal board.

  If there is any danger of Rext being cut off and the circuit opened, use the 10 kΩ → 0 OUT mode.
- To use a fixed resistor for Rext and to control it with a switch, select a closed short-circuit or continuous switch.

NOTE

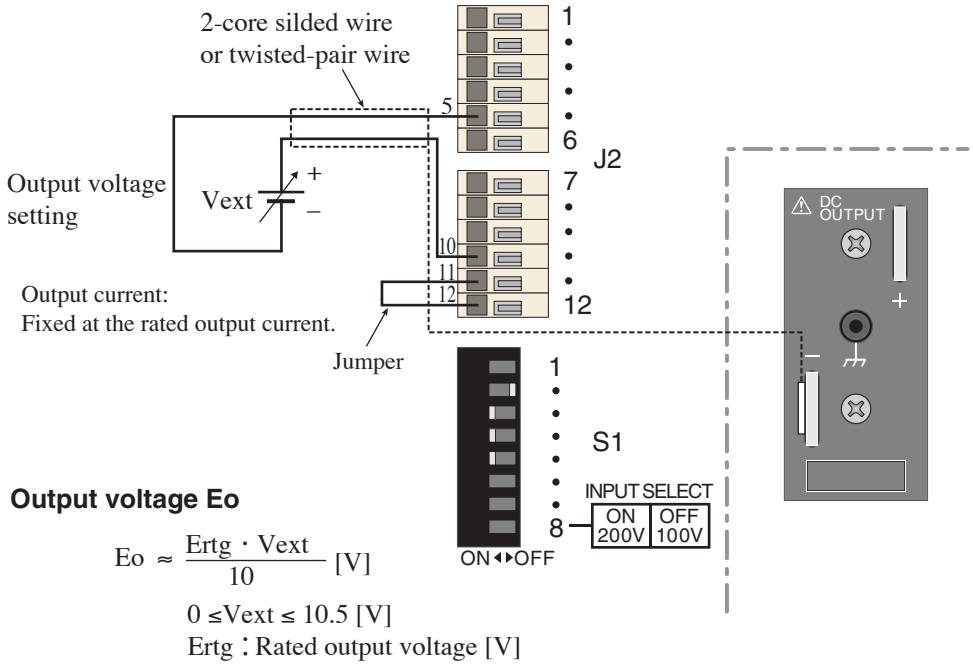
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Rext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
- For Rext, use a 1/2 W or larger resistor that has a good temperature coefficient and minimal aging effects, such as a metal film resistor or wire-wound resistor.
- Fig. 4-10 shows the general relationship between Rext1 and the output voltage Eo and between Rext2 and output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Rext1 and Rext2 values (Eo and Io applied to the 10 kΩ → 0 OUT mode).

Control 5 (CV:V, CC:Irtg), connection and setting

Table4-12 Setting S1 switches for Control 5

Switch No.	Settings	Description
1	OFF/ON	No effects on Control 5
2	OFF	Selects voltage as control source for output voltage
3	ON	10 kΩ → 0 OUT mode
4	ON	Selects resistor as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

$$Eo \approx \frac{Ertg \cdot Vext}{10} \ [V]$$

$0 \leq Vext \leq 10.5$ [V]

Ertg : Rated output voltage [V]

Output current Io

10 kΩ → 0 OUT mode

$$Io \approx \frac{10000 - Rext}{10000} \cdot Irtg \ [A]$$

Rext = 0 [Ω]

Irtg : Rated output current [A]

For Vext, set the voltage value well above the minimum level.

Fig. 4-11 Connection for Control 5

⚠ WARNING

- Insulate the external voltage source (Vext), the Jumper and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- Watch the polarity of Vext. Connection at incorrect polarity may damage the unit.
- If Vext is disconnected, an unexpected voltage may be supplied by external noise. Connect Vext securely to the J2 terminal board.
- Do not apply a reverse voltage or a voltage of 10.5V or greater between terminal 5 and terminal 10 of the J2 terminal board. Doing so will damage the unit.

NOTE

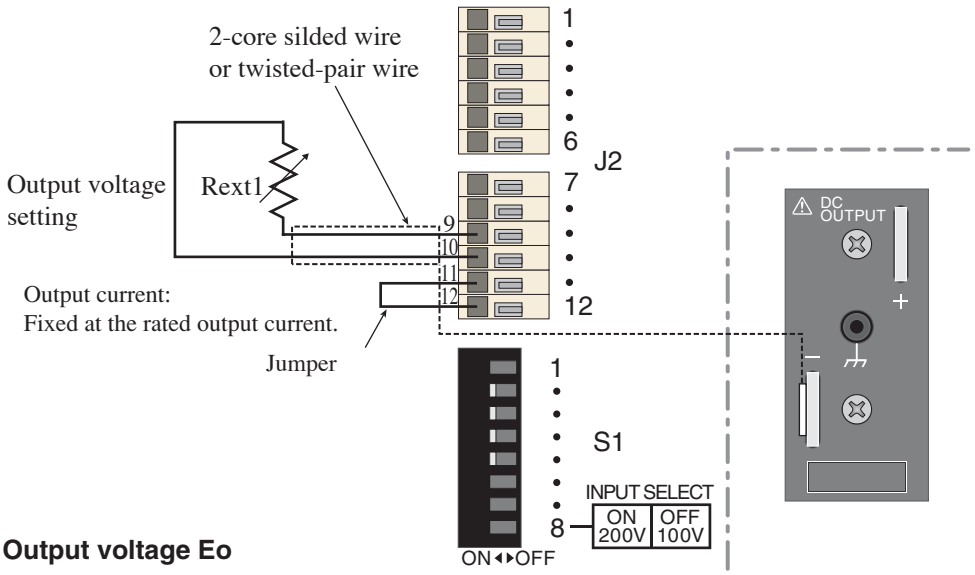
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Vext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
  For information on connecting the shield to the Vext side, see Page 4-28 "When you wish to connect the shield to Vext"
- The input impedance between terminal 5 and terminal 10 of the J2 terminal board is approximately 10 kΩ.
- For Vext, use a voltage source of low noise and good stability. Noise in Vext is multiplied by the amplification degree of the unit and appears in the unit's output. Thus, output ripple noise may not meet the unit's specifications.
- Fig. 4-11 shows the general relationship between Vext and output voltage Eo and between Rext and the output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Vext and Rext values .

Control 6 (CV:R, CC:Irtg), connection and setting

Table4-13 Setting S1 switches for Control 6

Switch No.	Settings	Description
1	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
2	ON	Selects resistor as control source for output voltage
3	ON	10 kΩ → 0 OUT mode
4	ON	Selects resistor as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

10 k Ω→ MAX OUT mode

$$Eo \approx \frac{Ertg \cdot Rext1}{10000} \ [V]$$

Rext1 ≤ 10000 [Ω]

Ertg : Rated output voltage [V]

10 k Ω→ 0 OUT mode

$$Eo \approx \frac{10000 - Rext1}{10000} \cdot Ertg \ [V]$$

For Rext1, set the resistance value well above the minimum level.

Output current Io

10 k Ω→ 0 OUT mode

$$Io \approx \frac{10000 - Rext2}{10000} \cdot Irtg \ [A]$$

Rext2 = 0 [Ω]

Irtg : Rated output current [A]

Fig. 4-12 Connection for Control 6

⚠ WARNING

- Insulate the external resistor source (Rext1), the Jumper and the cable connected to it with at least the isolation voltage of the unit. For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- In the 10 kΩ → MAX OUT mode, if Rext1 is disconnected, an excessively large current can flow or excessively large voltage can output to the load. Connect Rext1 securely to the J2 terminal board.

  If there is any danger of Rext1 being cut off and the circuit opened, use the 10 kΩ → 0 OUT mode.
- To use a fixed resistor for Rext1 and to control it with a switch, select a closed short-circuit or continuous switch.

NOTE

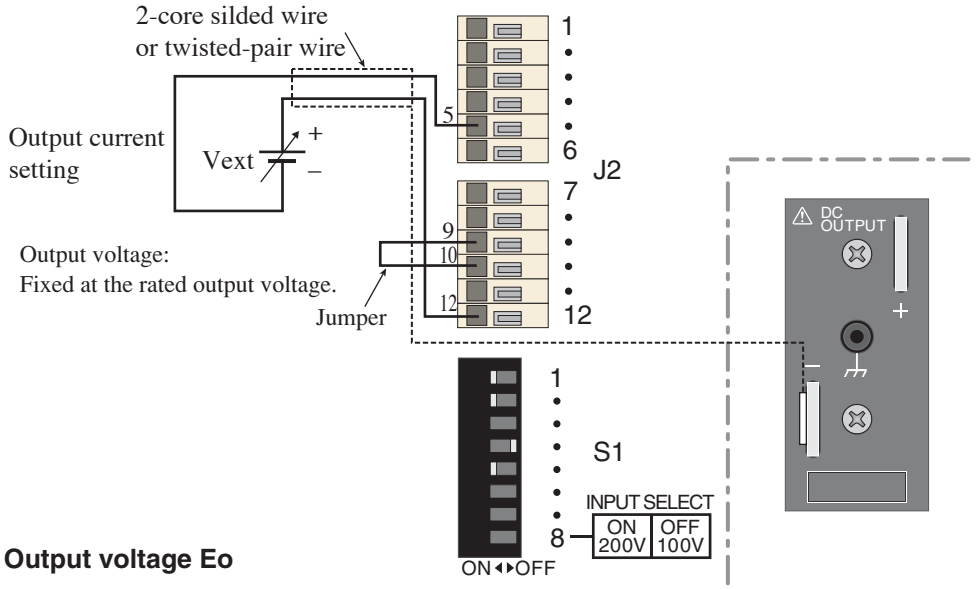
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Rext1 and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
- For Rext1, use a 1/2 W or larger resistor that has a good temperature coefficient and minimal aging effects, such as a metal film resistor or wire-wound resistor.
- Fig. 4-12 shows the general relationship between Rext1 and the output voltage Eo and between Rext2 and output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Rext1 and Rext2 values (Eo applied to the 10 kΩ → 0 OUT mode).

Control 7 (CV:Etrg, CC:V), connection and setting

Table4-14 Setting S1 switches for Control 7

Switch No.	Settings	Description
1	ON	10 kΩ → 0 OUT mode
2	ON	Selects resistor as control source for output voltage
3	OFF/ON	No effects on Control 7
4	OFF	Selects voltage as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

10 k Ω→ 0 OUT mode

$$Eo \approx \frac{10000 - Rext}{10000} \cdot Ertg \ [V]$$

Rext ≤ 0 [Ω]
Ertg : Rated output voltage [V]

For Vext, set the voltage value well above the minimum level.

Output current Io

$$Io \approx \frac{Irtg \cdot Vext}{10} \ [A]$$

0 ≤ Vext ≤ 10.5 [V]
Irtg : Rated output current [A]

Fig. 4-13 Connection for Control 7

⚠ WARNING

- Insulate the external voltage source (Vext), the Jumper and the cable connected to it with at least the isolation voltage of the unit. Float Vext outputs instead of grounding them (floating). For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- Watch the polarity of Vext. Connection at incorrect polarity may damage the unit.
- If Vext is disconnected, an unexpected voltage may be supplied by external noise. Connect Vext securely to the J2 terminal board.
- Do not apply a reverse voltage or a voltage of 10.5V or greater between terminal 5 and terminal 12 of the J2 terminal board. Doing so will damage the unit.

NOTE

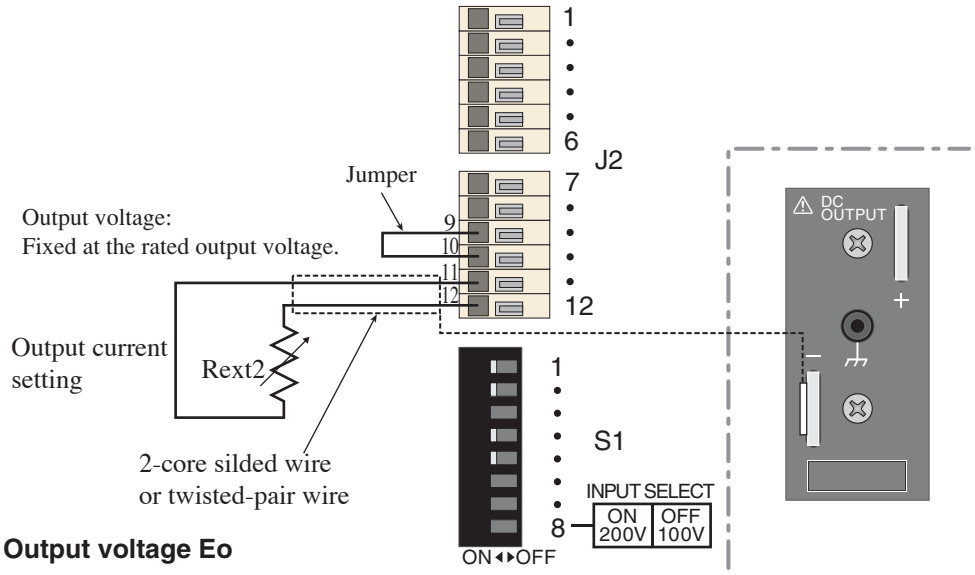
- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Vext and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
  For information on connecting the shield to the Vext side, see Page 4-28 "When you wish to connect the shield to Vext"
- The input impedance between terminal 5 and terminal 12 of the J2 terminal board is approximately 10 kΩ.
- For Vext, use a voltage source of low noise and good stability. Noise in Vext is multiplied by the amplification degree of the unit and appears in the unit's output. Thus, output ripple noise may not meet the unit's specifications.
- Fig. 4-13 shows the general relationship between Rext and the output voltage Eo and between Vext and the output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Vext and Rext values .

Control 8 (CV:Etrg, CC:R), connection and setting

Table4-15 Setting S1 switches for Control 8

Switch No.	Settings	Description
1	ON	10 kΩ → 0 OUT mode
2	ON	Selects resistor as control source for output voltage
3	OFF	10 kΩ → MAX OUT mode
	ON	10 kΩ → 0 OUT mode
4	ON	Selects resistor as control source for output current
5	ON	Selects output control with analog signal
6	OFF/ON	OFF when not using OUTPUT ON/OFF control
7	OFF/ON	OFF when not using remote sensing
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON: 200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).



Output voltage Eo

10 k Ω→ 0 OUT mode

$$Eo \approx \frac{10000 - Rext1}{10000} \cdot Ertg \ [V]$$

Rext1 ≤ 0 [Ω]

Ertg : Rated output voltage [V]

Output current Io

10 k Ω→ MAX OUT mode

$$Io \approx \frac{Irtg \cdot Rext2}{10000} \ [A]$$

Rext2 ≤ 10000 [Ω]

Irtg : Rated output current [A]

10 k Ω→ 0 OUT mode

$$Io \approx \frac{10000 - Rext2}{10000} \cdot Irtg \ [A]$$

For Rext2, set the resistance value well above the minimum

Fig. 4-14 Connection for Control 8

⚠ WARNING

- Insulate the external resistor source (Rext2), the Jumper and the cable connected to it with at least the isolation voltage of the unit. For details, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

⚠ CAUTION

- In the 10 kΩ → MAX OUT mode, if Rext2 is disconnected, an excessively large current can flow or excessively large voltage can output to the load. Connect Rext2 securely to the J2 terminal board.

  If there is any danger of Rext2 being cut off and the circuit opened, use the 10 kΩ → 0 OUT mode.
- To use a fixed resistor for Rext2 and to control it with a switch, select a closed short-circuit or continuous switch.

NOTE

- To reduce the effects of noise on output, use a 2-core shielded wire or a twisted-pair wire to connect between Rext2 and J2 terminal board, making them as short as possible.
  Longer wiring results in greater susceptibility to the effects of noise, and use of cables with antinoise measures may not solve the problem, resulting in improper operation.
  When using a shielded wire, connect the shield to the - (neg.) output terminal.
- For Rext2, use a 1/2 W or larger resistor that has a good temperature coefficient and minimal aging effects, such as a metal film resistor or wire-wound resistor.
- Fig. 4-14 shows the general relationship between Rext1 and the output voltage Eo and between Rext2 and output current Io. But since they are approximate formulas, if you need precise zero and maximum values for output values, adjust the Rext1 and Rext2 values (Io applied to the 10 kΩ → 0 OUT mode).

When you wish to connect the shield to Vext

⚠ CAUTION • When connecting the shield to the Vext side, do not connect the shield to the - (neg.) output terminal of the unit.

When using a shielded wire for connection, some external voltage sources may require that the shield be connected to the external voltage source (Vext). In such cases, the grounding method used for the Vext and the unit creates a condition where the output is short-circuited, as shown in Fig. 4-15. Thus, do not connect the shield to the - (neg.) output terminal of the unit.

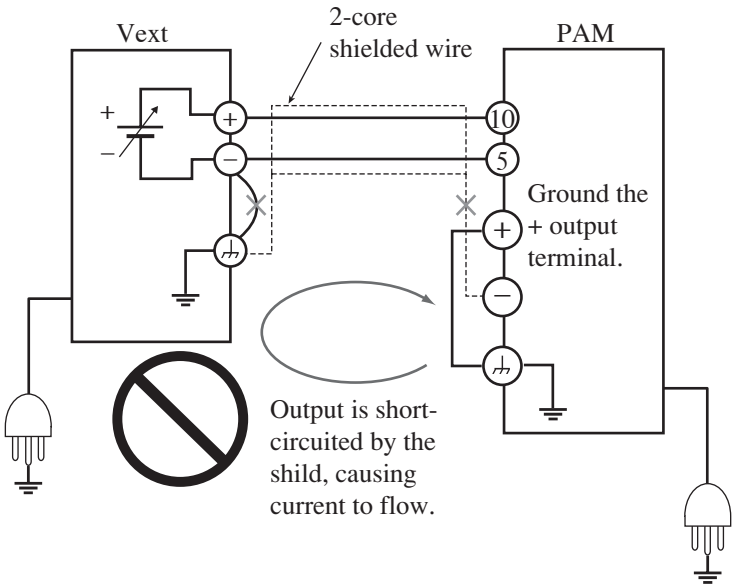


Fig. 4-15 A connection where output is short-circuited by the shield

⚠ WARNING • Do not ground the output of the Vext – float it instead. The potential of terminal 5 to terminal 12 of the J2 terminal board are nearly the same as that of the unit's - (neg.) output terminal, and short-circuit currents are provided to the signal line without a shield.

4.3.2 Output ON/OFF control with an external contact

This method is used to control output ON/OFF operations with an external contact. In this method, you can select either of the following two modes:

Table4-16 Output ON/OFF control mode using an external contact

Control mode	Control mode
Close OFF mode	The output is turned OFF when the external contact is closed.
Close ON mode	The output is turned ON when the external contact is closed.

The OUTPUT switch on the front panel is used to control output ON/OFF using an external contact. For outputs, OFF has priority over ON. For this reason, to turn the output ON/OFF using an external contact, you need to set the OUTPUT switch on the front panel to "ON." See Table 4-17.

Table4-17 Settings for each switch and output status

Control mode	OUTPUT switch on front panel	External contact	Output status
Close ON mode (No.6 of S1 switch is ON.)	ON	ON (Close)	ON
		OFF (Open)	OFF
	OFF	ON (Close))	OFF
		OFF (Open)	OFF
Close ON mode (No.6 of S1 switch is OFF.)	ON	ON (Close))	OFF
		OFF (Open)	ON
	OFF	ON (Close)	OFF
		OFF (Open)	OFF

NOTE

- To operate without output ON/OFF control using an external contact, set No.6 of S1 switch to OFF, or you will be unable to turn output ON/OFF with the OUTPUT switch on the front panel.

Connection and setting for the external contacts

⚠WARNING
- Never attempt to connect wires to the J2 terminal board while the POWER switch turned on. This may result in electric shock or damage to the internal circuitry.
- Insulate the external contacts (S) and the cables leading to then with at least the isolation voltage of the unit. For more information, see "2.6 Grounding the output terminal"
- When using a shielded cable for the connection, protect the uncovered part of the cable with an insulation tube of at least the isolation voltage of the unit.

NOTE
- When the OUTPUT switch is OFF, the load may suffer a slight reverse current, as a reversed polar voltage of about 0.1 V to 0.2 V often occurs at outputs. If a short circuit is likely on the output, be aware that a slight reverse current of a low percentage of the rated current may occur.
  The voltmeter and ampere meter display positive values, but not negative voltages or currents. Instead, "0 V" or "0 A" is displayed.

1. Turn off the POWER switch.
2. Set the S1 switches as shown in Table 4-18.
3. As shown in Table 4-16, connect a contact S (switch) between terminal 5 and terminal 6 of the J2 terminal board.

NOTE
- To reduce output noise, use a two-core shielded wire or a twisted-pair wire to connect the contact to the J2 terminal board. Use as short a wire as possible.
  The longer the wire, the worse the effects of noise. Even if provided with noise protection, such wires can malfunction.
  When using a shielded-wire, connect the shield to the – (neg.) output terminal.
- The release voltage between terminal 5 and terminal 6 of the J2 terminal board is about 15 V at maximum, and the short-circuit current is about 5 mA at maximum.
- Use an external contact rated for at least 20 VDC and 10 mA.
- For long-distance wiring, use a small relay and extend the wiring from the coil side.

4. Turn on the OUTPUT switch.
5. Recheck that the J2 terminal board and setting of switch.

Table4-18 Setting S1 switches for output ON/OFF control

Switch No.	Setting	Description
1	OFF/ON	No effect when Switch 5 is OFF. Depends on settings for each control mode when Switch 5 is ON.
2	OFF/ON	
3	OFF/ON	
4	OFF/ON	
5	OFF/ON	OFF when not using output control using an analog signal.
6	ON	Selects the Close ON mode.
	OFF	Selects the Close OFF mode.
7	OFF/ON	OFF when not using remote sensing.
8	OFF/ON	Selects an input voltage (*1) (OFF: 100 V, ON:200 V)

NOTE *1 The PAM series 4 kW model does not have this function (the line is fixed at 200 V, regardless of whether the switch is ON or OFF).

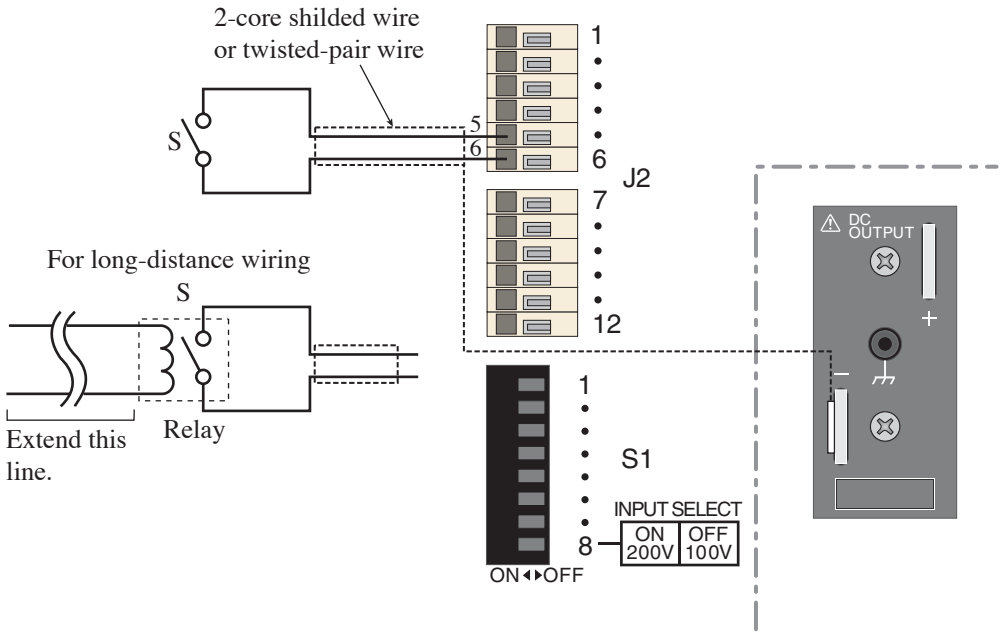


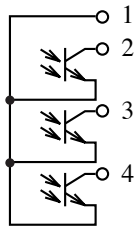
Fig. 4-16 Connection for output ON/OFF control

4.4 Remote monitoring

4.4.1 External monitor for operating mode

The J2 terminal board generates three status outputs to enable external monitoring of unit operations : constant voltage (CV), constant current (CC), and alarm (ALM). These statuses are reflected on the front panel display. Each output is generated from the open collector of the photocoupler and insulated from the unit's interior.

Table4-19 Status outputs

Terminal No.	Signal No.	Description	Circuit
1	STAT COM	Common line for status outputs. Photocoupler emitter input.	
2	CV MODE	Low during constant-voltage operation Photocoupler collector output.	
3	CC MODE	Low during constant current operation. Photocoupler collector output.	
4	ALM	Low during operation of the protective circuit. Photocoupler collector input.	

⚠CAUTION • Do not apply a voltage or reverse voltage exceeding 40 V between terminal 1 and terminals 2, 3, and 4 of the J2 terminal board. Otherwise, the unit may suffer damage.

NOTE • Rated maximum value of each signal terminal

Maximum applied voltage (for terminal 1): 40 V, Max current: 1 mA

4.4.2 External monitor for output voltage and output current

The J2 terminal board generates monitor outputs for the output voltage and current.

Table4-20 Monitor output for output voltage and current

Switch No.	Setting	Description
5	ANLG COM	Common line for remote-control inputs. Common line for the output monitor.
7	V MON	Monitor output for output voltage. 0 V to about 10 V at 0 to rated output voltage.
8	I MON	Monitor output for output current. 0 V to about 10 V at 0 to rated output current.

⚠ WARNING

- Never attach cables to the J2 terminal board with the POWER switch ON. Doing so may result in electric shock or damage to internal circuits.
- Insulate the cable connected to the monitor terminal with at least the isolation voltage of the unit. For more information, see "2.6 Grounding the output terminal"
- The potential of terminal 5 to terminal 12 of J2 terminal board is nearly the same as that of the - (neg.) output terminals of the unit. If part of the wire extending off a terminal board makes contact with the chassis, electric shock or internal circuit breakage may be caused. Insert wires into the terminals in such a way that bare parts are not exposed.

⚠ CAUTION

- To prevent malfunctions, do not short-circuit the V MON terminal or the I MON terminal with the ANLG COM terminal.

NOTE

- Rate monitor output value

  Output impedance: 1 kΩ or less, Maximum output current: about 10 mA.
- The signal output on each monitor is intended to monitor the DC voltage (average value). It is incapable of precisely monitoring the actual output voltage and AC current elements (such as ripples and transient response waveforms).
- While the POWER switch is turned ON or OFF, a transient voltage of a few volts may momentarily occur.

5

Chapter 5 Names and Functions of Controls

Provides an outline of the switches and terminals on the panels, including their names and functions.

Read this chapter to learn the meanings of the alert marks ⚠ indicated on the panels of the unit.

5.1 Front panel

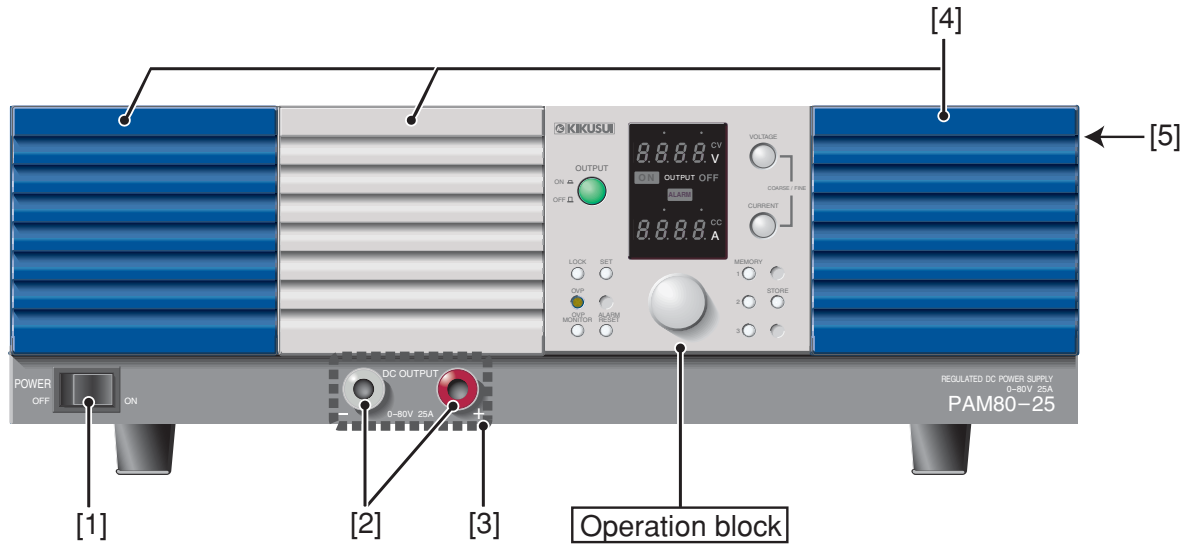


Fig.5-1 Front panel of PAM series 2kW model (PAM80-25)

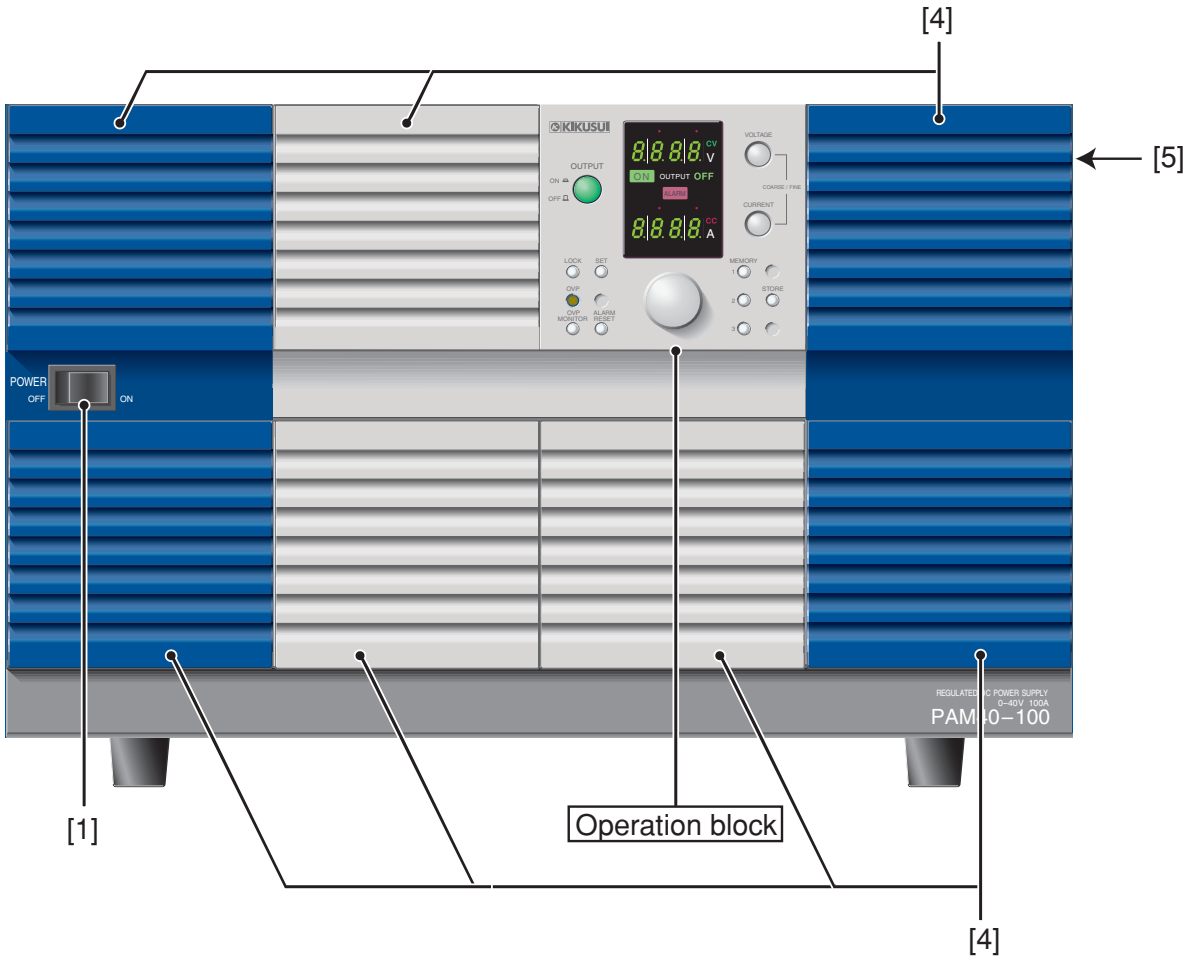


Fig. 5-2 Front panel of PAM series 4kW model (PAM40-100)

[1] POWER

The power switch for the unit. The power is ON when the switch is on the ON side, and OFF when the switch is on the OFF side.

[2] DC OUTPUT (Auxiliary output terminal)

This terminal permits you to obtain outputs from the unit in a simple and quick. Note that this terminal may not meet the unit's specifications.

⚠WARNING • To avoid electric shock, turn the POWER switch OFF before touching this terminal.

NOTE • Models that the rated output current is 50 A or more have no [2] DC OUTPUT (Auxiliary output terminal).

[3] Auxiliary output terminal cover

This terminal cover is used to ensure safety. Before using the unit, install this cover. (Fig. 5-1 shows the unit without the cover.)

NOTE • No cover is provided for models without auxiliary output terminals.

[4] Louver

The louver is an air inlet used to exhaust internal heat with a fan. A dust filter is installed in the louver. Clean the dust filter periodically. For more information, see "6.1.2 Cleaning the dust filter"

[5] Screw hole

The screw holes on the left and right sides (two holes in the 2 kW model, and four holes in the 4 kW model) are used for installation of optional rack mount brackets for incorporating the unit into a rack.

The following optional rack mount brackets are available.

For PAM series 2kW model

KRB3-TOS (84100) EIA standard (inch type)

KRB150-TOS (84110) JIS standard (metric type)

For PAM series 4kW model

KRB6-PAM (84210) EIA standard (inch type)

KRB300-PAM (84200) JIS standard (metric type)

For details, contact Kikusui distributor/agent.

Operation block

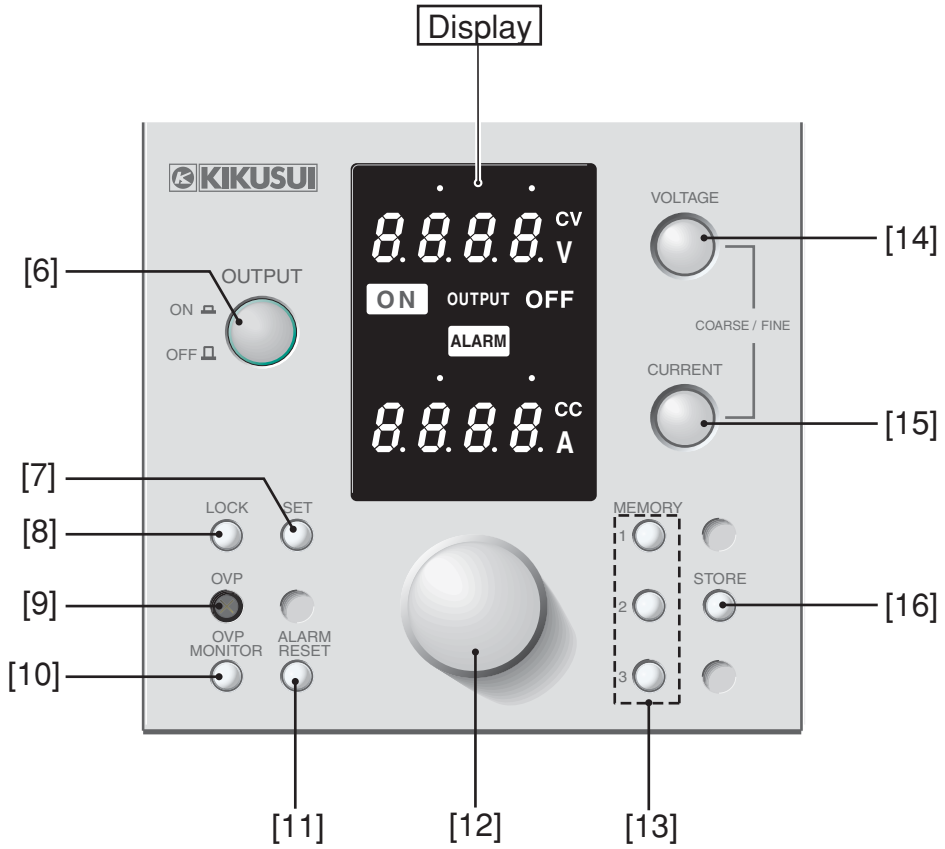


Fig. 5-3 Operation block

[6] OUTPUT

This switch is used to turn outputs ON/OFF. The switch is ON when it is down, and OFF when up. When the line is live, the status is indicated by [20] OUTPUT ON/OFF.

[7] SET

This switch is used to set and check the output voltage and current. To display the preset output value, turn this switch so that it lights.

[8] LOCK

This switch is used to limit operations on the front panel.

[9] OVP

This variable resistor can be used to make settings for the overvoltage protective circuit. To make settings, keep pressing the [10] OVP MONITOR.

[10] OVP MONITOR

This switch is used to make settings for the overvoltage protective circuit with the [9] OVP.

[11] ALARM RESET

This switch is used to reset output OFF after the protective circuit is activated.

[12] Dial

Turn this dial in either direction to set the voltage and current.

[13] MEMORY 1/2/3

These switches are used to set the unit to the voltage and current values stored in memory. When you select and press one to turn it on, the unit is set to a specific set of orders in the memory.

To write values to memory, specify a memory number. See [16] STORE

[14] VOLTAGE

This switch is used in voltage settings to alter the amplitude of change for a single click of the dial. Each time the switch is pressed, the setting resolutions (COARSE/ FINE) alternate.

[15] CURRENT

This switch is used in current settings to alter the amplitude of change for a single click of the dial. Each time the switch is pressed, the setting resolutions (COARSE/ FINE) alternate.

[16] STORE

This switch is used to store preset values for output voltage and current in memory. To store the values in the desired memory unit, press this switch, then press one of the [13] MEMORY 1/2/3.

Display

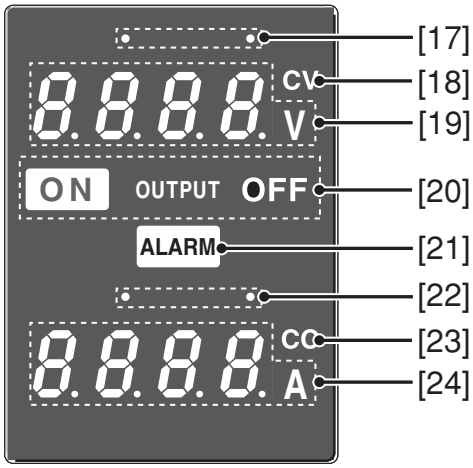


Fig. 5-4 Display

[17] VOLTAGE resolution indicator

For COARSE, the left LED lights to allow voltage settings at the resolution shown by the digit. For FINE, the right LED lights to allow voltage settings at the resolution shown by the digit.

[18] CV

This indicator lights during constant-voltage operations.

[19] Voltmeter

When the SET switch lights, the preset output voltage value is displayed. When the SET does not light, the output voltage values are shown.

[20] OUTPUT ON/OFF

When the output is on, the “ON” indication is lit. Conversely, when output is off, “OFF” lights.

[21] ALARM

This indicator lights when the protective circuit is activated.

[22] CURRENT resolution indicator

For COARSE, the left LED lights to allow current settings at the resolution indicated by the digit. For FINE, the right LED lights to allow current settings at the resolution indicated by the digit.

[23] CC

This indicator lights during constant current operations.

[24] Ampere meter

When the SET switch lights, the preset output current value is displayed. When the SET does not light, the output current values are shown.

5.2 Rear panel

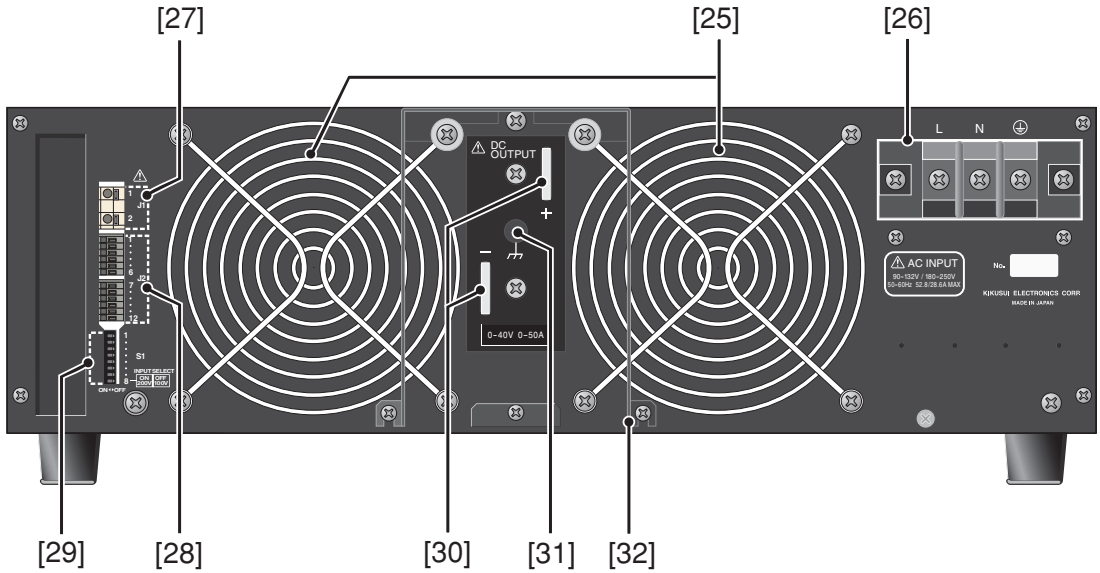


Fig. 5-5 Rear panel of PAM series 2kW model (PAM40-50)

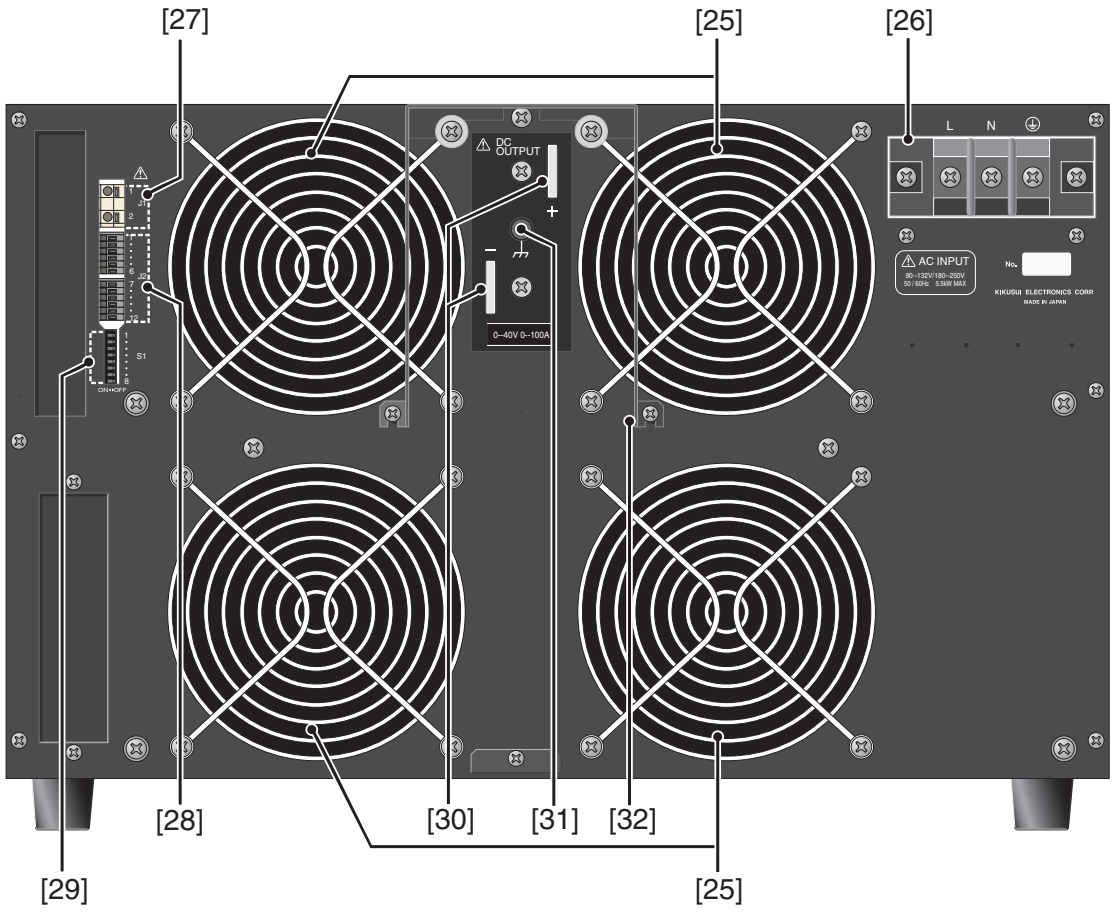


Fig. 5-6 Rear panel of PAM series 4kW model (PAM40-100)

[25] Exhaust ports

This port uses a fan to exhaust heated air from inside. Keep sufficient space around the unit for good ventilation.

[26] AC INPUT ⚠

AC input terminals. Connect the supplied AC power cord.

⚠WARNING
- Incorrect handling may cause electric shock. For details, see "1.5 Connecting the AC power cord".
- Make sure that the ground terminal is securely grounded. For details, see section "1.6 Grounding".

---

[27] J1 ⚠

This terminal board is used for the remote sensing function.

⚠WARNING
- Incorrect handling may cause electric shock. For details, see "4.1.1 J1 and J2 terminal boards".

---

[28] J2 ⚠

This terminal board is used for the analog remote control or monitor.

⚠WARNING
- Incorrect handling may cause electric shock. For details, see "4.1.1 J1 and J2 terminal boards".

---

[29] S1 ⚠

Turn this switch on when using the function. See "4.1.2 S1 switches".

[30] DC OUTPUT ⚠

This is the output terminal board.

⚠WARNING
- To avoid electric shock, always turn off the POWER switch whenever it is necessary to touch the terminals.

---

[31] ⏚

chassis terminal. See "2.6 Grounding the output terminal".

[32] Output terminal cover

This is the terminal cover for safety. Install the cover on the terminal when the unit is in use.

Chapter 6 Maintenance

This chapter describes unit maintenance and calibration, as well as the proper procedures for handling unit malfunctions.

⚠WARNING • The unit contains components that present risk of serious injury. Do not remove the outer cover.

6.1 Cleaning

⚠WARNING • For maintenance work, always turn off the POWER switch, and turn off the switch on the switchboard.

6.1.1 Cleaning the panel

When the panel gets soiled, wet a piece of soft cloth with a water-diluted neutral detergent, and wipe the panel softly

⚠CAUTION • Do not use volatile solvents such as thinner and benzine. They may discolor the unit surface coating, erase printed characters, or make face of indicator opaque.

6.1.2 Cleaning the dust filter

A dust filter is provided inside the louver in the front panel. Clean the filter on a regular basis to keep it from clogging.

⚠CAUTION • Filter clogging can weaken cooling effects inside the unit, cause malfunctions, and shorten the life of the unit.

1. Hook a finger on the 2nd lowest layer of the louver. Holding down the bottom layer, draw it toward you to remove the louver from the panel.

   If you have difficulty removing the louver, hold down the top layer while drawing the louver toward you.

   When handling a model equipped with an auxiliary output terminal, remove the auxiliary output terminal cover beforehand. Failure to do so will prevent removal of the louver on the terminal.

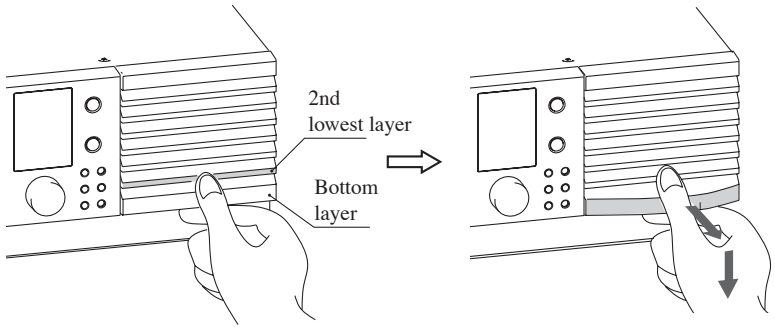


Fig.6-1 Removing the louver

2. Remove the dust filter from inside the louver and clean it.

   Use a vacuum cleaner to remove dirt and dust from the dust filter. Wash off heavy stains with a water-diluted neutral detergent and thoroughly dry the dust filter.

⚠CAUTION • During operations, air flows into the unit through the dust filter to be cooled. If it remains in the dust filter, this water can raise internal temperatures and humidity, leading to malfunctions.

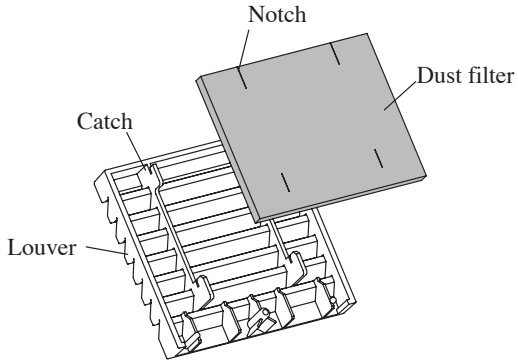


Fig. 6-2 Dust filter

3. Install the dust filter in the louver.

   Install so that the louver catch fits into the notch of the dust filter notch.

4. Holding the 2nd lowest layer of the louver, raise the louver until the pin is locked to set the louver on the panel.

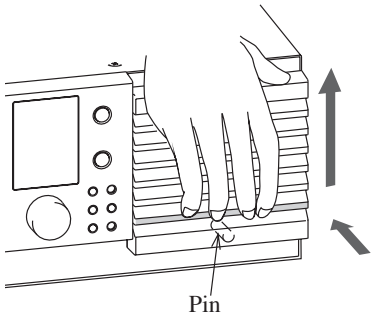


Fig. 6-3 Installing the louver

6.2 Inspection

AC power cord

Check that there is no damage on the insulation coating, and that the plug is firmly attached and free from cracks.

⚠WARNING
- For maintenance work, always turn off the POWER switch and the switch on the switchboard.
- Breaks in the insulation coating may cause electric shock. If a break is found, immediately stop using the unit.

To purchase accessories, contact Kikusui distributor/agent.

6.3 Calibration

Before shipment, the PAM series is thoroughly calibrated. After a extended periods of use, however, the power supply will require regular calibration.

To have calibration performed, you may contact Kikusui distributor/agent.

6.4 Malfunctions and Causes

This section describes some symptoms of possible malfunctions encountered during use of the unit, along with appropriate remedies.

Here, we provide seven typical symptoms and possible check items for each; you simply find the relevant item. Ideally, you will be able to cure these symptoms without difficulty.

When you find a relevant item, follow the corresponding remedy. If this does not solve or improve the problem, or if no relevant item can be located, please contact Kikusui distributor/agent.

Symptom1: The control panel displays nothing.

Check item	Cause and remedy
☐ Check that the wires to the AC IN terminals are connected correctly.	• Wiring to the L, N, and GND terminals is wrong. Connect the wires to these terminals correctly by referring to Section "1.5 Connecting the AC power cord"
☐ Check that the AC power cord contains no broken wires.	• Replace the power code with a new AC power cord.
☐ A voltage outside the input voltage range is input.	• In the PAM series 2kW model, a voltage of 100V is input with the input voltage range set to 200V. To correct the settings, see "1.4 Input power"

Symptom2: When you turn on the POWER switch, it is turned off or the "ALARM" LED lights up.

Check item	Cause and remedy
☐ A voltage outside the input voltage range is input.	• In the PAM series 2kW model, a voltage of 100V is input with the input voltage range set to 200V. To correct the settings, see "1.4 Input power"

Symptom3: When you turn on the POWER switch, the ALARM LED lights up.

Check item	Cause and remedy
☐ Check that the OVP trip point is not preset to a level below output voltage.	• The overvoltage protection circuit has been activated. Preset the OVP trip point to a level above the output voltage. See "3.2.2 OVP (OverVoltage Protection) trip point presetting"
☐ Check that the actual output voltage is not higher than voltage displayed on the panel.	• The overvoltage protection circuit has been activated. An external voltage is applied by a load such as a battery, or the unit is malfunctioning.
☐ Check that the SENS switch is on.	• The overvoltage protection circuit has been activated.The SENS switch should be off when the remote sensing function is not used. No.7 of S1 switch is set to OFF.
☐ Check that special load is connected.	• The overvoltage protection circuit has been activated. See the "2.3 Load"
☐ Check that control wires are not secure in analog remote control.	• The overvoltage protection circuit or internal protection circuit has been activated. See "4.3 Analog remote control"
☐ In analog remote control, there is an external overvoltage.	• The overvoltage protection circuit or internal protection circuit has been activated. See "4.3 Analog remote control"
☐ The internal temperature is rising to abnormal levels.	• The overheat protection circuit has been activated. Among the possibilities: the ambient temperature exceeds the operating ambient temperature; clogging of the inlet and outlet; clogging of the dust filter; and fan malfunction. If an ALARM LED lights, when the operating environment is normal, immediately stop using the unit and request repairs.
☐ An excessively long load cable is used in remote sensing.	• The sensing abnormality protective circuit has been activated. The polarity of the remote sensing cable is reversed, or both ends of the cable have been short-circuited. Also, the load cable is too thin or too long. Contain the voltage drop in the load cable within the compensation voltage range (1V or lower in single line). See "3.3.1 load cables" and "4.2 Remote sensing"

Malfunctions and Causes (Cont'd)

Symptom4: No output is generated even when the OUTPUT switch is turned on.

Check item	Cause and remedy
☐ Check to see if both the CV LED and CC LED are off.	• The voltage and current are set to 0 V and 0 A, respectively. Both LEDs may not light up, depending on the offset setting conditions. This is not a form of equipment failure. Set the required output using the VOLTAGE and CURRENT knobs.
☐ Check that the VOLTAGE or CURRENT knob has not been turned fully counterclockwise.	• Set the required output using the VOLTAGE or CURRENT knob.
☐ Check to see if the "OUTPUT ON" LED is off.	• In output ON/OFF control with an external contact, No.6 of S1 switch is set to OFF (Close OFF mode). See "4.3.2 Output ON/OFF control with an external contact"
☐ Check that the switches No.6 of S1 on the rear panel have not been set to on (left position).	• For control from the front panel, No.6 of S1 switch should be set to off. See "4.3.2 Output ON/OFF control with an external contact"

Symptom5: Output is unstable.

Check item	Cause and remedy
☐ Check to see if the operation mode changes from CV to CC or CC to CV.	• Set the regulated value (voltage or current) to a value larger then the current set value. If the settings are already at their maximum values, use a more powerful power supply to increase output voltage or current. See "2.4 Constant-voltage and constant-current power supplies"
☐ Check that No.7 of S1 switch is on.	• No.7 of S1 switch should be off when the remote sensing function is not used.
☐ Check to see if it has not been more than 30 minutes since a power-on.	• The output is unstable due to initial drift. Carry out a warm-up (power application) for at least 30 minutes.
☐ Check to see if both the CV and CC LEDs are lit.	• If remote sensing is carried out, causing oscillation, add a capacitor to the load end. • The internal circuit may be broken. Stop using the unit immediately and contact us for repair service.
☐ Check to see if current flows even though no load is connected.	• The internal circuit may be broken. Stop using the unit immediately and contact us for repair service.
☐ Check to see if output is generated even though the OUTPUT switch is turned off.	• The internal circuit may be broken. Stop using the unit immediately and contact us for repair service.

Symptom6: Large output ripple.

Check item	Cause and remedy
☐ Check that the input voltage is not below the correct range.	• Supply a voltage within the input voltage range.
☐ Check that there is intense magnetic or electric field generating source nearby.	• Being subjected to electromagnetic induction. Take measures such as locating the unit away from such generating sources and using twisted cables.
☐ Check that external voltage is noisy in controlling output with analog remote control.	• Take measures against noise by referring to See"4.3 Analog remote control"
☐ Check that No.7 of S1 switch is on.	• No.7 of S1 switch should be off when the remote sensing function is not used.
☐ The auxiliary output terminal on the front is used.	• Use the terminal on the rear.

Symptom7: Display value does not indicate output value.

Check item	Cause and remedy
☐ Check that No.7 of S1 switch is on.	• No.7 of S1 switch should be off when the remote sensing function is not used.
☐ Check that sensing wires or load cables are broken wires or have poor contact when the remote sensing function is used.	• Check that all cables and wires are connected correctly after turning off the POWER switch.
☐ Check that the load current has peaks or is pulse-shaped.	• See '"2.3 Load".

Chapter 7 Specifications

This chapter provides the electrical and mechanical specifications for the PAM series, as well as a list of accessories.

PAM series 2kW model

Unless otherwise specified, the specifications of the unit are based on the following conditions.

- The load is a pure resistance.
- The remote sensing function is not used.
- The output terminal is not connected to the chassis terminal.
- The unit should be used after 30 minutes warming-up time.

Standard value do not guarantee performance. They should be referred to as target values only.

The auxiliary output terminal may not meet the specifications.

Item			PAM40-50	PAM80-25	PAM160-12	PAM320-6
Input						
	Voltage range （Nominal value）		90 V to 132 V AC (100 V) / 180 V to 250 V AC (200 V) selected by switch			
	Frequency, Phase		50 Hz or 60 Hz, single phase			
	Current (Input voltage 100 V / 200 V)		Approx. 48 A / 26 A			
	Power		Approx. 2.50 kW	Approx. 2.44 kW	Approx. 2.44 kW	Approx. 2.44 kW
Output						
	Voltage	Rated voltage	40 V	80 V	160 V	320 V
		Variable range	0 V to 40 V	0 V to 80V	0 V to 160 V	0 V to 320V
		Resolution	0.01 V	0.01 V	0.1 V	0.1 V
		Accuracy*1	± 0.06 V	± 0.1 V	± 0.36 V	± 0.52 V
	Current	Rated current	50 A	25 A	12 A	6 A
		Variable range	0 A to 50 A	0 A to 25 A	0 A to 12 A	0 A to 6 A
		Resolution	0.01 A	0.01 A	0.01 A	0.001 A
		Accuracy*2	± 0.27 A	± 0.15 A	± 0.08 A	± 0.032 A
Constant voltage characteristics *3						
	Source effect (to ± 10 % of nominal line voltage)		0.05 % (of rated output voltage) + 5 mV or less *4			
	Load effect (to 0 % to 100 % of output current)		0.1 % (of rated output voltage) + 10 mV or less *4			
	Ripple and noise	(p - p)*5	0.2 V or less	0.3 V or less	0.4 V or less	0.6V or less
		(5 Hz to 1 MHz)	0.03 Vrms or less	0.04 Vrms or less	0.08 Vrms or less	0.15 Vrms or less
	Transient response*6		2 ms (standard value)			
	Rise time (No load/full load)		100 / 100 ms or less			
	Fall time (No load/full load)		2000 / 100 ms or less		2000 / 200 ms or less	
	Temperature coefficient		100 ppm / ˚C (standard value)			
Constant current characteristics						
	Source effect (to ± 10 % of nominal line voltage)		0.1 % (of rated output current) + 10 mA or less			
	Load effect (to 1 V to 100 % of output voltage)		0.2 % (of rated output current) + 10 mA or less			
	Ripple and noise(5 Hz-1 MHz)*7		0.15 Arms or less	0.1 Arms or less	0.05 Arms or less	0.03 Arms or less
	Temperature coefficient		200 ppm/ ˚C (standard value)			
Protective circuit						
	OVP (Output overvoltage protection)		Setting range: 20 % to 110 % of the rated output voltage: Output OFF during operation.			
	OHP (Overheat protection)		Abnormal temperature of the internal heat sink: Output OFF during operation.			
	Other		Abnormal input voltage, abnormal sensing, abnormal internal unit operations, etc.: Output OFF during operation.			

Item		PAM40-50	PAM80-25	PAM160-12	PAM320-6
Signal input					
External voltage control (at input of 0 V to approx. 10 V) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
External resistor control 1 (at input of 0 Ω to approx. 10 kΩ) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
External resistor control 2 (at input of about 10 kΩ to 0 Ω) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
Output ON/OFF control		With the contact signal (short-circuit), ON or OFF (selected with the switch)			
Signal output					
Voltage monitor (0 V to rated output voltage)		0 V to approx.10 V			
Current monitor (0 A to rated output current)		0 V to approx. 10 V			
Status	CV operating	Open collector active Low *9			
	CC operating	Open collector active Low *9			
	Alarm (With the protective function working)	Open collector active Low *9			
Remote sensing		Compensating voltage drop: Maximum 1 V, single way. *10			
Meter display					
Voltmeter (at 23 ˚C ± 5 ˚C)		4 digit indicate, within ±(0.1 % of rdg + 2digits) *11			
Ammeter(at 23 ˚C ± 5 ˚C)		4 digit indicate, within ±(0.5 % of rdg + 2digits)*11			
Insulation resistance (70 % RH or less of humidity)	Across input and shassis	500 V DC, 30 MΩ or more			
	Across output and shassis	500 V DC, 20 MΩ or more			
Withstanding voltage	Across input and output	1500 V AC, 1 min.			
	Across input and shassis	1500 V AC, 1 min.			
Isolation voltage		± 250V		± 500V	
Range of operation temperature and humidity		0 ˚C to 50 ˚C, 20 % to 80 % RH (no dew condensation allowed)			
Range of storage temperature and humidity		-10 ˚C to 60 ˚C, 10 % to 90 % RH (no dew condensation allowed)			
Safety		Supposed use in IEC61010-1 A2: 1995 Overvoltage Category II.			
Cooling system		Forced air cooling with fan			
Dimensions		See outline drawing.			
Weight		Approx. 18 kg			
Accessory	Operation manual	1 copy			
	Power cord	3 pcs.(Clamp terminal on one side 14mm^2, 3m)			
	Chassis connecting cable	1 pc. (Clamp terminal on both sides AWG16, 100 mm) (One fastening screw, M4)			
	Clamper	1 pair			

*1. Rated output voltage, no load,at 23˚C ± 5˚C.
*2. Rated output current, short-circuited, at 23˚C ± 5 ˚C.
*3. On the rear output terminal.
*4. At the sensing point.
*5. Measured with an oscilloscope with a frequency of 10 Hz to 20 MHz.
*6. Time taken by the output voltage to return to 0.1% ± 10 mV of the preset value when the output current is changed between 20 % and 100 % at an output voltage range of 50 % to 100 %.
*7. Models that output voltage is 80 V or less: within a range from 1 V to 100 %
Models that output voltage is 160 V or more: within a range from 3 % to 100 %
*8. One mode is selected with the switch from among the external voltage control, external resistor control 1, and external resistor control 2 (mode selection is possible separately for CV and CC). CV and CC can be controlled separately by supplying an external signal.
*9. Maximum applied voltage: 40 V, Maximum current: 1 mA.
*10. The output voltage can be compensated for up to the rated output voltage of + 0.6 V (on the rear output terminal).
*11. Only positive values are displayed.

PAM series 4kW model

Unless otherwise specified, the specifications of the unit are based on the following conditions.

- The load is a pure resistance.
- The remote sensing function is not used.
- The output terminal is not connected to the chassis terminal.
- The unit should be used after 30 minutes warming-up time.

Standard value do not guarantee performance. They should be referred to as target values only.

The auxiliary output terminal may not meet the specifications.

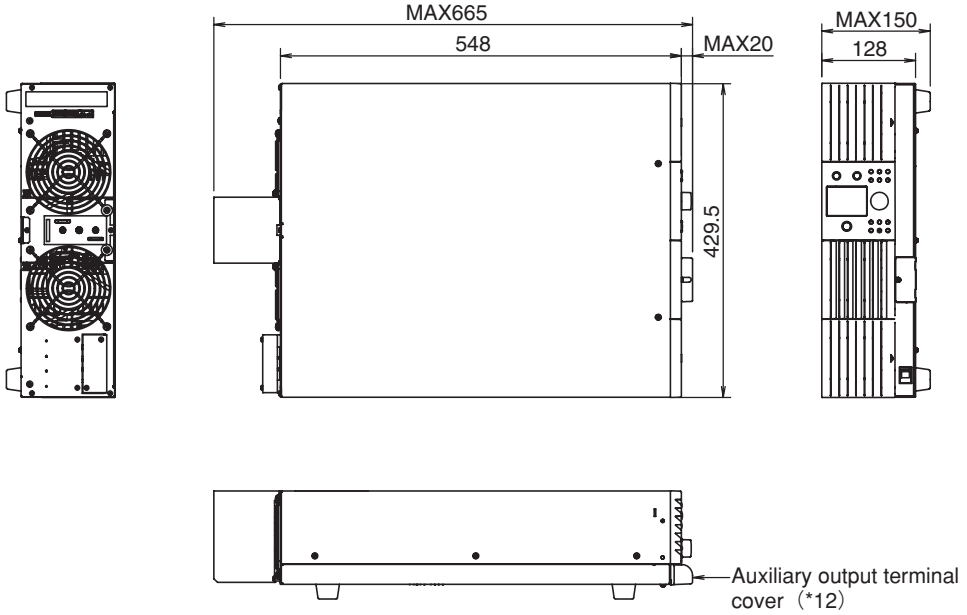
Item		PAM40-100	PAM80-50	PAM160-25	PAM320-12
Input					
Voltage range （Nominal value）		180 V to 250 V AC (200 V)			
Frequency, Phase		50 Hz or 60 Hz, single phase			
Current (Input voltage 200 V)		Approx. 48 A			
Power		Approx. 5.00 kW	Approx. 4.88 kW	Approx. 4.88 kW	Approx. 4.88 kW
Output					
Voltage	Rated voltage	40 V	80 V	160 V	320 V
	Variable range	0 V to 40 V	0 V to 80V	0 V to 160 V	0 V to 320V
	Resolution	0.01 V	0.01 V	0.1 V	0.1 V
	Accuracy*1	± 0.06 V	± 0.1 V	± 0.36 V	± 0.52 V
Current	Rated current	100 A	50 A	25 A	12 A
	Variable range	0 A to 100 A	0 A to 50 A	0 A to 25 A	0 A to 12 A
	Resolution	0.1 A	0.01 A	0.01 A	0.01 A
	Accuracy*2	± 0.7 A	± 0.27 A	± 0.15 A	± 0.08 A
Constant voltage characteristics *3					
Source effect (to ± 10 % of nominal line voltage)		0.05 % (of rated output voltage) + 5 mV or less *4			
Load effect (to 0 % to 100 % of output current)		0.1 % (of rated output voltage) + 10 mV or less *4			
Ripple and noise	(p - p)*5	0.3 V or less	0.45 V or less	0.6 V or less	0.9V or less
	(5 Hz to 1 MHz)	0.05 Vrms or less	0.06 Vrms or less	0.12 Vrms or less	0.22 Vrms or less
Transient response*6		2 ms (standard value)			
Rise time (No load/full load)		100 / 100 ms or less			
Fall time (No load/full load)		2000 / 100 ms or less		2000 / 200 ms or less	
Temperature coefficient		100 ppm / ˚C (standard value)			
Constant current characteristics					
Source effect (to ± 10 % of nominal line voltage)		0.1 % (of rated output current) + 20 mA or less			
Load effect (to 1 V to 100 % of output voltage)		0.2 % (of rated output current) + 20 mA or less			
Ripple and noise(5 Hz-1 MHz) *7		0.3 Arms or less	0.2 Arms or less	0.1 Arms or less	0.06 Arms or less
Temperature coefficient		200 ppm/ ˚C (standard value)			
Protective circuit					
OVP (Output overvoltage protection)		Setting range: 20 % to 110 % of the rated output voltage: Output OFF during operation.			
OHP (Overheat protection)		Abnormal temperature of the internal heat sink: Output OFF during operation.			
Other		Abnormal sensing, abnormal internal unit operations, etc.: Output OFF during operation.			

Item			PAM40-100	PAM80-50	PAM160-25	PAM320-12
Signal input						
	External voltage control (at input of 0 V to approx. 10 V) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
	External resistor control 1 (at input of 0 Ω to approx. 10 kΩ) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
	External resistor control 2 (at input of about 10 kΩ to 0 Ω) *8		CV: 0 V to rated output voltage, CC: 0 A to rated output current (CV and CC are controlled separately)			
	Output ON/OFF control		With the contact signal (short-circuit), ON or OFF (selected with the switch)			
Signal output						
	Voltage monitor (0 V to rated output voltage)		0 V to approx.10 V			
	Current monitor (0 A to rated output current)		0 V to approx. 10 V			
	Status	CV operating	Open collector active Low *9			
		CC operating	Open collector active Low *9			
		Alarm (With the protective function working)	Open collector active Low *9			
Remote sensing			Compensating voltage drop: Maximum 1 V, single way. *10			
Meter display						
	Voltmeter (at 23 ˚C ± 5 ˚C)		4 digit indicate, within ±(0.1 % of rdg + 2digits) *11			
	Ammeter(at 23 ˚C ± 5 ˚C)		4 digit indicate, within ±(0.5 % of rdg + 2digits) *11			
Insulation resistance (70 % RH or less of humidity)		Across input and shassis	500 V DC, 30 MΩ or more			
		Across output and shassis	500 V DC, 20 MΩ or more			
Withstanding voltage		Across input and output	1500 V AC, 1 min.			
		Across input and shassis	1500 V AC, 1 min.			
Isolation voltage			± 250V		± 500V	
Range of operation temperature and humidity			0 ˚C to 50 ˚C, 20 % to 80 % RH (no dew condensation allowed)			
Range of storage temperature and humidity			-10 ˚C to 60 ˚C, 10 % to 90 % RH (no dew condensation allowed)			
Safety			Supposed use in IEC61010-1 A2: 1995 Overvoltage Category II.			
Cooling system			Forced air cooling with fan			
Dimensions			See outline drawing.			
Weight			Approx. 30 kg			
Accessory		Operation manual	1 copy			
		Power cord	3 pcs.(Clamp terminal on one side 14mm^2, 3m)			
		Chassis connecting cable	1 pc. (Clamp terminal on both sides AWG16, 100 mm) (One fastening screw, M4)			
		Clamper	1 pair			
		Weight sticker	1 pc.			

*1. Rated output voltage, no load,at 23˚C ± 5˚C.
*2. Rated output current, short-circuited, at 23˚C ± 5 ˚C.
*3. On the rear output terminal.
*4. At the sensing point.
*5. Measured with an oscilloscope with a frequency of 10 Hz to 20 MHz.
*6. Time taken by the output voltage to return to 0.1% ± 10 mV of the preset value when the output current is changed between 20 % and 100 % at an output voltage range of 50 % to 100 %.
*7. Models that output voltage is 80 V or less: within a range from 1 V to 100 %
Models that output voltage is 160 V or more: within a range from 3 % to 100 %
*8. One mode is selected with the switch from among the external voltage control, external resistor control 1, and external resistor control 2 (mode selection is possible separately for CV and CC). CV and CC can be controlled separately by supplying an external signal.
*9. Maximum applied voltage: 40 V, Maximum current: 1 mA.
*10. The output voltage can be compensated for up to the rated output voltage of + 0.6 V (on the rear output terminal).
*11. Only positive values are displayed.

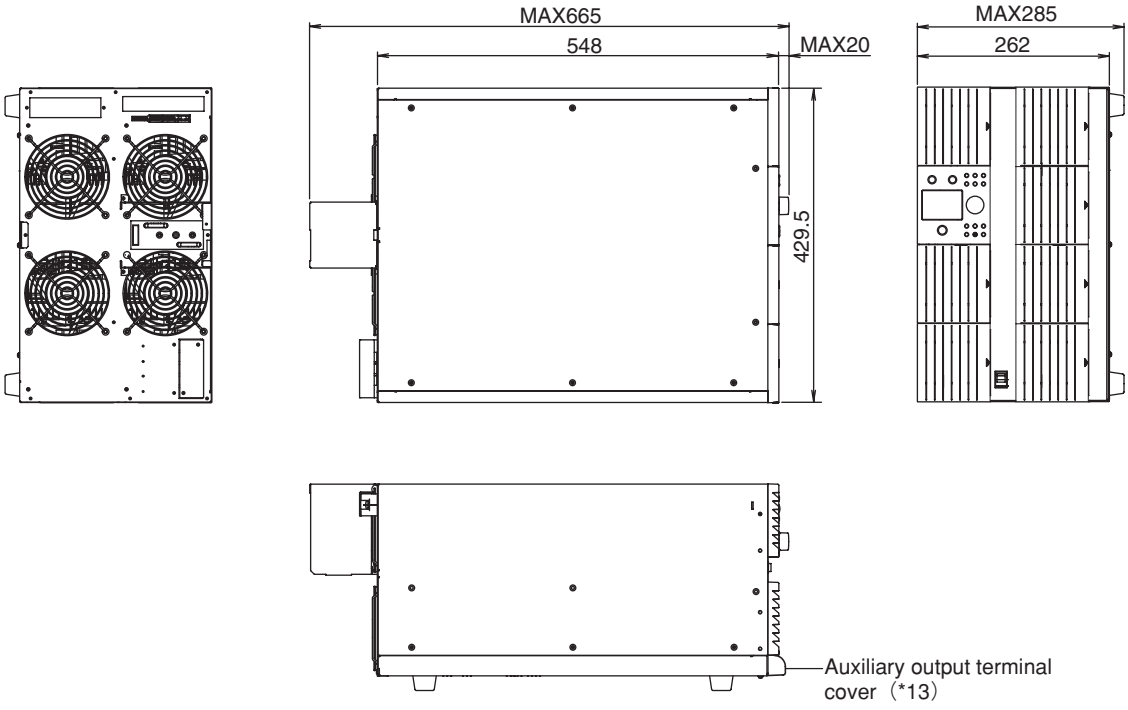
Dimensional drawings

PAM series 2kW model



*12 The PAM40-50 does not have auxiliary output terminal. Unit:mm

PAM series 4kW model



*13 The PAM40-100 and the PAM80-50 do not have auxiliary output terminal. Unit:mm

Appendix

About the ROM version

This section explains how to check the version of the ROM used in the unit. Before making inquiries concerning the unit, check the ROM version in accordance with the following procedure and record the results.

You do not need to check the version if you consider it is inappropriate to turn on the unit due to an internal fault.

Checking the version

1. While holding down the OVP MONITOR switch, turn the POWER switch ON.
2. As shown in Fig. A-1, the display shows four versions for a few seconds.

   The voltmeter indicates the version type and the ampere meter version number. For versions that include functions not provided in the unit, "- - - -" is displayed.
3. Following the display of the version numbers, the unit is ready for output settings.

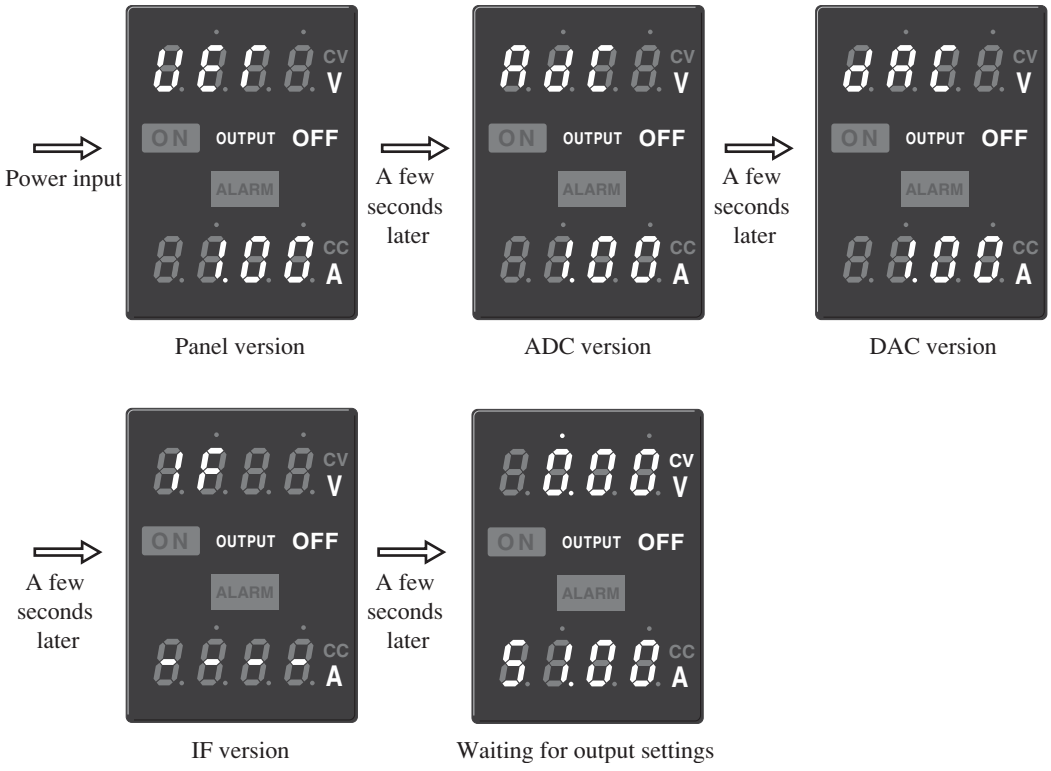


Fig.A-1 Versions on display

Index

R

S

T

V

PAM series Regulated DC power supply OPERATION MANUAL