

OPERATION MANUAL

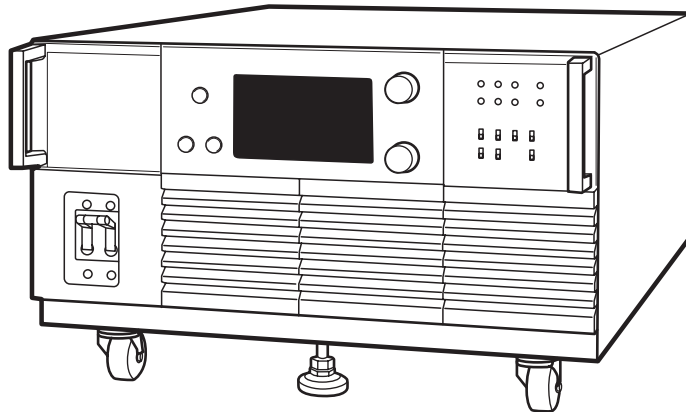
Regulated DC Power Supply
PAD-LA Series

TYPE III

PAD 16 -100LA	PAD 36 -60LA
PAD 60 -35LA	PAD 72 -30LA
PAD 110-20LA	PAD 250-8LA

TYPE IV

PAD 36-100LA	PAD 60 -60LA
PAD110-32LA	PAD250-15LA



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 it 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 cover.

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.

Reproduction and reprinting of this operation manual, whole or partially, without our permission is prohibited.

Both unit specifications and manual contents are subject to change without notice.

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Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.

(Revision should be applied to items indicated by a check mark)

Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

Input fuse

The rating of this product's input fuse is _____ A, _____ VAC, and _____.

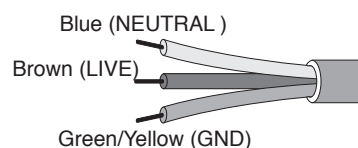
-
- ⚠ WARNING**
- To avoid electrical shock, always disconnect the AC power cord or turn off the switch on the switchboard before attempting to check or replace the fuse.
 - Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.
-

AC power cord

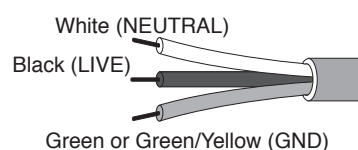
The product is provided with AC power cords described below. If the cord has no power plug, attach a power plug or crimp-style terminals to the cord in accordance with the wire colors specified in the drawing.

-
- ⚠ WARNING**
- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.
-

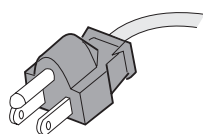
Without a power plug



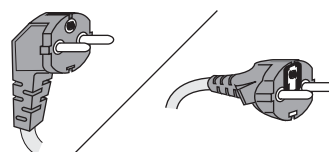
Without a power plug



Plugs for USA



Plugs for Europe



Provided by Kikusui distributor/agent

Kikusui distributor/agent can provide you with suitable AC power cord.
For further information, 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 1000 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.



Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.



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.



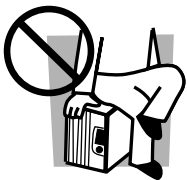
Safety Precautions

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.



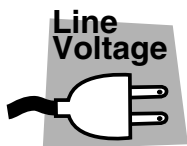
Users

- 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.



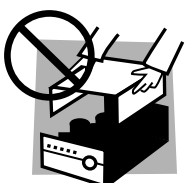
Input power

- Use the product with the specified input power voltage.
- For applying power, use the AC power cord provided. Note that the provided power cord is not use with some products that can switch among different input power voltages or use 100 V and 200 V without switching between them. In such a case, use an appropriate power cord.



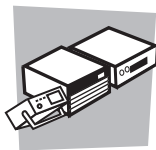
Fuse

- With products with a fuse holder on the exterior surface, the fuse can be replaced with a new one. When replacing a fuse, use the one which has appropriate shape, ratings, and specifications.



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



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. Also handle carefully when relocating tall products as they can fall over easily.
- Be sure the operation manual be included when the product is relocated.



Operation

- Check that the AC input voltage setting and the fuse rating are satisfied and that there is no abnormality on the surface of the AC power cord. Be sure to unplug the AC power cord or stop applying power before checking.
- If any abnormality or failure is detected in the products, stop using it immediately. Unplug the AC power cord or 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 unplug the AC power cord or 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 product and specifies its features.

Chapter 1 Setup

This chapter describes the necessary procedure from unpacking to preparation before use.

Chapter 2 Before Using the Power Supply

Before using the power supply, users are requested to thoroughly understand the following matters.

Chapter 3 Basic Operation


This chapter describes the basic operations that you can perform from the front panel.

Chapter 4 Application Operation

This chapter describes remote sensing, external output control, parallel operation, and series operation using the control terminal block on the rear panel.

Chapter 5 Names and Functions of Controls

This chapter describes the names and functions of switches, displays, terminals, and other parts of the front panel and rear panel.

Read this chapter to learn about the details of the  (alert) marks inscribed on the panel.

Chapter 6 Maintenance

This chapter describes maintenance and calibration of the power supply. It also describes troubleshooting measures when you suspect a malfunction in the power supply.

Chapter 7 Specifications

This chapter describes the electrical and mechanical specifications of the product.

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Preface

About This Manual

This manual covers the following products.

TYPE III

- PAD16-100LA
- PAD36-60LA
- PAD72-30LA
- PAD60-35LA
- PAD110-20LA
- PAD250-8LA

TYPE IV

- PAD36-100LA
- PAD60-60LA
- PAD110-32LA
- PAD250-15LA

Product Overview

The PAD-LA series is a regulated DC power supply with a constant voltage/current automatic crossover function utilizing a switching regulator system. The series regulator system equipped with phase-control preregulators achieves stable output with small amount of noise. The power supply can be used in a wide range of applications including use in the laboratory for experiment equipment, for tests on mass production lines, and for aging tests.

Features

Performance

- Improved power factor at rated output. The adoption of the choke input smoothing circuit enables operation using smaller input apparent power as compared to the capacitor input smoothing circuit.
- Standard transient response of 50 μ s. Enables the handling of drastic changes in the load.
- Rated voltage characteristics of 50 ppm/ $^{\circ}$ C (typ), a low temperature drift.

Functions

- Built-in overvoltage protection (OVP) circuit and overcurrent protection (OCP). The function can be set at 10 % to 110 % of the rated output. It protects a load from unexpectedly high voltage or current.
- Displays the output voltage and output current. Uses LED monitor with high visibility.
- Fine control of the output setting. Uses a wire wound variable resistor with 10 rotations for setting the voltage and the current.
- Remote control of the output voltage and output current. The output voltage or current is controlled using an external voltage or external resistance. In the remote control using an external voltage, the knob on the front panel can be used to vary the output.
- Equipped with a sensing function. Enables compensation for the voltage drop of the wire to which the load is connected.

- Covers can be attached to the output terminals for safety.
- Supports systemization such as automatic testing equipment. The PAD-LA power supply is used in conjunction with Kikusui's PIA4810 Power Supply Controllers.

NOTE

- Since the PAD-LA series power supplies use a phase control circuit for the preregulator, pulse-shaped noise is superimposed on the output signal. The noise level is suppressed to few hundred mV, but this may constitute a problem depending on the application. Please take this into consideration before using the power supply.

Rack mounting option of the type III model

The following rack mounting options are available.

Table P-1 Rack mounting option

	Inch rack EIA standard	Milli rack JIS standard	Notes
Bracket	KRB5-PAD	KRB250-PAD	
Blank panel	BP191	BP1H	1U, plate type
	BP191-M	BP1H-M	1U, mesh type

NOTE

- Since the PAD-LA type III model have intake ports for forced air cooling, blank panels must be installed when the power supplies are rack mounted. See Fig. P-2.

For details, contact your Kikusui agent or distributor.

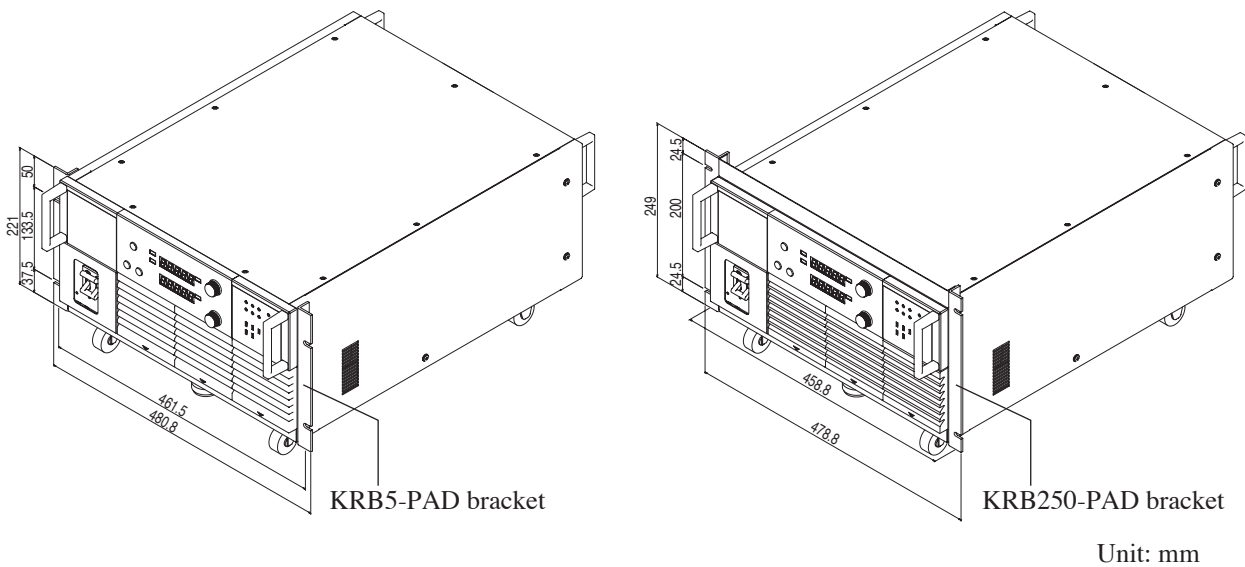
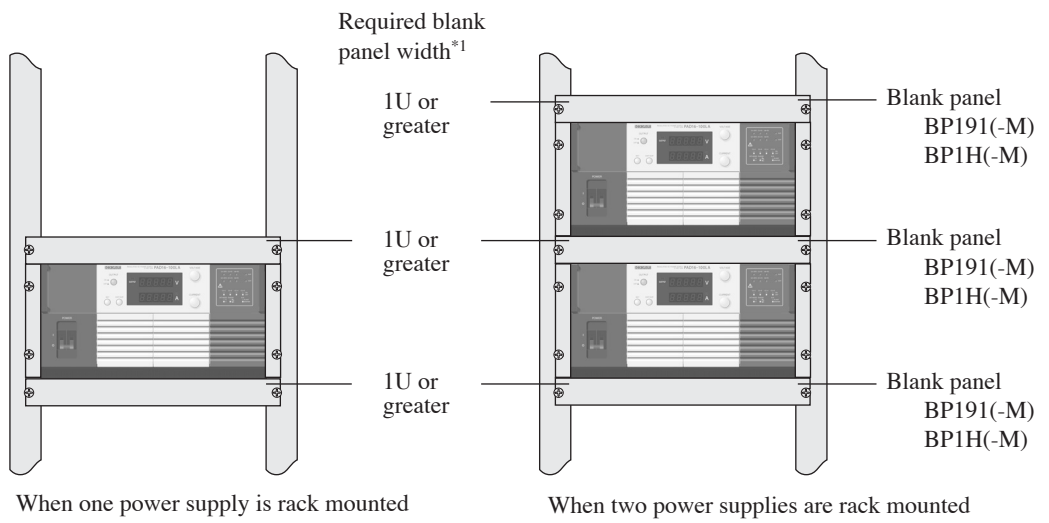


Fig.P-1 Bracket installation example of the type III model



*1: 1U; JIS standard: 50 mm, EIA standard: 44.45 mm

Fig. P-2 Blank panel installation example

Rack mounting option of the type IV model

The following rack mounting options are available.

Table P-2 Rack mounting option

	Inch rack EIA standard	Milli rack JIS standard	Notes
Bracket	KRB11-PAD	KRB500-PAD	

NOTE

- The PAD-LA type IV model, it is not necessary to install blank panels when the power supplies are rack mounted.

For details, contact your Kikusui agent or distributor.

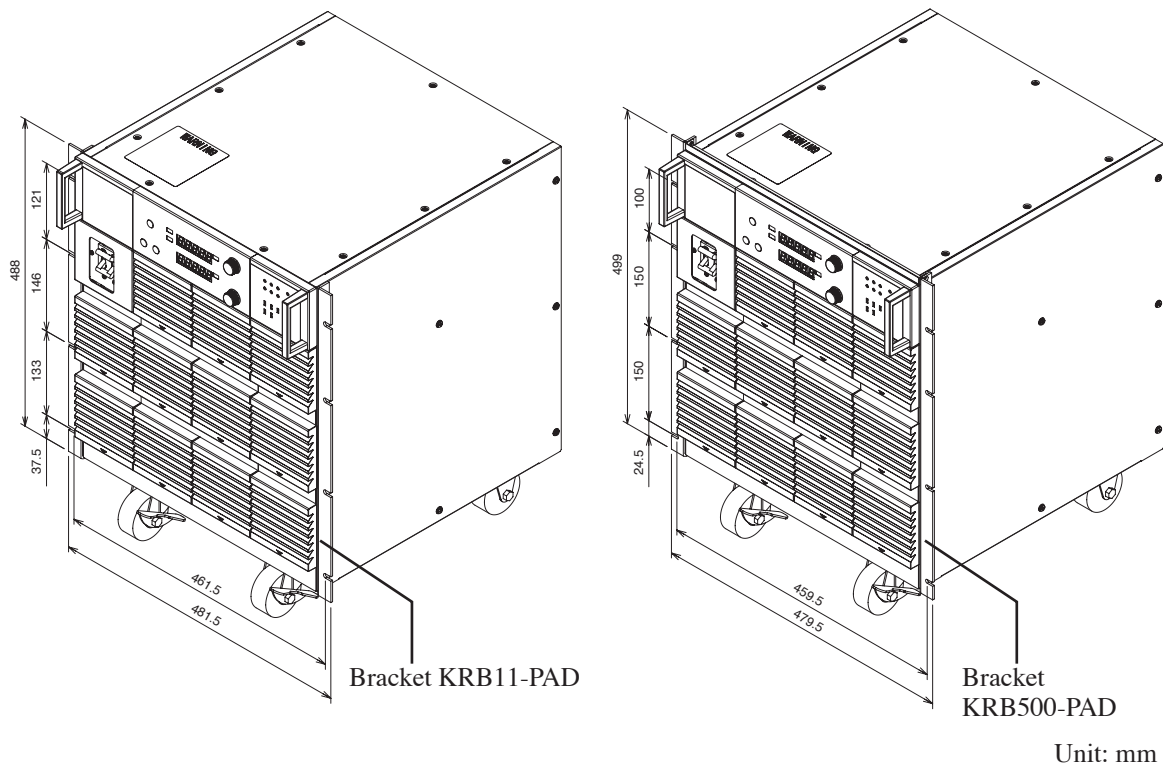


Fig.P-1 Bracket installation example of the type IV model

1



Chapter 1 Setup

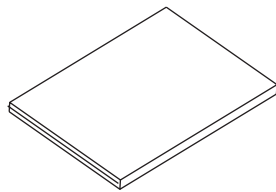
This chapter describes the necessary procedure from unpacking to preparation before use.

1.1 Checking the Package Contents

When you receive the product, check that all accessories are included and that the accessories have not been damaged during transportation.

If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

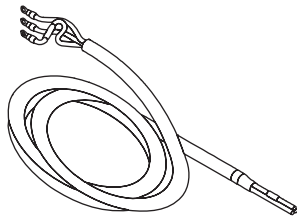
The Type III model includes the following accessories.



Operation manual (1 pc.)
[Z1-002-712]



Guard cap (2 pcs.)
GP01-PMC [83130]



Power cord (1 pc.)
[85-10-0730]

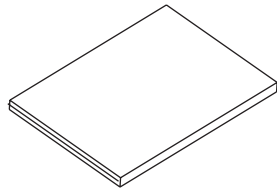
⚠ CAUTION Do not attach the sticker where the intake and exhaust ports of the power supply will be obstructed.



Weight sticker (1 pc.)
[A8-000-009]
(Attach the sticker in a location where it is easily visible as necessary.)

Fig.1-1 Accessories (Type III model)

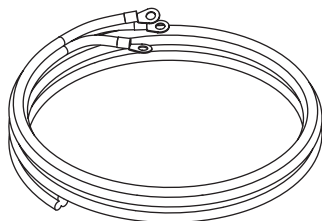
The Type IV model includes the following accessories.



Operation manual (1 pc.)
[Z1-002-712]



Guard cap (2 pcs.)
GP01-PMC [83130]

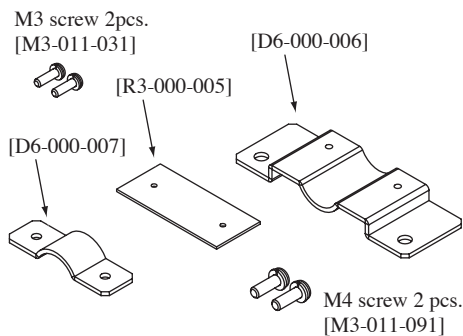


Power cord (1 set)
[91-87-6316]

CAUTION Do not attach the sticker where the intake and exhaust ports of the power supply will be obstructed.



Weight sticker (1 pc.)
[A8-000-017]
(Attach the sticker in a location where it is easily visible as necessary.)



Cable clamer (1 set)

Fig. 1-2 Accessories (Type IV model)

1.2 Precautions Concerning Installation Location

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

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

To prevent the possibility of 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 temperature or direct sunlight.**

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

Operating temperature range: 0 to 40 °C

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

■ **Avoid humid environments.**

Do not place the power supply in high-humidity locations--near a boiler, humidifier, or water supply.

Operating humidity range: 10 % to 90 % RH (no condensation)

Storage humidity range: 0 to 90 % RH (no condensation)

Condensation may occur even within the operating humidity range. In such case, do not use the power supply until the condensation dries up completely.

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

Do not install the power supply in a corrosive atmosphere or in environments containing sulfuric acid mist, etc. This may cause corrosion of various conductors and bad contacts of connectors inside the power supply leading to malfunction and failure, or in the worst case, a fire.

However, operation in such environments may be possible through alteration. If you wish to use the power supply in such environments, consult your Kikusui agent or distributor.

■ **Do not place the power supply in a dusty location.**

Accumulation of dust can lead to electric 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 panels other than the rear panel and exhausted from the ports on the rear panel. Secure adequate space around the power supply to prevent the possibility of fire caused by accumulation of heat.

■ **Do not place objects on the power supply.**

Placing objects on top of the power supply can cause failures (especially heavy objects).

■ **Do not place the product on an inclined surface or location subject to vibrations.**

The power supply may fall or tip over causing damages and injuries.

- **Do not use the power supply in a location subject to strong magnetic or electric fields.**

The power supply may malfunction and cause electric shock or fire.

- **Do not use the product near highly sensitive measuring instruments or transceivers.**

The noise generated by the power supply may affect them.

When fixing the power supply at the installation location

Casters are attached to the bottom of the power supply allowing you to move it with small force. To prevent moving the power supply inadvertently during use, fix the power supply in place using the stopper.

Using the Stopper of Type III model

1. Using a spanner turn nut 1 (M10) that is attached to the stopper axis and lower the nut position.
2. Using a spanner, turn nut 2 (M10) so that the bottom of the stopper is in contact with the installation surface.
3. Turn nut 1 to fix the stopper position.

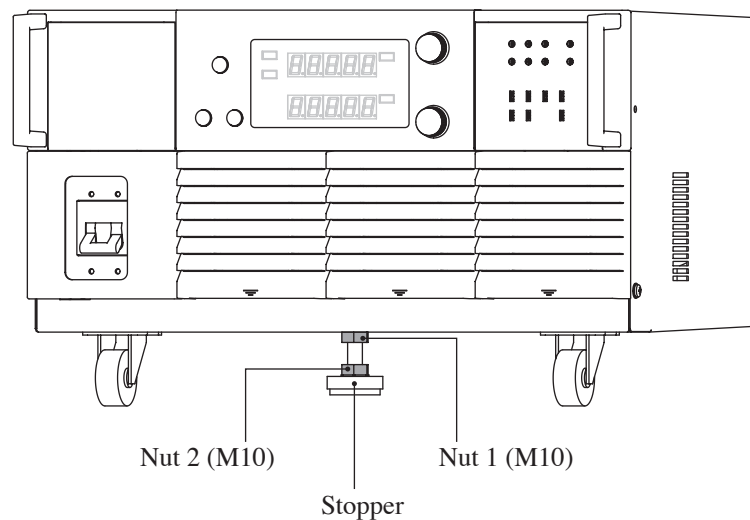


Fig. 1-3

Using the Stopper of Type IV model

1. Fixing stoppers are attached to the front caster on bottom.
Moving down strongly fixing stoppers toward the ON until stop.

NOTE

- These Stoppers are temporary. When fix certainly, power supplies are rack mounted
For details, see Page P-4 "Rack mounting option of the type IV model".
-

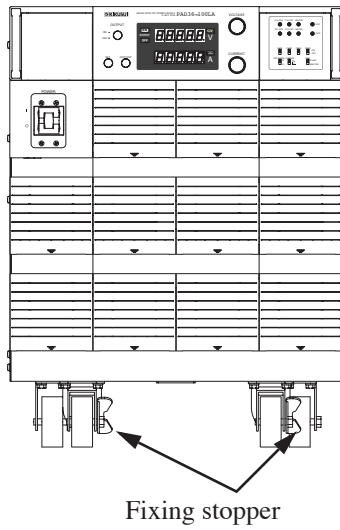


Fig. 1-4

1.3 Precautions When Moving the Power Supply

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

- **Turn off the POWER switch.**

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

- **Remove all wiring.**

Moving the power supply with the cables connected can cause wires to break or injuries due to the power supply falling over.

- **Release the stopper.**

If the power supply is fixed in place with the stopper, release the stopper. Otherwise, it may cause injuries due to the power supply falling over.

- **Have two or more people move the power supply.**

The power supply weighs over 60 kg. Have two or more people move the power supply. Use extra precaution at inclines and steps.

- **Check the Weight of the power supply beforehand.**

The weight is indicated on rear panel.

- **Be sure to check the safety.**

When using a forklift to move the power supply, place the fork underneath the power supply and confirm all safety conditions before lifting.

When lifting the power supply with a crane using lifting bands, always apply the bands at the equipment bottom and confirm all safety conditions before lifting.

- **Do not lay the power supply with its side up or place the power supply upside-down.**

- **Do not lift the power supply using the handles.**

The handles are used to grab the power supply when moving power supply on the casters. The handles are not strong enough to support the weight of the power supply. To lift the power supply, have two or more people hold the bottom of the front and rear panels.

1.4 Connecting the Power Cord

- ⚠ WARNING**
- Connection of the AC power cord to the switchboard must be carried out by qualified personnel.
 - To prevent electric shock, turn off the switch on the switchboard (to cut off the power feed from the switchboard) and then connect the AC power cord.
 - Install the AC power cord such that the distance between the power supply and the switch on the switchboard is within 3 m. This procedure facilitates operation of the switch on the switchboard in the event of emergency. If the distance to the switch on the switchboard is to be 3 m or more, install the AC power cord with a separate switch provided within 3 m from the power supply. For such a switch, use one with two poles that can be disconnected simultaneously.
- ⚠ CAUTION**
- Inside the power supply, protective circuits including input fuses are connected to match the polarity of input terminal. Make sure the insulation sleeve colors of the crimp terminals connected to the corresponding input terminals (L, N, and ⊕(GND)) are correct.
-

Connection procedure of Type III model

1. Connect the power cord provided to the AC INPUT terminal block as shown in Fig. 1-5.
To prevent the possibility of electric shock, be sure to attach the terminal cover.
2. Attach crimp terminals to the switchboard side of the power cord.
For termination, attach crimp terminals that conform to the terminal screws of the switchboard (the work must be performed by a qualified and licensed electrician).
3. Turn off the switchboard switch.
4. Connect the power cord to the switchboard.

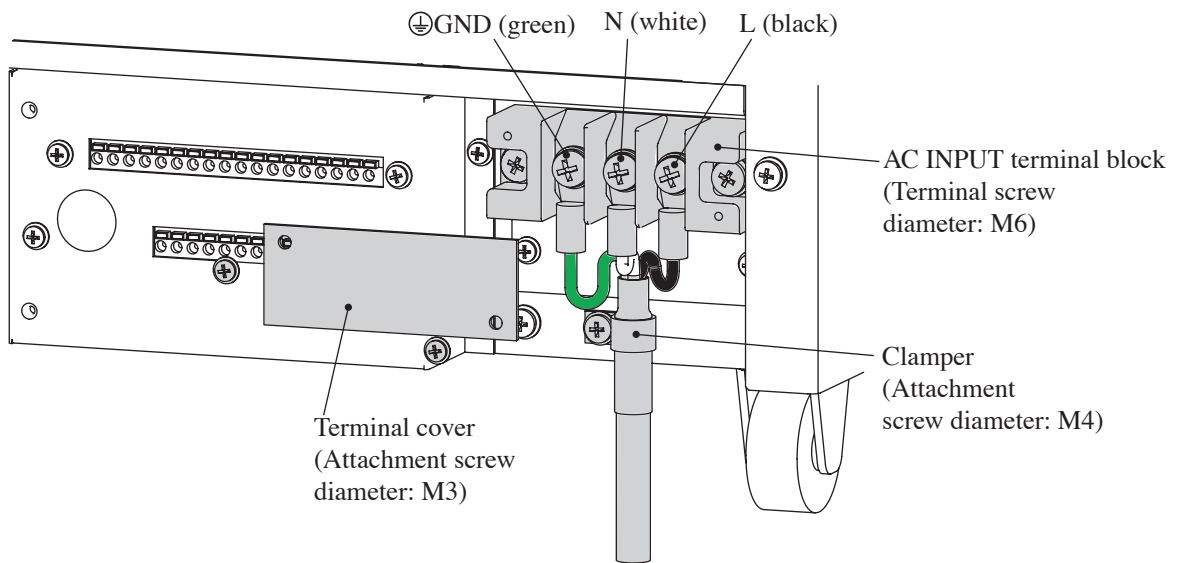


Fig. 1-5 AC INPUT terminal block connection of Type III model

Connection procedure of Type IV model

1. Connect the power cord provided to the AC INPUT terminal block and fix the cables securely by clamper as shown in Fig. 1-6.
To prevent the possibility of electric shock, be sure to attach the terminal cover.
2. Attach crimp terminals to the switchboard side of the power cord.
For termination, attach crimp terminals that conform to the terminal screws of the switchboard (the work must be performed by a qualified and licensed electrician).
3. Turn off the switchboard switch.
4. Connect the power cord to the switchboard.

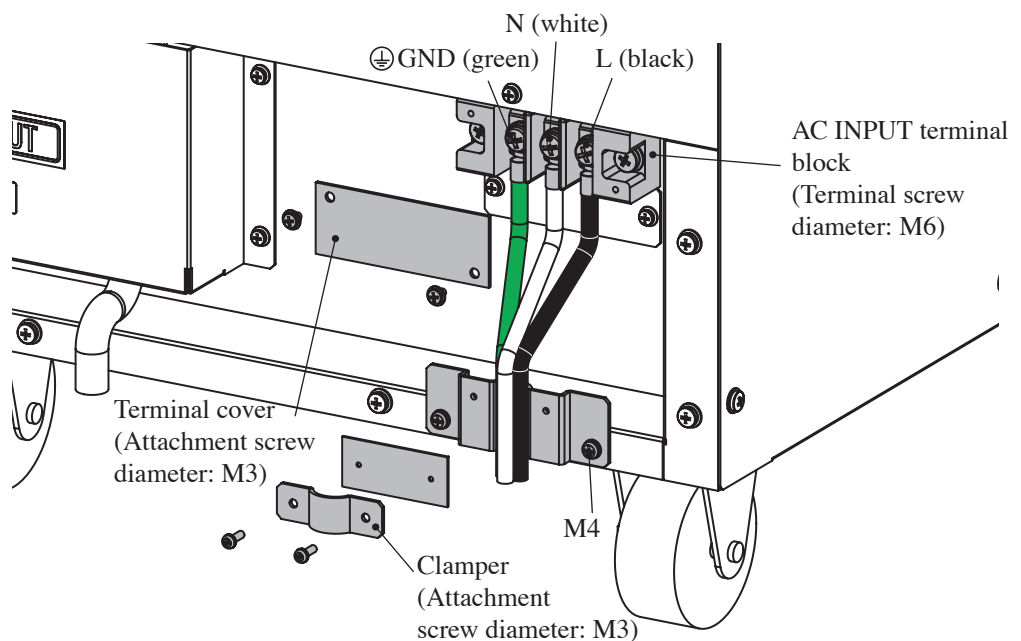


Fig. 1-6 AC INPUT terminal block connection of Type IV model

1.5 Grounding

- ⚠ WARNING** • Electric shock may occur, if proper grounding is not furnished.
Be sure to ground the power supply to prevent accidents resulting in death or injury.
 - Connect the ground terminal to an adequate earth ground.
 - ⚠ CAUTION** • If you do not ground the power supply, malfunction may occur due to external noise, or the noise generated by the power supply may become large.
-

Securely connect the GND wire of the power cord to the earth ground terminal of the switch board.

2

Chapter 2 Before Using the Power Supply

Before using the power supply, users are requested to thoroughly understand the following matters.

2.1 Inrush Current

An inrush current indicated below may flow when the POWER switch is turned on. If you are planning to use several power supplies in a system and turn on their POWER switches simultaneously, check that the AC power source or the switch-board is of sufficient capacity.

Allow at least 3 seconds between power cycles. Repeated on/off of the POWER switch at short intervals can shorten the service life of the input fuse and POWER switch due to the inrush current.

Table 2-1 Inrush current value

Maximum peak current	700 A
Half value width	2 ms to 5 ms

Moreover, a peak current flows several cycles when load is changed suddenly or OUTPUT is turned on.

Be sure to check that the switch board is of sufficient capacity.

2.2 Voltage of Negative Polarity

If the CURRENT knob is turned counterclockwise all the way, a negative voltage of approximately 0.6 V is generated at the output. This voltage causes approximately 10 mA of reverse current to flow through the load.

If this negative voltage constitutes a problem, set the power supply to constant voltage mode and adjust the output voltage offset. For the adjustment procedure, see "Adjusting the voltage system" in section 6.3.3, "Adjustment Procedure."

2.3 Load

Note that the output will become unstable if the following types of loads are connected.

1. When the load current has peaks or is pulse-shaped
2. When the load generates a reverse current to the power supply
3. When the load has accumulated energy such as batteries

2.3.1 When the Load Current Has Peaks or Is Pulse-shaped

Even when the power supply indicates a current less than the output current limit, the peak value may actually exceed the limit. This is due to the fact that the meter indicates mean values. In such case, the output voltage drops, because the power supply is instantaneously put into constant-current operation mode. If you watch the constant-current operation (CC) indicator carefully, you will notice that it illuminates lightly. For these types of loads, you must increase the output current limit or increase the current capacity.

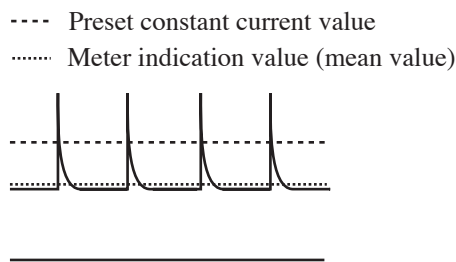


Fig.2-1 Load current with peaks

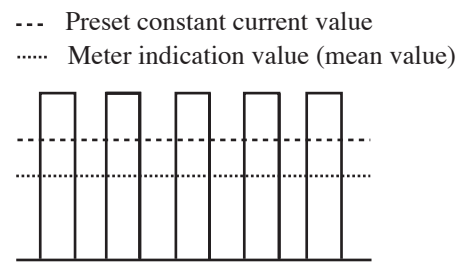


Fig. 2-2 Pulse-shaped load current

2.3.2 When the Load Generates a Reverse Current to the Power Supply

The power supply cannot absorb a reverse current from a regenerative load such as an inverter, converter, or transformer that supplies current to a power supply. Consequently, the output voltage will increase and the output will fluctuate.

For these types of loads, connect a resistor R_D as shown in Fig. 2-3 to bypass the reverse current. However, the amount of current to the load decreases by I_{rp} .

⚠ CAUTION • For resistor R_D , select an appropriate resistor rated for the power (allowing sufficient margin). If a resistor with insufficient rated power for the circuit is used, R_D may burn out.

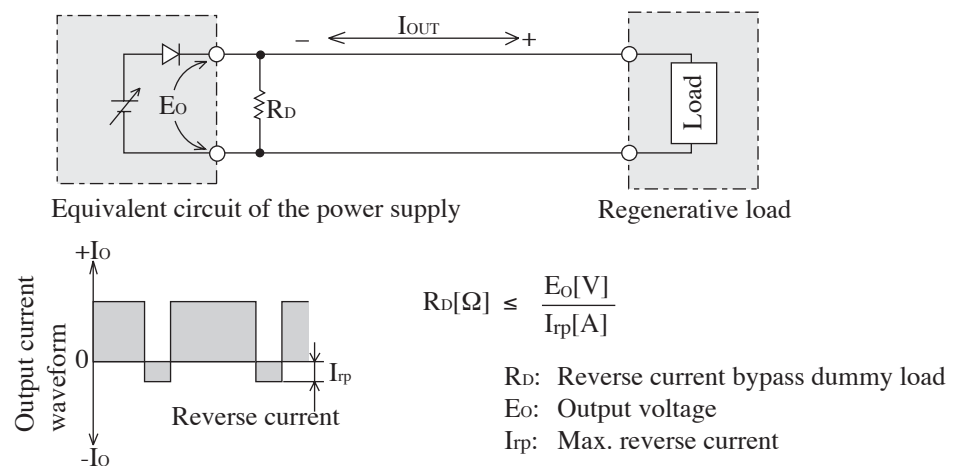


Fig. 2-3 Remedy for regenerative load

2.3.3 When the Load Has Accumulated Energy such as Batteries

Connecting a load with accumulated energy, such as a battery, to the power supply may cause large current to flow from the load into the capacitor inside the power supply through the protection diode of the internal output control circuit. This current may damage the power supply or reduce the life of the load.

For this type of loads, connect a reverse-current-prevention diode (DRP) between the power supply and the load in series as shown in Fig. 2-4.

-
- ⚠ CAUTION**
- Burnout may occur in the load or the power supply. Be sure to connect a reverse-current-prevention diode (DRP) between the power supply and the load in series.
 - To protect the load and the power supply, select DRP according to the following criteria.
 1. Reverse voltage withstand capacity of at least twice the rated output voltage of the power supply.
 2. Forward current capacity that is three to ten times the rated output current of the power supply.
 3. A diode with small loss.
 - Be sure to take into account the heat generated by DRP. DRP may burn out with inadequate heat dissipation.
 - When using DRP, remote sensing cannot be used.
-

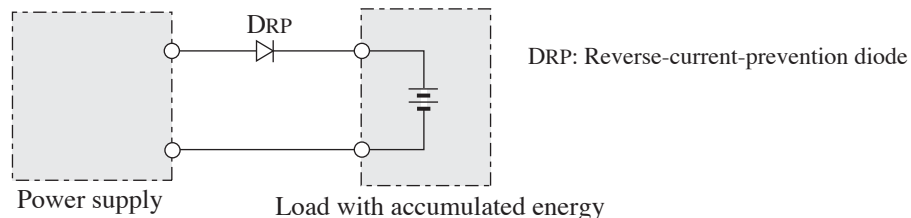


Fig. 2-4 Remedy against load with accumulated energy

2.4 CV Power Supply and CC Power Supply

The power supply is capable of both constant voltage and constant current operation. This section describes these operations.

An ideal constant voltage power supply has zero output impedance at all frequencies and maintains a constant voltage against all types of load current variations. An ideal constant current power supply has infinite output impedance at all frequencies and maintains constant current against load resistance variations.

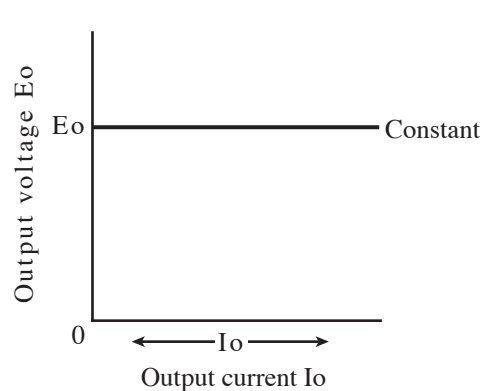


Fig. 2-5 Ideal constant voltage power supply

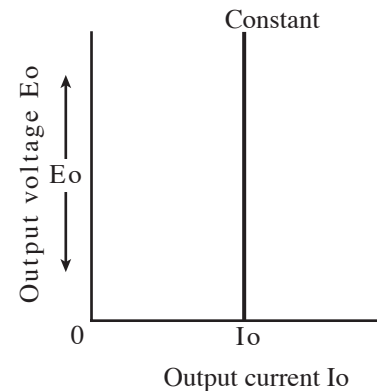


Fig. 2-6 Ideal constant current power supply

However, the output impedance of an actual constant voltage power supply is not zero, and that of a constant current power supply is finite. They also have a frequency response. In addition, since there are limitations in the maximum output voltage and current, power supplies are unable to maintain a constant voltage or current for all types of load current variations and load resistance variations.

Basic operations of the constant voltage (CV) and constant current (CC) modes

The following describes the relationship between the basic operations in constant voltage (CV) and constant current (CC) modes and the limit setting of the power supply. For simplicity, the following description assumes a power supply with a DC output of 100 V and 10 A (rated output voltage of 100 V and rated output current of 10 A) as a model.

■ Connecting a 10- Ω resistive load

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, the output voltage is raised gradually from 0 V. At this point, the power supply is operating in the constant voltage (CV) mode. The output current increases as the output voltage increases. When the output voltage reaches 50 V (that is, the output current has reached 5 A), the output voltage no longer increases even if you attempt to raise it. This is because the output current is limited to 5 A specified initially, causing the power supply to switch to the constant current (CC) operation mode. In this way, the

power supply automatically switches from the constant voltage to constant current operation to prevent an overcurrent from flowing. (The point at which the operation mode switches 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.

■ Connecting a 4-Ω resistive load

Let's consider the case in which a load resistance of 4 Ω is used. The output current limit is considered to be the rated output current (10 A). If you increase the output voltage from 0 V, the output current reaches the output current limit when the output voltage reaches 40 V; the power supply cannot output a voltage above 40 V. If you wish to increase the output voltage further, you must add another power supply in parallel or replace the power supply with 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 power supply enters constant current operation mode even when the current is set to the rated output current, the current capacity needs to be raised.

■ Connecting a 25-Ω resistive load

Let's consider the case in which a load resistance of 25 Ω is used. In this case, if the output current limit is set to 4 A or more, the power supply can output voltages from 0 V to the rated output voltage (100 V) in the constant voltage operation mode.

The output voltage limit is set to the rated output voltage under this load condition, and the output current is gradually increased from 0 A. At this point, the power supply is operating in the constant current (CC) mode. The output voltage increases as the output current increases. When the output voltage reaches 100 V, the output current no longer increases above 4 A even if you attempt to raise it. If you wish to increase the output current further, you must add another power supply in series and increase the output voltage. Particularly for loads that generate transient surge voltage, the voltage must be set so that the surge voltage does not reach (or exceed) the voltage limit.

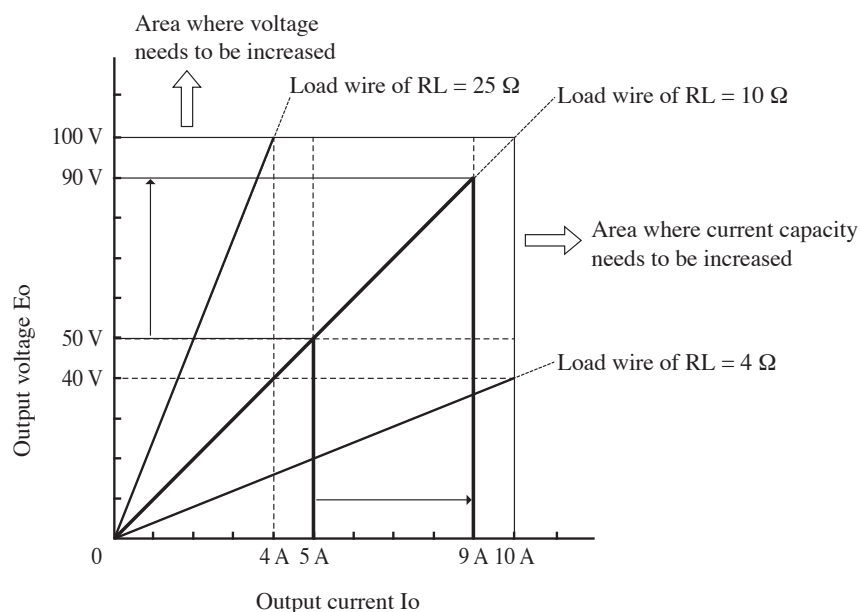


Fig. 2-7 Constant voltage operation and constant current operation

2.5 Protective Circuit

It is important to remember that a regulated power supply handles “power.” Accidents due to malfunction or erroneous operation of the power supply can cause the operation of an entire system to halt or cause damage to the power supply unit and load or in the worst case a fire.

Since the power supply is fundamental to the voltage circuit, current circuit and the system consisting of these circuits, its reliability is essential. If a malfunction does occur, a protective circuit that prevents accidents is an important element.

The protective circuit of the power supply is described below.

Overvoltage protection circuit

The power switch is shut down when the output exceeds the preset voltage. The operation time is approximately 50 ms.

Voltage detection circuit

The power switch is shut down when the voltage across the smoothing capacitor exceeds the rated voltage of the power supply. This circuit prevents erroneous operation such as when the user forgets to attach the short bar on the terminal block on the rear panel and protects the internal circuit from being damaged due to a rectification circuit malfunction.

Overcurrent protection circuit

The power switch is shut down when the output exceeds the preset current.

Temperature detection circuit

The power switch is shut down when the cooling fan exceeds prescribed temperature due to the rising ambient temperature or stopping of the fan. The circuit detects the temperature rise of the cooling package (semiconductor cooler).

Prescribed temperature: Type III model Approximately 100 °C
Type IV model Approximately 95 °C

Input fuse

The input current is shut down against overcurrent caused by internal circuit malfunction.

The fuse uses porcelain insulation tube and silica arc-extinguishing sand that prevents blowouts (fire) when it shuts down.

Output fuse

The output current is shut down against overcurrent caused by internal circuit malfunction.

2.6 Output Terminal Isolation

■ The output terminal is insulated

The output terminal of the power supply is insulated from the chassis. By connecting the GND wire of the power cord to the ground terminal of the switchboard, the chassis of the power supply is set to ground potential as shown in Fig. 2-8.

■ When the output terminal is not grounded

The cable and load that are connected to the output terminal (including the sensor terminal) must have an insulation capacity that is greater than the isolation voltage (*1, see Table 2-2) of the power supply with respect to the chassis.

In addition, cables and devices that are connected to the following pins must also have an insulation capacity that is greater than the isolation voltage of the power supply.

- Pins 1 to 30 on the control terminal block on the rear panel.

This is because the above pins are at approximately the same electrical potential as the positive output terminal of the power supply.

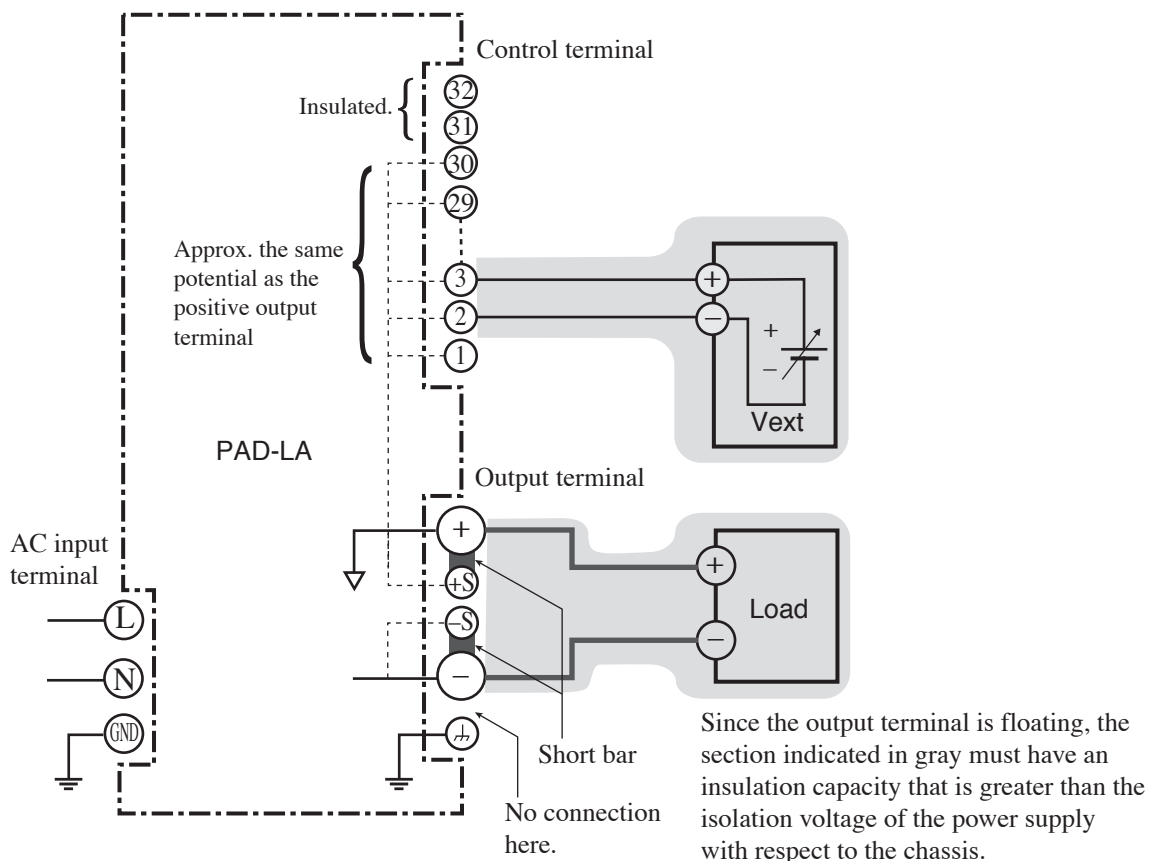


Fig. 2-8 When the output terminal is not grounded

DESCRIPTION *1 Isolation voltage: Maximum allowed voltage that appears across the output terminal of the power supply unit and the protective conductor terminal (chassis terminal).

■ When the negative output terminal is connected to the chassis terminal

As shown in Fig. 2-9, the negative output terminal will be at ground potential. Consequently, the cable and load that are connected to the output terminal (including the sensor terminal) must have an insulation capacity that is greater than the maximum output voltage of the power supply with respect to the chassis.

In addition, cables and devices that are connected to the following pins must also have an insulation capacity that is greater than the maximum output voltage of the power supply.

- Pins 1 to 30 on the control terminal block on the rear panel.

■ When the positive output terminal is connected to the chassis terminal

Since the positive output terminal will be at ground potential, the output will be negative with respect to the chassis. Cables and devices that are connected to the output terminal must have an insulation capacity that is greater than the maximum output voltage of the power supply with respect to the chassis.

In addition, cables and devices that are connected to the following pins must also have an insulation capacity that is greater than the maximum output voltage of the power supply with respect to the negative output terminal.

- Pins 1 to 30 on the control terminal block on the rear panel.

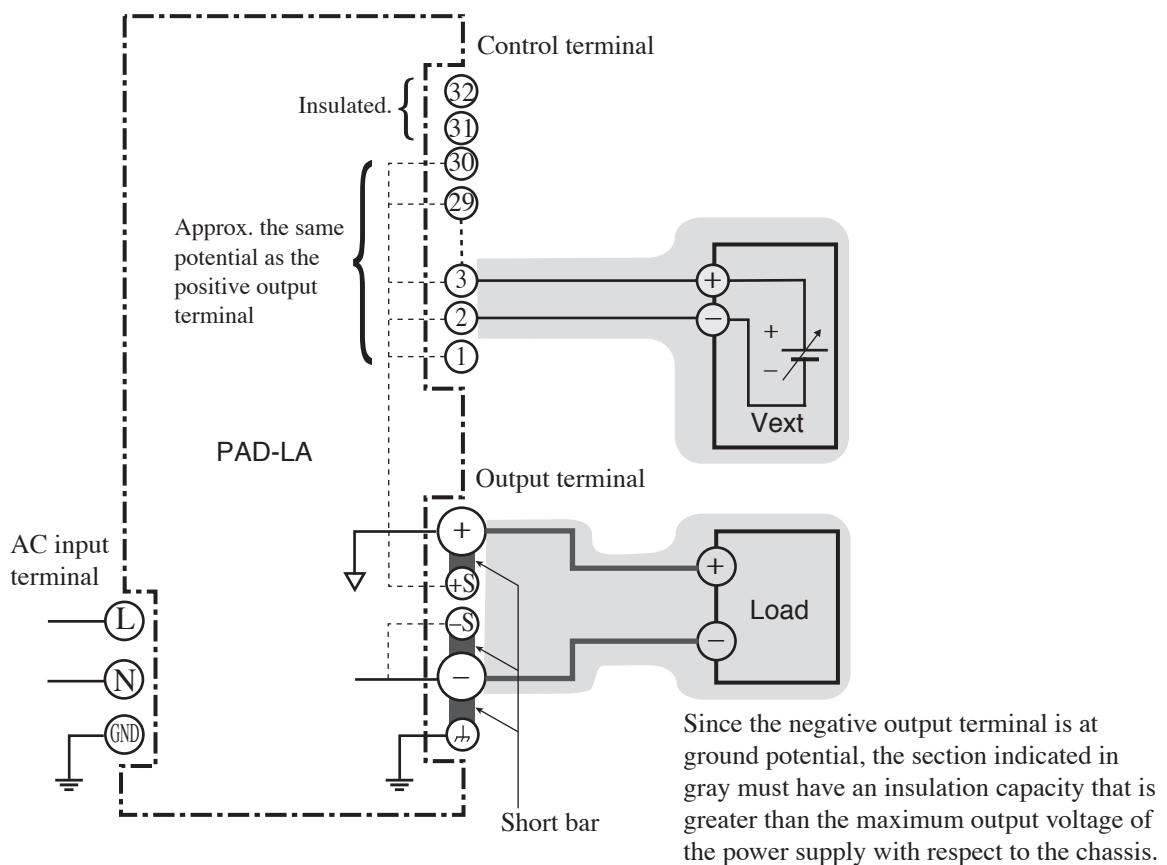


Fig. 2-9 When the negative output terminal is grounded

In summary, connect either output terminal to the chassis terminal for safety reasons unless your application requires the output terminal to be floating. Moreover, the output ripple may become large if the output terminal is not connected to the chassis terminal. The specifications of the power supply assume that the negative output terminal is connected to the chassis terminal.



WARNING • Possible electric shock. May lead to death or injury.

Be sure to securely connect the output terminal to the chassis terminal using the short bar provided.

• Possible electric shock and output short circuit. May lead to death or injury.

To establish isolation of the output terminal (including the sensing terminal) and pins 1 to 30 of the control terminal block, securely connect using cables of adequate rated voltage. If you cannot obtain a cable with sufficient rated voltage, secure adequate withstand voltage such as by passing the cable through an insulation tube with a withstand voltage greater than the isolation voltage of the power supply.

Table 2-2 Isolation voltage

TYPE III MODEL	PAD 16-100LA	PAD 36-60LA	PAD 60-35LA	PAD 72-30LA	PAD 110-20LA	PAD 250-8LA
Isolation voltage	±250 V	±250 V	±250 V	±250 V	±500 V	±500 V

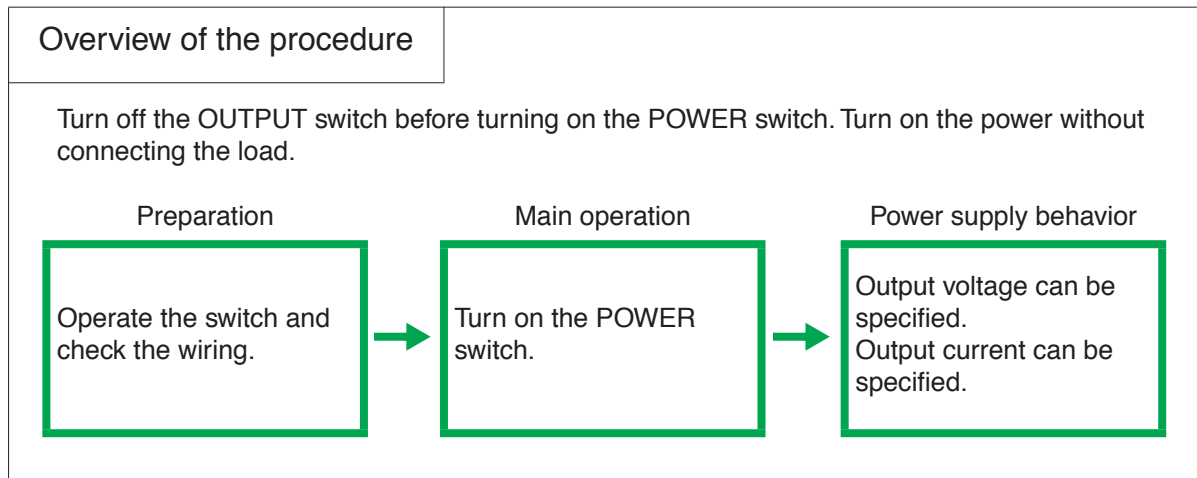
TYPE IV MODEL	PAD 36-100LA	PAD 60-60LA	PAD 110-32LA	PAD 250-15LA
Isolation voltage	±250 V	±250 V	±500 V	±500 V

3

Chapter 3 Basic Operation

This chapter describes the basic operations that you can perform from the front panel.

3.1 Turning On the Power



CAUTION • Burnout may occur in the load. Do not turn on the POWER switch while the OUTPUT switch is on.

NOTE • Turning on the POWER switch while the OUTPUT switch is on may cause AC ripple component to be superimposed on the rising edge of the output. AC ripple component may be superimposed on the rising edge of the output also when the OUTPUT switch is turned on after the POWER switch is turned on when the impedance of the input line is high or the input voltage is low. This is caused by the phase control circuit of the power supply not being able to follow the rise time of the output voltage.

Power up procedure

1. Turn off the POWER switch.
2. Turn off the OUTPUT switch.
3. Turn off all control switches or set them to the bottom side.
4. Check that the power cord is correctly connected.
5. Turn on the switch of the switchboard supplying power to the power supply.
6. Turn on the POWER switch.
The LED on the control panel illuminates.
7. While holding down the SET switch, turn the VOLTAGE knob (10 rotations).
The output voltage can be set in the range of zero to the rated voltage.
8. While holding down the SET switch, turn the CURRENT knob (10 rotations).
The output current can be set in the range of zero to the rated current.

The power supply is ready to be used.

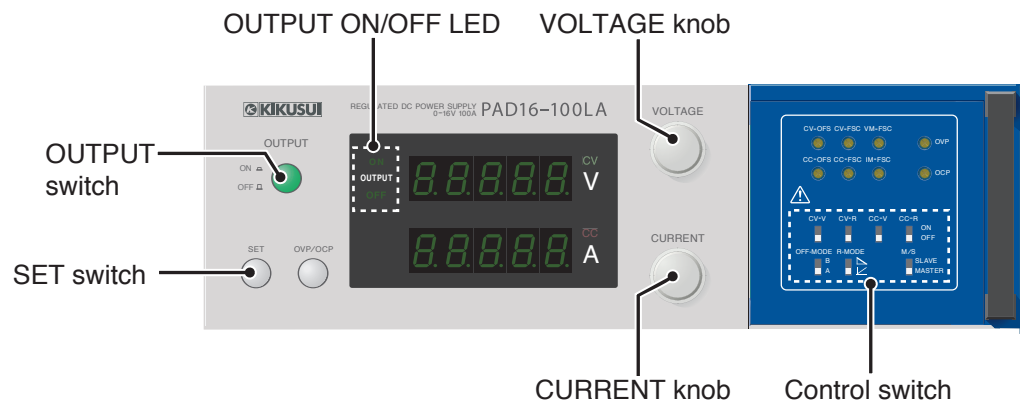


Fig.3-1 Control panel

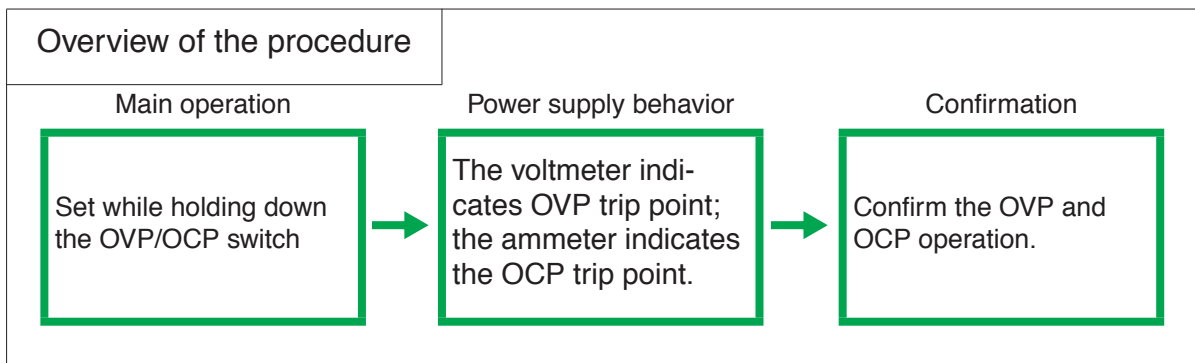
3.2 Basic Operation

The power supply has two modes: constant voltage operation (CV) mode and constant current operation (CC) mode. Before using the power supply, check which mode is to be used, and follow the procedure for the corresponding operation mode.

3.2.1 Setting the OVP (Overvoltage Protection) and OCP (Overcurrent Protection) Trip Points

OVP/OCP function

The OVP function protects a load from unexpectedly high voltage; the OCP function protects a load from unexpectedly high current. When OVP or OCP trips, the POWER switch is turned off. To turn on the power supply again, wait approximately 60 s, and turn on the POWER switch. In this case, if you do not decrease the preset output voltage or the preset output current, OVP or OCP trips again when the POWER switch is turn on.



CAUTION • Burnout may occur in the load. Set an appropriate OVP/OCP trip point for the load. The OVP/OCP trip point is factory-preset to approximately 110 % of the rated output voltage of the power supply.

NOTE • When turning on the POWER switch after OVP or OCP has tripped, wait at least 60 s after output shutdown to do so. Otherwise, the output shutdown circuit may still be latched, and output may not be possible.

Setting the OVP/OCP trip point

1. Turn off the OUTPUT switch.
2. Turn on the POWER switch.
3. While holding down the OVP/OCP switch, turn the OVP variable resistor or the OCP variable resistor using a Phillips screwdriver to the desired value.

While the OVP/OCP switch is held down, the voltmeter and ammeter indicate the current OVP trip point and the current OCP trip point, respectively.

The OVP/OCP trip point can be set in the range of 10 % to 100 % of the rated output.

4. Turn off the POWER switch.

CAUTION • Burnout may occur in the load. After setting the OVP/OCP trip point, be sure to check that OVP or OCP operates at the specified output voltage. When checking the trip point, do not connect the load. Check by opening (for OVP) or shorting (for OCP) the output terminal.

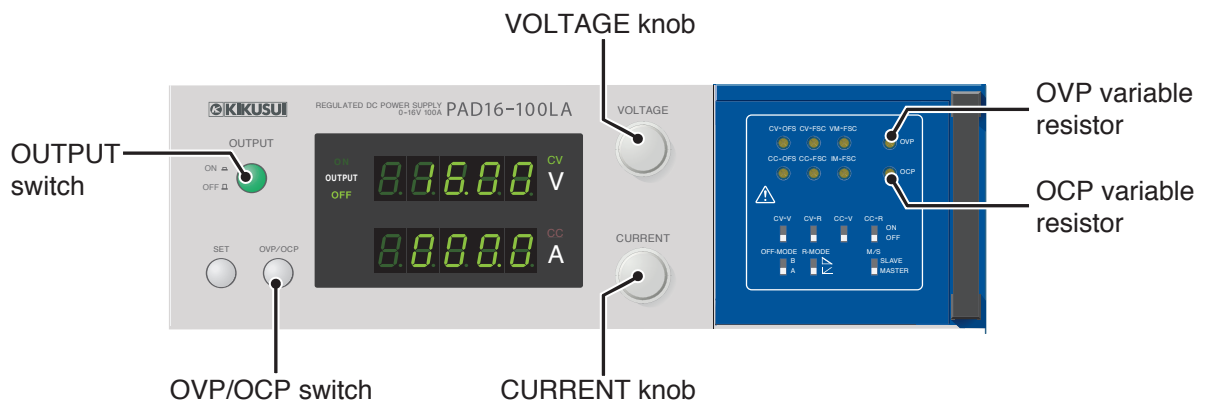


Fig. 3-2 Control panel

Checking the OVP/OCP operation

After setting the OVP/OCP trip point, be sure to check that OVP or OCP operates.

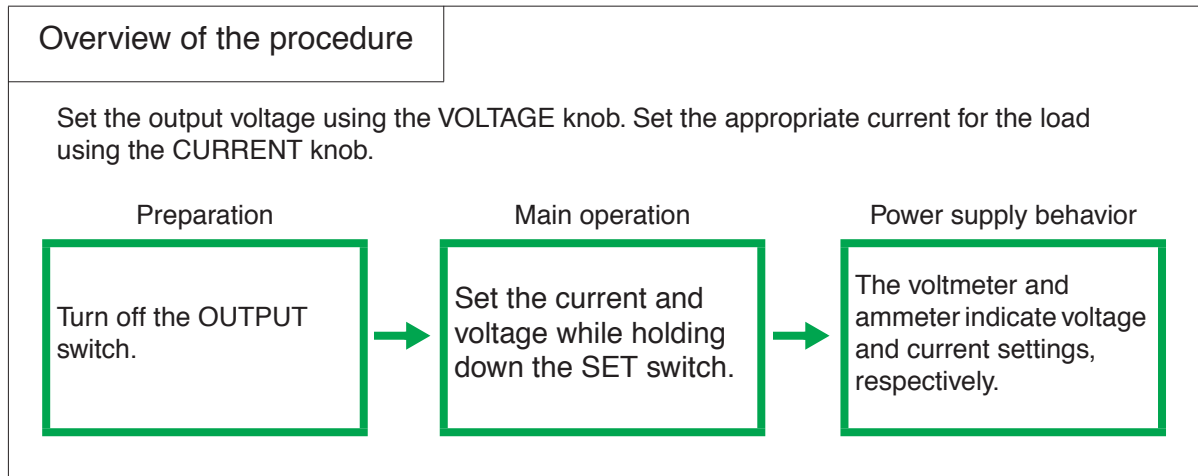
■ Checking the OVP operation

1. Turn off the OUTPUT switch.
2. Turn on the POWER switch.
3. Turn the VOLTAGE knob counterclockwise all the way.
4. Turn the CURRENT knob two to three times in the clockwise direction.
5. Turn on the OUTPUT switch.
6. Turn the VOLTAGE knob slowly clockwise.
When the output voltage reaches the specified OVP trip point, the POWER switch is turned off.
7. Turn the VOLTAGE knob counterclockwise all the way.
8. Turn off the OUTPUT switch.

■ Checking the OCP operation

1. Turn off the POWER switch and OUTPUT switch.
2. Short the output terminal using a load wire that can withstand the rated current.
3. Turn on the POWER switch.
4. Turn the CURRENT knob counterclockwise all the way.
5. Turn the VOLTAGE knob two to three times in the clockwise direction.
6. Turn on the OUTPUT switch.
7. Turn the CURRENT knob slowly clockwise.
When the output current reaches the specified OCP trip point, the POWER switch is turned off.
8. Turn the CURRENT knob counterclockwise all the way.
9. Turn off the OUTPUT switch.

3.2.2 Using the Power Supply as a Constant Voltage Power Supply



⚠ WARNING • Possible electric shock. May lead to death or injury. When connecting the load, turn off the POWER switch.

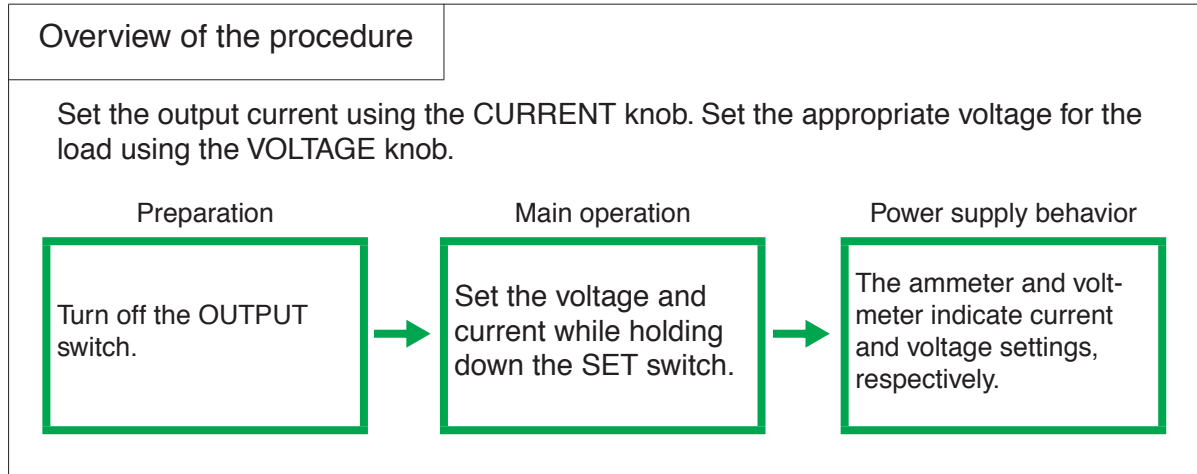
1. Turn off the OUTPUT switch.
2. Turn on the POWER switch.
3. While holding down the SET switch, set the appropriate current for the load using the CURRENT knob.
The value entered here becomes the current limit.
The SET switch is used only to display the current voltage and current settings. It is not a memory function.
4. While holding down the SET switch, set the required voltage using the VOLTAGE knob.
5. Turn on the OUTPUT switch.
The CV LED illuminates on the control panel indicating that the power supply is in constant voltage operation.

■ When the load is of a type on which applying a drastic voltage is not desirable

For the following types of loads, perform steps 6 to 8 after performing steps 1 to 3 above.

- a. Load of unknown resistance
 - b. Load of which the resistance varies greatly
 - c. Load with large inductance
6. Turn the VOLTAGE knob counterclockwise all the way.
 7. Turn on the OUTPUT switch.
 8. Turn the VOLTAGE knob slowly to gradually increase the voltage.
The CV LED illuminates on the control panel indicating that the power supply is in constant voltage operation.

3.2.3 Using the Power Supply as a Constant Current Power Supply



⚠ WARNING • Possible electric shock. May lead to death or injury. When connecting the load, turn off the POWER switch.

1. Turn off the OUTPUT switch.
2. Turn on the POWER switch.
3. While holding down the SET switch, set the allowable voltage using the VOLTAGE knob.
The value entered here becomes the voltage limit.
The SET switch is used only to display the current voltage and current settings. It is not a memory function.
4. While holding down the SET switch, set the required current using the CURRENT knob.
5. Turn on the OUTPUT switch.
If the load is connected, the CC LED on the control panel illuminates to indicate that the power supply is in the constant current operation.

■ **When the load is of a type on which flowing a drastic current is not desirable**

For the following types of loads, perform steps 6 to 8 after performing steps 1 to 3 above.

- a. Load of unknown resistance
 - b. Load of which the resistance varies greatly
 - c. Load with large inductance
6. Turn the CURRENT knob counterclockwise all the way.
 7. Turn on the OUTPUT switch.
 8. Turn the CURRENT knob slowly to gradually increase the current.
The CC LED illuminates on the control panel indicating that the power supply is in constant current operation.

3.3 Connecting the Load

This section describes the wire used to connect the power supply and the load and the connection to the output terminal.

3.3.1 Load Wire



- Possible burnout and overheating. Use load cables of sufficient current capacity with respect to the rated output current of the power supply as well as sufficient withstanding voltage against the isolation voltage of the power supply.
-

Current capacity of the load cable

Load cables must be rated to carry the maximum rated output current of the power supply. If their current rating exceeds the maximum rated output current, the cable will remain intact even if the load is short-circuited.

The allowable current is determined by the maximum allowable temperature of the cable insulation.

The cable temperature is determined by a current-caused resistance loss, ambient temperature, and thermal resistance to the outside. The allowable currents in Table 3-1 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 exceeds 30 °C, or the wires are bundled resulting in low heat radiation, the current capacity needs to be reduced.

Taking measures against noise

For measures against noise in the load cables, installing the positive and negative output lines side by side or bundling them together is more effective against unwanted noise. The Kikusui-recommended currents shown in Table 3-1 are allowable current values that have been reduced in consideration of the potential bundling of wires. Use these values as a guideline when installing load wires.

Limitations of the sensing function

Because wires have resistance, voltage drop in wires becomes greater as the wire becomes longer or the current becomes larger. This causes the voltage at the load end to be smaller. The power supply has a sensing function that compensates for this voltage drop. Compensation of up to approximately 0.6 V is available for a single line. If the voltage drop exceeds this level, wires having a greater sectional area should be used.

Table 3-1 Nominal cross-sectional area of wires and allowable currents

Nominal Cross-Sectional Area [mm ²]	AWG	(Reference Cross-Sectional Area) [mm ²]	Allowable Current(*) [A] (Ta = 30 °C)	Kikusui-Recommended Current [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	-

*Excerpts from Japanese laws related to electrical equipment

Withstanding voltage of the load wire

Use load wires with a rated voltage that is greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation."

3.3.2 Connecting to the Output Terminals

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. When connecting the load, turn off the POWER switch.
 - After connecting the load cable, attach the output terminal cover.
 - Securely connect the load wires to the output terminal such as by using crimp terminals.
-

Under normal use, use the short bar provided to connect the chassis terminal to the negative or positive output terminal. The output ripple may become large if the output terminal is not connected to the chassis terminal. The specifications of the power supply assume that the negative output terminal is connected to the chassis terminal. For details, see section 2.6, "Output Terminal Isolation."

Connection procedure of Type III model

1. Remove the terminal cover. (See Fig. 3-3 for the following procedure.)
2. Loosen the screws fixing the wire hole cover and move the cover all the way to the left.
3. Attach the load cables. Run the cable vertically.
4. Move the wire hole cover to the right so that it touches the cables and fix it in place by tightening the screws.
5. Attach the terminal cover.

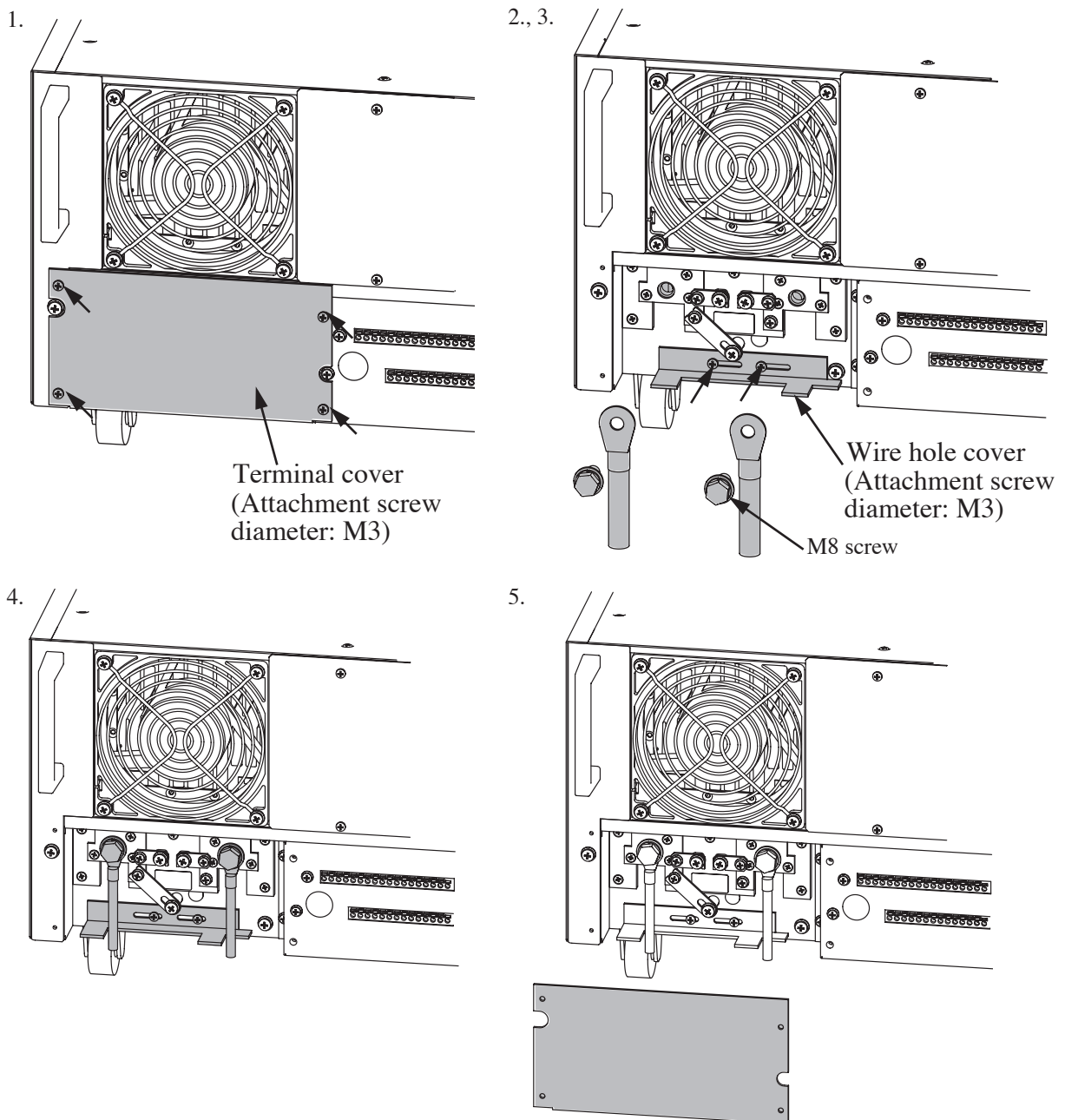


Fig. 3-3 Connecting to the output terminals (Type III model)

Connection procedure of Type IV model

1. Remove the terminal cover. (See Fig. 3-4 for the following procedure.)
2. Attach the load cables. Run the cable vertically.
3. Attach the terminal cover.

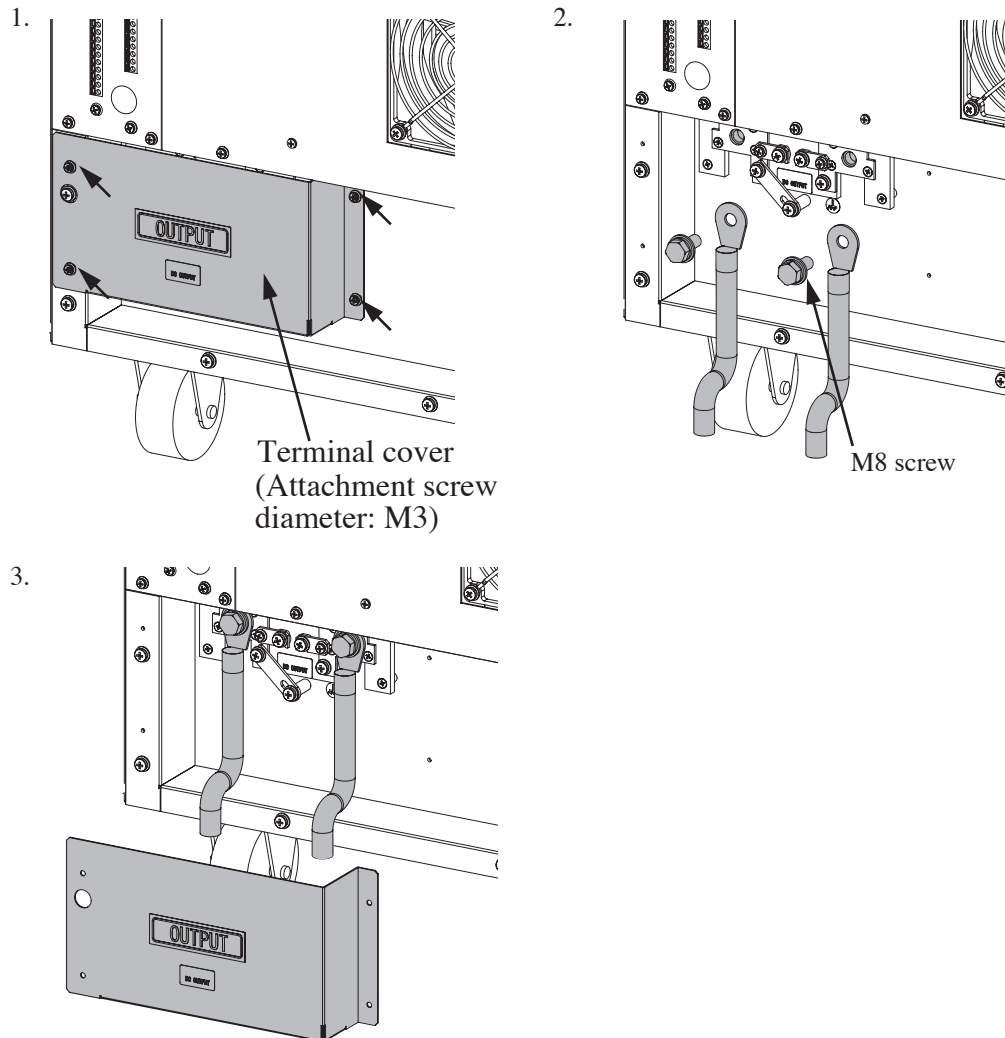


Fig. 3-4 Connecting to the output terminals (Type IV model)

3.4 Fixing the Output Setting

The power supply comes with guard caps for fixing or partially fixing the VOLTAGE knob or CURRENT knob mechanically. Use them when you wish to prevent changing the output setting inadvertently.

Using guard caps

1. Turn off the OUTPUT switch.
2. Turn on the POWER switch.
3. While holding down the SET switch, set the output (voltage or current) to the desired value. Coarse setting is fine here.
4. Pull and remove the VOLTAGE or CURRENT knob without turning it.
5. While holding down the SET switch, set the output to the desired value using a flat-blade screwdriver.

■ When fixing the setting

6. Attach the guard cap in place of the knob you just removed.
7. Press the SET switch again and check that the setting has not changed.

■ When partially fixing the setting

8. As shown in Fig. 3-5, pierce the guard cap such as by using a Phillips screwdriver.
9. Attach the guard cap in place of the knob you just removed.
Because the guard cap has been pierced, you can change the output using a flat-blade screwdriver.

NOTE

- If you plan to attach the knob again in the future, store it in a safe place where it will not get lost. Inside the bearing of the knob is a fitting that is used to engage with the axis of the variable resistor. See Fig. 3-6. Normally, this fitting does not come off the bearing when the knob is removed. However, if it does, keep the fitting inside the bearing.
-

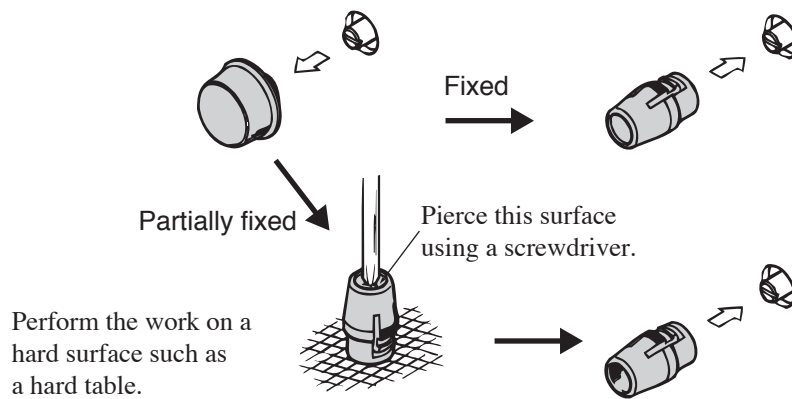


Fig. 3-5 Attaching the guard cap

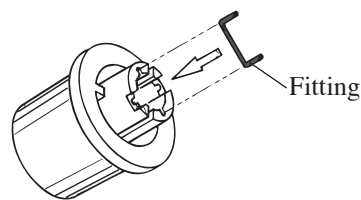


Fig. 3-6 Fitting inside the bearing

Reattaching the preset knob

There is a groove on the axis of the variable resistor. The knob must be attached so that it engages with this groove. Otherwise, the knob will rotate without rotating the axis. Follow the procedure below.

1. Check that the fitting is inside the bearing of the knob.
2. While holding the lock mechanism (2 locations), remove the guard cap.
3. Attach the knob so that it touches the axis of the variable resistor lightly.
4. With small force, turn the knob all the way counterclockwise.
5. While pressing the knob, turn the knob counterclockwise further and stop turning at the position where the knob is inserted deeply.

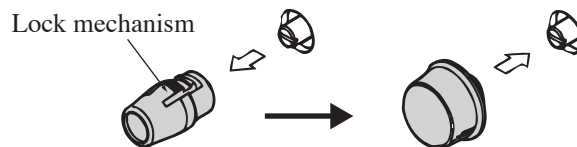


Fig. 3-7 Removing the guard cap

4

Chapter 4 Application Operation

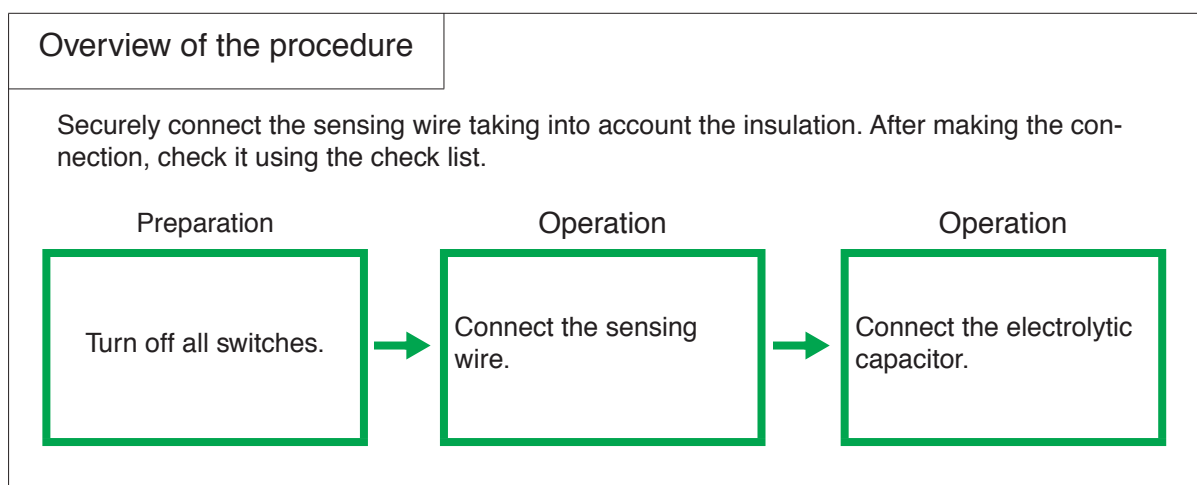
This chapter describes remote sensing, external output control, parallel operation, and series operation using the control terminal block on the rear panel.

4.1 Remote Sensing

The remote sensing function is used to reduce the influence of voltage drops due to the load cable resistance and stabilize the output voltage across the load. The remote sensing function of this power supply can compensate up to approximately 0.6 V for a single line. Select a load cable with sufficient current capacity so that the voltage drop of the load cable does not exceed the compensation voltage.

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

Connection procedure



⚠ WARNING • Possible electric shock. May lead to death or injury. Never connect wires to the control terminals while the POWER switch is turned on.
Always turn off the POWER switch.

1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. As shown in Fig. 4-1, remove the short bar for sensing.
4. As shown in Fig. 4-1, wire the sensing wire to the sensing terminals (+S terminal and -S terminal) and the load end.
Use twisted-pair or shielded wire for the sensing wires. Connect the shield to the positive terminal. This suppresses the output ripple voltages resulting from inductive effects.
5. Connect electrolytic capacitors (C1 and C2) between the output terminals and sensing terminals.
6. Connect an electrolytic capacitor (C) between 100 to 100000 μF at the load end.
7. Attach the output terminal cover after making the connection.

Table 4-1 Remote sensing connection check list

Item	Description
Insulation	For sensing wires, use cables with a higher voltage rating than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation." When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Secure connection	If the sensing wires come loose, the output voltage across the load cannot be stabilized and may cause excessive voltage to be applied to the load. Securely connect the sensing wires such as by using crimp terminals.
When using a mechanical switch	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. 4-1 and turn on/off the load cable and remote sensing wires simultaneously.
Operation near the rated output voltage	The output of the power supply is limited by the maximum voltage (103 % of the rated output voltage). If the voltage drop in the wiring to the load end (both ways) is large and the output of the power supply goes above 103 % of the rated voltage, the rated output voltage at the load end cannot be compensated. In such case, use a wire of large cross-sectional area with small voltage drop. Be sure that the output of the power supply is less than or equal to 103 % of the rated voltage.
Induction prevention	Use twisted-pair or shielded wire for the sensing wires. Connect the shield to the positive terminal. Protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Withstanding voltage of the electrolytic capacitor	Use a capacitor (C) whose withstanding voltage is greater than or equal to 120 % of the power supply's rated voltage.
Wiring length	If the wiring to a load is longer than 3 m, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation. In such case, the capacitor (C) prevents oscillation.
Pulse-shaped load current	If the load current changes suddenly to pulse shape, the output voltage may increase due to the effects from the inductance component of the wiring. In such case, the capacitor (C) also prevents fluctuations in output.

⚠ WARNING • Possible electric shock and output short circuit. May lead to death or injury.
For sensing wires, use cables with a higher voltage rating than the isolation voltage of the power supply.
Protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.

⚠ CAUTION • Burnout may occur in the load. If the sensing wires come loose, the output voltage across the load cannot be stabilized and may cause excessive voltage to be applied to the load. Securely connect the sensing wires such as by using crimp terminals.

NOTE

- When using the PAD16-100LA around the rated output voltage, use a load cable with a large cross-sectional area.

To achieve 16 V at the load end, be sure that the one-way voltage drop in the load wire is less than or equal to 0.24 V. If approximately 0.6 V of compensation is performed on one way, the voltage at the load end will be less than or equal to the rated voltage.

Below is the relationship between the voltage drop in the load cable and the voltage at the load end when the PAD16-100LA is at maximum output.

$$\Delta V = \frac{1}{2} (E - V_1)$$

ΔV : Voltage drop to be compensated (one way)

E: Voltage at the output end of the power supply (maximum output of the PAD16-100LA is 16.48 V)

V_1 : Voltage at the load end

When the voltage at the load end (V_1) is set to 16 V, $\Delta = 0.24$ V.

Stopping the remote sensing function

After you are finished using the remote sensing function, remove the sensing wire and be sure to attach a sensing short bar between the output terminal and sensing terminal.

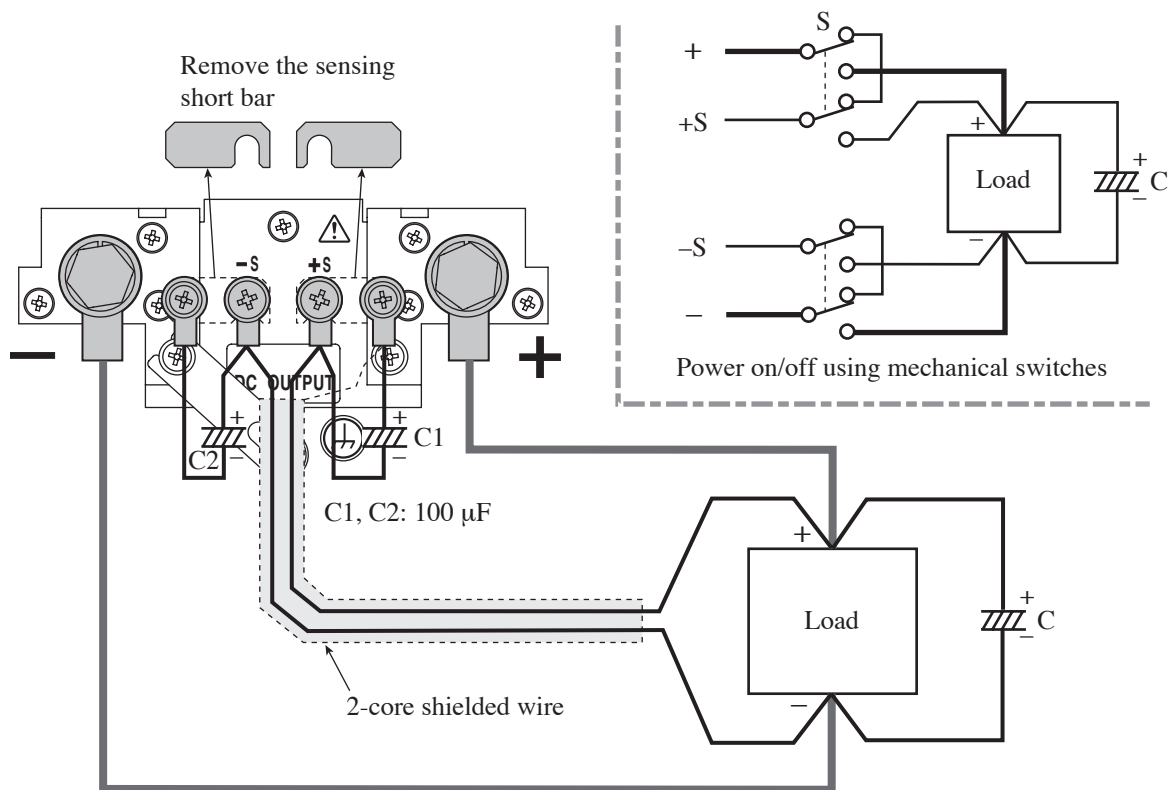


Fig. 4-1 Remote sensing connection

4.2 Control Terminal Block

The control terminal block on the rear panel can be used to perform the following operations.

- Control the output using an analog signal
- Control the output ON/OFF using an external contact
- Control the output shutdown using an external contact
- Master-slave parallel operation
- Master-slave series operation
- Monitor the output



- Improper handling of the control terminal block can lead to electric shock or output short circuit. When using remote control, be sure to follow the appropriate control procedure.

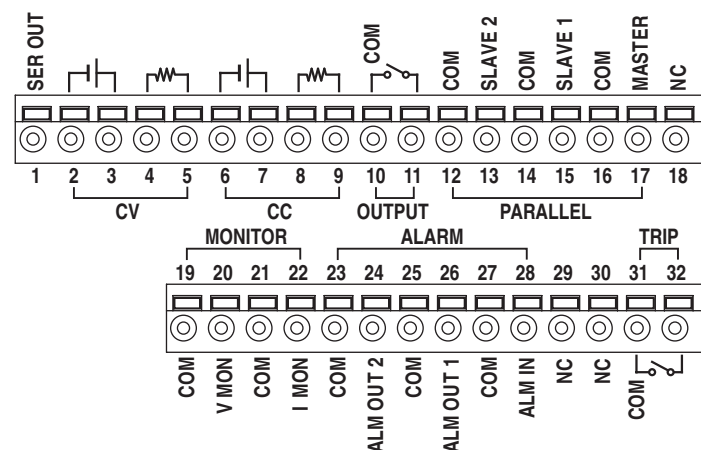


Fig. 4-2 Control terminal block

■ Wires and tools required for connection

1. Wires

- Solid wire: $\phi 0.4$ to $\phi 1.2$ (AWG26 to 16)
- Stranded wire: 0.3 mm^2 to 1.25 mm^2 (AWG22 to 16)
(Element wire diameter: $\phi 0.18$ or greater)

2. Flat-blade screwdriver

- Axis diameter: $\phi 3$
- End width: 2.6 mm

3. Wire stripper

Wire stripper suitable for the wires described above.

Table 4-2 Control terminal block arrangement

Terminal No.	Signal	Input/ Output/ Common	Description	Panel Marking	
1	SERIES SIG OUT	Output	Signal for master-slave series connection	SER OUT	
2	A COM	Common	Control signal for output voltage using an external voltage		CV
3	CV V CONT	Input			
4	CV R CONT OUT	Output	Control signal for output voltage using an external resistor		CV
5	CV R CONT IN	Input			
6	A COM	Common	Control signal for output current using an external voltage		CC
7	CC V CONT	Input			
8	CC R CONT OUT	Output	Control signal for output current using an external resistor		CC
9	CC R CONT IN	Input			
10	A COM	Common	OUTPUT ON/OFF control signal		OUT PUT
11	OUTPUT ON/OFF	Input			
12	SLAVE COM2	Common 2	Slave signal for master-slave parallel connection	COM	PARALLEL
13	SLAVE 2	Input/Output 2		SLAVE 2	
14	SLAVE COM1	Common 1	Slave signal for master-slave parallel connection	COM	
15	SLAVE 1	Input/Output 1		SLAVE 1	
16	MASTER COM	Common	Master signal for master-slave parallel connection	COM	
17	MASTER OUT	Output		MASTER	
18	NC		Not used	NC	
19	V MONITOR COM	Common	Voltage monitor output signal	COM	MONITOR
20	V MONITOR OUT	Output		V	
21	I MONITOR COM	Common	Current monitor output signal	COM	
22	I MONITOR OUT	Output		I	
23	PARALLEL ALM COM	Common*	ALM signal for master-slave parallel connection	COM	ALARM
24	PARALLEL ALM OUT 2	Input/Output 2		ALM OUT 2	
25	PARALLEL ALM COM	Common*	ALM signal for master-slave parallel connection	COM	
26	PARALLEL ALM OUT 1	Input/Output 1		ALM OUT 1	
27	MASTER ALM COM	Common*	ALM signal for master-slave parallel connection	COM	
28	MASTER ALM IN	Input		ALM IN	
29	NC		Not used	NC	
30	NC		Not used	NC	
31	BREAKER DOWN COM	Common	Output shutdown signal		TRIP
32	BREAKER DOWN SIG	Output			

CAUTION • The common voltage of terminal No. 23, 25, and 27 is at a different electric potential than that of other common terminals. To prevent a malfunction, do not connect these terminals to other common terminals.

Control terminal block connection procedure



- Possible electric shock. May lead to death or injury. Turn off the POWER switch when wiring the control terminal block.
- Electric shock or damage to the internal circuit may result if wire scraps protruding from the control terminal block come in contact with the chassis. Insert wires to the control terminal block so that the stripped sections do not protrude from the terminal block.

The common terminals of control terminal block is at approximately the same electrical potential as the positive output terminal of the power supply.

In addition, A COM is connected to +S.

1. Turn off the POWER switch.
2. Use a wire stripper to remove 9 mm of the covering from the wires.
Using the strip gauge shown under the control terminal block will ensure proper work.
3. As shown in Fig. 4-3, insert the wire into the control terminal block.
4. Remove the screwdriver from the terminal and check that the wire does not come loose.

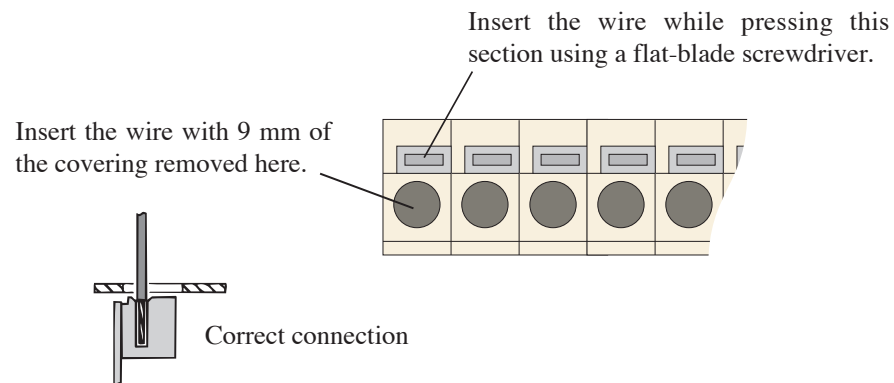


Fig. 4-3 Connection to the control terminal block

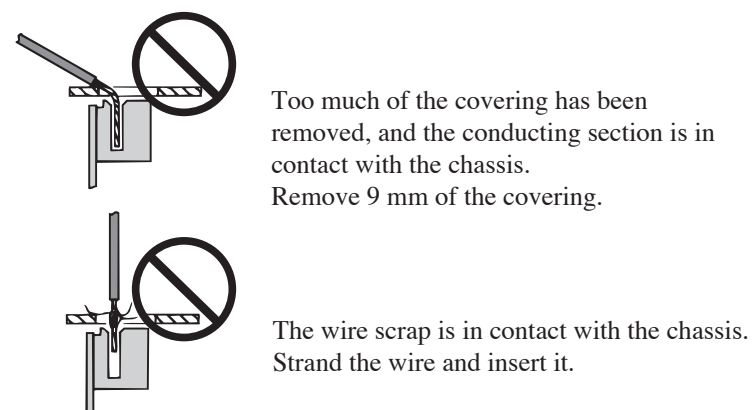


Fig. 4-4 Errors in connection

4.3 Analog Remote Control

This section describes remote control using an analog signal and external contact.

Table 4-3

1	Output voltage control using an external resistor (CV-R)
2	Output voltage control using an external voltage (CV-V)
3	Output current control using an external resistor (CC-R)
4	Output current control using an external voltage (CC-V)
5	OUTPUT ON/OFF using an external contact
6	Output shutdown using an external contact (TRIP)

NOTE

- Different remote control modes can be used simultaneously. However, simultaneous use of CV-R and CV-V or CC-R and CC-V is not possible. The following combinations can be used simultaneously.
 - CV-R and CC-R
 - CV-R and CC-V
 - CV-V and CC-R
 - CV-V and CC-V

■ Readjustment for remote/local switching

The power supply is adjusted at the time of factory shipment assuming a front panel operation (local control). When using remote control (excluding OUTPUT ON/OFF and shutdown using an external contact), the power supply must be readjusted. Readjustment is also necessary when switching back from remote control to local control. For the adjustment procedure, see section 6.3, "Adjustment."

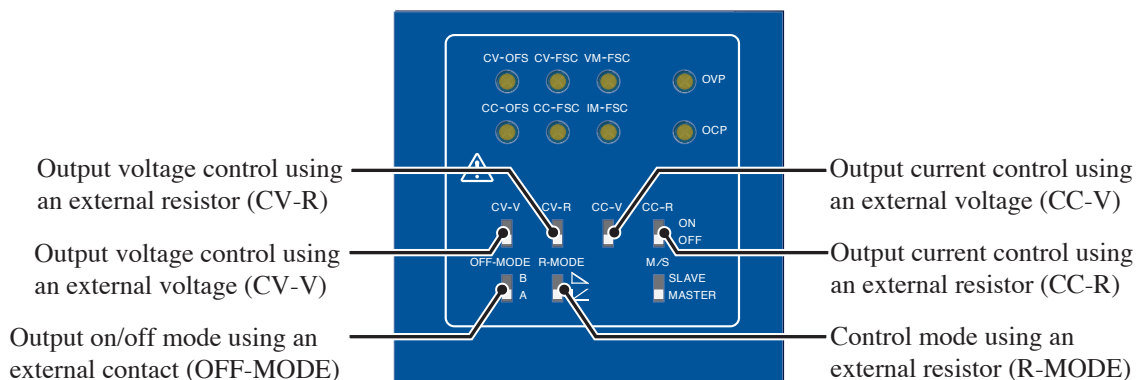


Fig. 4-5 Control switch arrangement

■ Mode in which the output is controlled using an external resistor

You can use one of the following two modes when controlling the output voltage or output current using an external resistor.

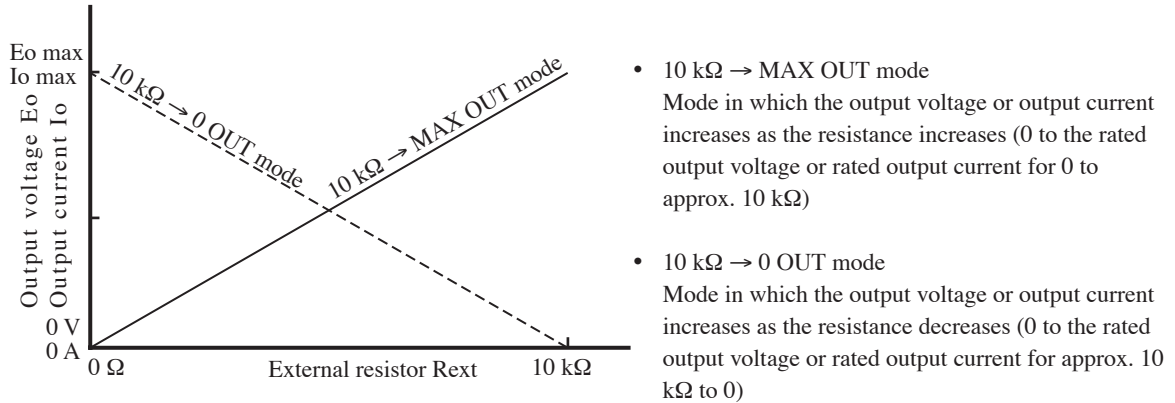


Fig. 4-6 $0 k\Omega \rightarrow \text{MAX OUT mode}$ and $10 k\Omega \rightarrow 0 \text{ OUT mode}$

Connection and setup procedure



- Possible electric shock. May lead to death or injury. Turn off the POWER switch when wiring the control terminal block.
- Possible electric shock and damage to internal circuit. The common terminal of the terminal block as well as resistors, voltage sources, and switches connected to the control terminal block are at approximately the same potential as the positive output terminal. Protect them using insulation material having a withstanding voltage that is greater than the isolation voltage of the power supply.

1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. Select the control mode from Table 4-3.
Combinations are also possible, but simultaneous use of CV-R and CV-V or CC-R and CC-V is not possible.
4. Refer to the setup and connection procedure for the appropriate control mode given on the subsequent pages and set the control switch and connect the control source.
5. Check the control terminal connection and switch settings.
6. After performing the setup above, readjustment is necessary. For the adjustment procedure, see section 6.3, "Adjustment."





- Damage to the load may occur. Do not change the control switch or connect the control source during operation. Be sure to turn off the POWER switch and OUTPUT switch beforehand.

4.3.1 Connection and Setup for Output Voltage Control Using an External Resistor (CV-R)

This mode is used to control the output voltage using an external resistor (R_{ext}) in the range of 0 to approx. 10 k Ω .

Table 4-4 CV-R switch setting

Switch	Setting	Description
CV-V	OFF	Be sure to turn this off when CV-R is selected.
CV-R	ON	Selects output voltage control using an external resistor (CV-R)
CC-V	OFF/ON	When also controlling the output current externally, turn on CC-V or CC-R.
CC-R	OFF/ON	
OFF-MODE	A/B	Be sure to select A when not controlling OUTPUT/OFF using an external contact.
R-MODE		Selects 10 k Ω \rightarrow 0 OUT mode
		Selects 10 k Ω \rightarrow MAX OUT mode

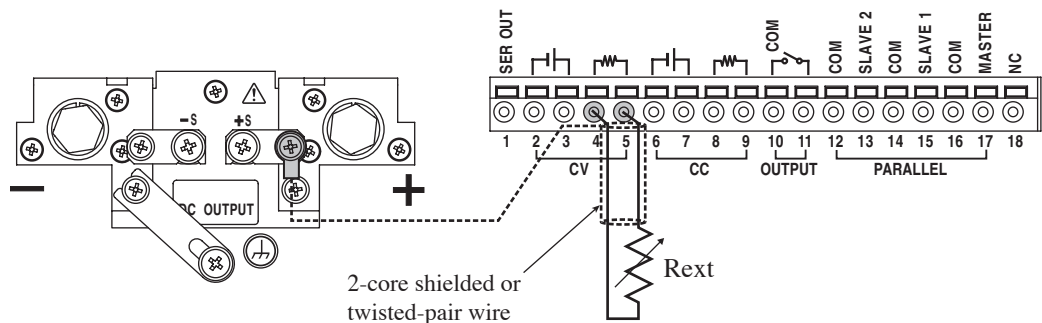


Fig. 4-7 CV-R connection

Output voltage E_o

10 k Ω \rightarrow MAX OUT mode

$$E_o \approx \frac{E_{rtg} \times R_{ext}}{10000} \text{ [V]}$$

$$R_{ext} \leq 10000 \text{ [}\Omega\text{]}$$

E_{rtg} : Rated output voltage [V]

10 k Ω \rightarrow 0 OUT mode

$$E_o \approx \frac{10000 - R_{ext}}{10000} \times E_{rtg} \text{ [V]}$$

Table 4-5 CV-R connection checklist

Item	Description
Insulation	The insulation of the Rext and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation." When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Secure connection	If Rext comes loose when using the 10 kΩ → MAX OUT mode, excessive voltage may be applied to the load. Securely connect the wires to the control terminal block. If there is a possibility that Rext will be cut off resulting in an open circuit, we recommend 10 kΩ → 0 OUT mode.
When using a fixed resistor for Rext and switching using a switch	An excessive voltage may be applied to the load depending on the timing of the switch. Therefore, use a short-circuit or continuous switch.
Prevention of noise influence	To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using a shielded cable, connect the shield to the positive output terminal.
Current flowing through Rext	A current of approximately 1 mA flows through Rext at all times. For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

-
- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the Rext and the cable connecting to it should be greater than the isolation voltage of the power supply.
-

■ CV-R control source

The control source for CV-R control is an external resistor. The control source when combined with another analog control is indicated below.

Table 4-6 Combination of analog control and control source

Combination	Control Source for Output Voltage	Control Source for Output Current
CV-R only	External resistor	CURRENT knob
CV-R and CC-R		External resistor
CV-R and CC-V		External voltage and CURRENT knob

4.3.2 Connection and Setup for Output Voltage Control Using an External Voltage (CV-V)

This mode is used to control the output current using an external voltage (V_{ext}) in the range 0 to approx. 10 V.

Table 4-7 CV-V switch setting

Switch	Setting	Description
CV-V	ON	Selects output voltage control using an external voltage (CV-V)
CV-R	OFF	Be sure to turn this off when CV-V is selected.
CC-V	OFF/ON	When also controlling the output current externally, turn on CC-V or CC-R.
CC-R	OFF/ON	
OFF-MODE	A/B	Be sure to select A when not controlling OUTPUT/OFF using an external contact.
R-MODE	▷ / ◁	When using CV-V only, this setting is arbitrary. When also using CC-R, select the mode.

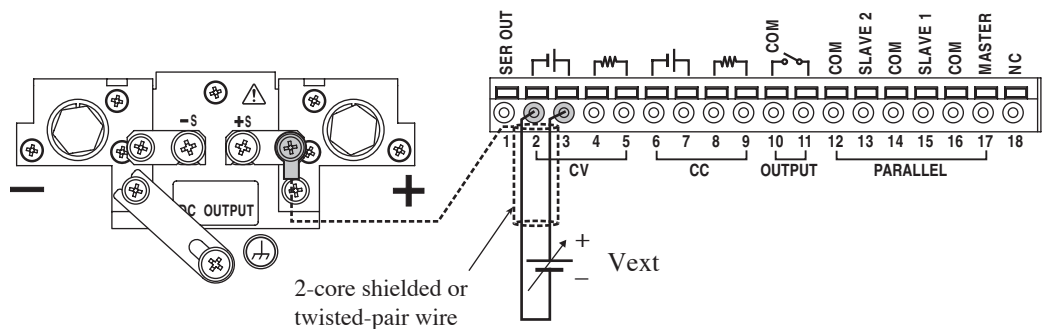


Fig. 4-8 CV-V connection

Output voltage E_o

$$E_o \approx \frac{E_{rtg} \times V_{ext} \times \alpha}{10} \text{ [V]}$$

$$0 \leq V_{ext} \leq 10.3 \text{ [V]}$$

E_{rtg} : Rated output voltage [V]

α : Coefficient between 0 and 1 specified by the VOLTAGE knob position

Counterclockwise all the way $\alpha = 0$

Clockwise all the way $\alpha = 1$

NOTE

- Turn the VOLTAGE knob clockwise all the way.

Under CV-V control, the ratio of the output voltage with respect to the input voltage from V_{ext} can be adjusted using the VOLTAGE knob. Therefore, the knob must be turned clockwise all the way to allow external control up to the rated output voltage.

- To fix the output setting on the panel, use the guard cap provided.

Table 4-8 CV-V connection checklist

Item	Description
Insulation	<p>The insulation of the Vext and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation."</p> <p>When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.</p>
Secure connection	<p>If Vext comes loose, erroneous operation may result due to external noise. Securely connect the wires to the control terminal block.</p>
Vext polarity	<p>Do not apply voltage or reverse current exceeding 10.3 V across terminals 2 and 3 of the control terminal block. Otherwise, damage to the power supply may result. If the polarity is reversed, damage to the power supply may result.</p>
Relationship with the VOLTAGE knob	<p>When controlling the output voltage using an external voltage, the ratio of the output voltage with respect to the input voltage from Vext can be adjusted using the VOLTAGE knob. Therefore, the knob must be turned clockwise all the way to allow external control up to the rated output voltage. In addition, to fix the output setting on the panel, use the guard cap provided.</p>
Prevention of noise influence	<p>To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using a shielded cable, connect the shield to the positive output terminal. If the shield needs to be connected to the Vext side, see "Connecting the Shield to the Vext Side."</p>
Input impedance	<p>The input impedance across terminals 2 and 3 of the control terminal block is approximately 10 kΩ.</p>
Stable voltage source for Vext	<p>Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the power supply and appears at the power supply's output. Thus, the output ripple noise may not meet the power supply's specifications.</p>

-
- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the Vext and the cable connecting to it should be greater than the isolation voltage of the power supply. In addition, leave the output of the external voltage source (Vext) floating.
-

■ CV-V control source

The control source for CV-V control is an external voltage. The control source when combined with another analog control is indicated below.

Table 4-9 Combination of analog control and control source

Combination	Control Source for Output Voltage	Control Source for Output Current
CV-V only	External voltage	CURRENT knob
CV-V and CC-R		External resistor
CV-V and CC-V		External voltage and CURRENT knob

Connecting the shield to the Vext side

-
- ⚠ CAUTION** • Possible damage to internal circuit due to short circuit. If you are connecting the shield to the Vext side, do not connect the shield to the positive output terminal of the power supply.
-

When using shielded wires, some of Vexts may require that the shield be connected to the Vext.

In such case, the grounding method used for Vext and the power supply creates a condition in which the output is short-circuited, as shown in Fig. 4-9. Thus, do not connect the shield to the positive output terminal of the power supply.

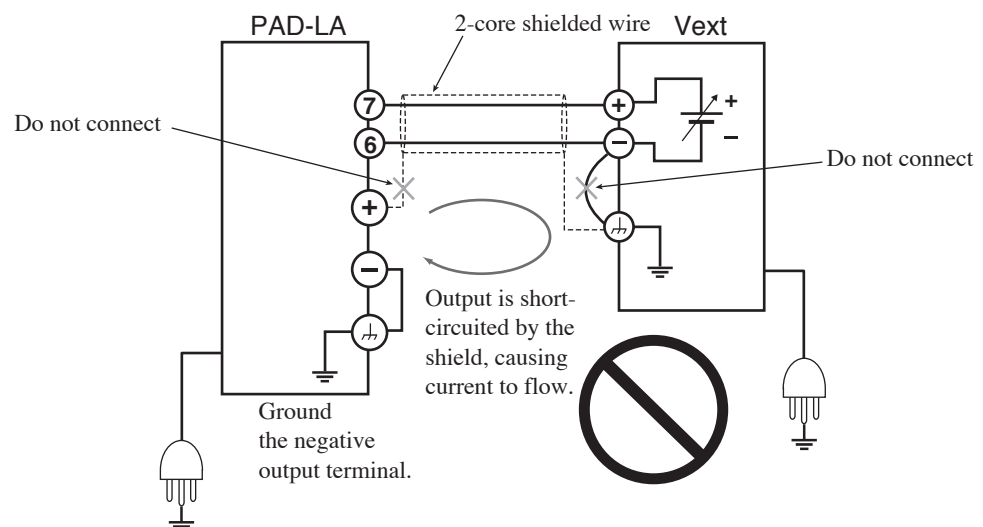




Fig. 4-9 A connection in which the output is short-circuited by the shield

-
- ⚠ WARNING** • Possible damage to internal circuit due to short circuit. Leave the output of the external voltage source (Vext) floating. Since terminals 2 and 3 of the control terminal block are at approximately the same potential as the positive output terminal, short-circuit current flows through the signal wire even without a shield.
-

4.3.3 Connection and Setup for Output Current Control Using an External Resistor (CC-R)

This mode is used to control the output current using an external resistor in the range of 0 to approx. 10 kΩ.

Table 4-10 CC-R switch setting

Switch	Setting	Description
CV-V	OFF/ON	When also controlling the output voltage externally, turn on CV-V or CV-R.
CV-R	OFF/ON	
CC-V	OFF	Be sure to turn this off when CC-R is selected.
CC-R	ON	Selects output current control using an external resistor (CC-R)
OFF-MODE	A/B	Be sure to select A when not controlling OUTPUT/OFF using an external contact.
R-MODE		Selects 10 kΩ → 0 OUT mode
		Selects 10 kΩ → MAX OUT mode

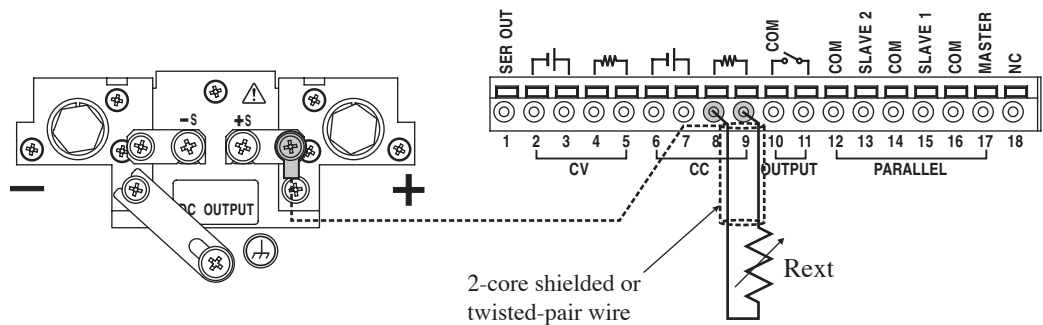


Fig. 4-10 CC-R connection

Output current I_o

10 kΩ → MAX OUT mode

$$I_o \approx \frac{I_{rtg} \times R_{ext}}{10000} \text{ [A]}$$

$$R_{ext} \leq 10000 \text{ [} \Omega \text{]}$$

I_{rtg} : Rated output current [A]

10 kΩ → 0 OUT mode

$$I_o \approx \frac{10000 - R_{ext}}{10000} \times I_{rtg} \text{ [A]}$$

Table 4-11 CC-R connection checklist

Item	Description
Insulation	The insulation of the Rext and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation." When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Secure connection	If Rext comes loose when using the 10 kΩ → MAX OUT mode, excessive voltage may be applied to the load. Securely connect the wires to the control terminal block. If there is a possibility that Rext will be cut off resulting in an open circuit, we recommend 10 kΩ → 0 OUT mode.
When using a fixed resistor for Rext and switching using a switch	When using a fixed resistor for Rext and switching using a switch. An excessive voltage may be applied to the load depending on the timing of the switch. Therefore, use a short-circuit or continuous switch.
Prevention of noise influence	To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Rext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using a shielded cable, connect the shield to the positive output terminal.
Current flowing through Rext	A current of approximately 0.1 mA flows through Rext at all times. For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

-
- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the Rext and the cable connecting to it should be greater than the isolation voltage of the power supply.
-

■ CC-R control source

The control source for CC-R control is an external resistor. The control source when combined with another analog control is indicated below.

Table 4-12 Combination of analog control and control source

Combination	Control Source for Output Current	Control Source for Output Voltage
CC-R only	External resistor	VOLTAGE knob
CC-R and CV-R		External resistor
CC-R and CV-V		External voltage and VOLTAGE knob

4.3.4 Connection and Setup for Output Current Control Using an External Voltage (CC-V)

This mode is used to control the output current using an external voltage in the range of 0 to approx. 10 V.

Table 4-13 CC-V switch setting

Switch	Setting	Description
CV-V	OFF/ON	When also controlling the output voltage externally, turn on CV-V or CV-R.
CV-R	OFF/ON	
CC-V	ON	Selects output current control using an external voltage (CC-V)
CC-R	OFF	Be sure to turn this off when CC-V is selected.
OFF-MODE	A/B	Be sure to select A when not controlling OUTPUT/OFF using an external contact.
R-MODE	▷ / ◁	When using CC-V only, this setting is arbitrary. When also using CV-R, select the mode.

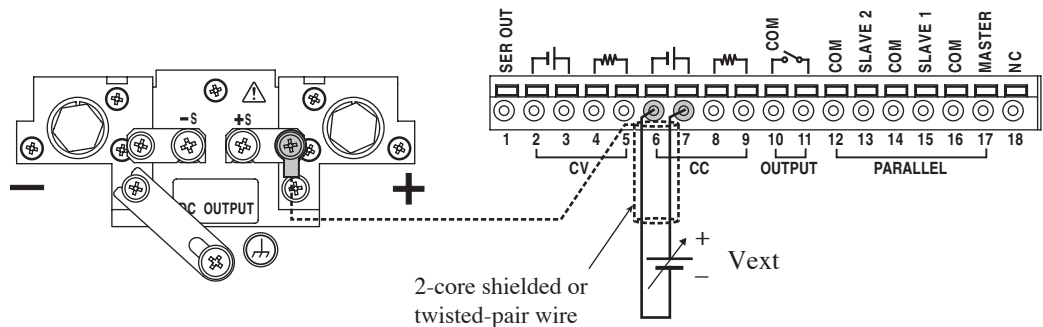


Fig. 4-11 CC-V connection

Output current I_o

$$I_o \approx \frac{I_{rtg} \times V_{ext} \times \beta}{10} \text{ [A]}$$

$$0 \leq V_{ext} \leq 10.3 \text{ [V]}$$

I_{rtg} : Rated output current [A]

β : Coefficient between 0 and 1 specified by the CURRENT knob position
 Counterclockwise all the way $\beta = 0$
 Clockwise all the way $\beta = 1$

NOTE

- Turn the CURRENT knob clockwise all the way.

Under CC-V control, the ratio of the output current with respect to the input voltage from V_{ext} can be adjusted using the CURRENT knob. Therefore, the knob must be turned clockwise all the way to allow external control up to the rated output current.

- To fix the output setting on the panel, use the guard cap provided.

Table 4-14 CC-V connection checklist

Item	Description
Insulation	<p>The insulation of the Vext and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation."</p> <p>When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.</p>
Secure connection	<p>If Vext comes loose, erroneous operation may result due to external noise. Securely connect the wires to the control terminal block.</p>
Vext polarity	<p>Do not apply voltage or reverse current exceeding 10.3 V across terminals 6 and 7 of the control terminal block. Otherwise, damage to the power supply may result. If the polarity is reversed, damage to the power supply may result.</p>
Relationship with the CURRENT knob	<p>When controlling the output current using an external voltage, the ratio of the output current with respect to the input voltage from Vext can be adjusted using the CURRENT knob. Therefore, the knob must be turned clockwise all the way to allow external control up to the rated output current. In addition, to fix the output setting on the panel, use the guard cap provided.</p>
Prevention of noise influence	<p>To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using a shielded cable, connect the shield to the positive output terminal. If the shield needs to be connected to the Vext side, see "Connecting the Shield to the Vext Side."</p>
Input impedance	<p>The input impedance across terminals 6 and 7 of the control terminal block is approximately 100 kΩ.</p>
Stable voltage source for Vext	<p>Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the power supply and appears at the power supply's output. Thus, the output ripple noise may not meet the power supply's specifications.</p>

-
- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the Vext and the cable connecting to it should be greater than the isolation voltage of the power supply. In addition, leave the output of the external voltage source (Vext) floating.
-

■ CC-V control source

The control source for CC-V control is an external voltage. The control source when combined with another analog control is indicated below.

Table 4-15 Combination of analog control and control source

Combination	Control Source for Output Current	Control Source for Output Voltage
CC-V only	External voltage	VOLTAGE knob
CC-V and CV-R		External resistor
CC-V and CV-V		External voltage and VOLTAGE knob

Connecting the shield to the Vext side

-
- ⚠ CAUTION** • Possible damage to internal circuit due to short circuit. If you are connecting the shield to the Vext side, do not connect the shield to the positive output terminal of the power supply.
-

When using shielded wires, some of Vexts may require that the shield be connected to the Vext.

In such case, the grounding method used for Vext and the power supply creates a condition in which the output is short-circuited, as shown in Fig. 4-12. Thus, do not connect the shield to the positive output terminal of the power supply.

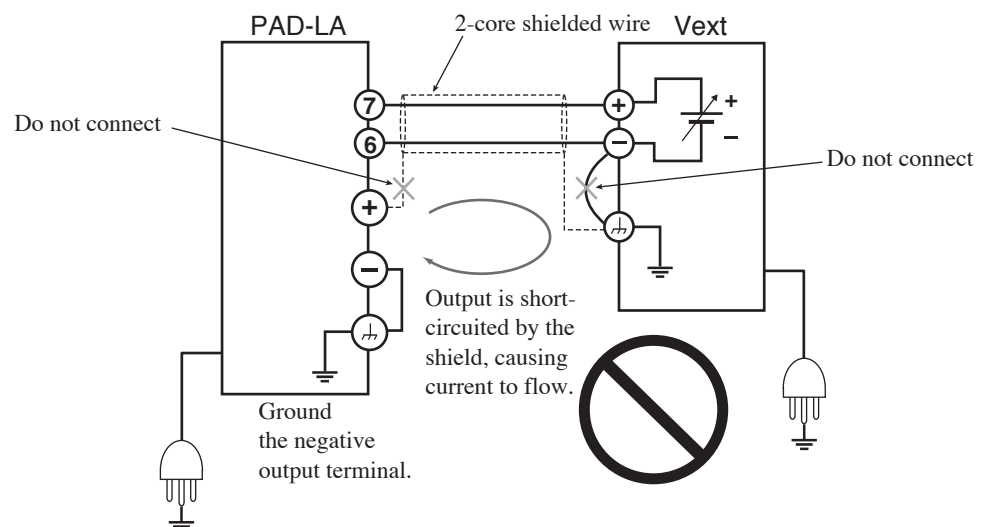


Fig. 4-12 A connection in which the output is short-circuited by the shield

-
- ⚠ WARNING** • Possible damage to internal circuit due to short circuit. Leave the output of the external voltage source (Vext) floating. Since terminals 6 and 7 of the control terminal block are at approximately the same potential as the positive output terminal, short-circuit current flows through the signal wire even without a shield.
-

4.3.5 Connection and Setup for OUTPUT ON/OFF Control Using an External Contact

This mode is used to control the output on/off status using an external contact. One of two modes can be selected.

Table 4-16 OUTPUT ON/OFF control mode using an external contact

Control Mode	Description
A mode	Mode in which the output is turned off when the external contact closes
B mode	Mode in which the output is turned on when the external contact closes

The OUTPUT switch on the front panel is valid at all times, and OFF is prioritized. Therefore, the OUTPUT switch on the front panel must be turned on to allow OUTPUT on/off control using an external contact. See Fig. 4-17.

Table 4-17 Switch settings and output status

Control Mode	OUTPUT on the Front Panel	SwitchExternal contact	Output status
A mode (OFF-MODE switch is A)	ON	ON (close)	OFF
		OFF (open)	ON
	OFF	ON (close)	OFF
		OFF (open)	OFF
B mode (OFF-MODE switch is B)	ON	ON (close)	ON
		OFF (open)	OFF
	OFF	ON (close)	OFF
		OFF (open)	OFF

NOTE

- Set OFF-MODE switch to A when not using the OUTPUT ON/OFF control using an external contact. Otherwise, the output cannot be turned on/off using the OUTPUT switch on the front panel.

Table 4-18 OUTPUT ON/OFF switch setting

Switch	Setting	Description
CV-V	OFF/ON	When controlling the output voltage externally, turn on CV-V or CV-R.
CV-R	OFF/ON	
CC-V	OFF/ON	When controlling the output current externally, turn on CC-V or CC-R.
CC-R	OFF/ON	
OFF-MODE	A	Selects A mode (output turns OFF when the external contact is closed)
	B	Selects B mode (output turns ON when the external contact is closed)
R-MODE	▷ / ◁	When also using CV-R and/or CC-R, select the mode.

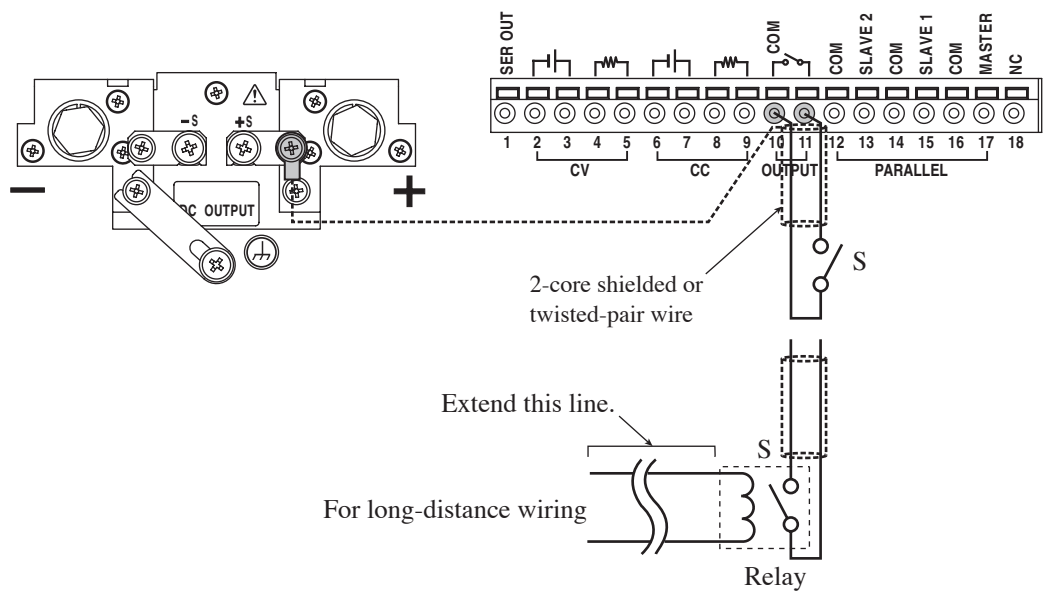


Fig. 4-13 OUTPUT ON/OFF connection

Table 4-19 OUTPUT ON/OFF connection checklist

Item	Description
Insulation	<p>The insulation of the external contact (S) and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation."</p> <p>When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.</p>
Negative voltage when output is turned off	<p>A negative voltage of approximately 0.1 V may be generated when the output is turned off causing a reverse current in the order of 10 mA to flow.</p>
Prevention of noise influence	<p>To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Vext. Make the wires as short as possible. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using a shielded cable, connect the shield to the positive output terminal.</p>
Potential of the terminal used	<p>Terminal 10 of the control terminal block is the common terminal for the control circuit. Inside the power supply, it is connected to +S.</p>
Performance of the external contact	<p>The open-circuit voltage across terminals 10 and 11 of the control terminal block is approximately 5 V. The short-circuit current between the two is approximately 1.5 mA. Use external contacts with a contact rating of at least 10 VDC and 10 mA.</p>
Measures for long-distance wiring	<p>When wiring over a great distance, use a small relay and extend the coil side of that relay.</p>

-
- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the external contact (S) and the cable connecting to it should be greater than the isolation voltage of the power supply.
-

4.3.6 Connection and Setup for Output Shutdown (TRIP) Control Using an External Contact

The output can be tripped using an external contact such as when abnormalities occur. When the external contact is closed, the POWER switch is turned off.

When turning the POWER back on, wait approximately 60 s, remove the cause that caused the external contact to close, and then turn on the POWER switch. When using a load with accumulated energy such as batteries, take into account the reverse current that flows through the power supply. For details, see section 2.3.3, "When the Load Has Accumulated Energy such as Batteries"

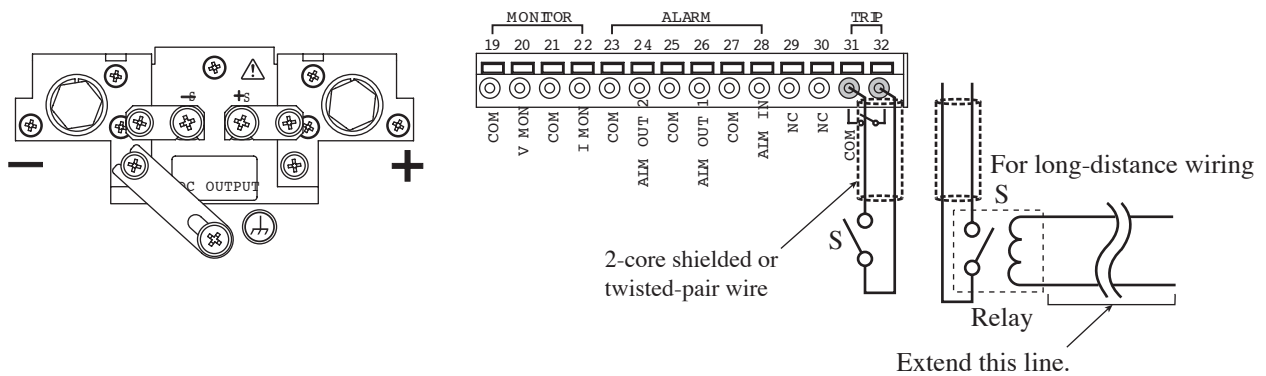


Fig. 4-14 TRIP connection

Table 4-20 TRIP connection checklist

Item	Description
Insulation	The insulation of the external contact (S) and the cable connecting to it should be greater than the isolation voltage of the power supply. For details, see section 2.6, "Output Terminal Isolation." When using shielded wires, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Prevention of noise influence	To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect the control terminal and Vext. Make the wires as short as possible.
Potential of the terminal used	Terminal 31 of the control terminal block is the common terminal for the control circuit. It is isolated from other terminals and the output terminal.
Performance of the external contact	The open-circuit voltage across terminals 31 and 32 of the control terminal block is approximately 5 V. The short-circuit current between the two is approximately 1.5 mA. Use external contacts with a contact rating of at least 10 VDC and 10 mA.
Measures for long-distance wiring	When wiring over a great distance, use a small relay and extend the coil side of that relay.

- ⚠ WARNING** • Possible electric shock and damage to internal circuit. The insulation of the external contact (S) and the cable connecting to it should be greater than the isolation voltage of the power supply.

4.4 Master-Slave Parallel Operation

Up to two slave power supplies can be connected in parallel with a master power supply to increase the current capacity. In master-slave parallel operation, the total output of the power supplies connected in parallel can be controlled using only the master power supply.

When using master-slave parallel operation, an electrolytic capacitor is required at the load end.

-
- CAUTION**
- Connecting power supplies with different rated outputs can cause a malfunction. Only PAD-LA series power supplies with the same rated output voltage and rated output current can be connected in parallel.
 - Be sure to use master-slave parallel operation when using parallel operation. Simply connecting the output of each power supply in parallel can cause a malfunction.
-

■ OVP/OCP trip point setting during master-slave parallel operation

When using parallel operation, be sure to set the OVP (overvoltage protection) trip point on the slave power supplies in addition to the master power supply. Set the OVP trip point of the slave power supply approximately 1 % higher than the OVP trip point setting of the master power supply. However, do not set a value exceeding 103 % of the rated voltage.

Likewise, set the OCP (overcurrent protection) trip point.

The protection circuit may trip on the slave power supply before the master power supply due to the effects of errors in setting. OVP/OCP trip operation is indicated in Table 4-21.

Table 4-21 Operation when the protection circuit is tripped

Power supply in which the protection circuit tripped first	Operation
Master	Only the POWER switch on the master power supply is turned off to turn off the output.
Slave	The POWER switches on the master and slave power supplies are turned off to turn off the output.

-
- CAUTION**
- Burnout may occur in the load. Securely connect the control wires. If the wiring comes loose, the POWER switch on the master power supply will not turn OFF even when the protection circuit on the slave power supply is tripped. (Output will remain on.)
-

Connection and setup procedure

1. Turn off the OUTPUT switches of all power supplies.
2. Turn off the POWER switches of all power supplies.
3. Choose the power supply that will be the master.
4. Set the OVP (overvoltage protection) trip point on the master and slave power supplies.
Set the OVP trip point of the slave power supply approximately 1 % higher than the OVP trip point setting of the master power supply. However, do not set a value exceeding 103 % of the rated voltage.
5. Set the M/S switch on the master and slave power supplies as shown in Fig. 4-15.
6. Connect the master and slave power supplies as shown in Fig. 4-16.
The figure shows the case when two slave power supplies are connected.
7. As necessary, connect an electrolytic capacitor (C) between 100 to 100000 μF at the load end.

-
- ⚠ WARNING** • Use a load cable with sufficient current capacity with respect to the rated current.
- ⚠ CAUTION** • Use wires of the same length and thickness for connecting each power supply to the load. Otherwise, the output current of each power supply may not match.
- Take measures to securely connect the load cable to the terminals such as by using crimp terminals.
 - Attach the output terminal cover after making the parallel connection.
 - Install power supplies with sufficient space in between. Do not stack the power supplies.
-

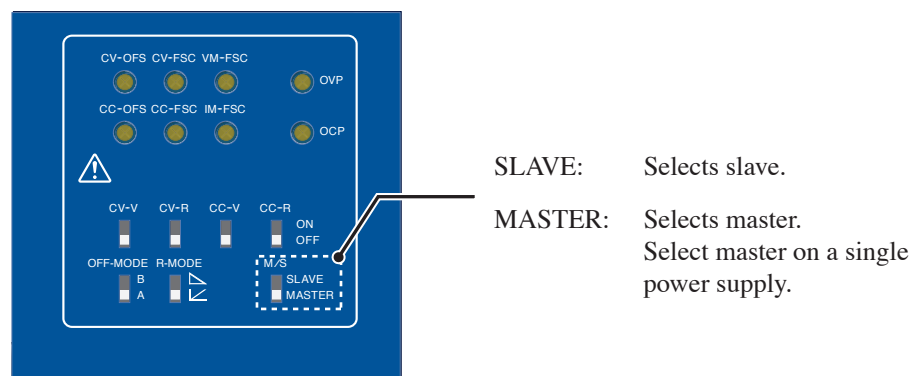


Fig. 4-15 Master-slave parallel operation setup

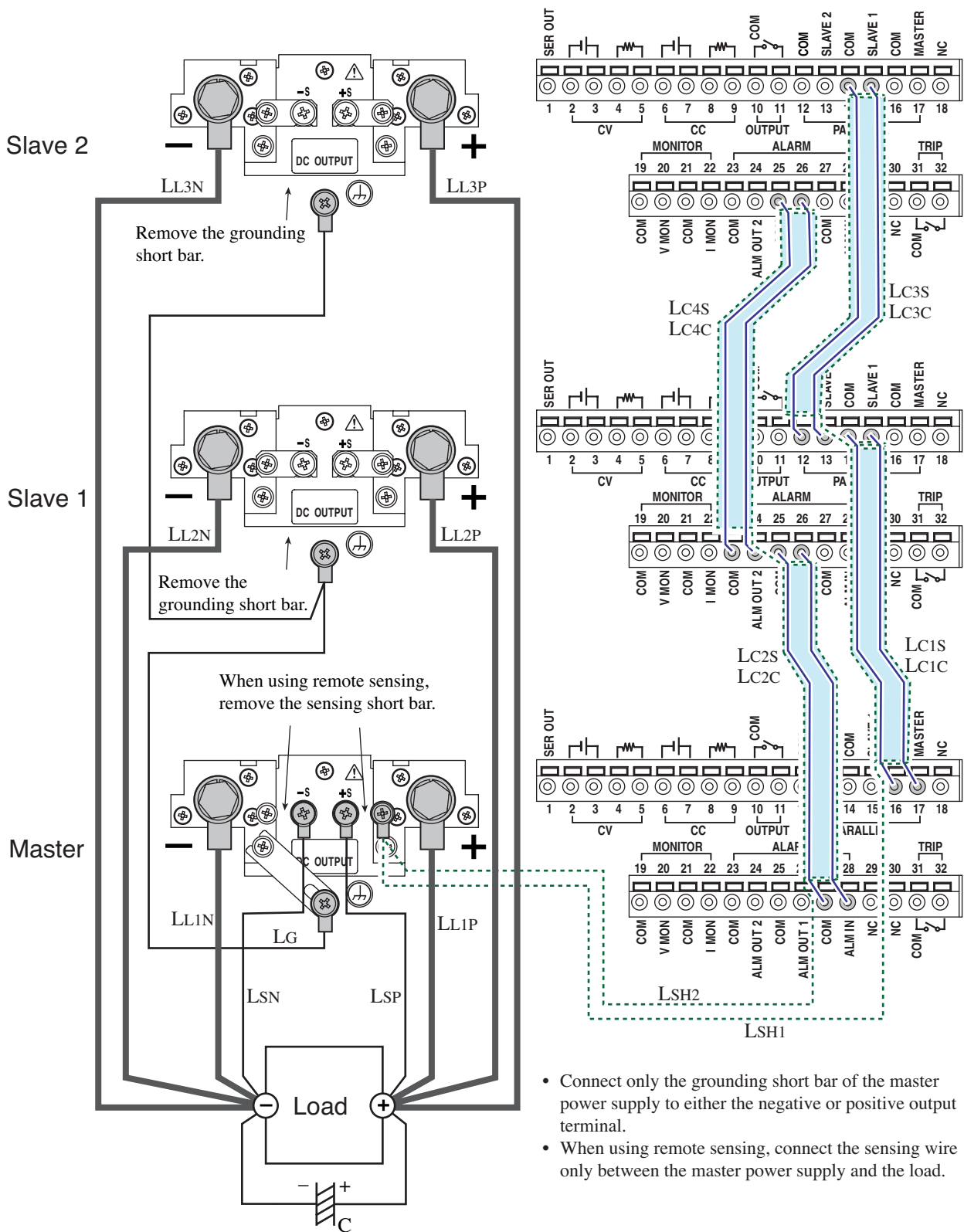


Fig. 4-16 Master-slave parallel operation connection

- Connect only the grounding short bar of the master power supply to either the negative or positive output terminal.
- When using remote sensing, connect the sensing wire only between the master power supply and the load.

Table 4-22 Master-slave parallel operation wiring list

Wiring Name	Load Terminal		Master Terminal		Slave 1 Terminal		Slave 2 Terminal	Note
Control wire								
LC1S			Terminal 17 (MASTER)	↔	Terminal 15 (SLAVE1)			
LC1C			Terminal 16 (COM)	↔	Terminal 14 (COM)			
LC2S			Terminal 28 (ALM IN)	↔	Terminal 26 (ALM OUT 1)			
LC2C			Terminal 27 (COM)	↔	Terminal 25 (COM)			
LC3S					Terminal 13 (SLAVE2)	↔	Terminal 15 (SLAVE1)	
LC3C					Terminal 12 (COM)	↔	Terminal 14 (COM)	
LC4S					Terminal 24 (ALM OUT 2)	↔	Terminal 26 (ALM OUT 1)	
LC4C					Terminal 23 (COM)	↔	Terminal 25 (COM)	
LSH1			Positive output terminal	↔	LC1 shield	↔	LC3 shield	Wire only when a shielded wire is used for the control wire.
LSH2			Positive output terminal	↔	LC2 shield	↔	LC4 shield	
Load wire								
LL1P	Positive input terminal	↔	Positive output terminal					Use same wires for connecting to the load. Make the length as close as possible.
LL1N	Negative input terminal	↔	Negative output terminal					
LL2P	Positive input terminal	↔			Positive output terminal			
LL2N	Negative input terminal	↔			Negative output terminal			
LL3P	Positive input terminal	↔					Positive output terminal	
LL3N	Negative input terminal	↔					Negative output terminal	
Grounding wire								
LG			Chassis terminal	↔	Chassis terminal	↔	Chassis terminal	Remove the grounding short bar of the slave power supply.
Sensing wire								
LSP	Positive input terminal	↔	+S terminal					When using remote sensing, wire only the master power supply.
LSN	Negative input terminal	↔	-S terminal					

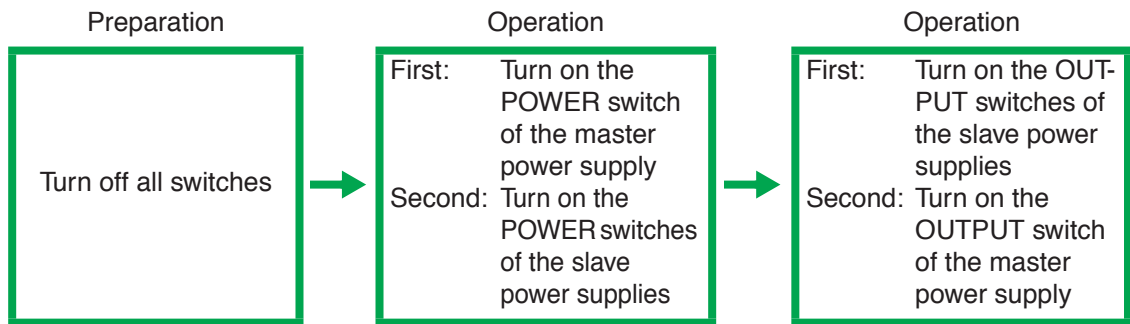
Table 4-23 Master-slave parallel operation connection checklist

Item	Description
Load wire	Use wires with sufficient current capacity with respect to the rated current. Use wires of the same length and thickness for connecting each power supply to the load. Otherwise, the output current of each power supply may not match.
Secure connection	Take measures to securely connect the load cable to the terminals such as by using crimp terminals.
Wiring length	If the wiring to a load is longer than 3 m, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation. In such case, the capacitor (C) prevents oscillation.
Withstanding voltage of the electrolytic capacitor	Use a capacitor (C) whose withstanding voltage is greater than or equal to 120 % of the power supply's rated voltage.
Induction prevention	To minimize the influence of noise on the output, use a 2-core shielded wire or a twisted-pair wire to connect between the control terminals. Susceptibility to the effects of noise increases as the wires get longer. When wires are long, proper operation may be hindered even if a cable with anti-noise measures is used. When using shielded wires, connect the shield between the master and slave power supplies to the positive terminal of the master power supply. Connect the shield between slave power supplies to the shield between the master and slave power supplies.
Insulation	When using shielded wires for connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the power supply.
Output terminal cover	Attach the output terminal cover after making the parallel connection.
When using remote sensing	When using remote sensing during master-slave parallel operation, wire only the master power supply. For the connection procedure of the remote sensing function, see section 4.1, "Remote Sensing."
Installation spacing	Install power supplies with sufficient space in between. Do not stack the power supplies.

Starting the parallel operation

Overview of the procedure

The POWER switch and OUTPUT switch on the master and slave power supplies must be turned on in a certain order.



- ⚠ CAUTION** • When starting master-slave parallel operation, be sure to follow the procedure below. Since the slave power supply is under master power supply's control, improper procedure may cause the slave power supply to output the maximum output voltage.

1. Turn off the OUTPUT switches of all power supplies.
2. Turn on the POWER switch of the master power supply.
3. Turn on the POWER switch of the slave power supply.
4. Turn the VOLTAGE and CURRENT knobs of the slave power supply clockwise all the way.

If the output setting of the slave power supply is not set to the maximum, the slave power supply will not be able to follow the output setting of the master power supply.

5. While holding down the SET switch on the master power supply, set the output voltage and output current.

The actual output current setting is the value specified on the master power supply multiplied by the number of power supplies.

When the SET switch on the slave power supply is pressed, the current reading is a value that has no relevance to the output current.

6. Turn on the OUTPUT switch of the slave power supply.

The CC LED illuminates on the control panel of the slave power supply indicating that the power supply is in constant current operation.

7. Turn on the OUTPUT switch of the master power supply.

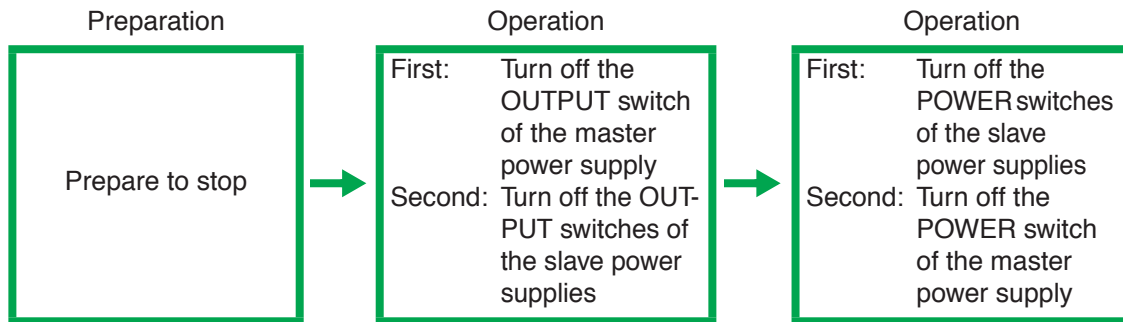
The CV LED illuminates on the control panel of the master power supply indicating that the power supply is in constant voltage operation.

The output voltage and output current on the slave power supply shows the same values as those of the master power supply. This means that the total of the current values of all power supplies is flowing through the load.

Stopping the parallel operation

Overview of the procedure

The POWER switch and OUTPUT switch on the master and slave power supplies must be turned off in a certain order.



⚠ CAUTION • When stopping master-slave parallel operation, be sure to follow the procedure below. If the POWER switch of the master power supply is turned off first while parallel operation is in progress, the slave power supplies may output the maximum output voltage.

1. Turn off the OUTPUT switch of the master power supply.
2. Turn off the OUTPUT switch of the slave power supply.
3. Turn off the POWER switch of the slave power supply.
4. Turn off the POWER switch of the master power supply.

4.5 Master-Slave Series Operation

Up to two slave power supplies (one in the case of the PAD250-8LA or the PAD250-15LA) can be connected in series with a master power supply to increase the output voltage. In master-slave series operation, the total output of the power supplies connected in series can be controlled using only the master power supply.

⚠ WARNING • Be sure to observe the maximum number of slave power supplies that can be connected in series. If the maximum output voltage of the power supplies connected in series exceeds the isolation voltage, electric shock may occur.

⚠ CAUTION • Only PAD-LA series power supplies with the same rated output voltage and rated output current can be connected in series. Connecting power supplies with different rated outputs can cause a malfunction.

- Be sure to use master-slave series operation when using series operation. Simply connecting the output of each power supply in series can cause a malfunction.
- When using master-slave series operation, the rise time of the output is delay by the number of power supplies connected in series, because the master and slave power supplies are powered up in order. Consequently, an AC ripple component may be superimposed on the output. If the rise waveform causes a problem, use a single high-voltage model.

NOTE • Wire the output cables connecting the power supplies as thick and as short as possible. If the voltage drop in the output cable is large, the difference in potential between power supply units and load fluctuations becomes large.

■ OVP/OCP trip point setting during Master-Slave series operation

When using series operation, be sure to set the OVP (overvoltage protection) trip point on the slave power supplies in addition to the master power supply. Set the OVP trip point of the slave power supply approximately 1 % higher than the OVP trip point setting of the master power supply.

Likewise, set the OCP (overcurrent protection) trip point.

Table 4-24 Operation when the protection circuit is tripped

Power supply in which the protection circuit tripped first	Operation
Master	Only the POWER switch on the master power supply is turned off to turn off the output.
Slave	Only the POWER switch on the slave power supply is turned off to turn off the output.

Connection and setup procedure

1. Turn off the OUTPUT switches of all power supplies.
2. Turn off the POWER switches of all power supplies.
3. Choose the power supply that will be the master.
4. Set the OVP/OCP trip point on the master and slave power supplies.
Set the OVP/OCP trip point of the slave power supply approximately 1 % higher than the OVP/OCP trip point setting of the master power supply.
5. Set the CV-V switch on the master and slave power supplies as shown in Fig. 4-17.
In master-slave series operation, the M/S switch is not used to set the master and slave power supplies. Set the M/S switch on all power supplies to the MASTER position.
6. Connect the master and slave power supplies as shown in Fig. 4-18.
The figure shows the case when two slave power supplies are connected.

-
- ⚠ WARNING** • Use a load cable with sufficient current capacity with respect to the rated current.
- ⚠ CAUTION** • Take measures to securely connect the load cable to the terminals such as by using crimp terminals.
- Attach the output terminal cover after making the series connection.
 - Install power supplies with sufficient space in between. Do not stack the power supplies.
 - Connect either the negative output terminal or the positive output terminal to the chassis terminal using the short bar.
-

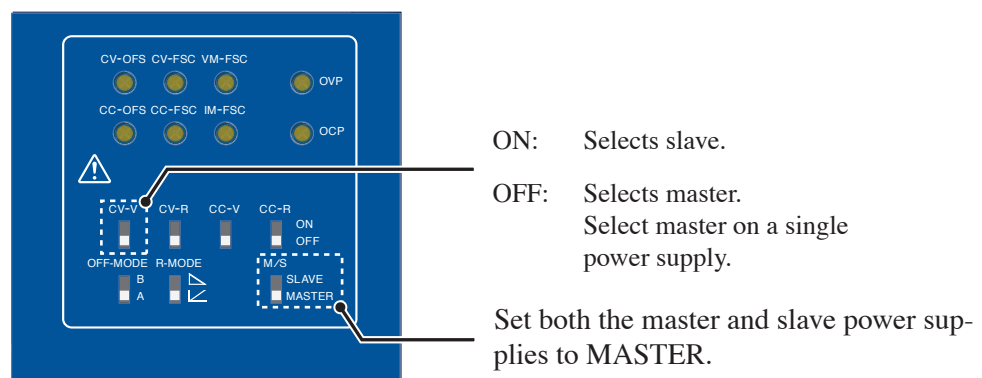


Fig. 4-17 Master-slave series operation setup

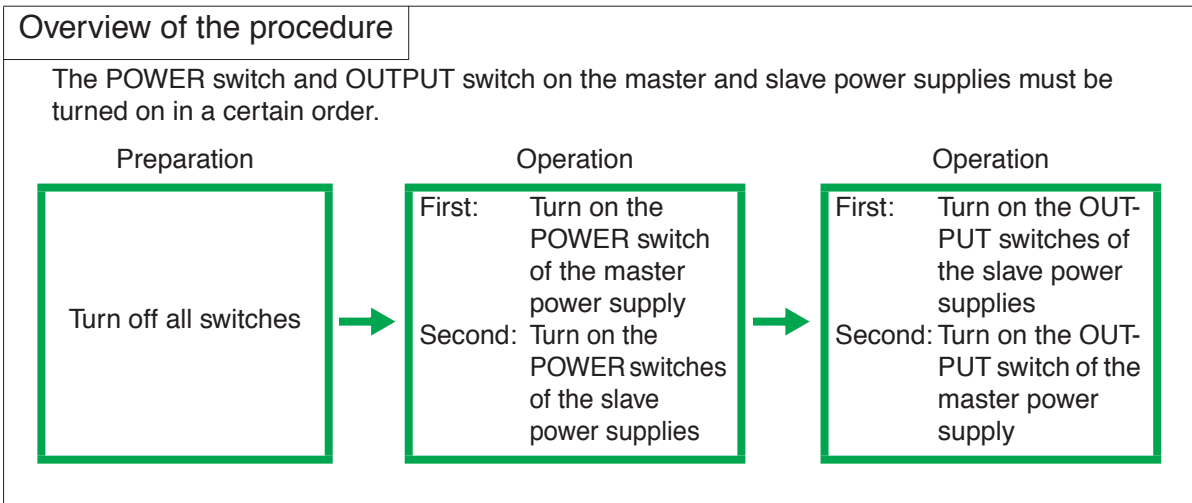
Table 4-25 Master-slave series operation wiring list

Wiring Name	Load Terminal		Master Terminal		Slave 1 Terminal		Slave 2 Terminal	Note
Control wire								
LC1			Terminal 1 (SER OUT)	↔	Terminal 3 (CV-V)			
LC2					Terminal 1 (SER OUT)	↔	Terminal 3 (CV-V)	
LSH			Positive output terminal	↔	LC1 shield	↔	LC2 shield	Wire only when a shielded wire is used for the control wire.
Load wire								
LL1	Positive input terminal	↔	Positive output terminal					Use same wires for connecting to the load. Make the length as close as possible.
LL2	Negative input terminal	↔					Negative output terminal	
LL3			Negative input terminal	↔	Positive output terminal			
LL4					Negative output terminal	↔	Positive output terminal	
Grounding wire								
LG			Chassis terminal	↔	Chassis terminal	↔	Chassis terminal	Connect the grounding short bar to either the negative output terminal or the positive output terminal.
Sensing wire								
LSP	Positive input terminal	↔	+S terminal					When using remote sensing, connect the sensing wire between the +S terminal of the master power supply and the load and between the -S terminal of the slave power supply at the end of the chain and the load.
LSN	Negative input terminal	↔					-S terminal	

Table 4-26 Master-slave series operation connection checklist

Item	Description
Load wire	Use wires with sufficient current capacity with respect to the rated current.
Secure connection	Take measures to securely connect the load cable to the terminals such as by using crimp terminals.
⚠ Chassis terminal	Connect either the negative output terminal or the positive output terminal to the chassis terminal using the short bar.
Output terminal cover	Attach the output terminal cover after making the series connection.
Installation spacing	Install power supplies with sufficient space in between. Do not stack the power supplies.

Starting the series operation



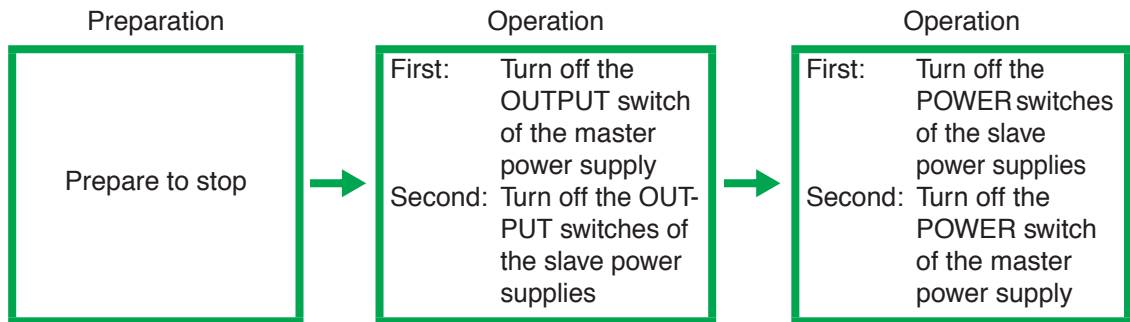
CAUTION • When starting master-slave series operation, be sure to follow the procedure below. Since the slave power supply is under the master power supply's control, do not turn on the POWER switch of the slave power supply first.

1. Turn off the OUTPUT switches of all power supplies.
2. Turn on the POWER switch of the master power supply.
3. Turn on the POWER switch of the slave power supply.
4. Turn the VOLTAGE and CURRENT knobs of the slave power supply clockwise all the way.
If the output setting of the slave power supply is not set to the maximum, the slave power supply will not be able to follow the output setting of the master power supply.
5. While holding down the SET switch on the master power supply, set the output voltage and output current.
The actual output voltage setting is the value specified on the master power supply multiplied by the number of power supplies.
6. Turn on the OUTPUT switch of the slave power supply.
The CV LED illuminates on the control panel of the slave power supply indicating that the power supply is in constant voltage operation.
7. Turn on the OUTPUT switch of the master power supply.
The CV LED illuminates on the control panel of the master power supply indicating that the power supply is in constant voltage operation.
The output voltage and output current on the slave power supply shows the same values as those of the master power supply. This means that the total of the voltage values of all power supplies is applied to the load.

Stopping the series operation

Overview of the procedure

The POWER switch and OUTPUT switch on the master and slave power supplies must be turned off in a certain order.



⚠ CAUTION • When stopping master-slave series operation, be sure to follow the procedure below. If the POWER switch of the master power supply is turned off first while series operation is in progress, the slave power supplies may not operate properly.

1. Turn off the OUTPUT switch of the master power supply.
2. Turn off the OUTPUT switch of the slave power supply.
3. Turn off the POWER switch of the slave power supply.
4. Turn off the POWER switch of the master power supply.

4.6 External Monitoring of the Output

Output voltage and output current monitor outputs are provided on the control terminal block.

Table 4-27 Monitor output of output voltage and output current

Terminal No.	Signal Name	Operation
19	V MONITOR COM	Common terminal of the output voltage monitor
20	V MONITOR OUT	Output voltage monitor output 0 V to approx. 10 V for 0 to rated output voltage
21	I MONITOR COM	Common terminal of the output current monitor
22	I MONITOR OUT	Monitor output of output current 0 V to approx. 1 V for 0 to rated output current

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. Never connect wires to the control terminal block while the POWER switch is turned on.
 - The insulation of the cable connecting to the monitor terminal should be greater than the isolation voltage of the power supply.
 - Electric shock or damage to the internal circuit may result if wire scraps protruding from the control terminal board come in contact with the chassis. Insert wires to the control terminal board so that the stripped sections do not protrude from the terminal board.


The control terminal board is at approximately the same electrical potential as the positive output terminal of the power supply.

- ⚠ CAUTION**
- Shorting the V MONITOR OUT terminal or the I MONITOR OUT terminal and the COM terminal can cause a malfunction.
-

5

Chapter 5 Names and Functions of Controls

This chapter describes the names and functions of switches, displays, terminals, and other parts of the front panel and rear panel.

Read this chapter to learn about the details of the  (alert) marks inscribed on the panel.

5.1 Front Panel

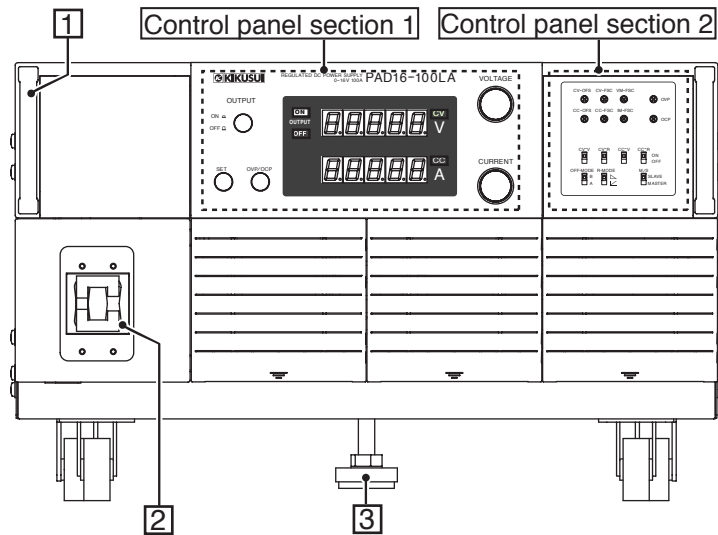


Fig.5-1 PAD-LA series front panel (Type III model)

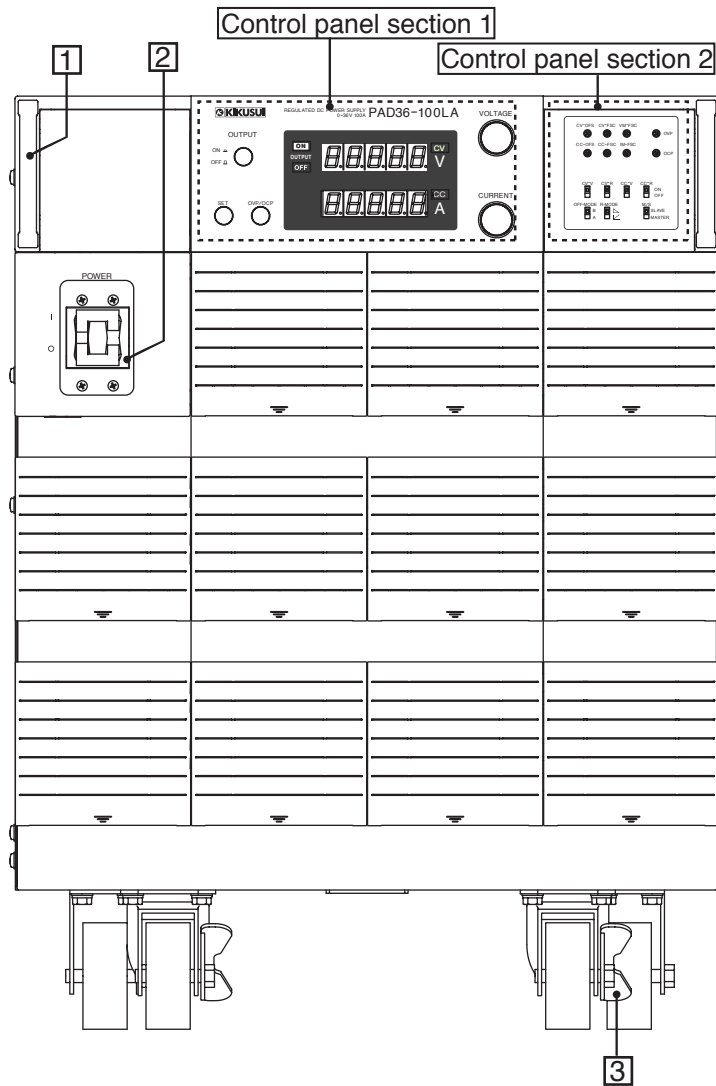


Fig. 5-2 PAD-LA series front panel (Type IV model)

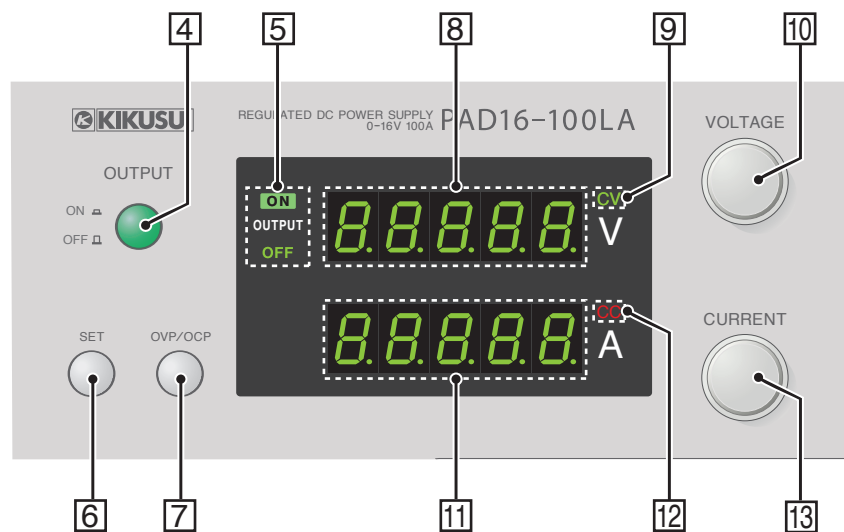


Fig. 5-3 Control panel section 1

[1] Handle

The handles are used to grab the power supply when moving power supply on the casters. The handles are not strong enough to support the weight of the power supply.

[2] POWER switch

Power switch of the power supply. Set the lever to the up position for ON (|) and down position for OFF (○).

[3] Stopper

Used to fix the power supply in place at the installation location. For the procedure of fixing the power supply in place, see “When fixing the power supply at the installation location” in section 1.2, “Precautions Concerning Installation Location.”

[4] OUTPUT switch

Output on/off switch. Depressed condition is on. When the output is turned off, the output of the power supply is at high impedance (several k Ω).

[5] OUTPUT ON/OFF indicator

Indicates the output status.

[6] SET switch

Used to set or check the output voltage value or output current value. The current preset voltage and current are indicated by using the knob on the panel or an external analog signal while this switch is held down.

[7] OVP/OCP switch

Used to set or check the OVP (overvoltage protection) and OCP (overcurrent protection) trip points. The current preset OVP voltage and OCP current are indicated while this switch is held down.

[8] Voltmeter

Displays the output voltage. However, the display indicates the preset output voltage when the [6] SET switch is held down and the OVP voltage when the [7] OVP/OCP switch is held down.

[9] CV indicator

When the power supply is in constant voltage operation, CV (Constant Voltage) illuminates.

[10] VOLTAGE knob

Sets the output voltage. (10 rotations)

[11] Ammeter

Displays the output current. However, the display indicates the preset output current when the [6] SET switch is held down and the OCP current when the [7] OVP/OCP switch is held down.

[12] CC indicator

When the power supply is in constant current operation, CC (Constant Current) illuminates.

[13] CURRENT knob

Sets the output current. (10 rotations)

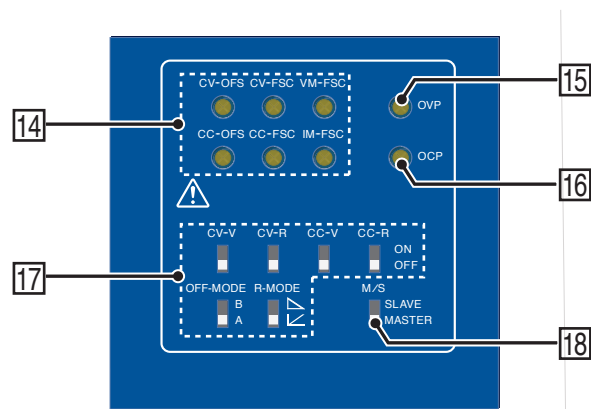


Fig. 5-4 Control panel section 2

[14] Adjustment variable resistor

Variable resistor used to adjust the output and display. For the adjustment procedure, see section 6.3, “Adjustment.”

[15] OVP variable resistor

Variable resistor used to set the OVP trip point. For the setup procedure, see section 3.2.1, “Setting the OVP (Overvoltage Protection) and OCP (Overcurrent Protection) Trip Points.”

[16] OCP variable resistor

Variable resistor used to set the OCP trip point. For the setup procedure, see section 3.2.1, “Setting the OVP (Overvoltage Protection) and OCP (Overcurrent Protection) Trip Points.”

[17] Remote control setup switch

Switch used to set the analog remote control operation mode. For details, see section 4.3, “Analog Remote Control.”

[18] M/S switch

Switch used to set master or slave when performing master-slave parallel operation or master-slave series operation. For details, see section 4.4, “Master-Slave Parallel Operation” or 4.5, “Master-Slave Series Operation.”

5.2 Rear Panel

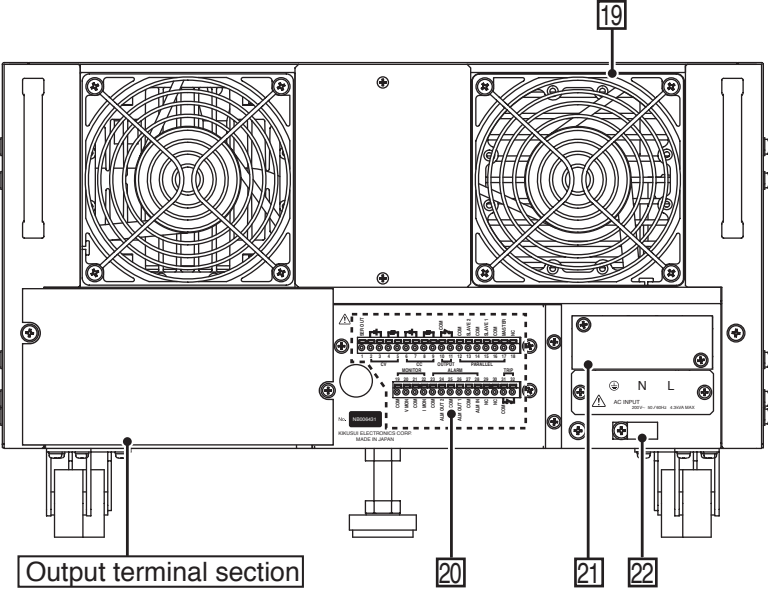


Fig. 5-5 PAD-LA series rear panel (Type III model)

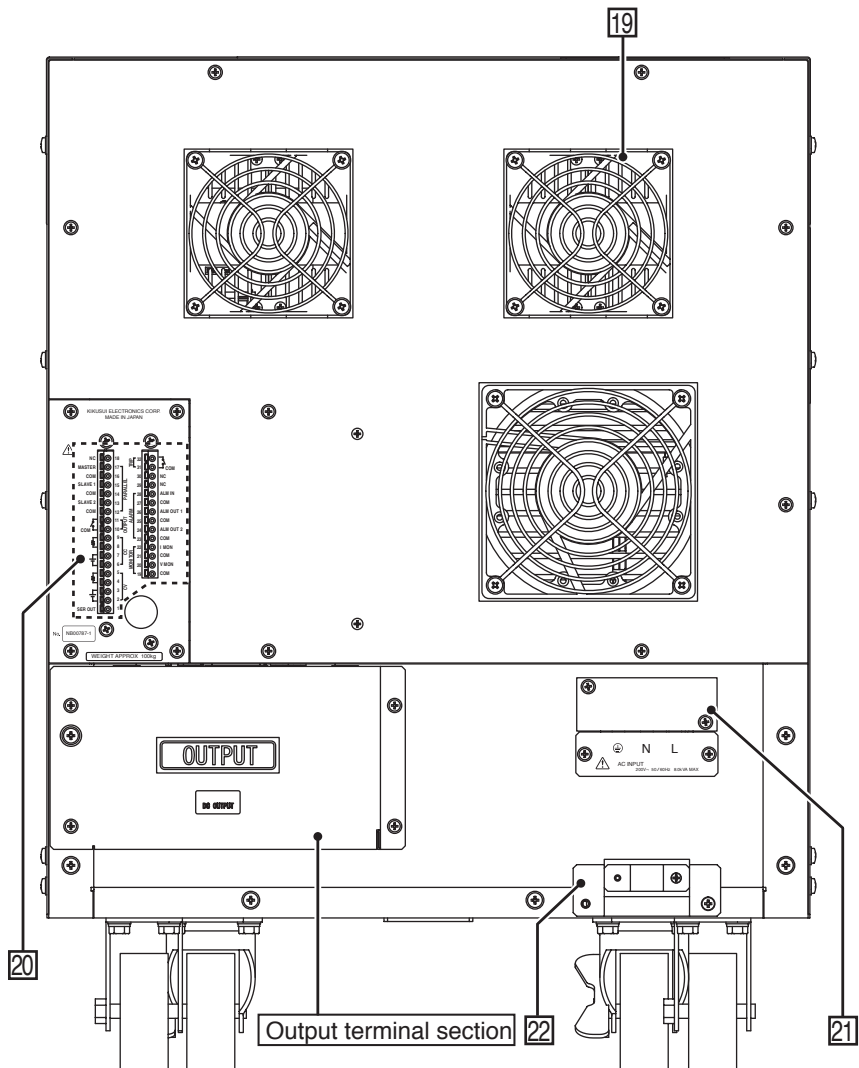


Fig. 5-6 PAD-LA series rear panel (Type IV model)

[19] Exhaust port

Exhaust port used to exhaust the internal heat using a fan. Provide adequate space around the power supply to allow sufficient air circulation.

[20] Control terminal block

Terminal block used to perform application operations such as remote control.

⚠ WARNING • Improper handling can lead electric shock. For details, see chapter 4, “Application Operation.”

[21] AC INPUT terminal block

AC input terminal. Connect the power cord that came with the package.

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. Be sure to follow the directions given in section 1.4, “Connecting the Power Cord.”
 - Be sure to ground the protective conductor terminal. For details, see section 1.5, “Grounding.”
-

[22] Cable clamp

Fixes the power cord to the panel.

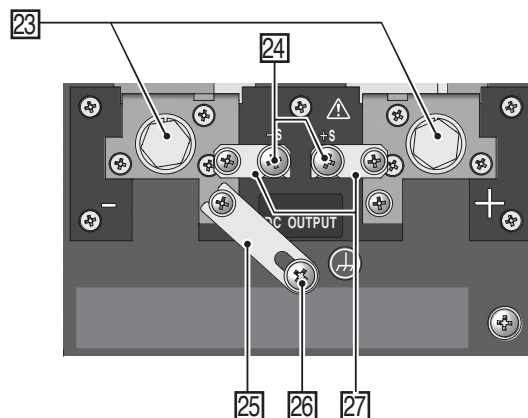


Fig. 5-7 Output terminal section

[23] DC OUTPUT terminal

Output terminal.

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. Be sure to turn off the POWER switch when touching this terminal.
-

[24] Sensing terminal

Used when using the sensing function. For details on its use, see section 4.1, “Remote Sensing.”

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. Be sure to turn off the POWER switch when touching this terminal.

- ⚠ CAUTION**
- Possible damage to internal circuit. Do not remove the load from the sensing terminal.
-

[25] Grounding short bar

Used to connect the negative or positive output terminal to the chassis terminal.

[26] Chassis terminal

Connected to the chassis of the power supply.

[27] Sensing short bar

Used to connect the sensing terminal and the output terminal. Be sure the terminal is connected when not using the sensing function.



6

Chapter 6 Maintenance

This chapter describes maintenance and calibration of the power supply. It also describes troubleshooting measures when you suspect a malfunction in the power supply.

⚠ WARNING • Possible electric shock. May lead to death or injury. Do not remove the external cover.

6.1 Cleaning

⚠ WARNING • Possible electric shock. May lead to death or injury. Be sure to turn off the POWER switch and the switchboard switch.

6.1.1 Cleaning the Panels

If the panel needs cleaning, gently wipe using a soft cloth with water-diluted neutral detergent.

⚠ CAUTION • Do not use volatile solvents such as thinner or benzene. They may discolor the surface, erase printed characters, or cloud the display.

6.1.2 Cleaning the Dust Filter

A dust filter is installed on the inside of the louver on the front panel. Periodically clean the filter to prevent clogging.

⚠ CAUTION • Clogged filters hinder the cooling of the inside of the power supply and can cause a malfunction and shortening of the service life.

Cleaning procedure

1. Remove the louver from the panel by placing a finger on the 2nd level of the louver and pulling down the 1st level while pulling it toward you.
If the louver does not come off easily, pressing down the top level of the louver will ease the work.

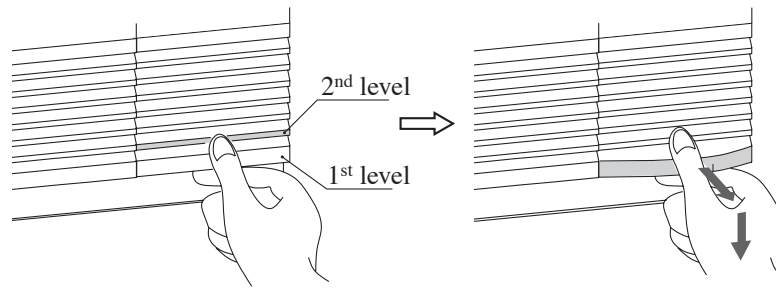


Fig.6-1 Removing the louver

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

Remove the dust on the dust filter such as by using a vacuum cleaner. If the filter is extremely dirty, clean it using a water-diluted neutral detergent and dry it completely.

⚠ CAUTION • When the power supply is in operation, air is sucked through the dust filter to cool the power supply. If moisture is included in the dust filter, the temperature or humidity inside the power supply increases and may cause a malfunction.

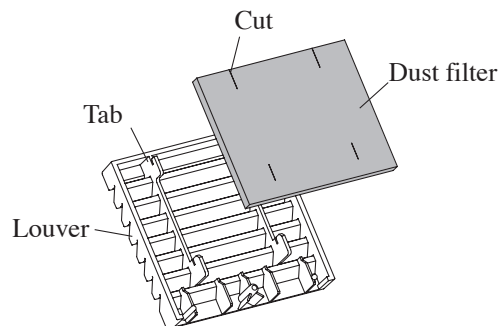


Fig. 6-2 Dust filter

3. Attach the dust filter to the louver.

Attach it so that the tab on the louver fits into the cut on the dust filter.

4. Attach the louver to the panel by pulling up on the louver while holding the 2nd level of the louver with your hand until the pin is fixed in place.

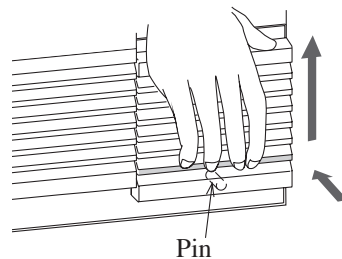


Fig. 6-3 Attaching the louver

6.2 Inspection

Power cord

Check that the insulation coating is not broken and that the crimp terminal is not loose.

-
- ⚠ WARNING**
- Possible electric shock. May lead to death or injury. Be sure to turn off the POWER switch and the switchboard switch.
 - Breaks in the insulation coating may cause electric shock. If a break is found, stop using it immediately.
-

To purchase accessories, contact your Kikusui agent or distributor.

6.3 Adjustment

The power supply is adjusted at the factory before shipment. However, adjustment is necessary after a long period of use.

For adjustment, contact your Kikusui agent or distributor. If you wish to adjust the power supply yourself, follow the procedure below.

6.3.1 Test Equipment Required

For adjustment, the following equipment is necessary.

- DC voltmeter (DVM): Measuring accuracy of 0.02 % or better
- Shunt resistor: Accuracy of 0.1 % or better
(a resistor capable of handling the rated output current of the PAD-LA series power supply being adjusted)

6.3.2 Environment

Perform adjustments under the following environment.

- Ambient temperature: 23 °C ± 5 °C
- Ambient humidity: 80 % RH or less

To minimize the adjustment error due to initial drift, warm up (turn on) the power supply for at least 30 minutes before adjustment. In addition, warm up the DVM and shunt resistor for their appropriate time.

6.3.3 Adjustment Procedure

Adjustment items can be grouped into two types: voltage system and current system. There is adjustment also for remote control.

Adjustment procedure for the voltage system

The following three items are available in the voltage system. Since the items are related, be sure to perform all three items according to the following procedure.

- Output voltage offset
- Output voltage in full scale
- Output voltage display in full scale

■ Connecting the equipment

1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. Connect the sensing terminal and output terminal using a short bar.
4. Connect the negative terminal and the chassis terminal using a short bar.
5. Connect a DVM to the output terminal.

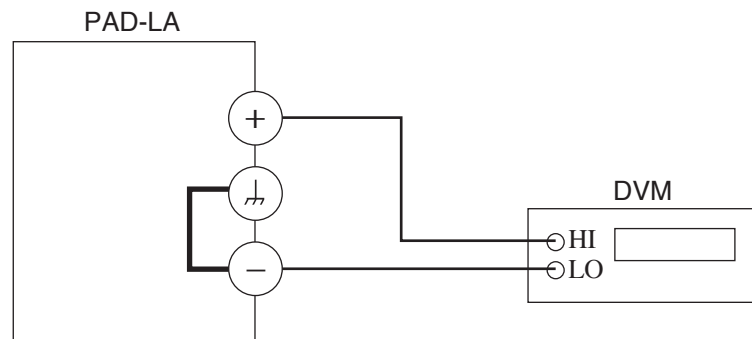


Fig. 6-4 Connection for voltage system adjustment

6. Turn on the POWER switch.

■ Warm-up

To minimize the adjustment error due to initial drift, warm up (turn on) the power supply for at least 30 minutes before adjustment.

7. Set the output voltage to the rated output voltage.

When using local control, turn the VOLTAGE knob clockwise all the way.
When using remote control, set the control signal to 10 V or 9.5 k Ω .


-
8. Turn on the OUTPUT switch.
 9. Turn off the OUTPUT switch after at least 30 minutes elapses.

Output voltage offset

10. Set the output voltage to the minimum.
When using local control, turn the VOLTAGE knob counterclockwise all the way. When using analog remote control, set the control signal to 0 V or 0 Ω .
11. Turn on the OUTPUT switch.
12. Turn the CURRENT knob clockwise until constant voltage operation is achieved.
Offset adjustment is always performed under constant voltage operation.
When the current is also controlled remotely and the preset current is 0 A, constant current operation may result depending on the offset balance. Thus, use a setting that allows approximately 10 % of the rated current to flow.
13. Adjust the CV-OFS variable resistor so that the output voltage (external voltmeter reading) is 0 V.

Output voltage in full scale

14. Set the output voltage to the maximum output voltage.
When using local control, turn the VOLTAGE knob clockwise all the way. When using remote control, set the control signal to 10.5 V or 10 k Ω .
15. Adjust the CV-FSC variable resistor so that the output voltage (external voltmeter reading) is 103 % of the rated output voltage.
When using remote control through an external voltage, you can also set the control signal to 10 V and match the rated output voltage.

-
-  **CAUTION** • The maximum output voltage of the power supply is specified to be 103 % of the rated output voltage. You can use the CV-FSC variable resistor to set a value above 103 %, but using the power supply in such condition can cause damage.
-

Output voltage display in full scale

16. Set the output voltage (external voltmeter reading) to the rated output voltage using the VOLTAGE knob.
17. Adjust the VM-FSC variable resistor so that the output voltage indication of the power supply matches the external voltmeter reading.

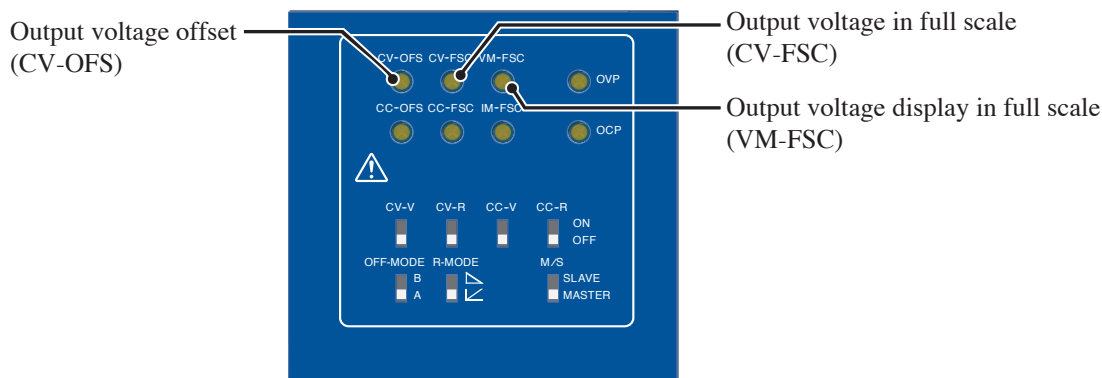


Fig. 6-5 Adjustment variable resistors for the voltage system

Adjustment procedure for the current system

The following three items are available in the current system. Since the items are related, be sure to perform all three items according to the following procedure.

- Output current offset
- Output current in full scale
- Output current display in full scale

■ Connecting the equipment

1. Turn off the OUTPUT switch.
2. Turn off the POWER switch.
3. Connect a shunt resistor and a DVM to the output terminal.
4. Connect the negative terminal and the chassis terminal using a short bar.

⚠ WARNING • Possible burnout or overheating of the wire. Use load wires with sufficient current capacity with respect to the rated current.

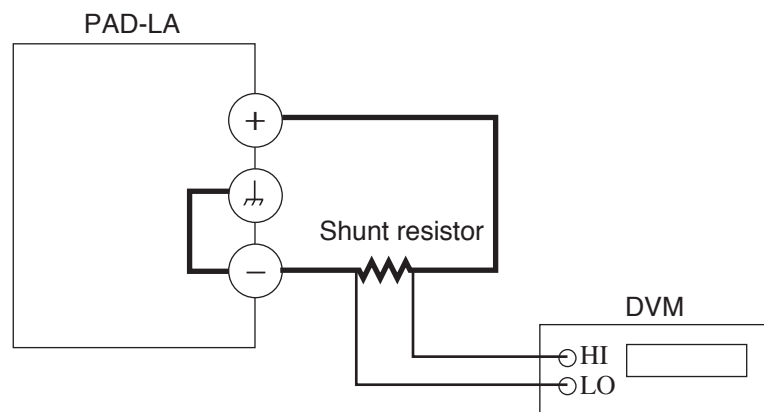


Fig. 6-6 Connection for current system adjustment

-
5. Turn on the POWER switch.

■ Warm-up

To minimize the adjustment error due to initial drift, warm up (turn on) the power supply for at least 30 minutes before adjustment.

6. Set the output current to the rated output current.
When using local control, turn the CURRENT knob clockwise all the way.
When using remote control, set the control signal to 10 V or 9.5 k Ω .
7. Turn on the OUTPUT switch.
8. Turn off the OUTPUT switch after at least 30 minutes elapses.

Output current offset

9. Set the output current to the minimum.
When using local control, turn the CURRENT knob counterclockwise all the way. When using analog remote control, set the control signal to 0 V or 0 Ω .
10. Turn on the OUTPUT switch.
11. Turn the VOLTAGE knob clockwise until constant current operation is achieved.
Offset adjustment is always performed under constant current operation.
When the voltage is also controlled remotely and the preset voltage is 0 V, constant voltage operation may result depending on the offset balance. Thus, use a setting that allows approximately 10 % of the rated voltage to be generated.
12. Adjust the CC-OFS variable resistor so that the output current (current value determined from the external voltmeter and shunt resistor) is 0 A.

Output current in full scale

13. Set the output current to the rated output current.
When using local control, turn the CURRENT knob clockwise all the way.
When using analog remote control, set the control signal to 10.5 V or 10 k Ω .
14. Adjust the CC-FSC variable resistor so that the output current (current value determined from the external voltmeter and shunt resistor) is 103 % of the rated output current.
When using remote control through an external voltage, you can also set the control signal to 10 V and match the rated output current.

-
- ⚠ CAUTION** • The maximum output current of the power supply is specified to be 103 % of the rated output current. You can use the CC-FSC variable resistor to set a value above 103 %, but using the power supply in such condition can cause damage.
-

Output current display in full scale

15. Set the output current (current value determined from the external voltmeter and shunt resistor) to the rated output current using the CURRENT knob.
16. Adjust the IM-FSC variable resistor so that the output current indication of the power supply matches the current value determined from the external voltmeter and shunt resistor.

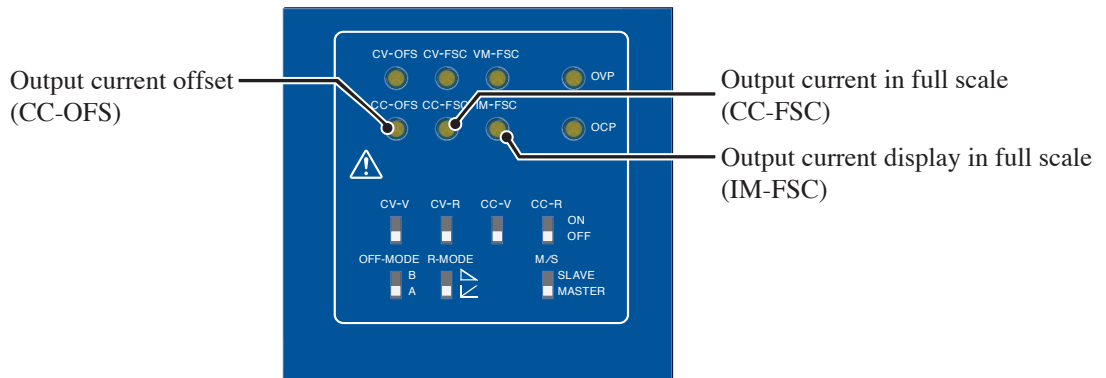


Fig. 6-7 Adjustment variable resistors for the current system

6.4 Malfunctions and Causes

This section describes remedies for malfunctions encountered during the use of the power supply.

Seven representative symptoms and their possible check items are indicated. Look for the item that corresponds to your case. In some cases, the problem can be solved quite easily.

If you find an item that corresponds to your case, follow the remedy for the item. If the remedy does not solve the problem or if your case does not match any of the items, contact your Kikusui agent.

Symptom 1: Nothing appears on the control panel when the POWER switch is turned on.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is there an error in the connection of the AC input terminal?	<input type="checkbox"/> Yes	The wiring of L, N, and GND is not correct.	[6.4.1.1] Wire L, N, and GND correctly. Reference: Section 1.4, "Connecting the Power Cord"
	<input type="checkbox"/> No	The switchboard breaker is off.	[6.4.1.2] Turn on the relevant breaker.
	<input type="checkbox"/> No	The internal input fuse is blown.	[6.4.1.3] Stop the use of the power supply immediately and remove the power cord. Request for repairs.
Is there a break in the power cord covering?	<input type="checkbox"/> Yes	The power cord is broken.	[6.4.1.4] Turn off the switchboard breaker, and replace the power cord with a new one.

Symptom 2: The POWER switch turns off even when it is turned on.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is the OUTPUT switch turned on?	<input type="checkbox"/> Yes	See symptom 3.	See symptom 3.
Is the input voltage waveform distorted into a rectangular shape?	<input type="checkbox"/> Yes	The voltage detection circuit of the phase control circuit is active. The crest factor of the input voltage is less than or equal to 1.2, and the phase control circuit is not operating correctly.	[6.4.2.1] Use an regulated AC power supply for the input power supply. The capacity of the regulated AC power supply must be at least twice the power consumption (VA) of the power supply.
Is control terminals 31 and 32 shorted?	<input type="checkbox"/> Yes	The output shutdown circuit is tripped.	[6.4.2.3] Open the short circuit. Reference: Section 4.3.6, "Connection and Setup for Output Shutdown (TRIP) Control Using an External Contact"

Symptom 3: When the OUTPUT switch is turned on, the POWER switch turns off.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is the OVP trip point set less than or equal to the output voltage?	<input type="checkbox"/> Yes	The overvoltage protection circuit is tripped.	[6.4.3.1] Set the OVP trip point to a voltage greater than or equal to the output voltage. Reference: Section 3.2.1, "Setting the OVP (Overvoltage Protection) and OCP (Overcurrent Protection) Trip Points"
	<input type="checkbox"/> No	The sensing short bar is not attached.	[6.4.3.2] When not using remote sensing, attach the sensing short bar to the output terminal.
	<input type="checkbox"/> No	The actual output voltage is greater than the voltage displayed on the panel.	[6.4.3.3] Adjustment of the voltage system is necessary. Reference: Section 6.3.3, "Adjustment Procedure"
	<input type="checkbox"/> No	A special load is connected.	[6.4.3.4] Reference: Section 2.3, "Load."
Is the control cable removed when using control through an external resistor?	<input type="checkbox"/> Yes	The overvoltage or overcurrent protection circuit is tripped.	[6.4.3.5] Connect the load correctly. Reference: Section 4.3.1, "Connection and Setup for Output Voltage Control Using an External Resistor (CV-R)" or 4.3.3, "Connection and Setup for Output Current Control Using an External Resistor (CC-R)"
	<input type="checkbox"/> No	Remedies [6.4.3.1] to [6.4.3.5] are not correct.	[6.4.3.6] Execute the corresponding remedy correctly.
Is the control cable loose in external voltage control? Or, is the external voltage an overvoltage?	<input type="checkbox"/> Yes	The overvoltage or overcurrent protection circuit is tripped.	[6.4.3.7] Connect the external voltage correctly. Reference: Section 4.3.1, "Connection and Setup for Output Voltage Control Using an External Resistor (CV-R)" or 4.3.3, "Connection and Setup for Output Current Control Using an External Resistor (CC-R)"
	<input type="checkbox"/> No	Remedies [6.4.3.1] to [6.4.3.7] are not correct.	[6.4.3.8] Execute the corresponding remedy correctly
Is the fan stopped?	<input type="checkbox"/> Yes	The overheat protection circuit is tripped. The ambient temperature exceeds the operating ambient temperature, or the fan has malfunctioned.	[6.4.3.9] If the fan does not run even in the 0 to 40 °C range, stop using the power supply immediately. Then, request for repairs.
	<input type="checkbox"/> No	Remedies [6.4.3.1] to [6.4.3.8] are not correct.	[6.4.3.10] Execute the corresponding remedy correctly.

Symptom 4: Output does not turn on even when the OUTPUT switch is turned on.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is both the CV and CC LEDs turned off?	<input type="checkbox"/> Yes	The VOLTAGE and CURRENT knobs are turned clockwise all the way.	[6.4.4.1] Both LEDs may not light up depending on the offset adjustment. This is not a malfunction. Set the required output using the VOLTAGE or CURRENT knob.
	<input type="checkbox"/> No	The CV-V, CV-R, or M/S switch on the control panel is set to the on (up) side.	[6.4.4.2] When operating from the front panel, turn off CV-V, CV-R, and M/S switches (down). Reference: Section 4.3, "Analog Remote Control"
Is the OUTPUT ON LED off?	<input type="checkbox"/> Yes (Not illuminated)	The external contact is closed under the output on/off control using an external contact.	[6.4.4.3] Reference: Section 4.3.5, "Connection and Setup for OUTPUT ON/OFF Control Using an External Contact"
	<input type="checkbox"/> No (Illuminated)	Possible malfunction.	[6.4.4.4] Stop the use of the power supply immediately and remove the power cord. Request for repairs.
Is the CV-V, CV-R, or M/S switch on the control panel set to the on (up) side?	<input type="checkbox"/> Yes	In remote control mode.	[6.4.4.5] When operating from the front panel, turn off CV-V, CV-R, and M/S switches (down). Reference: Section 4.3, "Analog Remote Control"
	<input type="checkbox"/> No	Remedies [6.4.4.1] to [6.4.4.5] are not correct.	[6.4.4.6] Execute the corresponding remedy correctly.

Symptom 5: Output does not turn on even when the OUTPUT switch is turned on, or the output is unstable.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is the operation switched from CV to CC or from CC to CV?	<input type="checkbox"/> Yes	The preset amount (VOLTAGE or CURRENT) is not sufficient against the output amount.	[6.4.5.1] Set the knob that is limiting the output (VOLTAGE or CURRENT) clockwise. If the knob is turned clockwise all the way, you must use a power supply of a larger capacity.
	<input type="checkbox"/> No	The sensing short bar is not attached.	[6.4.5.2] When not using remote sensing, attach the sensing short bar to the output terminal.
Has 30 minutes elapsed since the power was turned on?	<input type="checkbox"/> No	The output is drifting because it is immediately after power on.	[6.4.5.3] Warm up (power turned on) the power supply for at least 30 minutes.
Is both the CV and CC LEDs turned on?	<input type="checkbox"/> Yes	The input voltage is low and is outside the input power range.	[6.4.5.4] Supply a voltage that is within the input voltage range.
	<input type="checkbox"/> Yes	The ambient temperature is outside the operating ambient temperature range.	[6.4.5.5] Use the power supply in the 0 to 40 °C range.
	<input type="checkbox"/> Yes	Oscillation is occurring from using remote sensing and master-slave parallel control.	[6.4.5.6] Add a capacitor at the load end. Reference: Section 4.1, "Remote Sensing" or 4.4, "Master-Slave Parallel Operation"
	<input type="checkbox"/> Yes	Possible malfunction. A load such as a battery is directly connected to the output terminal.	[6.4.5.7] Stop the use of the power supply immediately and remove the power cord. Request for repairs. Reference: See section 2.3, "Load."
Is current flowing even though a load is not connected?	<input type="checkbox"/> Yes	Possible malfunction. A large-capacity capacitor or battery is connected in reverse.	[6.4.5.8] Stop the use of the power supply immediately and remove the power cord. Request for repairs.
Is the output on even when the OUTPUT switch is turned off?	<input type="checkbox"/> Yes	Possible malfunction. A voltage exceeding the rating is applied to the output terminal. A load such as a battery is directly connected to the output terminal.	[6.4.5.9] Stop the use of the power supply immediately and remove the power cord. Request for repairs.

Symptom 6: The output ripple is large.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is the input power out of range?	<input type="checkbox"/> Yes	The input line voltage is low.	[6.4.6.1] Supply a voltage that is within the input voltage range.
	<input type="checkbox"/> No (Correct on the switchboard)	The power cord is too long causing a large voltage drop.	[6.4.6.2] Use the power cord that came with the package.
Are the output terminal and chassis terminal floating?	<input type="checkbox"/> Yes	Inductive effects are being received from the input power frequency (50/60 Hz).	[6.4.6.3] If possible, connect a capacitor greater than or equal to 0.1 μ F (note the withstanding voltage) between the output terminal and the chassis terminal.
Is a source of strong magnetic or electrical field nearby?	<input type="checkbox"/> Yes	Being subjected to electromagnetic induction.	[6.4.6.4] Take measures such as moving the power supply away from such generating sources and using twisted cables.
Is the noise on the external voltage large when using external voltage control?	<input type="checkbox"/> Yes	The influence due to external voltage noise is being received.	[6.4.6.5] Take measures against noise. Reference: Section 4.3.2, "Connection and Setup for Output Voltage Control Using an External Voltage (CV-V)" or 4.3.4, "Connection and Setup for Output Current Control Using an External Voltage (CC-V)"

Symptom 7: The output and reading do not match.

Check Item		Possible Cause	Remedy
Location and Status of the Object	Check Result		
Is remote sensing being used?	<input type="checkbox"/> Yes	The sensing wire or wiring to the load has a bad contact or is broken.	[6.4.7.1] Turn off the POWER switch and check the wiring.
	<input type="checkbox"/> No	The sensing short bar is loose or has a bad contact.	[6.4.7.2] When not using remote sensing, attach the sensing short bar to the output terminal.
Is there a peak in the load current or is the load current pulse shaped?	<input type="checkbox"/> Yes	There is a large peak in the load current.	[6.4.7.3] Reference: Section 2.3, "Load"

7

Chapter 7 Specifications

This chapter describes the electrical and mechanical specifications of the product.

7.1 Specifications of Type III model

Unless specified otherwise, the specifications are for the following conditions.

- The load is a pure resistance.
- The negative terminal is connected to the chassis terminal using the short bar.
- After the warm-up time of 30 minutes has elapsed.

Standard values and logical values do not guarantee the performance. Use these values as a guideline when using the power supply.

	PAD 16-100LA	PAD 36-60LA	PAD 60-35LA	PAD 72-30LA	PAD 110-20LA	PAD 250-8LA	
Input							
Input power	200 VAC±10 %, 50/60 Hz, 1 φ (100 V, 110 V, 120 V, 220 V, 230 V, and 240 V are factory options.)						
Power consumption (200 VAC Rated load)	Approx. 3.3 kVA	Approx. 3.8 kVA	Approx. 3.4 kVA	Approx. 3.8 kVA	Approx. 3.8 kVA	Approx. 3.4 kVA	
Output							
Voltage	Rated voltage	16 V	36 V	60 V	72 V	110 V	250 V
	Maximum voltage *1 (103 % of the rating)	16.48 V	37.08 V	61.8 V	74.16 V	113.3 V	257.5 V
	Variable range	0 V to 16 V	0 V to 36 V	0 V to 60 V	0 V to 72 V	0 V to 110 V	0 V to 250 V
	Resolution (Logical value) *2	3 mV	6.5 mV	11 mV	13 mV	20 mV	45 mV
	Setting knob Number of rotations	10 rotations					
	Accuracy of setting *3, *4	±(0.5 % rating +50 mV)	±(0.5 % rating +50 mV)	±(0.5 % rating +50 mV)	±(0.5 % rating +50 mV)	±(0.5 % rating +500 mV)	±(0.5 % rating +500 mV)
Current	Rated current	100 A	60 A	35 A	30 A	20 A	8 A
	Maximum current *1 (103 % of the rating)	103 A	61.8 A	36.05 A	30.9 A	20.6 A	8.24 A
	Variable range	0 A to 100 A	0 A to 60 A	0 A to 35 A	0 A to 30 A	0 A to 20 A	0 A to 8 A
	Resolution (Logical value) *2	18 mA	11 mA	6.3 mA	5.4 mA	3.6 mA	1.4 mA
	Setting knob Number of rotations	10 rotations					
	Accuracy of setting *3, *4	±(1 % rating +500 mA)	±(1 % rating +50 mA)	±(1 % rating +50 mA)	±(1 % rating +50 mA)	±(1 % rating +50 mA)	±(1 % rating +5 mA)
Rated voltage characteristics							
Ripple noise (5 Hz to 1 MHz, RMS)	0.5 mVrms	0.5 mVrms	0.5 mVrms	0.5 mVrms	1 mVrms	5 mVrms	
Source effect (with respect to ±10 % of the line voltage) *4, *5	0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +2 mV	
Load effect (with respect to 0 % to 100 % of the output current) *4, *5	0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +3 mV	
Transient response (standard value) *5, *6	50 μs						
Temperature coefficient (standard value)	50 ppm/°C						
Rise time (full load) *5, *7	80 ms	80 ms	80 ms	80 ms	100 ms	150 ms	
Fall time (no load) *5, *8	0.35 s	0.85 s	0.90 s	0.95 s	0.95 s	6 s	

	PAD 16-100LA	PAD 36-60LA	PAD 60-35LA	PAD 72-30LA	PAD 110-20LA	PAD 250-8LA	
Constant current characteristics							
Ripple noise (5 Hz to 1 MHz, RMS)	100 mArms	10 mArms	8 mArms	6 mArms	4 mArms	4 mArms	
Source effect (with respect to ± 10 % of the line voltage)	3 mA	3 mA	3 mA	3 mA	1 mA	1 mA	
Load effect (with respect to output voltage of approx. 1 V [voltage drop at the detection resistor] to 100 %)	5 mA	5 mA	3 mA	3 mA	3 mA	3 mA	
Temperature coefficient (standard value)	200 ppm/°C						
Constant voltage operation indication	CV, green LED indication						
Constant current operation indication	CC, red LED indication						
Range of operating temperature and humidity	0 °C to 40 °C / 10 % to 90 % RH (no condensation)						
Range of storage temperature and humidity	-10 °C to 60 °C / 90 % RH or less (no condensation)						
Cooling system	Forced air cooling using a fan.						
Output polarity	Positive or negative grounding possible						
Isolation voltage	± 250 V	± 250 V	± 250 V	± 250 V	± 500 V	± 500 V	
Insulation resistance							
Chassis - input terminals	500 VDC, 30 M Ω or more						
Chassis - output terminals	500 VDC, 20 M Ω or more						
Withstanding voltage							
Input terminals - output terminals	No abnormalities at 1500 VAC for 1 minute.						
Input terminals - chassis	No abnormalities at 1500 VAC for 1 minute.						
Meter							
Voltmeter	Maximum display	99.99	99.99	99.99	99.99	999.9	999.9
	Display error	$\pm(0.5$ % reading + 5 digits) at 23 °C ± 5 °C					
	Temperature coefficient	300 ppm/°C					
Ammeter	Maximum display	999.9	99.99	99.99	99.99	99.99	9.999
	Display error	$\pm(1$ % reading + 5 digits) at 23 °C ± 5 °C					
	Temperature coefficient	400 ppm/°C					

- *1. Do not guarantee the performance, the value as a guideline.
- *2. Value calculated from the number of windings of the variable resistor. In the actual case, take 3 to 5 times the value as a guideline.
- *3. Difference in the output with respect to the SET value.
- *4. Percentage (%) rating indicates the percentage of the rated output.
- *5. Measured at the sensing terminal.
- *6. The time it takes for the output voltage to recover within $\pm(0.05$ % + 10 mV) of the rated value when the output current fluctuates in the 5 % to 100 % range.
- *7. The time it takes for the output voltage to rise from 10 % to 90 % of rated output voltage when the output turns on.
- *8. The time it takes for the output voltage to fall from 90 % to 10 % of rated output voltage when the output turns off.

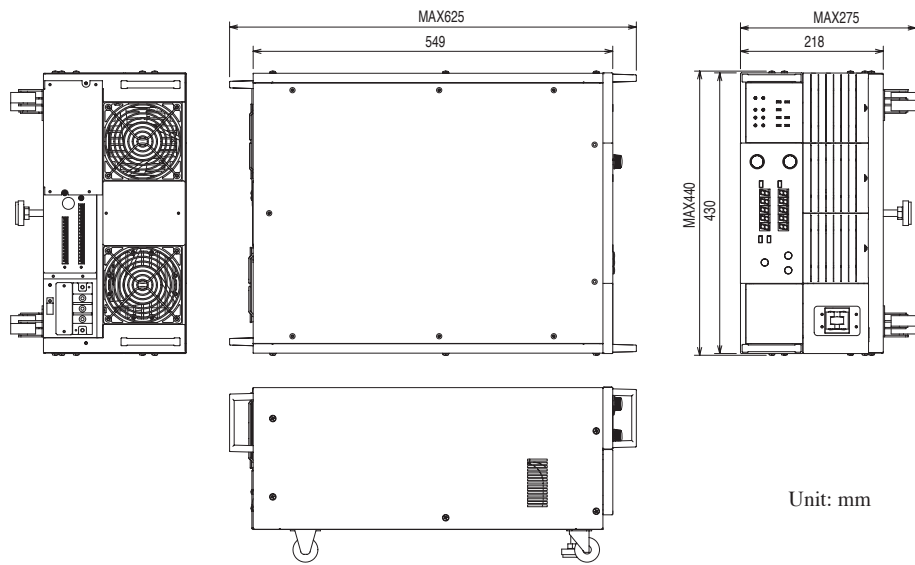
	PAD 16-100LA	PAD 36-60LA	PAD 60-35LA	PAD 72-30LA	PAD 110-20LA	PAD 250-8LA	
Control terminal block function							
Output voltage/control voltage ratio (1 % of rating at 23 °C ± 5 °C)	16 V/10 V	36 V/10 V	60 V/10 V	72 V/10 V	110 V/10 V	250 V/10 V	
Output voltage/control resistance ratio *9	16 V/approx. 10 kΩ	36 V/approx. 10 kΩ	60 V/approx. 10 kΩ	72 V/approx. 10 kΩ	110 V/approx. 10 kΩ	250 V/approx. 10 kΩ	
Output current/control voltage ratio (1 % of rating at 23 °C ± 5 °C)	100 A/10 V	60 A/10 V	35 A/10 V	30 A/10 V	20 A/10 V	8 A/10 V	
Output current/control resistance ratio *9	100 A/approx. 10 kΩ	60 A/approx. 10 kΩ	35 A/approx. 10 kΩ	30 A/approx. 10 kΩ	20 A/approx. 10 kΩ	8 A/approx. 10 kΩ	
Remote sensing	Possible (compensate up to approx. 0.6 V for a single line)						
Master-slave parallel operation	Up to 3 power supplies *10						
Master-slave series operation	Up to 3 power supplies *10					Up to 2 power supplies *11	
OUTPUT ON/OFF *9	Terminal short circuit is off/terminal short circuit is on						
POWER switch shutdown	POWER switch shutdown when the terminal is shorted						
Output voltage monitor 0 V to outputting the rated voltage (accuracy)	0 V to 10 V (± 0.1 V at 23 °C ± 5 °C)						
Output current monitor 0 A to outputting the rated current (accuracy)	0 V to 1 V (± 0.01 V at 23 °C ± 5 °C)						
Protective circuit							
Operation	POWER switch shutdown						
Temperature detection circuit operating temperature (at cooling package)	100 °C/110 °C	100 °C					
Overvoltage protection circuit (OVP)	Preset voltage range	1.6 V to 17.6 V	3.6 V to 39.6 V	6 V to 66 V	7.2 V to 79.2 V	11 V to 121 V	25 V to 275 V
	Operating pulse width (standard value)	50 ms					
Overcurrent protection circuit (OCP)	Preset current range	10 A to 110 A	6 A to 66 A	3.5 A to 38.5 A	3 A to 33 A	2 A to 22 A	0.8 A to 8.8 A
	Operating pulse width (standard value)	50 ms					
Input fuse (at 200 VAC)	30 A						
Output fuse rating	120 A	80 A	40 A	40 A	30 A	30 A	
Weight	Approx. 65 kg	Approx. 66 kg	Approx. 64 kg	Approx. 64 kg	Approx. 63 kg	Approx. 63 kg	
Dimensions	See outline drawing						
Accessories							
Operation manual	1 copy						
Guard caps	2 pcs.						
Power cord	3-core cabtire cable for 200 VAC 1 pc. (3.5 mm ² , approx. 3 m)						
Weight sticker	1 sheet						

*9 Switching to reverse operation mode possible using a switch.

*10 1 master and 2 slaves

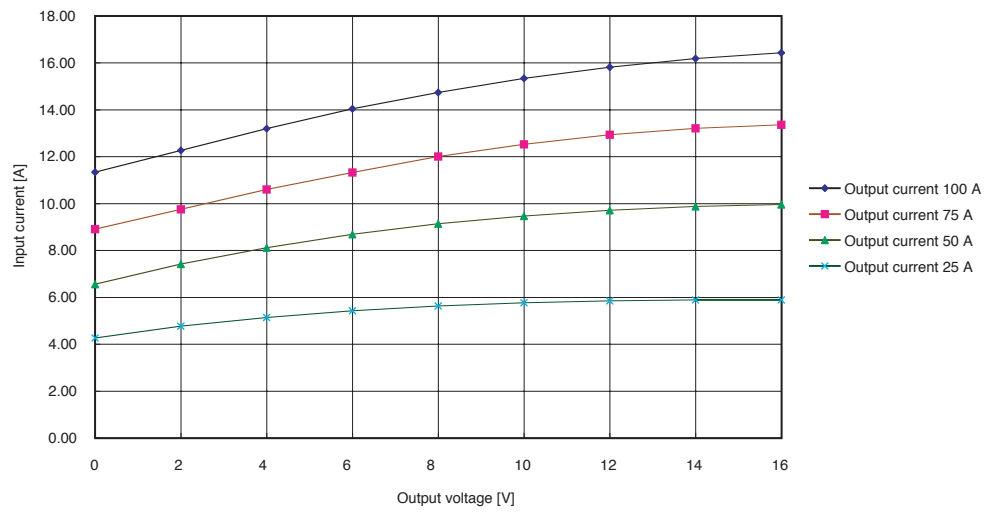
*11 1 master and 1 slave

Outline drawing (Type III model)

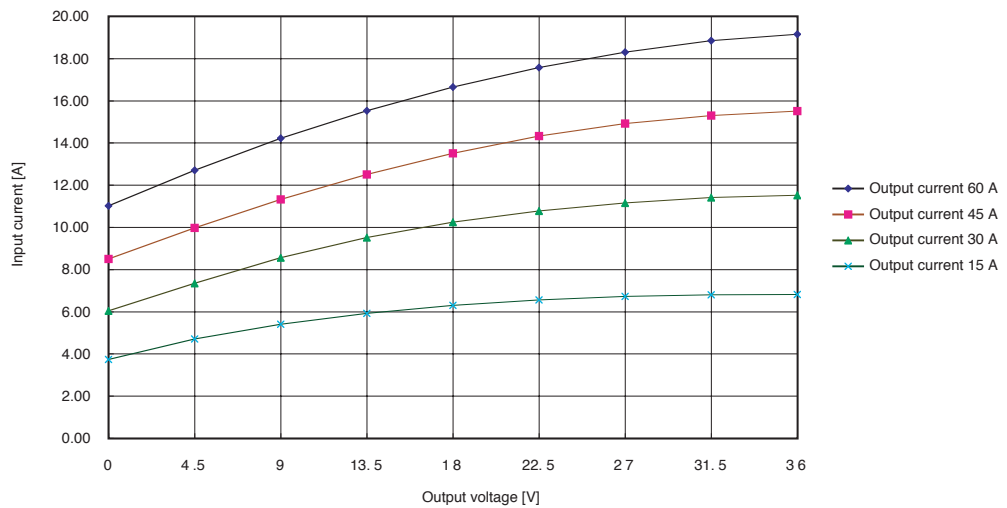


Input current vs. output voltage characteristics (Type III model)

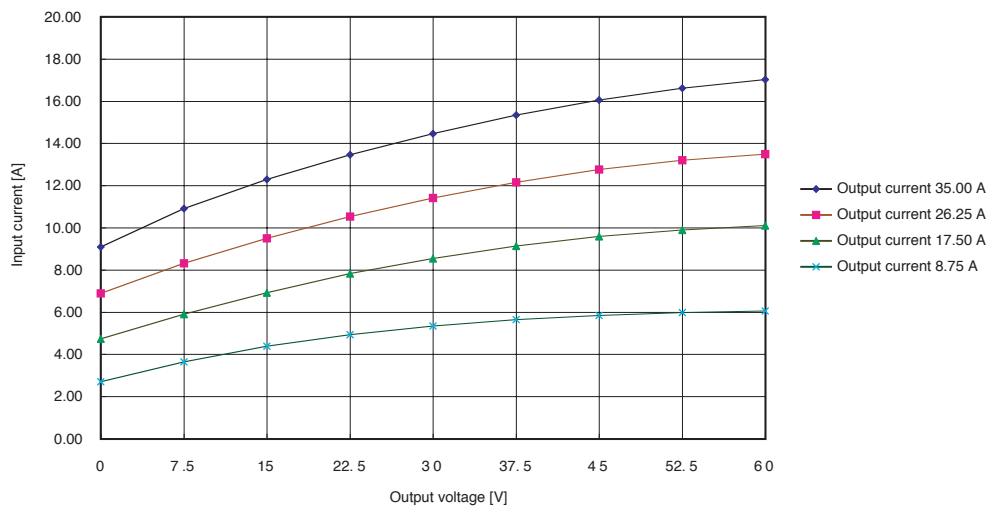
PAD16-100LA



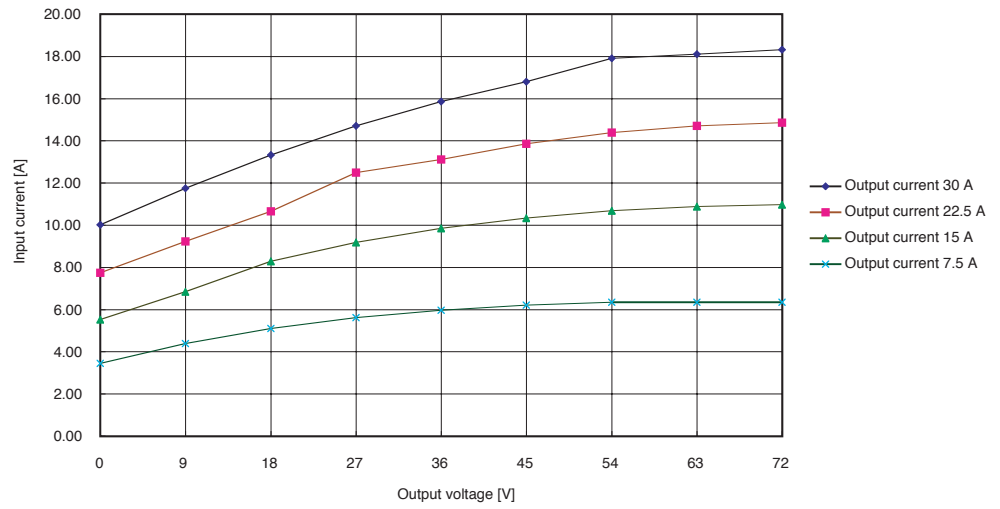
PAD36-60LA



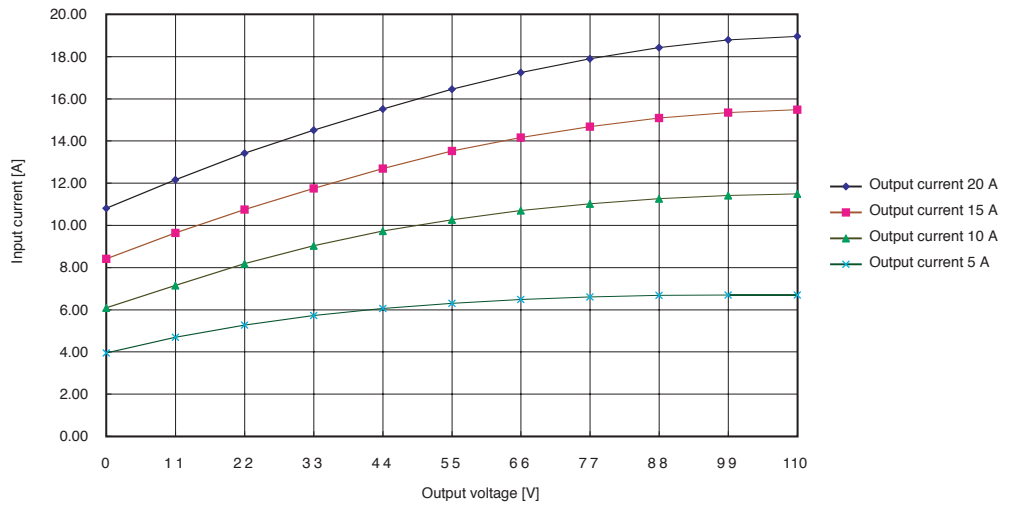
PAD60-35LA



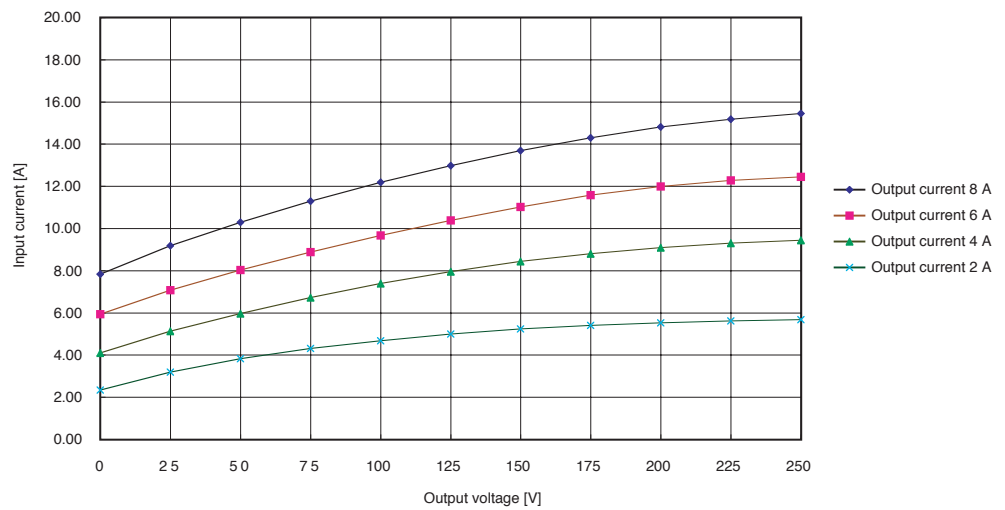
PAD72-30LA



PAD110-20LA



PAD250-8LA



7.2 Specifications of Type IV model

Unless specified otherwise, the specifications are for the following conditions.

- The load is a pure resistance.
- The negative terminal is connected to the chassis terminal using the short bar.
- After the warm-up time of 30 minutes has elapsed.

Standard values and logical values do not guarantee the performance. Use these values as a guideline when using the power supply.

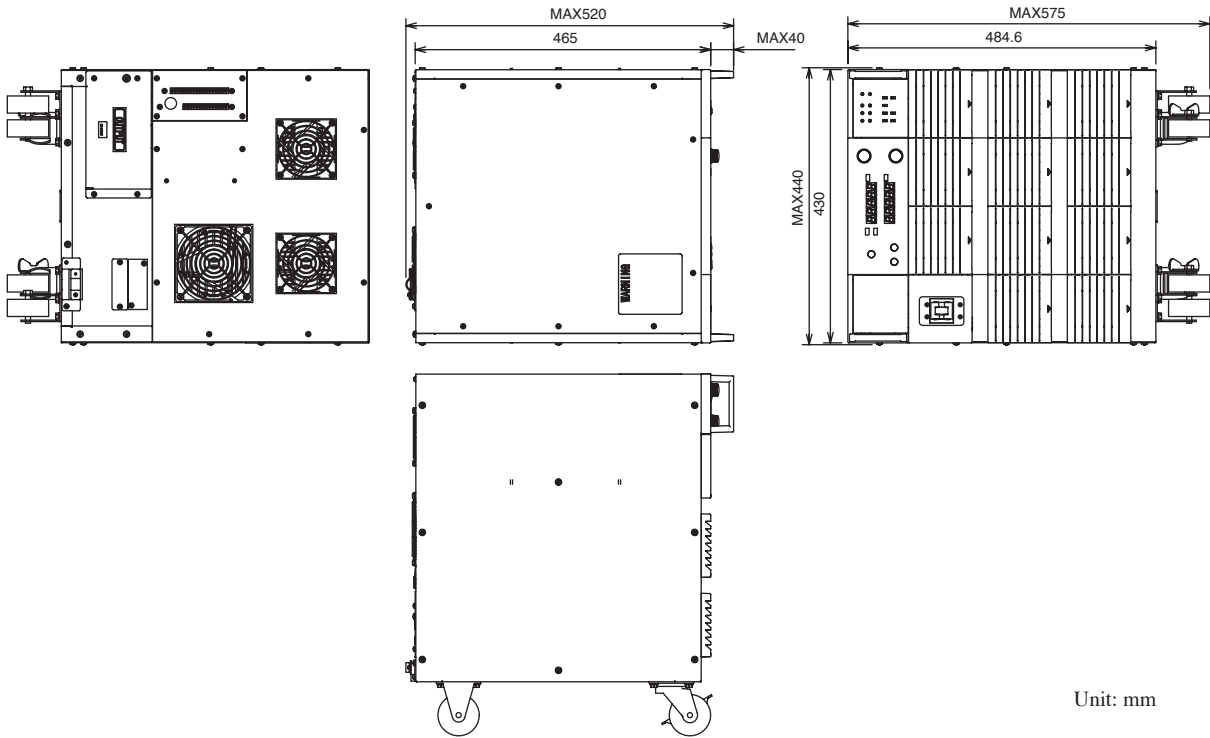
		PAD36-100LA	PAD60-60LA	PAD110-32LA	PAD250-15LA
Input					
Input power		200 VAC \pm 10 %, 50/60 Hz, 1 ϕ (220 V, 230 V, and 240 V are factory options.)			
Power consumption (200 VAC Rated load)		Approx. 7.1 kVA	Approx. 6.9 kVA	Approx. 6.7 kVA	Approx. 6.7 kVA
Output					
Voltage	Rated voltage	36 V	60 V	110 V	250 V
	Maximum voltage *1 (103 % of the rating)	37.08 V	61.8 V	113.3 V	257.5 V
	Variable range	0 V to 36 V	0 V to 60 V	0 V to 110 V	0 V to 250 V
	Resolution(Logical value) *2	6.5 mV	11 mV	18 mV	45 mV
	Setting knob Number of rotations	10 rotations			
	Accuracy of setting *3, *4	\pm (0.5 % rating +50 mV)	\pm (0.5 % rating +50 mV)	\pm (0.5 % rating +500 mV)	\pm (0.5 % rating +500 mV)
Current	Rated current	100 A	60 A	32 A	15 A
	Maximum current *1 (103 % of the rating)	103 A	61.8 A	32.9 A	15.45 A
	Variable range	0 A to 100 A	0 A to 60 A	0 A to 32 A	0 A to 15 A
	Resolution (Logical value) *2	18 mA	11 mA	6 mA	3 mA
	Setting knob Number of rotations	10 rotations			
	Accuracy of setting *3, *4	\pm (1 % rating +500 mA)	\pm (1 % rating +50 mA)	\pm (1 % rating +50 mA)	\pm (1 % rating +50 mA)
Rated voltage characteristics					
Ripple noise (5 Hz to 1 MHz, RMS)		0.5 mVrms	0.5 mVrms	1 mVrms	5 mVrms
Source effect (with respect to \pm 10 % of the line voltage) *4, *5		0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +1 mV	0.005 % rating +2 mV
Load effect (with respect to 0 % to 100 % of the output current) *4, *5		0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +2 mV	0.005 % rating +3 mV
Transient response (standard value) *5, *6		50 μ s			
Temperature coefficient (standard value)		50 ppm/ $^{\circ}$ C			
Rise time (full load) *5, *7		80 ms	80 ms	100 ms	150 ms
Fall time (no load) *5, *8		1 s	1.2 s	2 s	4 s
Constant current characteristics					
Ripple noise (5 Hz to 1 MHz, RMS)		50 mArms	20 mArms	10 mArms	5 mArms
Source effect (with respect to \pm 10 % of the line voltage)		3 mA	3 mA	3 mA	1 mA
Load effect (with respect to output voltage of approx. 1 V [voltage drop at the detection resistor] to 100 %)		5 mA	5 mA	5 mA	3 mA
Temperature coefficient (standard value)		200 ppm/ $^{\circ}$ C			
Constant voltage operation indication		CV, green LED indication			
Constant current operation indication		CC, red LED indication			
Range of operating temperature and humidity		0 $^{\circ}$ C to 40 $^{\circ}$ C / 10 % to 90 % RH (no condensation)			
Range of storage temperature and humidity		-10 $^{\circ}$ C to 60 $^{\circ}$ C / 90 % RH or less (no condensation)			
Cooling system		Forced air cooling using a fan.			
Output polarity		Positive or negative grounding possible			
Isolation voltage		\pm 250 V	\pm 250 V	\pm 500 V	\pm 500 V

		PAD36-100LA	PAD60-60LA	PAD110-32LA	PAD250-15LA
Insulation resistance					
Chassis - input terminals		500 VDC, 30 M Ω or more			
Chassis - output terminals		500 VDC, 20 M Ω or more			
Withstanding voltage					
Input terminals - output terminals		No abnormalities at 1500 VAC for 1 minute.			
Input terminals - chassis		No abnormalities at 1500 VAC for 1 minute.			
Meter					
Voltmeter	Maximum display	99.99	99.99	999.9	999.9
	Display error	$\pm(0.5\% \text{ reading} + 5 \text{ digits})$ at 23 °C \pm 5 °C			
	Temperature coefficient	300 ppm/°C			
Ammeter	Maximum display	999.9	99.99	99.99	99.99
	Display error	$\pm(1\% \text{ reading} + 5 \text{ digits})$ at 23 °C \pm 5 °C			
	Temperature coefficient	400 ppm/°C			
Control terminal block function					
Output voltage/control voltage ratio (1 % of rating at 23 °C \pm 5 °C)		36 V/10 V	60 V/10 V	110 V/10 V	250 V/10 V
Output voltage/control resistance ratio *9		36 V/approx. 10 k Ω	60 V/approx. 10 k Ω	110 V/approx. 10 k Ω	250 V/approx. 10 k Ω
Output current/control voltage ratio (1 % of rating at 23 °C \pm 5 °C)		100 A/10 V	60 A/10 V	32 A/10 V	15 A/10 V
Output current/control resistance ratio *9		100 A/approx. 10 kW	60 A/approx. 10 kW	32 A/approx. 10 kW	15 A/approx. 10 kW
Remote sensing		Possible (compensate up to approx. 0.6 V for a single line)			
Master-slave parallel operation		Up to 3 power supplies *10			
Master-slave series operation		Up to 3 power supplies *10	Up to 3 power supplies *10	Up to 3 power supplies *10	Up to 2 power supplies *11
OUTPUT ON/OFF *9		Terminal short circuit is off/terminal short circuit is on			
POWER switch shutdown		POWER switch shutdown when the terminal is shorted			
Output voltage monitor 0 V to outputting the rated voltage (accuracy)		0 V to 10 V (\pm 0.1 V at 23 °C \pm 5 °C)			
Output current monitor 0 A to outputting the rated current (accuracy)		0 V to 1 V (\pm 0.01 V at 23 °C \pm 5 °C)			

- *1. Do not guarantee the performance, the value as a guideline.
- *2. Value calculated from the number of windings of the variable resistor. In the actual case, take 3 to 5 times the value as a guideline.
- *3. Difference in the output with respect to the SET value.
- *4. Percentage (%) rating indicates the percentage of the rated output.
- *5. Measured at the sensing terminal.
- *6. The time it takes for the output voltage to recover within $\pm(0.05\% + 10 \text{ mV})$ of the rated value when the output current fluctuates in the 5 % to 100 % range.
- *7. The time it takes for the output voltage to rise from 10 % to 90 % of rated output voltage when the output turns on.
- *8. The time it takes for the output voltage to fall from 90 % to 10 % of rated output voltage when the output turns off.
- *9. Switching to reverse operation mode possible using a switch.
- *10. 1 master and 2 slaves
- *11. 1 master and 1 slave

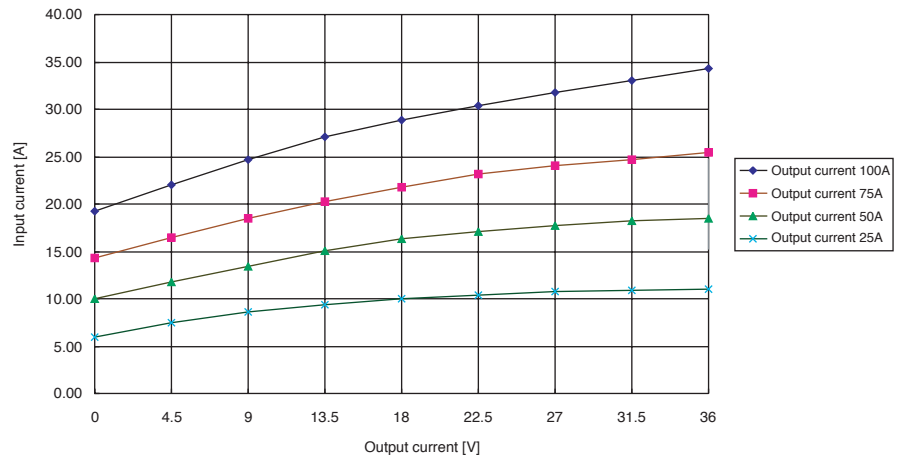
	PAD36-100LA	PAD60-60LA	PAD1100-32LA	PAD250-15LA		
Protective circuit						
Operation	Temperature detection circuit operating temperature (at cooling package)		POWER switch shutdown			
			95 °C			
	Overvoltage protection circuit (OVP)	Preset voltage range	3.6 V to 39.6 V	6 V to 66 V	11 V to 121 V	25 V to 275 V
		Operating pulse width (standard value)	50 ms			
	Overcurrent protection circuit (OCP)	Preset current range	10 A to 110 A	6 A to 66 A	3.2 A to 35.2 A	1.5 A to 16.5 A
		Operating pulse width (standard value)	50 ms			
Input fuse (at 200 VAC)		50 A				
Output fuse rating		120 A	80 A	40 A	40 A	
Weight	Approx. 96 kg	Approx. 96 kg	Approx. 94 kg	Approx. 92 kg		
Dimensions	See outline drawing					
Accessories						
Operation manual		1 copy				
Guard caps		2 pcs.				
Power cord		Single wire cable 3 pcs. (8 mm ² , approx. 3 m)				
Cable clamper		1 set				
Weight sticker		1 sheet				

Outline drawing (Type IV model)

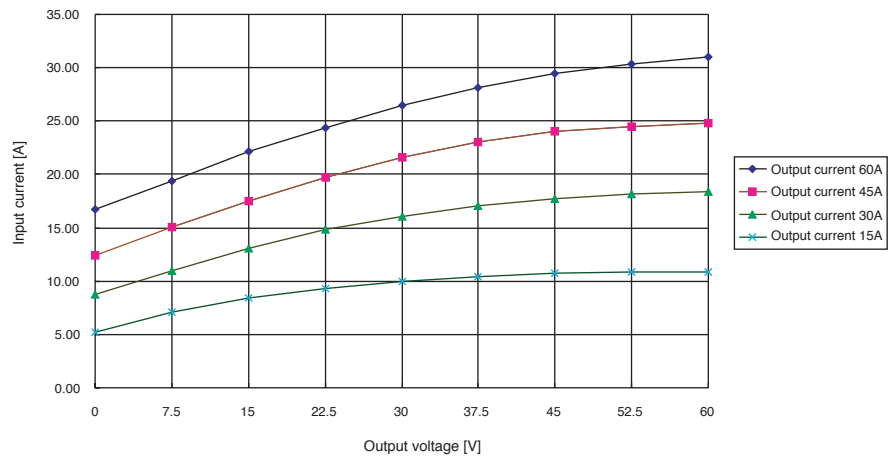


Input current vs. output voltage characteristics (Type IV model)

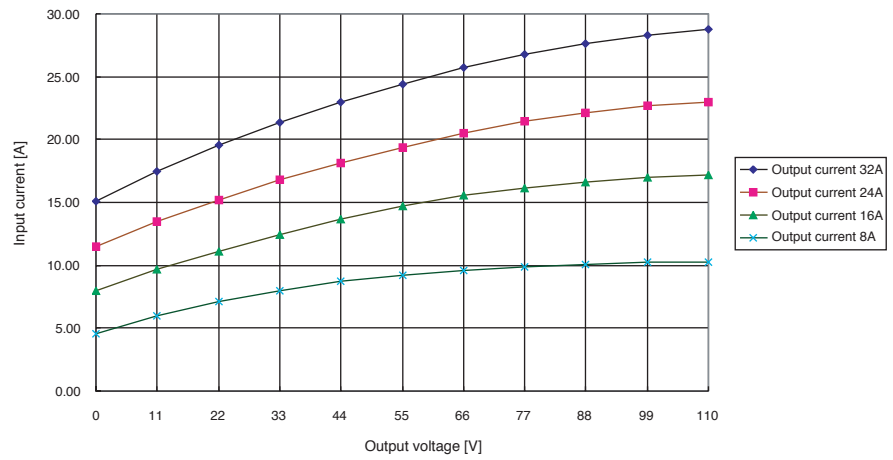
PAD36-100LA



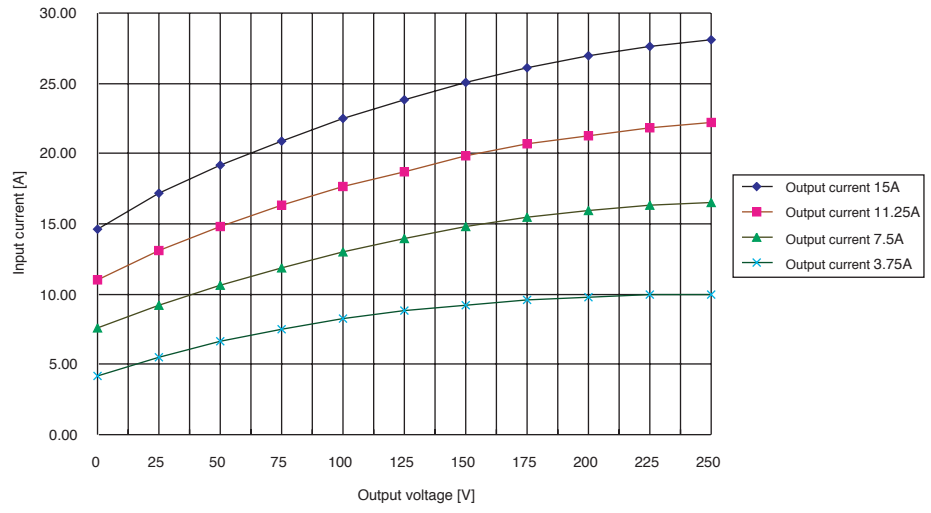
PAD60-60LA



PAD110-32LA



PAD250-15LA



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