Part No. Z1-003-902, IA004001
Mar. 2007

OPERATION MANUAL

Regulated DC Power Supply
PWR Series

400 W Type

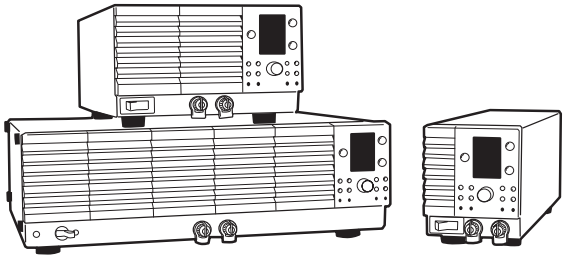
PWR400L PWR400M PWR400H

800 W Type

PWR800L PWR800M PWR800H

1600 W Type

PWR1600L PWR1600M PWR1600H



KIKUSUI

Use of Operation Manual

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

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

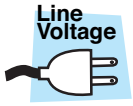
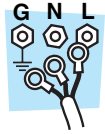
⚠ Safety Symbols

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).

ϟ or ⚠	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.
⚠ **WARNING**	Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.
⚠ **CAUTION**	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
⊘	Shows that the act indicated is prohibited.
⚠	Is placed before the sign “DANGER,” “WARNING,” or “CAUTION” to emphasize these. When this symbol is marked on the product, see the relevant sections in this manual.
⏚	Indicates a protective conductor terminal.
⏚	Indicates a chassis (frame) terminal.
|	On (supply).
○	Off (supply).
▬	In position of a bi-stable push control.
▭	Out position of a bi-stable push control.

⚠ Safety Precautions

The following safety precautions must be observed to avoid fire hazard, electric shock, accidents, and other failures. Keep them in mind and make sure that all of them are observed properly.
Using the product in a manner that is not specified in this manual may impair the protection functions provided by the product.

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 the supervision of qualified personnel (those who have electrical knowledge).
Purpose of use 	• Do not use the product for purposes other than those described in the operation manual. • This product is not designed or produced for home-use or use by general consumers.
Input power 	• Use the product within the rated input power voltage range. • For applying power, use the power cable provided. For details, see the respective page in the operation manual. • This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).
Cover 	• Some parts inside the product may cause physical hazards. Do not remove the external cover.
Grounding 	• This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). To prevent electric shock, be sure to connect the protective conductor terminal of the product to electrical ground (safety ground).

Installation 	• This product is designed for safe indoor use. Be sure to use it indoors. • When installing this product, be sure to observe the description in section 2.2.1, “Precautions Concerning Installation Location” in this manual. • When connecting the power cord to a switchboard, be sure the work is performed by a qualified and licensed electrician or under the direction of such person.
Relocation 	• Turn off the POWER switch, and disconnect all cables before relocating the product. • When relocating the product, be sure to include the manual.
Operation 	• Before using the product, be sure to check the input power voltage and that there is no abnormality in the appearance of the AC power cord. Be sure to unplug the power cord or turn off the switchboard breaker before checking it. • If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power cord plug from the outlet or turn the switchboard breaker off. Make sure the product is not used until it is completely repaired. • Use cables or wires with sufficiently large current capacity for output wires and load cables. • Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.
Maintenance and checking 	• To prevent electric shock, make sure to unplug the power plug or turn off the switchboard breaker before performing maintenance or checking. • Do not remove the cover when performing maintenance or checking. • To maintain the 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.

Warning label

- There is a warning label affixed to the product. If this label tears or falls off, replace with a new label. If you need a new label, contact your Kikusui agent or distributor.

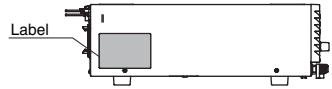
⚠ WARNING

DO NOT REMOVE COVERS, REFER TO THE QUALIFIED PERSONNEL FOR SERVICING.
SECURELY DISCONNECT THE POWER CORD FROM THE AC OUTLET OR SWITCHBOARD BEFORE HANDLING THE POWER CORD.
TO AVOID AN ELECTRIC SHOCK, THE POWER CORD PROTECTIVE CONDUCTOR TERMINAL MUST BE CONNECTED TO AN ELECTRICAL GROUND.

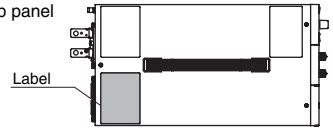
⚠ 警 告

本機のカバーは、絶対に取り外してはいけません。
電源コードの取り扱いは、必ず電源プラグを抜くか配電盤からの給電を遮断してから行ってください。
感電事故防止のため、電源コードの保護導体端子を必ず接地してご使用ください。

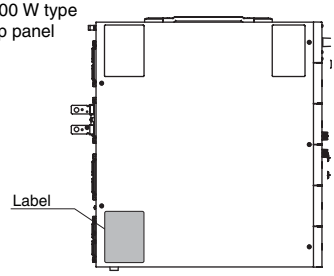
400 W type
Left side panel



800 W type
Top panel



1600 W type
Top panel



How to read this manual

Introduction

Thank you for purchasing the PWR regulated DC power supply series.
This manual is intended for first-time users of the PWR. It gives an overview of the regulated DC power supply and describes various settings, operation, device messages, maintenance, safety precautions, etc.
Read this manual thoroughly to use the functions of the PWR effectively. You can also review this manual when you are confused about an operation or when a problem occurs.

How to read this manual

This manual is designed to be read from beginning to end. We recommend that you read the manual thoroughly from the beginning before using the PWR for the first time.

Related manuals

For details on the PIA4810 or PIA4830 Power Supply Controller, see the operation manual of the respective product.

Intended readers of this manual

This manual is intended for users of the PWR regulated DC power supply series or persons teaching other users on how to operate them.
The manual assumes that the reader has knowledge about electrical aspects of regulated DC power supplies.
Information on device messages is provided with the premise that the reader has sufficient knowledge about controlling power supplies using a personal computer.

Arrangement of this manual

This Operation Manual is made up of the following sections.

Chapter 1 General Description

This chapter gives an overview and describes the features.

Chapter 2 Installation and Preparation

This chapter describes the procedures of unpacking and preparation of the PWR before use.

Chapter 3 Connecting the Load

This chapter describes the consideration to be given to the load, explains how to connect the load wires, and explains how to connect to the output terminals.

Chapter 4 Basic Operation

This chapter describes how to turn on/off the output and the basic operations that you can carry out from the front panel.

Chapter 5 External Control

This chapter describes external control and external monitoring using the J1 connector.

Chapter 6 Parallel/Series Operation

Parallel/Series Operation

Chapter 7 Remote Control

This chapter gives an overview of the remote control using the TP-BUS and describes the connection procedure and the device messages used in programming.

Chapter 8 Maintenance

This chapter describes maintenance and inspection of the PWR.

Chapter 9 Specifications

This chapter lists the specifications.

Notations used in the manual

The PWR regulated DC power supply series is also simply referred to as the PWR series in this manual.
The following markings are used in the explanations in the text.

⚠WARNING

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

⚠CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.

NOTE

Indicates information that you should know.

DESCRIPTION

Explanation of terminology or operation principle.

Indicates reference to detailed information.

C-x:x

The first two characters “C-” indicate a configuration setting, and the next one-digit number indicates the CONFIG parameter number. The character after the colon indicates the selected setting.

SHIFT+switch name (marked in blue)

Indicates an operation in which a switch marked in blue is pressed while holding down the SHIFT switch.

Contents

Contents by Function

Preparation

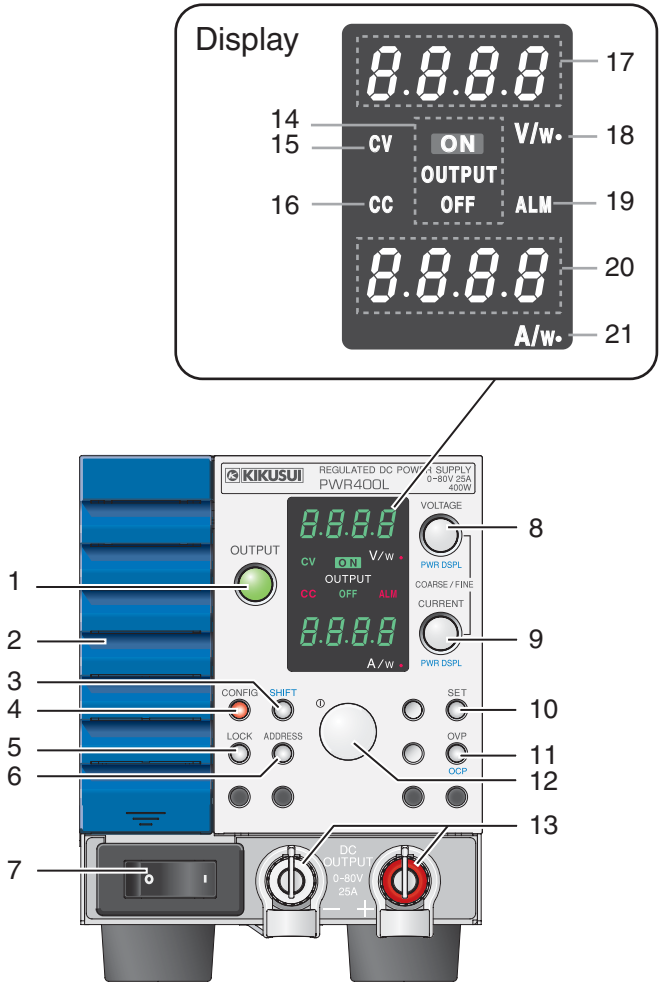
Situation	Heading	See Page
I want to check the accessories.	2.1 “Checking the Package Contents”	2-2
The installation space is limited. How much space is needed around the air inlet and outlet?	2.2 “Precautions Concerning Installation”	2-3
How do I connect the AC power supply?	2.4 “Connecting the Power Cord”	2-8
What kind of wires should be used to connect the load?	3.2 “Load Wire”	3-5
The wire connecting the load is long (distance to the load is long), but stable voltage is required.	4.8 “Lock Function”	4-28
How do I set the communication conditions for remote control?	7.2.1 “Setting the Remote Control”	7-6
How do I control the output voltage using an external DC voltage?	5.4.1 “External Voltage (Vext) Control”	5-10
How do I increase the current capacity in parallel operation?	6.2 “Master-Slave Parallel Operation”	6-8
How do I rack mount the PWR? What kind of parts is needed?	Rack	1-4

Operation

Situation	Heading	See Page
How can I use the PWR as a constant voltage power supply (CV)?	4.5 “Using the PWR as a CV or CC Power Supply (Setting the Output Voltage and Current)”	4-13
How do I set the protection function to prevent damage to the load?	4.6 “Protection Function and Alarm”	4-15
How can I monitor the output voltage and output current?	5.8 “External Monitoring”	5-23
How do I temporarily lock the keys?	4.8 “Lock Function”	4-28

Situation	Heading	See Page
How do I use the sample program for remote control?	7.4 “Sample Program”	7-30
How do I reset the PWR to factory default settings?	4.10 “Factory Default Settings”	4-32

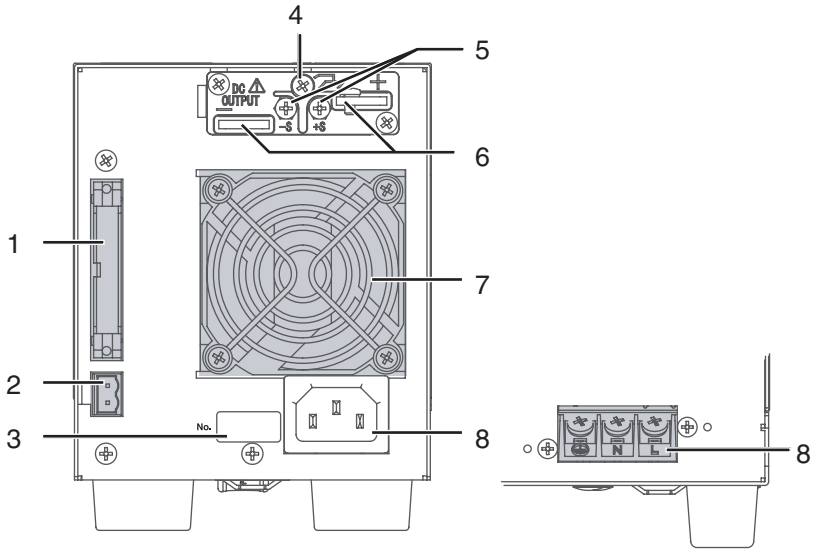
Front panel



PWR400L example

No.	Name +SHIFT	Description	See Page
1	OUTPUT	Output on/off switch.	4-6
2	Air inlet (louver)	Air inlet for internal cooling. A dust filter is built in.	8-3
3	SHIFT	Switch for calling up the functions marked in blue characters.	vii
4	CONFIG	Switch for setting various conditions concerning the operation.	4-23
5	LOCK	Switch with an LED for locking the operations other than turning the output on/off.	4-28
6	ADDRESS	Switch for setting the node address for remote control.	7-6
7	POWER	POWER switch. Press the (I) side to turn the power on and the (O) to turn the power off.	2-13
8	VOLTAGE	Switch for selecting coarse or fine (the digit) when setting the voltage.	4-4
	PWR DSPL	Displays the output power on the voltmeter.	4-2
9	CURRENT	Switch for selecting coarse or fine (the digit) when setting the current.	4-4
	PWR DSPL	Displays the output power on the ammeter.	4-2
10	SET	Switch with an LED for setting and checking the output voltage or output current	4-2
11	OVP	OVP (overvoltage protection) trip voltage display.	4-17
	OCP	OCP (overcurrent protection) trip current display.	
12	Setting knob	Knob for changing the setting. Press the knob to switch between coarse and fine.	4-4
13	DC OUTPUT	Output terminal with a cover on the front panel.	3-10
14	OUTPUT ON/OFF	Indicates the output status.	4-6
15	CV	Illuminates during constant voltage operation.	4-13
16	CC	Illuminates during constant current operation.	
17	Voltmeter	Displays the preset output voltage, the output voltage, and the output power.	4-2
18	V/W	Voltmeter unit. The LED on the right illuminates when displaying the power.	4-2
19	ALM	Illuminates when a protection function is activated.	4-15
20	Ammeter	Displays the preset output current, the output current, and the output power.	4-2
21	A/W	Ammeter unit. The LED on the right illuminates when displaying the power.	4-2

Rear panel



400 W type example

1600 W type

No.	Name	Description	See Page
1	J1	Connector for external control, series operation, and parallel operation.	5-2
2	TP-BUS	Remote control connector	7-4
3	Serial number	The serial number of the PWR.	–
4	Chassis terminal	A terminal used to ground the output.	3-7
5	Sensing terminal	A terminal used to connect the sensing wires.	4-29
6	DC OUTPUT	Output terminal on the rear panel.	3-7
7	Exhaust port	Exhaust port for cooling.	–
8	AC INPUT	400 W and 800 W: AC inlet. 1600 W: AC INPUT terminal block.	2-8

General Description

This chapter gives an overview and describes the features.

1.1 About This Manual

The PWR series is classified into three types depending on the output capacity. It is also classified into three types depending on the output voltage. This operation manual describes the following models.

Table 1-1 PWR series types

	L Type (80 V)	M Type (320 V)	H Type (650 V)
400 W type 	PWR400L	PWR400M	PWR400H
800 W type 	PWR800L	PWR800M	PWR800H
1600 W type 	PWR1600L	PWR1600M	PWR1600H

Applicable firmware version of the PWR

This manual applies to PWRs with firmware version 1.2x.

See Page 2-13

When contacting us about the product, please provide us the version number and the manufacturing number that is affixed to the rear panel.

1.2 Product Overview

The PWR Series are constant voltage/current automatic cross-over power supplies that are capable of delivering voltages and currents in a wide operating range within the rated output power.

Communication functions come standard with the PWR which enable remote control.

Features

● Power-factor improvement circuit

The power-factor improvement circuit reduces the effects of harmonic currents on the power line.

● High efficiency

The high power conversion efficiency reduces the cost of power and the cost of heat radiation design during system configuration.

● Communication functions

Equipped with a digital remote control function through TP-BUS (Twist Pair-BUS) communication. (The total length of TP-BUS is 200 m.)

By combining with Kikusui's PIA4800 Series Power Supply Controller, systemization for applications such as an automatic tester is possible.

● Master-slave operation

Output voltage or output current can be expanded by connecting multiple power supplies of the same model in series (only on the L type) or in parallel. This feature allows slave units to be controlled from a single master unit.

Options

Below are options available for the PWR series.

For details on the options, contact your Kikusui agent or distributor.

Rack

Table 1-2 Rack mounting options

Product	Model	Applicable Model	Notes
Rack mount frame	KRA3	400 W type 800 W type	Inch rack EIA standard
	KRA150		Milli rack JIS standard
Rack mount bracket	KRB3-TOS	1600 W type	Inch rack EIA standard
	KRB150-TOS		Milli rack JIS standard

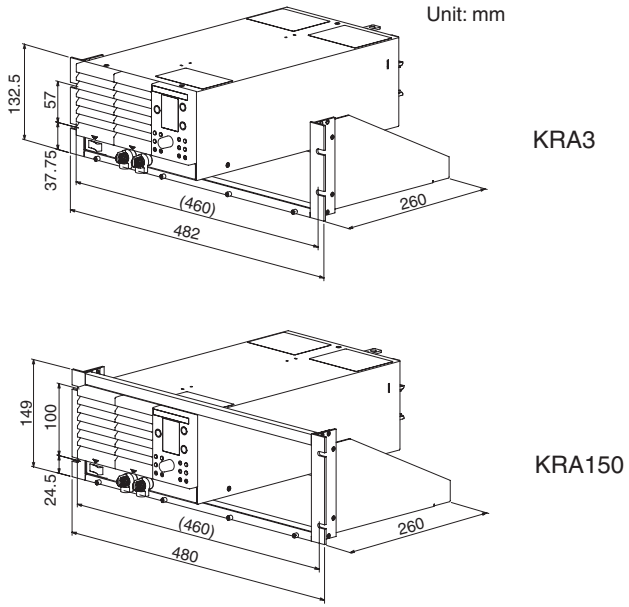


Fig. 1-1 Rack mount frame

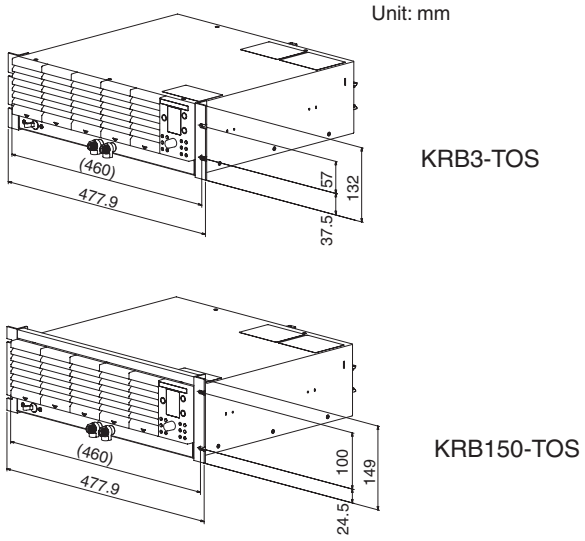
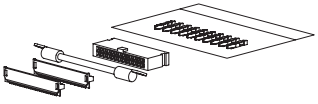


Fig. 1-2 Rack mount bracket

Analog Remote Control Connector Kit (OP01-PAS)

A kit for connecting to the J1 connector on the rear panel.



Component	Quantity
Socket	1 pc.
Pins	10 pcs.
Protection cover	1 set
Chassis connection wire	1 pc.

Fig. 1-3 Analog remote control connector kit

Handle (for the 400 W type) (CH01-PWR)

A carrying handle that can be attached to the top panel of the 400 W type.

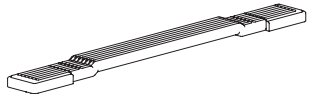


Fig. 1-4 Handle

Installation and Preparation

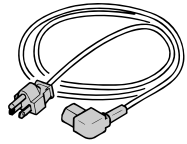
This chapter describes the procedures of unpacking and preparation of the PWR before use.

2.1 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.

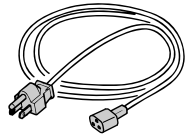
We recommend that all packing materials be saved, in case the product needs to be transported at a later date.



1 pc.
Plug: NEMA5-15
Rated voltage: 125 V
[85-AA-0003]

May vary depending on the shipment destination.

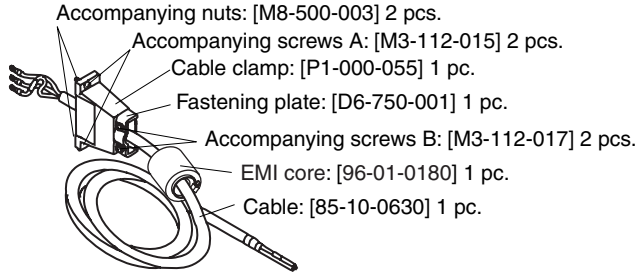
☐ Power cord for the 400 W type



1 pc.
Plug: NEMA5-15
Rated voltage: 125 V
[85-10-0740]

May vary depending on the shipment destination.

☐ Power cord for the 800 W type

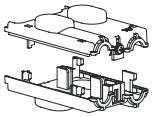


☐ Power cord for the 1600 W type
(with cable clamp and no plug)

Fig. 2-1 Accessories that vary depending on the type

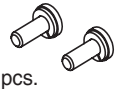
1 pc.
[84-61-5102]

☐ TP-BUS connector



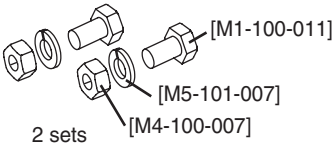
1 set
[Q1-500-077]

☐ OUTPUT terminal cover

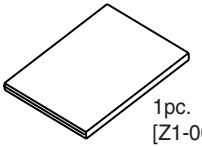


2 pcs.
[M3-112-026]

☐ M4 output terminal screws



☐ M8 output terminal screws



1pc.
[Z1-003-902]

☐ Operation Manual

Fig. 2-2 Accessories common to all types

2.2 Precautions Concerning Installation

This product cannot be used while it is on its side.

The feet on the side panel of the 1600 W type are for temporarily laying the unit on its side before carrying the unit by the handle.

Do not use or store the unit on its side as it may tip over.

2.2.1 Precautions Concerning Installation Location

Install the product indoors under the following conditions.

- **Do not use the product in a flammable atmosphere.**

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

- **Avoid locations where the product is exposed to high temperature or direct sunlight.**

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

Operating temperature range:	0 °C to +50 °C
Storage temperature range:	-25 °C to +70 °C

- **Avoid humid environments.**

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

Operating humidity range:	20 %rh to 85 %rh (no condensation)
Storage humidity range:	0 %rh to 90 %rh (no condensation)

  Condensation may occur even within the operating humidity range. If this happens, do not use the product until the condensation dries up completely.

- **Do not place the product in a corrosive atmosphere.**

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

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

- **Do not place the product in a dusty location.**

  Accumulation of dust may lead to electric shock or fire.

- Do not use the product where ventilation is poor.

  The product employs a forced air cooling system. Air is taken in from air inlet located on panels other than the rear panel and exhausted from the air outlet on the rear panel. Secure adequate space around the product to prevent fire caused by accumulation of heat.

  Allow at least 20 cm of space between the air inlet/outlet and the wall (or obstacles). Hot air (approximately 20 °C higher than the ambient temperature) is exhausted from the air outlet. Do not place objects that are affected by heat near the air outlet.

- Do not place objects on the product.

  Placing heavy objects on top of the product may cause failures.

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

  The product may fall or tip over causing damages and injuries.

- Do not use the product in a location where strong magnetic or electric fields are nearby or a location where large amount of distortion and noise is present on the input power supply waveform.

  The product may malfunction.

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

  The noise generated by the product may affect them.

2.2.2 Precautions to Be Taken When Moving the Product

Note the following points when moving the product or transporting the product to the installation location.

- Turn off the POWER switch.

  Moving the product while the POWER switch is turned on may cause electric shock or damage to it.

- Remove all wiring.

  Moving the product with the cables connected may cause wires to break or injuries due to the product falling over.

- When transporting the product, be sure to use the original packing materials.

  Otherwise, damage may result from vibrations or from the product falling during transportation.

- Be sure to include this manual.

2.3 Rack Mounting the Product

Remove the feet and handle before attaching the product to the rack mount frame. For details on rack mounting, see the operation manual of the KRA series or KRB series.

We recommend that you keep all the parts so that you can use them again when you detach the product from the frame.

To reattach the feet, use the parts that you removed.

400 W and 800 W types

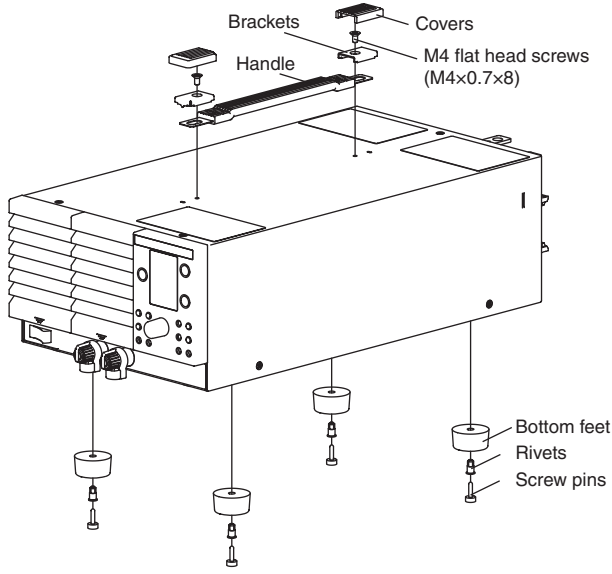


Fig. 2-3 Removing the handle and feet (400 W and 800 W types)

1600 W type

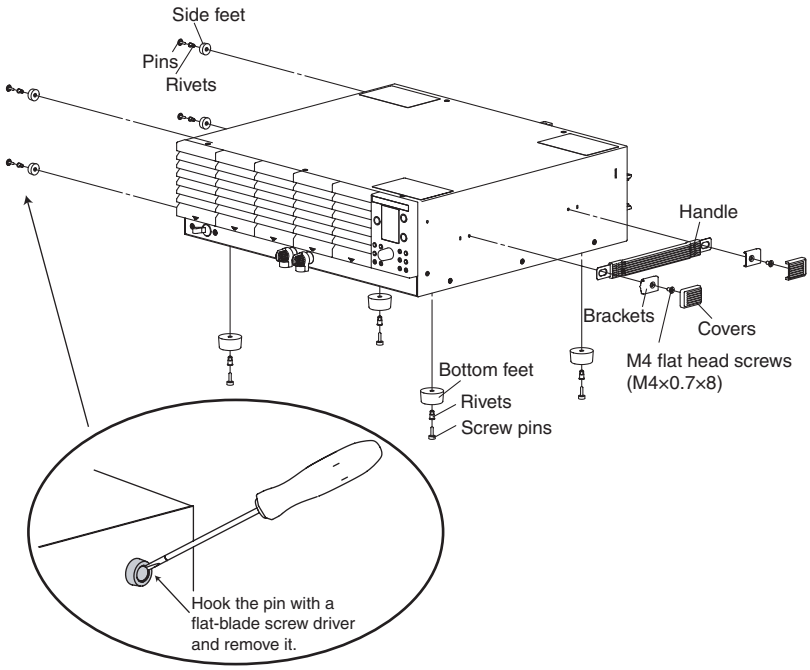


Fig. 2-4 Removing the handle and feet (1600 W type)

Removing the handle and feet

The handle is an option for the 400 W type.

1. Pull up on the handle covers (two locations).
2. Unfasten the M4 flat head screws (two locations) and remove the entire handle.
3. Remove the feet by detaching the screw pins while pulling the feet (four locations) downward.
4. Pull the internal pins of the side feet (four locations) using a flat-blade screwdriver and remove the feet (1600 W type only).

2.4 Connecting the Power Cord

The power cord provided with the PWR varies depending on the output capacity type. For the procedure to connect the power cord, see the respective section for each type.

This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).

⚠WARNING Possible electric shock.

- **This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). Be sure to ground the product to prevent electric shock.**
- **Connect the ground terminal to earth ground.**

400 W and 800 W types

NOTE

- Use the supplied power cord to connect to the AC line. If the supplied power cord cannot be used due to the rated voltage or the plug shape, replace it with an appropriate power cord of length 3 m or less.
- The rated voltage of the power cord with a three-prong plug that comes with the PWR is 125 VAC. If you are using an input power supply of a 200-V system, exchange the power cord with one that is suitable for the input voltage.
- Have a qualified engineer select the appropriate power cord. If obtaining a power cord is difficult, consult your Kikusui agent or distributor.
- The power cord with a three-prong plug is used to disconnect the PWR from the AC line in an emergency. Connect the power plug to an easily accessible power outlet so that the plug can be removed from the outlet at any time. Be sure to allow enough space around the power outlet.
- Do not use the supplied power cord on other instruments.

1 Check that the AC power supply meets the nominal input rating of the PWR.

The voltage that can be applied is any of the nominal power supply voltages in the range of 100 Vac to 240 Vac. The frequency is 50 Hz or 60 Hz.

2 Turn the POWER switch off.

3 Connect the power cord to the AC inlet on the rear panel.

4 Insert the power plug to a properly grounded power outlet.

1600 W type

The power cord that is included with the 1600 W type can be used on either a 100-Vac or 200-Vac system.

⚠WARNING **Possible electric shock.**

- **Turn off the circuit breaker of switchboard before connecting the cord.**

Possible Fire.

- **Have a qualified engineer connect the power cord to the switchboard.**
- **The breaker of switchboard is required to meet following requirement.**

⚠CAUTION

- Inside the product, protective circuits including input fuses are connected to match the polarity of the input terminal. Make sure the colors of the wires connected to the corresponding input terminals (L, N, and ⏚(GND)) are correct.

NOTE

- Turn off the circuit breaker of switchboard to disconnect the PWR from the AC line in an emergency.

■ Circuit breaker of switchboard requirement

- Rated current: 30 A (The circuit breaker of which the rated current is more than 30 A is disabled for safety.)
- Dedicate the circuit breaker for the PWR.
- Keep the switchboard easily accessible at any time.
- Require labeling to identify that the circuit breaker is dedicated for the PWR and disconnecting device.

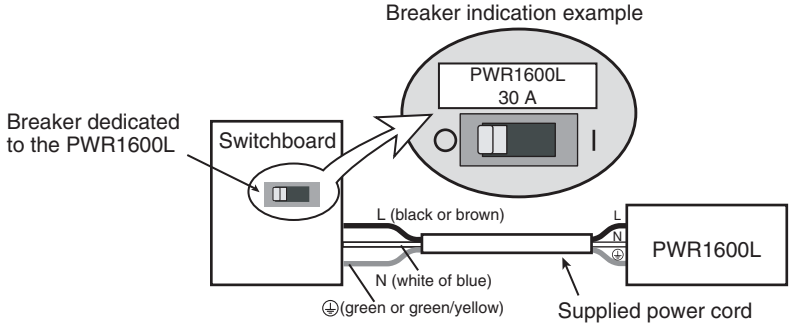


Fig. 2-5 Connection to the switchboard (PWR1600L example)

Procedure to connect the power cord

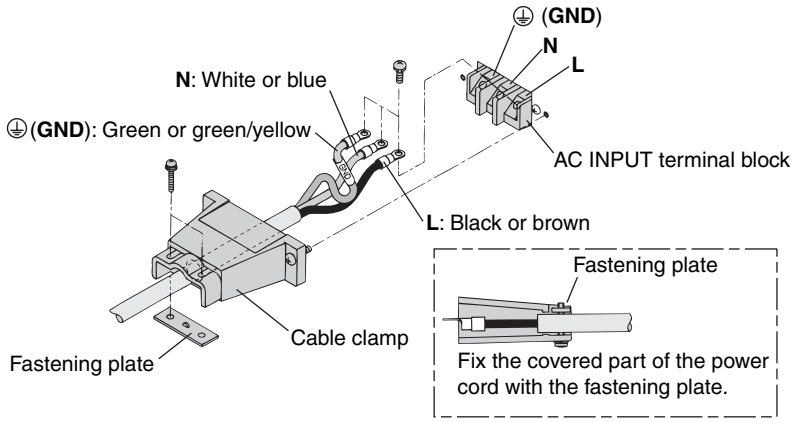


Fig. 2-6 Connecting the power cord

1. Check that the AC power line complies with the input rating of the PWR.

   The voltage that can be applied is any of the nominal power supply voltages in the range of 100 VAC to 240 VAC. The frequency is 50 Hz or 60 Hz.

2. Turn the POWER switch off.

3. Connect the power cord provided to the AC INPUT terminal block on the rear panel as shown in Fig. 2-6.

4. Attach crimping terminals at the switchboard end of the power cord.

5. Turn the switchboard breaker off.

6. Connect the power cord to match the L, N, and ⏚ (GND) of the switchboard.

2.5 Turning the Power On

Turn the power on without the load connected.

⚠CAUTION

- The CONFIG parameters can be set so that the output is automatically turned on when the POWER switch is turned on. When this function is enabled, the PWR powers up with the output turned on even if the output was off when the PWR was turned off the last time. There is a possibility that a load may break, if you connect a different load and turn the POWER and output on simultaneously without changing the OVP and OCP settings to appropriate values.

1. Turn the POWER switch off.
2. Check that the power cord is correctly connected.
3. Turn the POWER switch on.

   Push the (|) side of the POWER switch to turn the PWR on.
   If an odd sound, odd odor, fire, or smoke occurs around or in the PWR, remove the power plug from the outlet or turn the switchboard breaker off.
   The voltmeter and ammeter show the firmware version for approximately 1 second. After a few seconds, the PWR is ready for operation (displays the output value).

The PWR is ready for use.

Fig. 2-7 Version display at power-on (ver.1.00 example)

See
Page 4-32

If the POWER switch is turned on for the first time after purchasing the PWR, the PWR starts up in a factory default condition. For all other cases, the PWR starts up using the settings that existed when the POWER switch was turned off the last time.

■ Inrush current

An inrush current flows when the POWER switch is turned on. If you are planning to use several PWRs and turn on their POWER switches simultaneously, check that the AC power line or the switchboard has sufficient capacity. For the inrush current of each model, see Chapter 9, “Specifications.”

Turning the POWER switch off

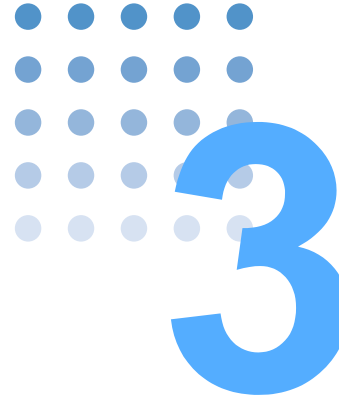
Push the (○) side of the POWER switch to turn the PWR off.

The PWR stores the panel settings (excluding output on/off condition) immediately before the POWER switch is turned off. For these items, the PWR starts up using the settings that existed when the POWER switch was turned off the last time.

If the POWER switch is turned off immediately after changing the settings, the last settings may not be stored.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the panel display lights out. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.



Connecting the Load

This chapter describes the consideration to be given to the load, explains how to connect the load wires, and explains how to connect to the output terminals.

3.1 Load Considerations

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

- Load current with peaks and pulse-shaped load current.
- Load that generates reverse current to the power supply.
- Load with accumulated energy.

Load current with peaks and pulse-shaped load current

The PWR indicates mean values. Even when the indicated value is less than the preset current value, the peak values may actually exceed the preset current value. If this happens, the PWR is instantaneously put into constant-current operation mode, and the output voltage drops accordingly.

For these types of loads, you must increase the preset current value or increase the current capacity.

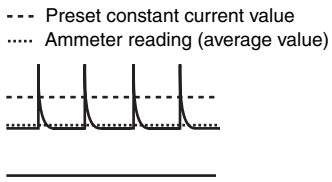


Fig. 3-1 Load current with peaks

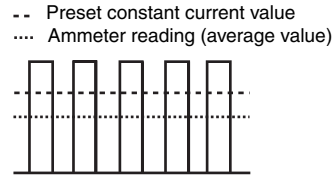


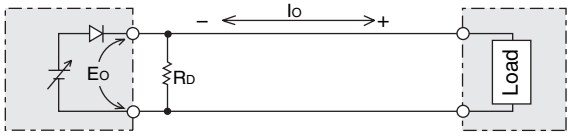
Fig. 3-2 Pulse-shaped load current

Load that generates reverse current to the power supply

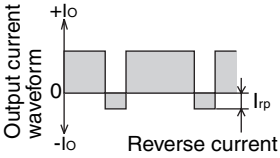
The PWR cannot absorb reverse current from the load. Therefore, if a regenerative load (such as an inverter, converter, or transformer) is connected, the output voltage increases and becomes unstable.

For these types of loads, connect a resistor (R_D) as shown in Fig 3-3 to bypass the reverse current. However, the amount of current to the load decreases by Irp.

⚠CAUTION • Select a resistor with sufficient rated power for R_D. If a resistor with insufficient rated power for the circuit is used, R_D may burn out.



Equivalent circuit of the PWR Regenerative load



$$R_D[\Omega] \leq \frac{E_O[V]}{I_{rp}[A]}$$

R_D: Reverse current bypass dummy load
E_O: Output voltage
I_{rp}: Max. reverse current

Fig. 3-3 Remedy for regenerative load

Load with accumulated energy

Connecting a load with accumulated energy, such as a battery, to the PWR may cause current to flow from the load to the internal circuit of the PWR. This current may damage the PWR or degrade the service life of the load.

For this type of loads, connect a reverse-current-prevention diode (DRP) between the PWR and the load in series as shown in Fig 3-4.

⚠CAUTION

- To protect the load and the PWR, select a DRP that complies with the following conditions.
  Reverse voltage withstand capacity of at least twice the rated output voltage of the PWR.
  Forward current capacity that is 3 to 10 times the rated output current of the PWR.
  A diode with small loss.
- Be sure to take into account the heat generated by DRP. DRP may burn out without adequate heat dissipation.

NOTE

- Cannot be used in combination with remote sensing.

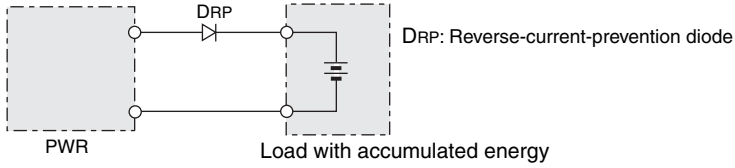


Fig. 3-4 Remedy against load with accumulated energy

3.2 Load Wire

Note the following points concerning the wire used to connect the load.

⚠WARNING

- **To prevent fire, use a load wire with sufficient current capacity with respect to the rated output current of the power supply.**
- **Possible electric shock. Use a load wire with a higher voltage rating than the isolation voltage of the PWR. For the isolation voltage of each model, see Chapter 9 "Specifications."**

■ Current capacity of the load wire

If the current rating exceeds the maximum rated output current, the wire will remain intact even if the load is short-circuited. Load wires must be rated to carry the maximum rated output current of the PWR.

■ Allowable current of the wire dependent on the maximum allowable temperature of the cable insulation

The wire temperature is determined by a current-caused resistance loss, ambient temperature, and thermal resistance to the outside. Table 3-1 shows the allowable capacity of current that can flow 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

When connecting wires that have the same heat-resistant temperature, more current can flow by separating the wires to make heat radiation as great as possible. However, installing the + (pos.) and - (neg.) output wires side by side or bundling them together is more effective against unwanted noise. The Kikusui-recommended cur-

rents shown in Table 3-1 are allowable current values that have been reduced in consideration of the potential bundling of load wires. Use these values as a guideline when connecting load cables.

■ Limitations of the sensing function

All wires have resistance. The voltage drop in wires becomes greater as the wire becomes longer or the current becomes larger. This results in the voltage applied at the load end to be smaller. The PWR has a sensing function that compensates for this voltage drop up to approximately 0.6 V 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*1 [A] (Ta = 30°C)	Current Recommended by Kikusui [A]
2	14	(2.08)	27	10
3.5	12	(3.31)	37	-
5.5	10	(5.26)	49	20
8	8	(8.37)	61	30
14	5	(13.3)	88	50
22	3	(21.15)	115	80
30	2	(33.62)	139	-
38	1	(42.41)	162	100
50	1/0	(53.49)	190	-
60	2/0	(67.43)	217	-
80	3/0	(85.01)	257	200
100	4/0	(107.2)	298	-
125	-	-	344	-
150	-	-	395	300
200	-	-	469	-

*1. Excerpts from Japanese laws related to electrical equipment.

3.3 Connecting to the Output Terminal

3.3.1 Connecting to the Output Terminal on the Rear Panel

⚠WARNING • **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal on the rear panel. Be sure to attach the OUTPUT terminal cover after wiring the load.**

The chassis connection wire is not included. If you are using the chassis connection wire that comes with the analog remote control connector kit (OP01-PAS), you can use it immediately as it is already assembled.

1. Turn the POWER switch off.
2. Connect the chassis terminal to either the - (neg.) or + (pos.) output terminal using the chassis connection wire.

   The output terminal has an M3 hole used to connect the chassis connection wire. Provide your own M3 screws and spring washers.
   If you are not using the optional OP01-PAS, attach a crimping terminal to a wire of AWG18 or higher to make the connection.

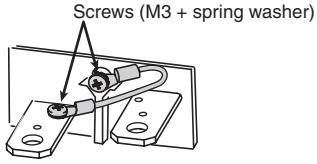


Fig. 3-5 Connection of the chassis connection wire (example in which the - (neg.) output terminal is connected)

3. Attach crimping terminals to the load wires.

   The output terminal on the rear panel has M4- (with taps) and M8-sized holes for connecting the load wires. Attach the crimping terminal that matches the screws.

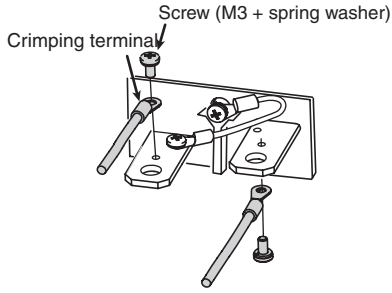
   Use crimping terminals that are less than equal to 5.5 mm^2 with the M4-sized holes.

See Fig 3-6

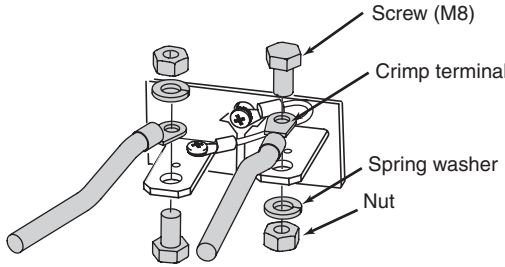
4 Connect the load wire to the output terminal on the rear panel.

If you are using M8 screws, pay attention to the direction of the screws.

Connection using M4 screws



Connection using M8 screws



If you do not connect the wire as shown, the OUTPUT terminal cover may hit the M8 screw.

Fig. 3-6 Connecting the load wire to the output terminal on the rear panel

Attaching the OUTPUT terminal cover

There are two types of OUTPUT terminal covers: bottom cover and top cover.

1. Insert the hook of the bottom cover into the hole located above and to the left of the output terminal.

   The bottom cover is the one without screws.

2. Align the hook of the bottom cover to the groove located to the side of the output terminal.

3. Align the bottom cover with the top cover, and fix them in place using the screws attached to the top cover.

   Check that the screws are securely fastened.

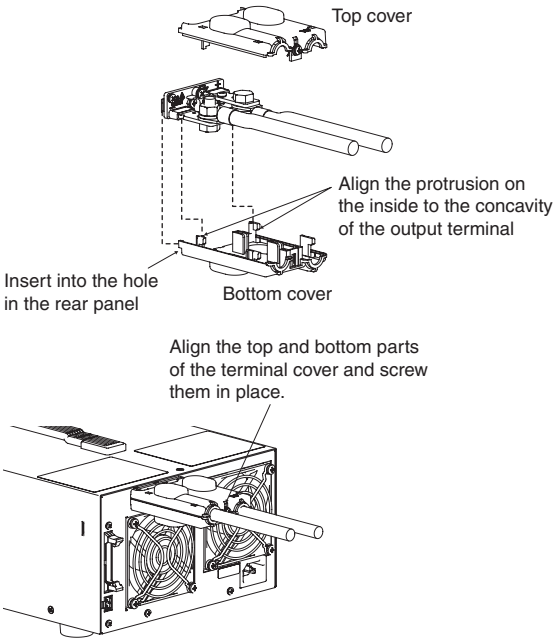


Fig. 3-7 Attachment of the OUTPUT terminal cover

3.3.2 Connection to the Output Terminal on the Front Panel

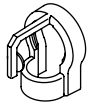
The specifications of the PWR are defined for output terminal on the rear panel. Those on the front panel may not satisfy the specifications. Like the output terminal on the rear panel, the chassis terminal is normally connected to either the - (neg.) or + (pos.) output terminal.

See Fig 3-5

⚠WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal on the front panel.**
  Do not use the terminal with the front output terminal cover removed. In addition, be sure to attach the OUTPUT terminal cover on the rear panel.
- **Possible overheating or fire. Do not supply currents that exceed 30 A from the output terminal on the front panel on the L type.**

If the front output terminal cover is damaged or lost, contact Kikusui distributor/agent.



[P1-000-408]

Fig. 3-8 Front output terminal cover

1. Turn the POWER switch off.
2. Attach crimping terminals to the load wires.
3. Remove the knob and connect the load wire to the output terminal on the front panel.
4. Attach the knob.

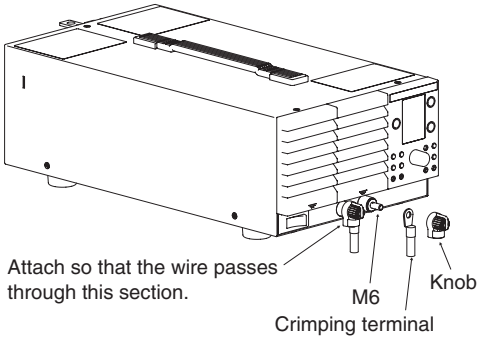


Fig. 3-9 Connection to the output terminal on the front panel

Basic Operation

This chapter describes how to turn on/off the output and the basic operations that you can carry out from the front panel.

4.1 Measured Value Display and Setting Display

The voltage and current displays have the following three states.

- Measured value display
- Setting display

In addition to the voltage and current displays, OVP/OCP setting, system configuration, and node address displays are available.

Measured value display

The measured value display shows the present output terminal voltage and load current. In this state, the SET switch LED is off.

See Page 4-13

You can change the voltage or current while viewing the actual output voltage or output current even with the output turned on.

If you turn the setting knob when the output is off, the SET switch automatically illuminates even if it is off and the setting display appears.

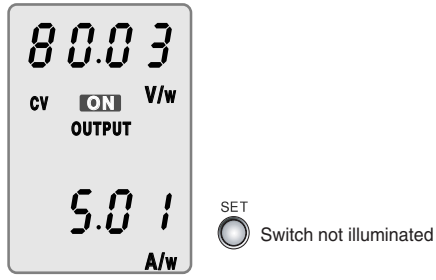


Fig. 4-1 Measured value display example

■ Power display

Press the PWR DSPL (SHIFT+CURRENT) switch to display the output power on the ammeter. Press the PWR DSPL (SHIFT+VOLTAGE) switch to display the output power on the voltmeter.

The output power is displayed when the output is on. You can change the voltage or current while viewing the actual output power. The output power is a value calculated from the measured output voltage and measured output current.

The unit (V/w or A/w) to the right of the LED illuminates when the power is displayed. If you press the VOLTAGE or CURRENT switch when the power is displayed, the power display position switches.

Press the PWR DSPL (SHIFT+CURRENT or SHIFT+VOLTAGE) switch to show the measured value display.

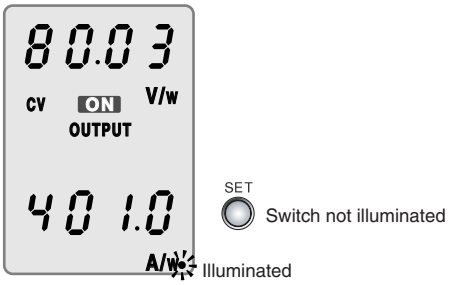


Fig. 4-2 Power display example
(displaying power on the ammeter)

Setting display

Press the SET switch. The switch LED illuminates, and the present output voltage or current setting is displayed.

Press the SET switch again to show the measured value display.

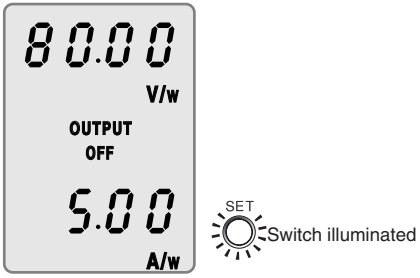


Fig. 4-3 Setting display example

4.2 Panel control

For measured value display, setting display, and OVP/OCP setting value display

Turn the setting knob to change the highlighted digit or higher digits on the panel display.

The value can be changed regardless of whether the OUTPUT is on or off.

See Page 4-11

To set the current to a value greater than 105 % of the rated output current in the extended operating area (L type only), turn the setting knob while holding down the SHIFT switch. You do not have to hold down the SHIFT switch when decreasing the current from a setting greater than or equal to 105 %.

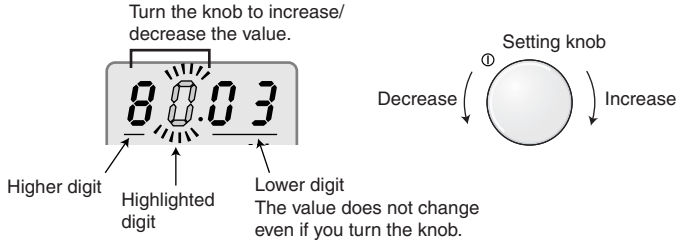


Fig. 4-4 Example of increasing or decreasing the setting

To set the voltage, press the VOLTAGE switch. The voltmeter is highlighted.

To set the current, press the CURRENT switch. The ammeter is highlighted.

If you turn the setting knob when the output is off on the measured value display, the SET switch automatically illuminates even if it is off, and the setting display appears.

■ Coarse/Fine

Press the VOLTAGE switch when the voltmeter is highlighted or the CURRENT switch when the ammeter is highlighted to switch between coarse and fine.

You can also press the setting knob to switch between coarse and fine.

The highlighted digit varies depending on the model. See Table 4-1. The underlined digit is highlighted.

Table 4-1 Highlighted digit

Model	Display	Coarse	Fine
PWR400L	Voltmeter/ Ammeter	0<u>0</u>.00	00.0<u>0</u>
PWR800L	Voltmeter/ Ammeter	0<u>0</u>.00	00.0<u>0</u>
PWR1600L	Voltmeter	0<u>0</u>.00	00.0<u>0</u>
	Ammeter	00<u>0</u>.0	000.<u>0</u>
PWR400M	Voltmeter	00<u>0</u>.0	000.<u>0</u>
	Ammeter	0.<u>0</u>00	0.00<u>0</u>
PWR800M	Voltmeter	00<u>0</u>.0	000.<u>0</u>
	Ammeter	00.<u>0</u>0	00.0<u>0</u>
PWR1600M	Voltmeter	00<u>0</u>.0	000.<u>0</u>
	Ammeter	00.<u>0</u>0	00.0<u>0</u>
PWR400H	Voltmeter	0<u>0</u>0.0	000.<u>0</u>
	Ammeter	0.<u>0</u>00	0.00<u>0</u>
PWR800H	Voltmeter	0<u>0</u>0.0	000.<u>0</u>
	Ammeter	0.<u>0</u>00	0.00<u>0</u>
PWR1600H	Voltmeter	0<u>0</u>0.0	000.<u>0</u>
	Ammeter	0<u>0</u>.00	00.0<u>0</u>

■ For other displays

When showing the system configuration display, use the setting knob to change the highlighted setting.

4.3 Output Operation

The OUTPUT switch is a toggle switch. When the output is on, the OUTPUT ON indicator on the display illuminates; when the output is off, the OUTPUT OFF indicator illuminates.

When the output is on, the present setting is output. If you change the setting while the output is on, the change is applied to the output.

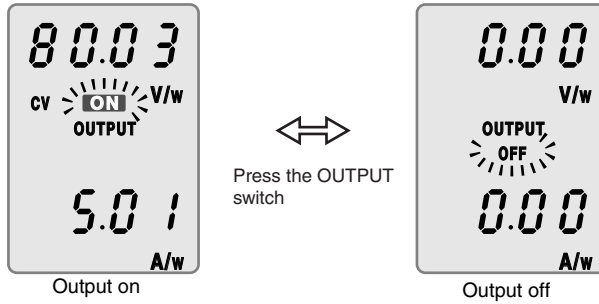


Fig. 4-5 Output indication

Output on/off when power is turned on

By factory default, the output is off when the power is turned on. You can set the output state at power-on to on (C-4: 1) in the CONFIG settings.

If you set the output state at power-on to on, check the OVP trip point setting before you turn off the POWER switch.

If the breaker trip setting that is applied when a protection function activates is set to “trip” (C-8: 0) and the OVP trip point is set lower than the output voltage setting, the OVP will activate every time you turn the POWER switch on and the POWER switch will turn off.

If the condition above occurs and you are unable to change any of the settings, turn the POWER switch on while holding down the OUTPUT switch to power up with the output temporarily turned off.

⚠CAUTION • If the OVP/OCP settings are not appropriate when you change the load, the load may break.

4.4 Description of Operation

The PWR is a constant voltage/current regulated DC power supply that is capable of delivering voltages and currents in a wide operating range within the rated output power. Fig. 4-6 shows the operating area of the 400 W type.

See Page 4-11

A in the figure indicates the rated operating area, and B indicates the extended operating area. The extended operating area is valid only on the L type.

If the PWR is configured in way that satisfies the equation output voltage × output current ≤ rated output power, the PWR operates as a conventional constant voltage/current power supply.

See Page 4-22

If the PWR is configured in a way that satisfies the equation output voltage × output current > rated output voltage, the actual output is limited by the power limit (approx. 105% of the rated output power) and the output voltage or output current varies depending on the load value.

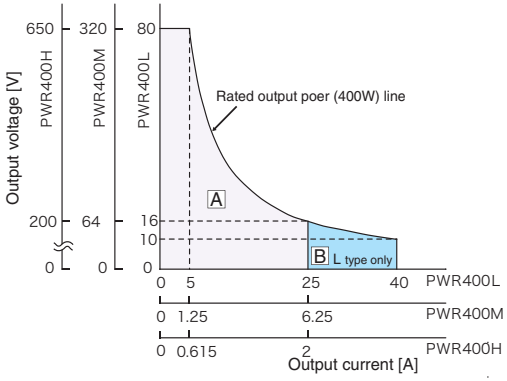


Fig. 4-6 Operating area (400 W type example)

The output current must be derated with respect to the temperature at ambient temperatures greater than or equal to 45 °C (30 °C when operating in the extended operating area) on the L type and 40 °C on the M/H type.

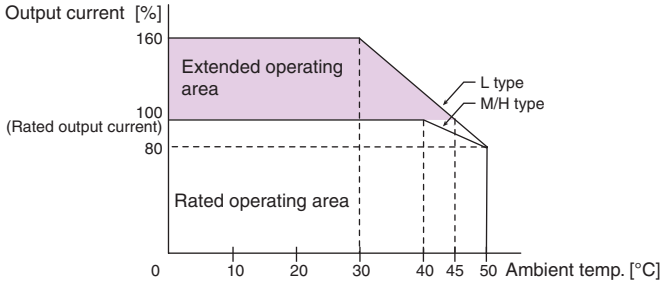


Fig. 4-7 Derating of the output current

4.4.1 Constant Voltage (CV) and Constant Current (CC) Power Supplies

The PWR has a constant voltage power supply function that maintains the output voltage at a constant level and a constant current power supply function that maintains the output current at a constant level even when the load changes. The condition in which the PWR is operating as a constant voltage power supply is called the constant voltage (CV) mode. The condition in which the PWR is operating as a constant current power supply is called the constant current (CC) mode. The operation mode is determined by the following three values.

- Preset output voltage (Vs)
- Preset output current (Is)
- Load resistance (R_L)

The operation modes are described below.

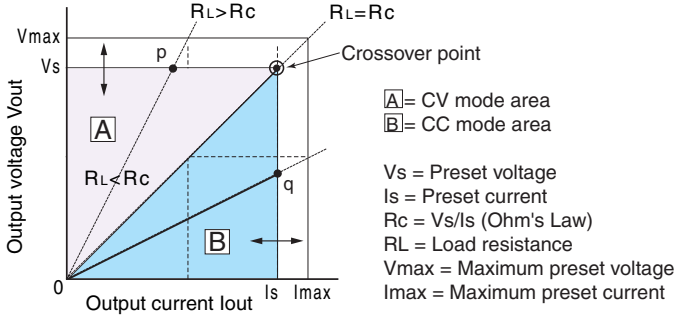


Fig. 4-8 Constant voltage operation and constant current operation

Fig. 4-8 shows the operation modes of the PWR. We denote the load resistance as RL and the resistance calculated from the preset current and voltage as Rc (Rc = Vs/Is). The power supply is designed so that it operates in CV mode in area A and CC mode in area B. The boundary is the line defined by RL = Rc. This line represents the load at which the output voltage and the preset voltage are equal and the output current and preset current are equal. If load resistance RL is greater than resistance Rc, the operating point is in area A, and the PWR operates in CV mode (point p). In this case, preset current Is is the current limit.

When operating in CV mode, the output voltage is maintained at the preset voltage. Output current I is determined by the relationship defined by the equation I = Vs/RL. It is a current less than current limit Is. In this mode, the actual current that flows is not necessarily equal to the specified value.

For loads in which transient peak current flows, preset current Is must be set so that the peak value does not reach the current limit.

Conversely, if load resistance RL is less than resistance Rc, the operating point is in area B, and the PWR operates in CC mode (point q). In this case, preset voltage Vs is the voltage limit.

When operating in CC mode, the output current is maintained at the preset current. Output voltage V is determined by the relationship defined by the equation V = Is × RL. It is a voltage less than voltage limit Vs. In this mode, the actual voltage that is applied is not necessarily equal to the specified value.

For loads that generate transient surge voltage, preset voltage Vs must be set so that the surge voltage does not reach the voltage limit.

■ Crossover point

CV mode and CC mode switch automatically according to the changes in the load. The point at which the mode switches is called the crossover point.

For example, if the load changes and the output current reaches the current limit when operating in CV mode, the operation mode automatically switches to CC to protect the load. Likewise, if the output voltage reaches the voltage limit when operating in CC mode, the operation mode automatically switches to CV.

CV and CC mode operation example

This section uses a power supply with a rated output voltage of 100 V and a rated output current of 10 A as an example.

A load resistance (R_L) of 8 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 8 Ω is greater than 6 Ω (R_L > Rc), the operation mode is CV. If you want to increase the voltage in CV mode, the voltage can be increased up to the voltage defined by the following equation: Vs = Is × RL. Substituting the values, we obtain Vs = 5A × 8 Ω = 40 V. If you try to increase the voltage above this point, the crossover point is reached, and the operation mode automatically switches to CC mode. To maintain CV mode, increase the current limit.

Next a load resistance (R_L) of 5 Ω is connected to the output terminals of the power supply. The output voltage and output current are set to 30 V and 5 A, respectively. In this case, Rc = 30 V/5 A = 6 Ω. Since, 5 Ω is greater than 6 Ω (R_L < Rc), the operation mode is CC. If you want to increase the current in CC mode, the current can be increased up to the current defined by the following equation: Is = Vs/RL. Substituting the values, we obtain Is = 30 V/5 Ω = 6 A. If you try to increase the current above this point, the crossover point is reached, and the operation mode automatically switches to CV mode. To maintain CC mode, increase the voltage limit.

4.4.2 Extended operating area (L type only)

Of the output current setting range of the PWR as illustrated in Fig. 4-9, the range between the rated output current and the maximum output current (160 % of the rating) is the extended operating area.

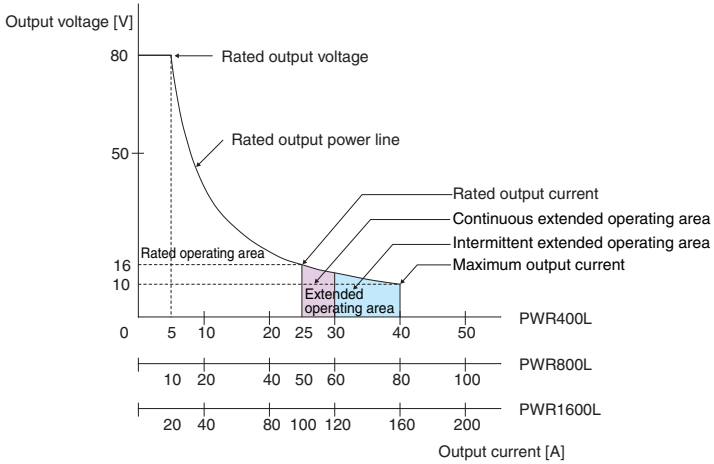


Fig. 4-9 Extended operating area

See Fig. 4-10

The specifications of load fluctuation, input fluctuation, ripple/noise, and so on are not met in the extended operating area. The extended operating area is divided into the continuous extended operating area and the intermittent extended operating area with the limitations listed below.

- Continuous output is possible in the continuous extended operating area. However, at ambient temperatures greater than or equal to 30 °C, the output current must be derated with respect to the temperature.
- The output duration is limited in the intermittent extended operating area. See Table 4-2.

When using the PWR in the extended operating area, pay attention to the ambient temperature, preset current, and output duration.

The ALM LED blinks when operating in the extended operating area. In this case, the ALM signal is not output.

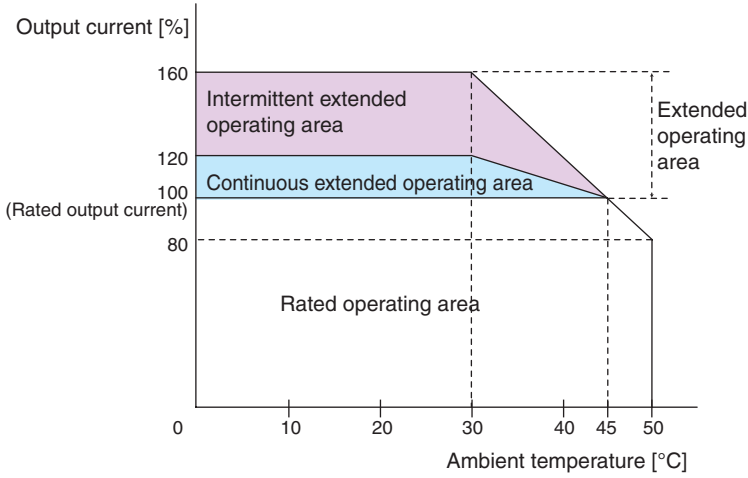


Fig. 4-10 Derating of the output current (L type)

Table 4-2 Guideline of the time duration of operation in the intermittent extended operating area

Maximum Output Duration*1	Pause Duration*1
10 minutes	At least twice the output duration

*1. When operating by itself with no devices that generate heat around the PWR.

NOTE

- If you attempt to output a current exceeding the conditions of use as described above, the internal protection function trips, and the OUTPUT is turned off.
- When rack mounting multiple PWRs, pay attention to the ambient temperature and the output current derating.

4.5 Using the PWR as a CV or CC Power Supply (Setting the Output Voltage and Current)

When using the PWR as a constant voltage power supply, the preset current is the limit that can flow through the load.

When using the PWR as a constant current power supply, the preset voltage is the limit that can be applied to the load.

If the specified limit is reached, the operation mode automatically switches. If the operation mode switches, the CV and CC indicators on the display change to indicate the switch.

1. Turn the POWER switch off.

See Page 3-7

2. Connect the load to the output terminal.
3. Turn the POWER switch on.

   If the OUTPUT ON indicator on the display is illuminated, press the OUTPUT switch to turn the output off.

4. Press the SET switch to show the setting display.

   The SET switch illuminates.

See Page 4-4

5. Use the VOLTAGE switch and setting knob to set the voltage.
6. Use the CURRENT switch and setting knob to set the current.
7. Press the OUTPUT switch to turn the output on.

   The SET switch turns off, and the OUTPUT ON indicator on the display illuminates. Voltage/current is delivered to the output terminal. The CV indicator on the display illuminates when the PWR is operating as a constant voltage power supply. The CC indicator illuminates when the PWR is operating as a constant current power supply.

You can change the actual output voltage or output current while viewing the value even with the output turned on by carrying out step 5 and step 6 .

See
Page 4-2

You can also change the actual output voltage or output current while viewing the power.

The internal capacitor is charged when the output is turned on. Depending on the preset current, the PWR may instantaneously enter CC mode.

4.6 Protection Function and Alarm

The PWR is equipped with the following protection function.

- Overvoltage protection (OVP)
- Overcurrent protection (OCP)
- Overpower protection (OPP)
- Overheat protection (OHP)
- Shutdown (SHUT)
- Power limit (POWER LIMIT)

4.6.1 Alarm occurrence and release

Alarm occurrence

When a protection function activates, the PWR behaves as follows:

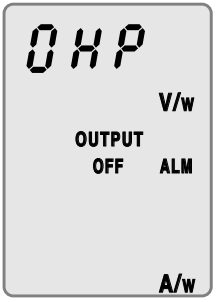


Fig. 4-11 Alarm indication (OHP example)

- Output off (excluding the case when the power limit trips).

  For the overvoltage protection (OVP), overcurrent protection (OCP), overpower protection (OPP), and shutdown (SHUT), you can select breaker trip in the CONFIG settings.

See Page 4-27

- The ALM indicator on the front panel display illuminates or blinks.

  The ALM indicator illuminates approximately 0.5 to 3 seconds even if the breaker trips.

- The alarm signal is output from pin 20 of the J1 connector (excluding the case when the power limit trips).

  The alarm signal is delivered approximately 0.5 to 3 seconds even if the breaker trips.

The ALM LED blinks when operating in the extended operating area. In this case, the ALM signal is not output.

■ Breaker trip function when the OVP, OCP, OPP, or SHUT is activated

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when the OVP, OCP, or OPP function activates or when a shutdown signal is applied.

The breaker trip function is common to OVP, OCP, OPP, and SHUT. It cannot be set separately by protection function.

Clearing the alarm

If you cannot clear the alarm even when all of the causes of the alarm are eliminated, the PWR may have malfunctioned. If this happens, stop using the PWR and contact your Kikusui agent or distributor.

■ When the breaker trips (when the POWER switch turns off)

After eliminating the cause of the alarm, turn on the POWER switch.

■ When the output turns off

Turn off the POWER switch, eliminate the cause the alarm, and then turn the POWER switch back on.

Alarm signal

The alarm signal output is isolated from other terminals by an open-collector photocoupler.

Maximum voltage: 30 V

Maximum current: 8 mA

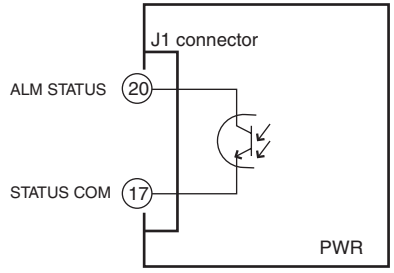


Fig. 4-12 Alarm signal

4.6.2 Overvoltage protection (OVP) and overcurrent protection (OCP)

The overvoltage protection (OVP) and overcurrent protection (OCP) functions activate under the following conditions.

Conditions in which the OVP is activated

- When the output terminal voltage exceeds the specified voltage (OVP trip point).
- When the sensing cable comes loose.
- When there is a problem with the load or the PWR.

Conditions in which the OCP is activated

- When the output current exceeds the specified current (OCP trip point).
- When there is a problem with the load or the PWR.

You must set appropriate values for the OVP and OCP trip points. Be sure to first set the OVP and OCP trip points appropriate for the load immediately after installing the PWR or changing the load.

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when the OVP or OCP function activates.

Setting the trip points

You can set the trip points regardless of whether the output is on or off.

The OVP function of the PWR operates against the output terminal voltage. If you want to activate the function on the voltage across the load, set the OVP trip point by considering the voltage drop in the load wire.

Table 4-3 OVP trip point range

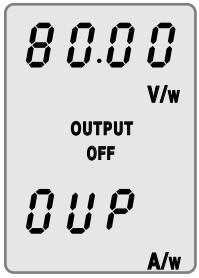
Type	OVP Trip Point Range
L type	8.0 V to 88.0 V
M type	32.0 V to 352.0 V
H type	65.0 V to 715.0 V

Table 4-4 OCP trip point range

Model	OCP Trip Point Range
PWR400L	2.50 A to 44.00 A
PWR800L	5.00 A to 88.00 A
PWR1600L	10.00 A to 176.0 A

Model	OCP Trip Point Range
PWR400M	0.625 A to 6.875 A
PWR800M	1.25 A to 13.75 A
PWR1600M	2.50 A to 27.50 A

PWR400H	0.20 A to 2.20 A
PWR800H	0.40 A to 4.40 A
PWR1600H	0.80 A to 8.80 A



OVP

OCP

Fig. 4-13 OVP/OCP setting value display example

■ Setting the OVP trip point

1 Press the OVP switch.

The voltmeter shows the setting, and the ammeter shows "OVP."

See Page 4-4

2 Use the VOLTAGE switch and setting knob to set the OVP trip point.

If the output is on and the OVP trip point is set lower than the preset output voltage, the OVP trips, and the output turns off or the POWER switch turns off.

3 Press the OVP switch to exit from the OVP setup.

The measured value display appears.

■ Setting the OCP trip point

1. Press the OCP (SHIFT+OVP) switch.

   The ammeter shows the setting, and the voltmeter shows “OCP.”

See Page 4-4

2. Use the CURRENT switch and setting knob to set the OCP trip point.

   If the output is on and the OCP trip point is set lower than the preset output current, the OCP trips, and the output turns off or the POWER switch turns off.

3. Press the OCP (SHIFT+OVP) switch to exit from the OCP setup.

   The measured value display appears.

Checking the OVP or OCP operation

The OVP or OCP is a function for protecting the load. Once you set the OVP or OCP trip point, check that the OVP or OCP works before you connect the load by carrying out the procedure below.

See Page 4-26

1. Check that the output status setting at power-on is set to “output off at power-on” (C-4: 0).

2. Check that the load is not connected to the output terminal.

   If it is, turn the POWER switch off and disconnect the load. Then, turn the POWER switch on.

3. Press the OUTPUT switch to turn the output off.

   The OUTPUT OFF indicator on the display illuminates.

See Page 4-4

4. Set the output voltage to a value less than the OVP-trip point.

5. Press the OUTPUT switch to turn the output on.

   The OUTPUT ON indicator on the display illuminates.

6 Turn the setting knob slowly clockwise, and check that the output turns off or the breaker trips when the output voltage exceeds the preset OVP trip point.

7 Turn the POWER switch off.

8 Short the output terminal.

9 Turn the POWER switch on.

10 Set the output voltage to a value less than the OVP trip point.

11 Set the output current to a value less than the OCP trip point.

12 Press the OUTPUT switch to turn the output on.

The OUTPUT ON indicator on the display illuminates.

13 Turn the setting knob slowly clockwise, and check that the output turns off or the breaker trips when the output current exceeds the preset OCP trip point.

14 Set the output current to a value less than the OCP trip point.

4.6.3 Other Protection Functions

Overpower protection (OPP)

This function is activated when a condition that exceeds approximately 110 % of the rated output power persists for a certain period (approximately 2 seconds) such as due to a transient load change.

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when the OPP function activates.

Table 4-5 OPP value (fixed)

Type	OPP Value
400 W type	440 W
800 W type	880 W
1600 W type	1760 W

Overheat protection (OHP)

This function protects the PWR with turning off the output when the internal temperature rises abnormally.

The OHP is activated under the following conditions.

- When the PWR is operated outside its operating temperature range (0 °C to +50 °C).
- When the PWR is used with the intake or exhaust port blocked.
- When the fan motor stops.

If you turn the POWER switch back on without correcting the condition that caused the OHP, the OHP will be activated again.

Shutdown (SHUT)

See Page 5-21

Shutdown is not activated as a result of the PWR detecting an error. It is a function used to turn off the output by applying an external signal to the J1 connector on the rear panel when an abnormal condition occurs.

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when the shutdown signal is applied..

Power limit (PL:POWER LIMIT)

This function varies the output voltage or output current according to the changes in the load resistance. It limits the output power at approximately 105 % of the rated output power and does not turn the output off.

The ALM indicator blinks while the power limit is activated. In this case, the alarm signal is not output.

Table 4-6 Power limit value (fixed)

Type	Power Limit Value
400 W type	420 W
800 W type	840 W
1600 W type	1680 W

4.7 CONFIG Settings

CONFIG settings are used to set the system configuration of the PWR. You can set or display the parameters in Table 4-7 in the CONFIG settings.

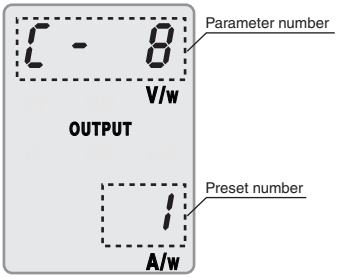


Fig. 4-14 CONFIG setting/display example

- Parameter number

  Displays the parameter number on the voltmeter.

- Preset number

  Displays the CONFIG parameter setting as a value with the lowest 2 digits of the ammeter.

Table 4-7 CONFIG parameter number and setting

Parameter Number	CONFIG Parameter
C-1	CV control source setting.
C-2	CC control source setting.
C-3	Remote sensing setting.
C-4	Output status setting at power-on.
C-5	Serial/parallel master-slave operation setting.
C-6	External control logic setting of the output on/off.
C-7	Termination setting during remote control
C-8	Breaker trip setting when the protection function trips.
C-9	Status signal setting of the power on/off.

Setting the system configuration

Set the system configuration of the PWR.

1. While holding down the CONFIG switch, turn on the POWER switch.

   Keep holding down the CONFIG switch until the voltmeter displays “ConF.”
   The CONFIG switch illuminates, and a parameter number highlighted.

2. Turn the setting knob to select the parameter number you want to set.

3. Press the CURRENT switch to select the preset number.

   The preset number is highlighted.

4. Turn the setting knob to select the preset number you want to set.

5. To continue setting the system configuration, press the VOLTAGE switch to select the CONFIG parameter number. Then, repeat steps step 2 to step 4 .

6. When you are done, turn off the POWER switch.

   The specified operating conditions are stored by the PWR when the POWER switch is turned off.

Checking the system configuration

Check the system configuration of the PWR.

1. Press the CONFIG switch when the POWER switch is turned on.

   The CONFIG switch illuminates..

2. Turn the setting knob to select the parameter number, and check the preset number.

   The setting corresponding to the parameter number is displayed with the lowest 2 digits on the ammeter. The CURRENT switch is invalid.

3. Press the CONFIG switch to end the CONFIG display.

   The CONFIG switch turns off, and the measured value display appears.

CONFIG parameter details

The details of the CONFIG parameters are described below.

C-1 CV control source setting

See Page 5-10 Page 5-12

Selects the constant voltage control mode.

Preset Number	Description
0	Panel control (Factory default)
1	External voltage control
2	External resistance control 10 kΩ → MAX OUT
3	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

C-2 CC control source setting

See Page 5-16

Selects the constant current control mode.

Preset Number	Description
0	Panel control (Factory default)
1	External voltage control
2	External resistance control 10 kΩ → MAX OUT
3	External resistance control 10 kΩ → 0 OUT (FAIL SAFE)

C-3 Remote sensing setting

See Page 4-29

Selects whether to perform remote sensing.

Preset Number	Description
0	Disable remote sensing. (Factory default)
1	Enable remote sensing.

C-4 Output status setting at power-on

See Page 4-29

Sets the output state when the POWER switch is turned on. This setting is invalid when the output is turned off using an external contact.

Preset Number	Description
0	Output is off at power-on. (Factory default)
1	Output is on at power-on.

C-5 Serial/parallel master-slave operation setting

See Page 6-6 Page 6-14

Sets the PWR condition during master-slave series/parallel operation. Select 0 for independent operation.

Preset Number	Description
0	Master unit or independent operation. (Factory default)
1	Slave unit during parallel operation.
2	Slave unit during series operation (L type only).

C-6 External control logic setting of the output on/off

See Page 5-18

Sets the logic used to control the output on/off using an external contact (J1 connector).

Select 0 when not controlling the output on/off with an external contact.

Preset Number	Description
0	Turn the output on with a high signal. (Factory default)
1	Turn the output on with a low signal.

C-7 Termination setting during remote control

See Page 7-6

Turns on/off the termination for remote control.

Preset Number	Description
0	Termination: Off (Factory default)
1	Termination: On

C-8 Breaker trip setting when the protection function trips

See Page 5-21

Sets whether to trip the breaker (turn the POWER switch off) when the OVP (overvoltage protection), OCP (overcurrent protection), OPP (overpower protection) is activated or when an external shutdown (SHUT) signal is applied.

Preset Number	Description
0	Trip (turn the POWER switch off). (Factory default)
1	Not trip (turn the output off).

C-9 Status signal setting of the power on/off

See Page 5-23

Sets whether to output a low level signal when the power is on or when the power is off when monitoring the PWR power on/off status externally (through the J1 connector).

Preset Number	Description
0	Output a low level signal while the power is on (PWR ON STATUS). (Factory default)
1	Output a low level signal for 0.5 s to 3 s when the power is off (PWR OFF STATUS).

4.8 Lock Function

The PWR has a lock function that prevents the settings from being changed inadvertently.

When the panel lock is enabled (LOCK switch illuminates), the switches on the front panel (excluding the OUTPUT switch) and the setting knob are disabled.

1. Set all the required parameters such as the output voltage and output current.
2. Press the LOCK switch.

   The LOCK switch illuminates, and panel lock is enabled.

Press the LOCK switch again to release the panel lock.

4.9 Remote Sensing Function

The remote sensing function is used to reduce the influence of voltage drops due to the load wire resistance and stabilize the output voltage across the load.

The remote sensing function of the PWR can compensate up to approximately 0.6 V for a single line. Select a load wire with sufficient current capacity so that the voltage drop in the load wire does not exceed the compensation voltage.

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

Connecting the sensing cable

⚠WARNING Possible electric shock or damage to the internal circuitry.

- **Never wire the cable to the sensing terminals while the POWER switch is turned on.**
- **Use sensing wires with a higher voltage rating than the isolation voltage of the PWR. Protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PWR. For the isolation voltage of each model, see Chapter 9 "Specifications."**
- **To turn on/off the power supplied to a load using a mechanical switch, provide additional switches between the sensing cables as shown in Fig. 4-16 and turn on/off the power and remote sensing cables simultaneously. Be sure to turn off the OUTPUT switch or POWER switch before turning on/off the mechanical switch.**

If the sensing cables come loose, the output voltage across the load cannot be stabilized and may cause excessive voltage to be applied to the load. If an appropriate OVP trip point is set, the OVP trips and prevents excessive voltage output.

See Page 4-24

After you are done using the remote sensing function, remove the sensing wires, and be sure to turn off remote sensing in the CONFIG settings (C-3: 0).

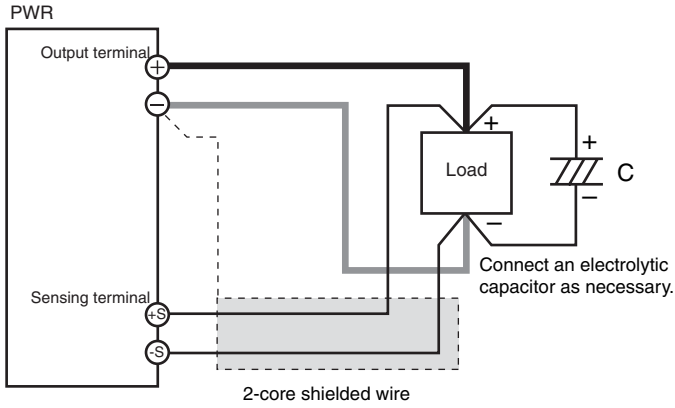


Fig. 4-15 Remote sensing connection

See Page 4-24

1. Turn on remote sensing through CONFIG settings (C-3: 1).
2. Turn the POWER switch off.
3. As shown in Fig. 4-15, connect the sensing cable between the sensing terminal and the load terminal.

   To decrease output ripple voltages resulting from inductive effects, use a two-core shielded wire for the sensing cables. Connect the shield to the - (neg.) terminal.
   If you cannot use shielded wires, twist the + (pos.) and - (neg.) wires thoroughly.

■ Electrolytic capacitor connected at the load end

If the inductance in the wire is large, the following symptoms may appear.

- Oscillation

  If the wiring cable to a load is long, the phase shift caused by the inductance and capacitance of the wiring becomes non-negligible, thereby causing oscillation.

- Fluctuating output

  If the load current changes suddenly to pulse form, the output voltage may increase due to the effects from the inductance component of the wiring.

Twisting the load wires reduces the inductance, thereby stabilizing the output. However, if this does not solve the problem, connect an electrolytic capacitor at the load end.

Electrolytic capacitor required

Capacitance:	0.1 µF to several hundred µF
Withstand voltage:	Greater than or equal to 120 % of the rated output voltage of the PWR

■ When inserting a mechanical switch between the PWR and the load

If you are using a mechanical switch that is inserted between the PWR and the load to turn on/off the connection between them, insert a switch also in the sensing cable as shown in Fig. 4-16 and turn on/off the load wire and the sensing cable simultaneously. Be sure to turn off the OUTPUT switch or POWER switch before turning on/off the mechanical switch.

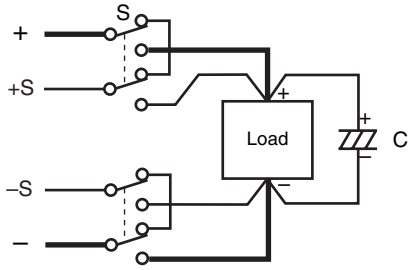


Fig. 4-16 On/off using the mechanical switch

4.10 Factory Default Settings

Turning ON the POWER switch while holding down the SHIFT switch initializes the settings to factory default (excluding the node address setting).

See Page 7-6

If you want to reset all the settings to factory default, set the node address to 5 after carrying out the initialization procedure above.

The factory default settings are given in the tables below.

Table 4-8 Basic settings

Basic item	Setting
Output voltage	0 V
Output current	105 % of the rated output current
OVP (overvoltage protection)	110 % of the rated output voltage
OCP (overcurrent protection)	176 % of the rated output current (L type) 110 % of the rated output current (M/H type)

Table 4-9 CONFIG settings (values are all zeroes)

Parameter number	CONFIG parameter	Setting
C-1	CV control source	Panel control
C-2	CC control source	Panel control
C-3	Remote sensing	Disable
C-4	Output status setting at power-on	Output is off at power-on.
C-5	Serial/parallel master-slave operation	Master unit or independent operation.
C-6	External control logic setting of the output on/off	Turn the output on with a high signal.
C-7	Termination during remote control	Off
C-8	Breaker trip when the protection circuit is activated	Trip
C-9	Status signal of the power on/off	Output a low level signal while the power is on.

External Control

This chapter describes external control and external monitoring using the J1 connector.

5.1 Overview of External Control

The J1 connector on the rear panel of the PWR can be used to perform external control listed below.

- Output voltage control

  Control using external voltage or external resistance

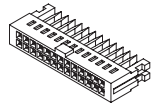
- Output current control

  Control using external voltage or external resistance

- Output on/off using external contact
- Shutdown using external contact

5.2 J1 connector

At the factory shipment, the protection socket is attached to the J1 connector. Keep this protection socket and be sure to attach when the J1 connector is not used. If the protection socket is damaged or lost, contact Kikusui distributor/agent.



[84-49-0110]

Fig. 5-1 Protection socket

⚠WARNING Possible electric shock.

- **The J1 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

The connector parts needed to connect the J1 connector (standard MIL connector) are not provided. Table 5-1 shows the tools an parts that are needed.

For information on how to obtain the tools and parts, contact your Kikusui agent or distributor.

An optional OP01-PAS Analog Remote Control Connector Kit is available for making the connection.

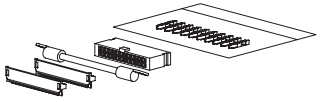


Fig. 5-2 OP01-PAS [84500]

Table 5-1 Connector parts by Omron needed to connect the J1 connector

Product	Model	Kikusui Parts No.	Notes
Single contact connection tool	XY2B-7006	Y2-070-001	–
Contact removal tool	XY2E-0001	Y2-070-002	–
Pin (contact)	XG5W-0031	84-49-0100	Recommended wire size AWG24 (UL-1061)
Socket	XG5M-2632-N	84-49-0160	MIL standard type socket
Protection cover (semi cover)	XG5S-1301	84-49-0161	–

For details on how to use the tools, read the catalog by Omron.

Table 5-2 J1 connector arrangement

Pin No.	Signal Name	Description
1	A COM	An analog signal common for pins 3 to 7. Connected to the negative electrode (-S) of the sensing input when remote sensing is used; connected to - (neg.) output when remote sensing is not used.
2	D COM	Connected to the negative electrode (-S) of the sensing input when remote sensing is used; connected to - (neg.) output when remote sensing is not used.
3	OUT ON/OFF CONT	Output on/off terminal. Turns off when a low (or high) TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ .
4	EXT V CV CONT	External voltage control of the output voltage. (0 % to 100 % of the rated output voltage in the range of 0 V to 10 V).
5	EXT V CC CONT	External voltage control of the output current. (0 % to 100 % of the maximum output current in the range of 0 V to 10 V).
6	EXT R CV CONT	External resistance control of the output voltage. 0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ or 100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ .
7	EXT R CC CONT	External resistance control of the output current. 0 % to 100 % of the rated output current in the range of 0 kΩ to 10 kΩ or 100 % to 0 % of the rated output current in the range of 0 kΩ to 10 kΩ .*1
8	V MON	Output voltage monitor (outputs 0 % to 100 % of the rated voltage using 0 V to 10 V).
9	I MON	Output current monitor (outputs 0 % to 100 % of the maximum current using 0 V to 10 V).
10	SHUT DOWN	Shutdown (Turns the output or POWER switch off when a low TTL level signal is applied. The internal circuit is pulled up to +5 V through 10 kΩ).
11	SER IN+	Positive electrode input terminal during master-slave series operation.
12	PRL IN+	Positive electrode input terminal during master-slave parallel operation.
13	S/P IN-	Negative electrode input terminal during master-slave series/parallel operation.

Pin No.	Signal Name	Description
14	COMP IN	Correction signal input terminal during master-slave parallel operation
15	NEXT PRL OUT+	Positive electrode output terminal to the next device during master-slave parallel operation.
16	NEXT COMP OUT	Correction signal output terminal to the next device during master-slave parallel operation.
17	STATUS COM	Common for status signals from pin 18 through 22.
18	CV STATUS	Turns on during CV operation (open collector output by a photocoupler).*2
19	CC STATUS	Turns on during CC operation (open collector output by a photocoupler).*2
20	ALM STATUS	Turns on when the OVP, OCP, OPP, or OHP trips or when a shutdown signal is applied (open collector output by a photocoupler)*2
21	OUT ON STATUS	Turns on when the output is on (open collector output by a photocoupler)*2
22	PWR ON/OFF STATUS	PWR ON STATUS (C-9:0):Outputs a low level signal when the power is on. PWR OFF STATUS (C-9:1):Output a low level signal for approximately 0.5 to 3 s when the power is turned off. (open collector output by a photocoupler)*2, *3
23	SER OUT+	Positive electrode output terminal during master-slave series operation.
24	PRL OUT+	Positive electrode output terminal during master-slave parallel operation.
25	S/P OUT-	Negative electrode output terminal during master-slave series/parallel operation
26	COMP OUT	Correction signal output terminal during master-slave parallel operation.

*1. The maximum current is the rated current on the M/H type.
*2. Open collector output:Maximum voltage of 30 V and maximum current of 8 mA.
It is insulated from the control circuit.
*3. PWR ON/OFF STATUS: Either PWR ON STATUS (C-9: 0) or PWR OFF STATUS (C-9:1) that you specify using the status signal setting of the output on/off is activated.

5.3 Output Terminal Insulation

Note the following points and insulate the output terminals.

⚠WARNING

- **Possible electric shock. For safety reasons, even if the output terminal is grounded, make sure the insulation capacity of the output terminal (including the sensing terminal) is greater than the isolation voltage of the PWR. For the isolation voltage of each model, see Chapter 9 "Specifications."**
  If you cannot obtain a wire with sufficient rated voltage, secure adequate withstand voltage by passing the wire through an insulation tube with a withstand voltage greater than the isolation voltage of the PWR.

⚠CAUTION

- The signal wire may burn out. If the PWR is to be controlled through an external voltage (Vext), do not ground it (leave it floating).

The wire 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 of the PWR with respect to the chassis. Isolation voltage indicates the maximum allowed voltage that appears across the output terminal of the power supply unit and the protective conductor terminal (chassis terminal).

5.3.1 When the Output Terminal Is Not Grounded (Floating)

The output terminal of the PWR is isolated from the protective conductor terminal. By connecting the GND wire of the power cord to the ground terminal of the switchboard, the chassis of the PWR is set to ground potential as shown in Fig. 5-3.

Pins 3 through 16 of the J1 connector on the rear panel (for external control and output monitoring) are at approximately the same potential as the - (neg.) output terminal of the PWR. Therefore, wires and devices that are connected to these pins must also have an insulation capacity that is greater than the isolation voltage of the PWR.

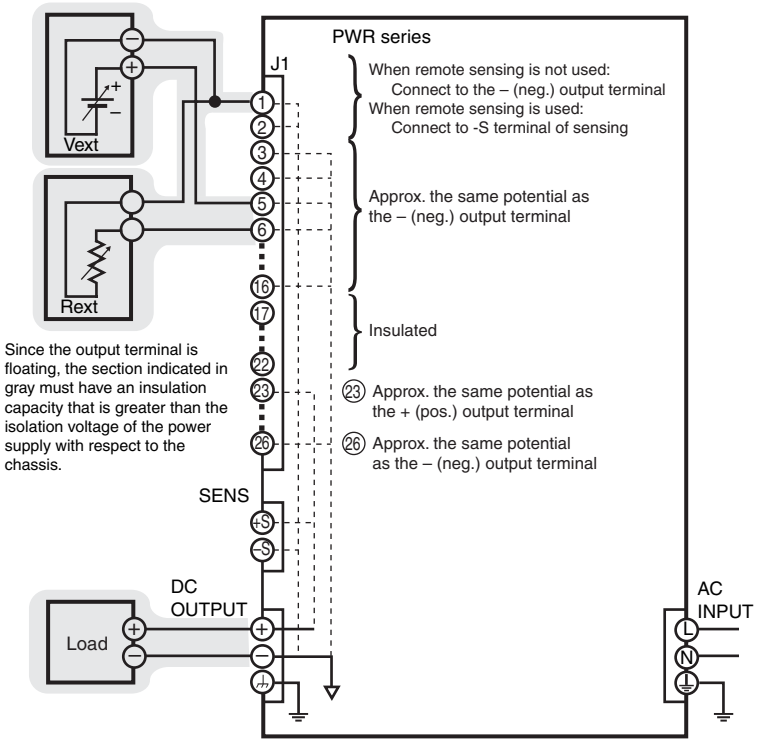


Fig. 5-3 When the output terminal is not grounded

5.3.2 When the Output Terminal Is Grounded

If the positive output terminal is connected to the chassis terminal, the terminal is at ground potential as shown in Fig. 5-4. Therefore, the wires and load that are connected to the output terminal (including the sensing terminal) only require an insulation capacity that is greater than the maximum output voltage of the PWR with respect to the chassis.

The same holds true when the negative terminal is connected to the chassis terminal. The wire and load require an insulation capacity that is greater than the maximum output voltage of the PWR.

For safety reasons, connect either output terminal to the chassis terminal unless your application requires the output terminal to be floating.

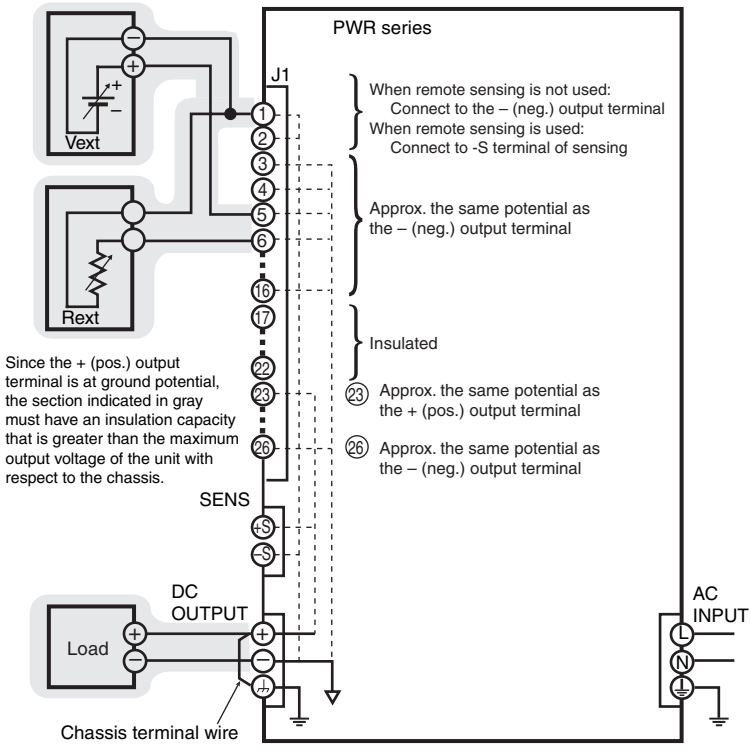


Fig. 5-4 When the + (pos.) output terminal is grounded

Precautions to be taken when using the external voltage (Vext)

Be sure that the output is not shorted as shown in Fig. 5-5 and Fig. 5-6.

⚠CAUTION The signal wire may burn out.

- Leave the Vext output floating.
- If you are connecting the shield at the Vext end, do not connect the shield to the output terminal of the PWR.

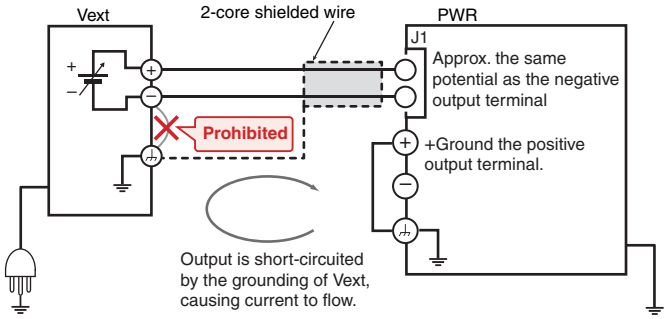


Fig. 5-5 The output is short-circuited by the grounding of Vext (example of a prohibited connection)

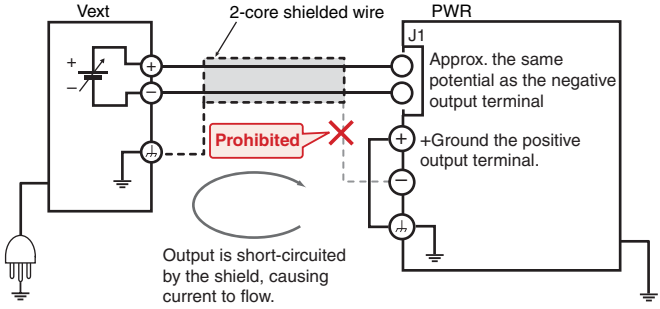


Fig. 5-6 Tthe output is short-circuited by the shield (example of a prohibited connection)

5.4 Output Voltage Control

This section explains the method used to control the output voltage using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ.

If no load is connected, it takes a long time for the output voltage to fall.

⚠WARNING **Possible electric shock.**

- **The insulation of the Vext or Rext and the connected wire should be greater than the isolation voltage of the PWR. For the isolation voltage of each model, see Chapter 9 "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PWR.**

5.4.1 External Voltage (Vext) Control

See Page 4-23

To control the output voltage using Vext, set the CV control source in the CONFIG settings to external voltage control (C-1: 1).

The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external voltage (Vext) in the range of 0 V to 10 V.

$$Eo = Ertg \times Vext / 10 \text{ [V]} \quad Vext = 10 \times Eo / Ertg \text{ [V]}$$

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- If the polarity is reversed, the PWR may break. Make sure the polarity of Vext is correct.
- The PWR may break. Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins.

Connecting the external voltage (Vext)

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PWR and appears at the output. Thus, the output ripple noise may not meet the PWR's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals 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.

See Page 5-9

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext end, see " Precautions to be taken when using the external voltage (Vext)."

Pins 1 and 4 of the J1 connector are used. The input impedance across the pins is approximately 30 kΩ .

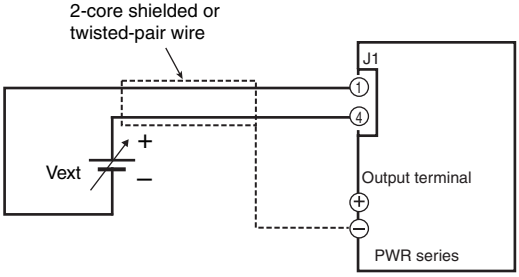


Fig. 5-7 Connection of the output voltage control using Vext

5.4.2 External Resistance (Rext) Control

See Page 4-23

To control the output voltage using Rext, select the CV control source in the CONFIG settings from the following two modes.

- External resistance control 10 kΩ → MAX OUT (C-1: 2)

  The output voltage (Eo) varies in the range of 0 to the rated output voltage (Ertg) by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Eo = Ertg × Rext /10 [V] Rext = 10 × Eo /Ertg [V]

- External resistance control 10 kΩ → 0 OUT (FAIL SAFE) (C-1: 3)

  The output voltage (Eo) varies in the range of the rated output voltage (Ertg) to 0 by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ.

  Eo = Ertg × (10-Rext)/10 [V]

  Rext = 10 × (Ertg-Eo)/Ertg [V]

NOTE

- If Rext comes loose when using the 10 kΩ → MAX OUT CV mode, excessive voltage may be applied to the load. For your safety, it is recommended that fail-safe 10 kΩ → 0 OUT CV mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals 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 - (neg.) output terminal.

Pins 1 and 6 of the J1 connector are used.

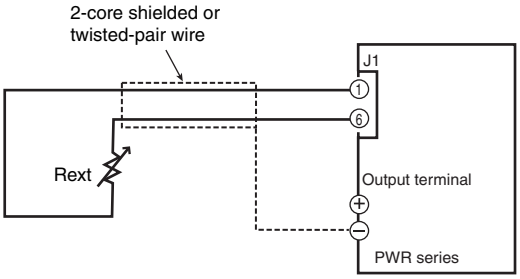


Fig. 5-8 Connection of the output voltage control using Rext

5.5 Output Current Control

This section explains the method used to control the output current using an external voltage (Vext) in the range 0 V to approx. 10 V or an external resistor (Rext) in the range 0 kΩ to approx. 10 kΩ .

⚠WARNING Possible electric shock.

- **The insulation of the Vext or Rext and the connected wire should be greater than the isolation voltage of the PWR. For the isolation voltage of each model, see Chapter 9 "Specifications."**
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PWR.**

5.5.1 External Voltage (Vext) Control

See Page 4-23

To control the output current using Vext, set the CC control source in the CONFIG settings to external voltage control (C-2: 1).

The output current (Io) varies in the range of 0 to the maximum preset current (Imax) on the L type by setting the external voltage (Vext) in the range of 0 V to 10 V. On the M/H type, Imax is the rated output current (Irtg).

$$Io = Imax \times Vext / 10 \ [A] \quad Vext = 10 \times Io / Imax \ [A]$$

⚠CAUTION

- The signal wire may burn out. Leave the Vext output floating.
- If the polarity is reversed, the PWR may break. Make sure the polarity of Vext is correct.
- The PWR may break. Do not apply voltage or reverse voltage exceeding 10.5 V across the external voltage control pins.

External voltage source (Vext) connection

Use a low-noise and stable voltage source for Vext. The noise in Vext is multiplied by the amplification factor of the PWR and appears at the PWR output. Thus, the output ripple noise may not meet the PWR's specifications.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals 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.

See Page 5-9

When using a shielded cable, connect the shield to the - (neg.) output terminal. If the shield needs to be connected to the Vext end, see " Precautions to be taken when using the external voltage (Vext)."

Pins 1 and 5 of the J1 connector are used. The input impedance across the external voltage control pins is approximately 30 kΩ.

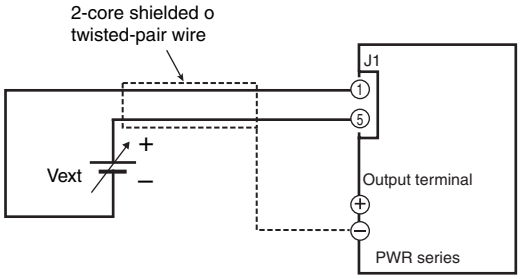


Fig. 5-9 Connection of the output current control using Vext

5.5.2 External Resistance (Rext) Control

See Page 4-23

To control the constant current using Rext, select the CC control source in the CONFIG settings from the following two modes.

- External resistance control 10 kΩ → MAX OUT (C-2: 2)

  The output current (Io) varies in the range of 0 to the maximum output current (Imax) on the L type by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ . On the H type, Imax is the rated output current (Irtg).

  Io = Imax × Rext /10 [A] Rext = 10 × Io /Imax [A]

- External resistance control 10 kΩ → 0 OUT (FAIL SAFE) (C-2: 3)

  The output current (Io) varies in the range of the maximum output current (Imax) to 0 on the L type by setting the external resistance (Rext) in the range of 0 kΩ to 10 kΩ. On the M/H type, Imax is the rated output current (Irtg).

  Io = Imax × (10-Rext)/10 [A]

  Rext = 10 × (Imax-Io)/Imax [A]

NOTE

- If Rext comes loose when using the 10 kΩ → MAX OUT CC mode, excessive current may flow through the load. For your safety, it is recommended that fail-safe 10 kΩ → 0 OUT CC mode be used.
- If you are using fixed resistors for Rext and controlling the output voltage by switching through them, use a short-circuit or continuous type switch.

External resistance (Rext) connection

For Rext, use a 1/2 W or larger metal film or wire-wound type resistor with good temperature coefficient and small aging effect.

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals 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 - (neg.) output terminal.

Pins 1 and 7 of the J1 connector are used.

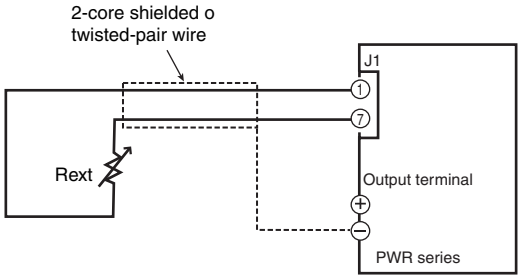


Fig. 5-10 Connection of the output current control using Rext

5.6 Controlling the Output On/Off

This section explains the method used to control the on/off of the output by using an external contact.

⚠WARNING Possible electric shock.

- **The insulation of the external contact (S) and the connected wire should be greater than the isolation voltage of the PWR.**
  For the isolation voltage of each model, see Chapter 9 "Specifications."
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PWR.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. 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 - (neg.) output terminal.

See Page 4-26

To control the output on/off using external contact, select the external control logic setting of output on/off in the CONFIG settings from the following two modes.

- Turn the output on with a high signal (C-6: 0)

  The output turns on when pin 3 of the J1 connector is set high (TTL level) or opened.

- Turn the output on with a low signal (C-6: 1)

  The output turns on when pin 3 of the J1 connector is set low (TTL level).

If the output is set to off using an external contact, the OUTPUT switch on the front panel is invalid. If you are not controlling the output using an external contact, turn the output on by setting the external control logic setting of output on/off in the CONFIG settings to high (C-6: 0).

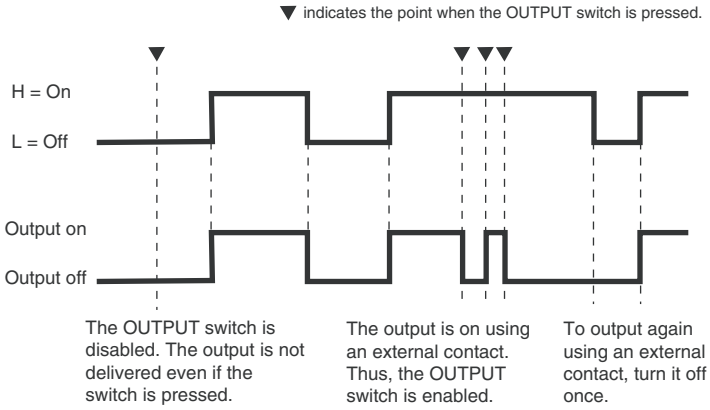


Fig. 5-11 Output on/off control (example in which the output is on at high)

External contact connection

Pins 2 and 3 of the J1 connector are used.
The release voltage across pins 2 and 3 is approx. 5 V ± 5 % maximum, and the short circuit current is approx. 500 µA ± 5 % maximum. (The internal circuit is pulled up to 5 V through 10 kΩ .)

Use parts with a contact rating of 5 Vdc and 10 mA for the external contact.

If multiple units are used under floating conditions and a single external contact is used to turn on/off the output, isolate the signal to each unit such as by using a relay on the external contact signal.

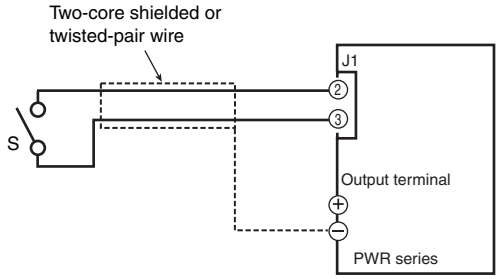


Fig. 5-12 On/off control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil end of the relay.

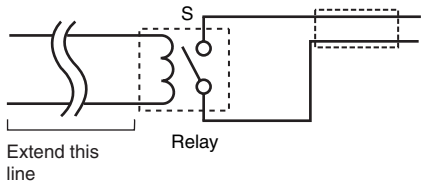


Fig. 5-13 On/off control using an external contact (for long-distance wiring)

5.7 Shutdown Control

This section explains the method used to trip the breaker (turn the POWER switch off) or turn the output off using external contact.

⚠WARNING **Possible electric shock.**

- **The insulation of the external contact (S) and the connected cable should be greater than the isolation voltage of the PWR.**
  For the isolation voltage of each model, see Chapter 9 "Specifications."
- **When using shielded wires for the connection, protect the uncovered section of the shielded wire by using insulation tubes with a withstand voltage greater than the isolation voltage of the PWR.**

To minimize the influence of noise on the output, use a two-core shielded wire or a twisted-pair wire to connect the control terminals and the external contact. 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 - (neg.) output terminal.

See Page 4-27

To control the shutdown using an external contact, select the breaker trip setting that is applied when the protection function is activated in the CONFIG settings from the following two modes.

- Trip (C-8: 0)

  The breaker trips when pin 10 of the J1 connector is set low (TTL level). To recover, set pin 10 high (TTL) or open the pin and turn on the POWER switch.

- Not trip (C-8: 1)

  The output turns off when pin 10 of the J1 connector is set low (TTL level). The breaker is not tripped. To recover, set pin 10 high (TTL) or open the pin and turn the POWER switch off and then back on.

Shutdown control connection

Pins 2 and 10 of the J1 connector are used.
The release voltage across pins 2 and 10 is approx. 5 V ± 5 % maximum, and the short circuit current is approx. 500 µA ± 5 % maximum. (The internal circuit is pulled up to 5 V through 10 kΩ.)

Use parts with a contact rating of 5 Vdc and 10 mA for the external contact.

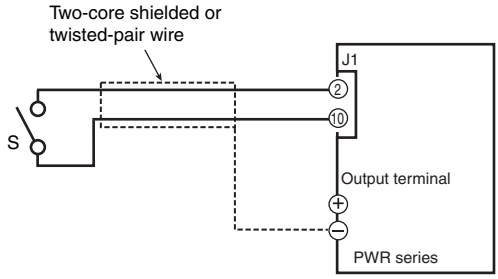


Fig. 5-14 Shutdown control connection using an external contact

■ For long-distance wiring

When wiring over a great distance, use a small relay and extend the coil end of the relay.

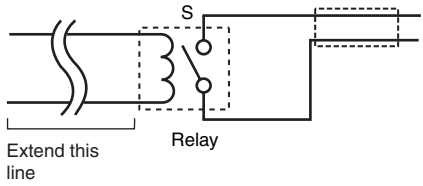


Fig. 5-15 Shutdown control connection using an external contact (for long-distance wiring)

5.8 External Monitoring

External monitoring of the output voltage and output current

The J1 connector consists of monitor outputs for output voltage and output current.

Table 5-3 Monitor output of output voltage and output current

Pin No.	Signal Name	Description
1	A COM	Common for remote control input. Common for output monitor.
8	V MON	Monitor output of output voltage. 0 to approx. 10 V for 0 to the rated output voltage.
9	I MON	Monitor output of output current. L type: 0 to approx. 10 V for 0 to the maximum output current. H type: 0 to approx. 10 V for 0 to the rated output current.

⚠CAUTION • Shorting V MON and I MON to A COM can cause damage to the PWR.

Monitor output rating

Output impedance: 1 kΩ or less

Maximum output current: Approx. 10 mA

The monitor outputs are used to monitor the DC voltage (mean value). They cannot be used to accurately monitor the AC components (ripple, transient response, etc.) of the actual output voltage or current.

External monitoring of the operating status

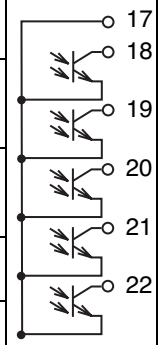
The J1 connector consists of status outputs that is used to externally monitor the operating status of the PWR. The following five status outputs are available.

The outputs are open collector outputs of photocouplers; they are insulated from the internal circuits of the PWR.

The maximum rating of each signal terminal is as follows:

- Maximum voltage: 30 V
- Maximum current (sink): 8 mA

Table 5-4 Status output

Pin No.	Signal Name	Description	Circuit
17	STATUS COM	Common for status output. Photocoupler emitter output.	
18	CV STATUS	Set to low level when in constant voltage mode. Photocoupler collector output.	
19	CC STATUS	Set to low level when in constant current mode. Photocoupler collector output.	
20	ALM STATUS	Set to low level when a protection function is activated. Photocoupler collector output.	
21	OUT ON STATUS	Set to low level when output is turned off. Photocoupler collector output.	
22	PWR ON/ OFF STATUS*1	Set to low level when the POWER switch is on (PWR ON STATUS) or when the POWER switch is turned off (POWER OFF STATUS: approx. 0.5 to 3 seconds). Photocoupler collector output.	

*1. Status signal setting of the output on/off in the CONFIG settings is used to select whether to output a low level signal when the output is on (C-9: 0) or when the output is off (C-9: 1).

6 Parallel/Series Operation

This chapter describes the functions of the master-slave parallel/serial operation and the connection, setup, and operation procedures.

In master-slave operation, one of the PWRs is made the master unit and connected to the same model as slave units. The master unit is used to control the entire system.

During series/parallel operation, the setting accuracy of master and slave units is the same as that of single units. The error in preset values between master and slave units is within approx. 3 %.

6.1 Master-Slave Series Operation (L Type Only)

WARNING

- **Master-slave series operation is not possible on the M/H type. If connected in series, the output voltage will exceed the isolation voltage creating a dangerous condition.**

Up to two units can be connected in series. The total of the output voltages of the two units in master-slave series operation is supplied to the load.

6.1.1 Functions (Series Operation)

The functions in master-slave series operation are as follows.

Voltage display and current display

The current is displayed only on the master unit. The voltage is displayed both on the master unit and slave unit. Sum the voltages of the master and slave units. The power can be displayed only on the master unit. The power of the entire system cannot be displayed.

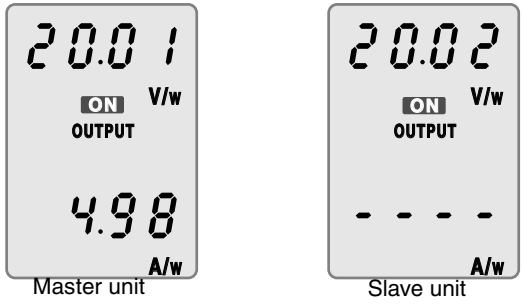


Fig. 6-1 Panel display example during series operation

Remote sensing

Cannot be used.

External control

See Chap5

Can be used only on the master unit.

External monitoring

See Page 5-23

WARNING • **Be careful of short-circuits and electric shock while monitoring signals. The common electric potential of the output voltage and output current monitor signals during master-slave series operation are different between the master unit and slave unit.**

- External monitoring of output voltage (V MON)

  The output voltage of the master unit and that of the slave unit can be monitored. For the total output voltage, sum the monitor values of the master and slave units.

- External monitoring of output current (I MON)

  Can be monitored only on the master unit.

- Status monitoring

  The status of the constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on, power on, and alarm can be monitored on the master unit and slave unit.

Alarm

If an alarm is detected, the units behave as follows:

- Slave unit

  An alarm is activated independently. Then, the output is turned off, or the breaker is tripped.

- Master unit

  If an alarm is detected on the master unit, the alarm on the slave unit is also activated, and the output of the entire system is turned off or the breaker is tripped.

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when an alarm is detected.

■ Clearing the alarm

See Page 4-16 Page 6-7

Turn off the POWER switch of the slave unit first followed by the master unit. After removing all the causes of alarm, turn on the POWER of the master unit first followed by the slave unit.

6.1.2 Connection (Series Operation)

Connect two PWRs of the same model.

Connecting the signal wires (series operation)

See Page 5-2

The connector needed to connect the J1 connector is not provided. For detail, see section 5.2 “J1 connector.”

⚠WARNING Possible electric shock.

- **The J1 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

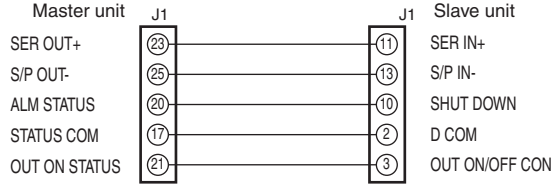


Fig. 6-2 Connection for series operation

Connect the J1 connectors on the rear panel of the master and slave units as shown in Fig. 6-2.

Load connection (series operation)

Connect the load as shown below.

⚠WARNING • **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

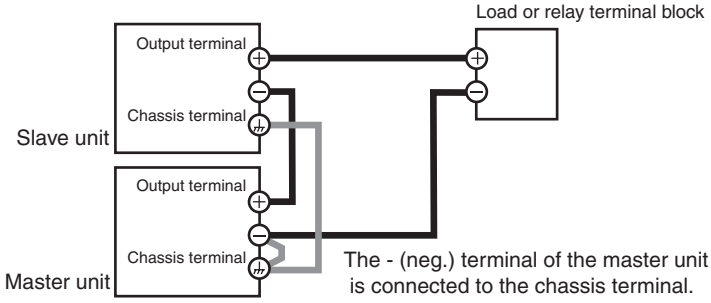


Fig. 6-3 Load connection example for series operation

1. Turn off the POWER switches on all PWR Series power supply units to be connected in series.

See Page 3-9

2. Remove the OUTPUT terminal cover.
3. Connect the output terminal (+ or –) of the master or slave unit to the chassis terminal.

   If you are using the master and slave units under floating conditions, do not connect the output terminal to the chassis terminal.

See Page 3-7

4. As shown in Fig. 6-3, connect the load wires of the master and slave units to the load or the relay terminal block.

   Use load wires with sufficient current capacity. Wire the connection cables between the power supply units as thick and as short as possible. If the voltage drop in the output cable is large, the difference in the potential and the load effect between power supply units becomes large.

5. Attach the OUTPUT terminal cover.

6.1.3 Setup (Series Operation)

■ Setting the overvoltage protection (OVP) and overcurrent protection (OCP)

See Page 4-17

Set the OVP and OCP on both the master unit and slave unit.

The OVP is set to one-half the voltage to be protected to the master unit and slave unit.

Set the OVP/OCP trip point of the slave unit slightly higher than that of the master unit, so that the OVP/OCP function of the master unit is activated first. If the OVP/OCP trip point of the slave unit is set lower than that of the master unit, the overvoltage/overcurrent protection of the slave unit activates first, and the output of the slave unit is turned off. The output of the master unit is not turned off even if the slave unit turns off.

Setup Procedure (Series Operation)

By factory default, the PWR is set to master.

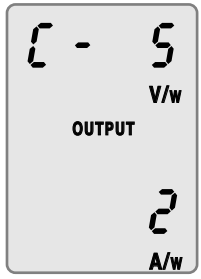


Fig. 6-4 Specifying the slave unit for series operation

1 Set the overvoltage protection and overcurrent protection.

You cannot set the OVP or OCP after specifying the master unit or slave unit. Set the OVP/OCP trip point of the slave unit slightly higher than the trip point of the master unit.

2 Specify master unit (C-5: 0) or slave unit (C-5: 2) in the serial/parallel master-slave operation setting of the CONFIG settings.

If slave unit is specified, the CC/CV control source (C-1/C-2) is set to local.

6.1.4 Procedure (Series Operation)

The power supplies may not operate properly if the procedure is not followed.

Turning the power on

1. Turn on the POWER switch on the master unit.
2. Turn on the POWER switch on the slave unit.
3. Carry out normal operations on the master unit.

   The panel operation on the slave units is disabled. Turn the output on/off on the master unit.

Turning the power off

1. Turn off the POWER switch on the slave unit.
2. Turn off the POWER switch on the master unit.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the panel display lights out. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

6.2 Master-Slave Parallel Operation

The output current can be expanded using master-slave parallel operation (maximum output current: the rated output current of a unit × number of units connected in parallel).

Maximum number of units that can be connected is five including the master.

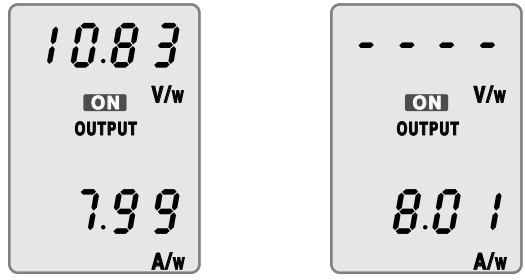
6.2.1 Functions (Parallel Operation)

The functions in master-slave parallel operation are as follows.

■ Voltage display and current display

The voltage is displayed only on the master unit. The current is displayed both on the master unit and slave units. Sum the current of the master and slave units.

The power can be displayed only on the master unit. The power of the entire system cannot be displayed.



Master unit Slave unit

Fig. 6-5 Panel display during parallel operation

Remote sensing

See Page 4-28

Can be used only on the master unit.

External control

See Chap5

Can be used only on the master unit.

External monitoring

See Page 5-23

⚠CAUTION • Do not connect the common wires of the master and slave monitors outside the PAT. If the wire connecting the load comes loose, the common wire will break.

- External monitoring of output voltage (V MON)

  Can be monitored on the master unit.

- External monitoring of output current (I MON)

  The output current of each master and slave unit can be monitored. For the total output current, sum the monitor values of the master and slave units.

- Status monitoring

  The status of the constant voltage operation (CV STATUS), constant current operation (CC STATUS), output on, power on, and alarm can be monitored on the master unit and slave unit. However, slave units always output the status of the constant current operation.

Alarms

If an alarm is detected, the units behave as follows:

- Slave unit

  An alarm is activated independently. Then, the output is turned off, or the breaker is tripped.

- Master unit

  If an alarm is detected on the master unit, the alarm on the slave unit is also activated, and the output of the entire system is turned off or the breaker is tripped.

See Page 4-27

You can select whether to trip the breaker (C-8: 0/1) when an alarm is detected.

■ Clearing the alarm

See Page 4-16 Page 6-15

Turn off the POWER switch of the slave unit first followed by the master unit. After removing all the causes of alarm, turn on the POWER of the master unit first followed by the slave unit.

6.2.2 Connection (Parallel Operation)

Up to 5 units can be connected including the master unit.

Connecting the signal wires (parallel operation)

An example in which two slave units are connected is given below.

See Page 5-2

The connector needed to connect the J1 connector is not provided. For detail, see section 5.2 “J1 connector.”

⚠WARNING Possible electric shock.

- **The J1 connector contains pins that are at the same electric potential as the output terminal. If you are not using the J1 connector, be sure to insert the protective socket provided.**
- **Be sure to use the protective cover on the sockets.**

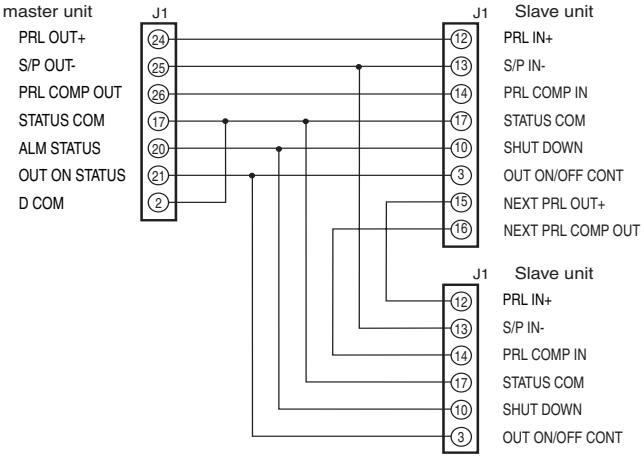


Fig. 6-6 Connection for parallel operation (two slave units)

Connect the J1 connectors on the rear panel of the master unit, slave unit 1, and slave unit 2 as shown in Fig. 6-6. To connect 4 or more PWRs in parallel, connect the slave units in the same fashion as the connection between slave unit 1 and slave unit 2.

Connecting the load (parallel operation)

Connect the load as shown below.

WARNING

- **Possible electric shock. Be sure to turn the POWER switch off before touching the output terminal. Be sure to attach the OUTPUT terminal cover after wiring the load.**

CAUTION

- When connecting the output terminal to the chassis terminal, be sure that the output terminal of the same polarity (positive or negative) for both the master and slave units is connected to the chassis terminal. If you connect the output terminal of different polarities for the master and slave units, the output is short-circuited through the GND cable of the power cord. This not only impedes the retrieval of correct voltage but also may burn out the chassis terminal cable.

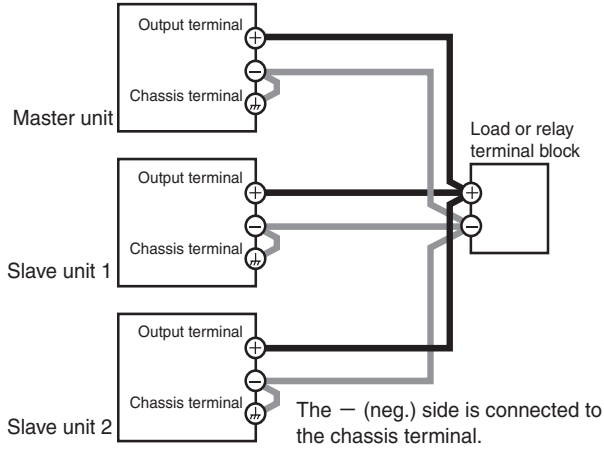


Fig. 6-7 Load connection example for parallel operation (two slave units)

1 Turn off the POWER switches on all PWR Series power supply units to be connected in parallel.

See Page 3-9

2 Remove the OUTPUT terminal cover.

3 Connect the output terminals (+ or –) of the master and slave units to the chassis terminal.

Use the same polarities for the output terminals of the master and slave units. If you are using the master and slave units under floating conditions, do not connect the output terminals to the chassis terminal.

See Page 3-7

4 Connect the load wires to the output terminals of the master and slave units.

5 As shown in Fig. 6-7, connect the load wires of the master and slave units to the load or the relay terminal block.

Use load wires with sufficient current capacity. In addition, use the shortest load wires of the same length and cross-sectional area from each power supply to the load.
Wire the signal cable of the J1 connector and load cables as far apart as possible.

6 Attach the OUTPUT terminal cover.

To connect 4 or more PWRs in parallel, connect the slave units in the same fashion as the connection between slave unit 1 and slave unit 2.

6.2.3 Setup (Parallel Operation)

■ Setting the overvoltage protection (OVP) and overcurrent protection (OCP)

See Page 4-17

Set the OVP and OCP on both the master unit and slave units.

Set the value equal to the current to be protected divided by the number of units connected in parallel for OCP.

Set the OVP/OCP trip point of the slave units slightly higher than that of the master unit, so that the OVP/OCP function of the master unit is activated first. If the OVP/OCP trip point of a slave unit is set lower than that of the master unit, the overvoltage/overcurrent protection of the slave unit activates first, and the output of the slave unit is turned off. The output of the master unit is not turned off even if the slave unit turns off.

Setup Procedure (Parallel Operation)

By factory default, the PWR is set to master.

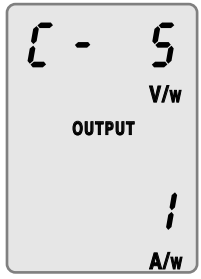


Fig. 6-8 Specifying the slave unit for parallel operation

1. Set the overvoltage protection and overcurrent protection.

   You cannot set the OVP or OCP after specifying the master unit or slave unit. Set the OVP/OCP trip point of the slave units slightly higher than the trip point of the master unit.

2. Specify master unit (C-5: 0) or slave unit (C-5: 1) in the serial/parallel master-slave operation setting of the CONFIG settings.

   If slave unit is specified, the CC/CV control source (C-1/C-2) is set to local.

6.2.4 Procedure (Parallel Operation)

The power supplies may not operate properly if the procedure is not followed.

Turning the power on

1. Turn on the POWER switch on the master unit.
2. Turn on the POWER switch on the slave units.
3. Carry out normal operations on the master unit.

   The panel operation on the slave units is disabled. Turn the output on/off on the master unit.

Turning the power off

1. Turn off the POWER switch on the slave units.
2. Turn off the POWER switch on the master unit.

⚠CAUTION

- When turning the POWER switch off and then back on, allow at least 10 seconds after the panel display lights out. Repeated on/off of the POWER switch at short intervals can cause damage to the inrush current limiter and shorten the service life of the POWER switch and internal input fuse.

Remote Control

This chapter gives an overview of the remote control using the TP-BUS and describes the connection procedure and the device messages used in programming.

7.1 Remote Control Overview

In addition to operating the PWR from the front panel, you can use a power supply controller (PIA4830 or PIA4810) to remotely control the PWR via the GPIB or RS232C interface.

For details on how to set the power supply controller and how to connect to a PC, see the operation manual for the power supply controller.

NOTE

- Version 2.20 or later is required for the PIA4810/4830 Power Supply Controller. If you are using an earlier version, you need to update the firmware. For details, contact your Kikusui agent.
  You can check the PIA4810/4830 version using *IDN?. For detail, see section 7.3.1 “Registers and General Purpose Messages.”
- The PIA3200 Power Supply Controller is not supported.

7.2 Connecting to the Power Supply Controller

The PWR and power supply controller are connected via a TP-BUS. Up to 32 devices can be connected to the TP-BUS.

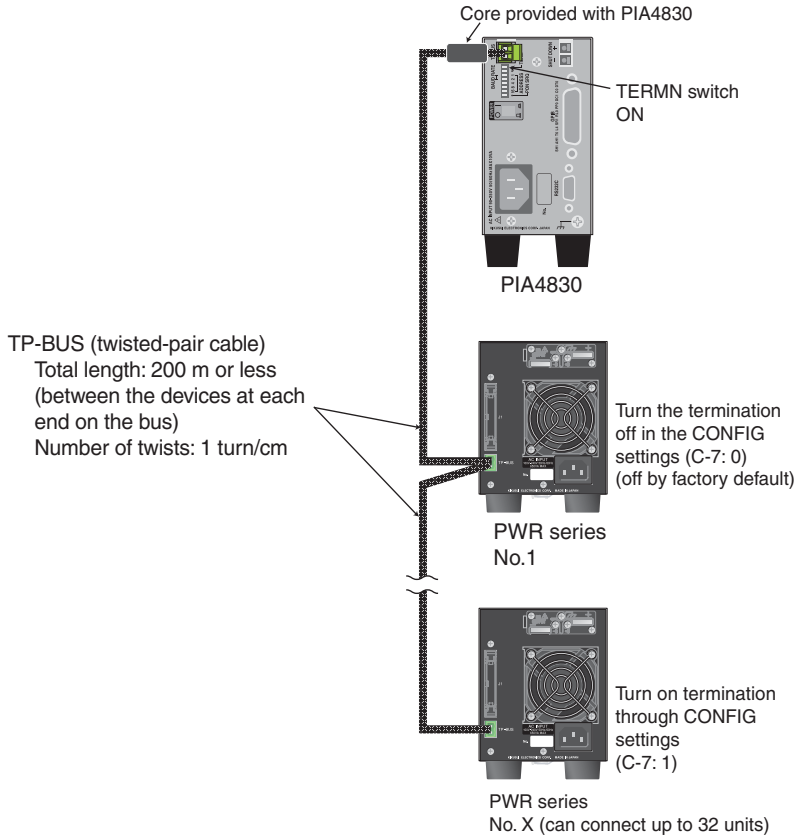


Fig. 7-1 TP-BUS connection (connection example with the PIA4830)

■ Wires and tools required for the connection

- Wires (stranded: 0.32 mm^2 (AWG22))
- Flat-blade screwdriver (axis diameter: ϕ3, end width: 2.6 mm)
- Wire stripper suitable for the wires described above.

Wiring the TP-BUS connector

The TP-BUS is connected in a chain by connecting twisted-pair cables to the TP-BUS connectors (plug) provided as shown in Fig. 7-1.

In master-slave series/parallel operation, connect the TP-BUS only to the master unit. Remote control does not work if the TP-BUS is connected to both the master and slave units. The controller handles the PWRs connected in parallel/series as a single master unit.

1. Turn off the POWER switch of all units that are to be connected.
2. Insert the TP-BUS connector (plug) provided to the TP-BUS connector on the rear panel on all units.

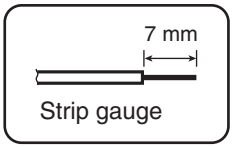
   This facilitates the wire connection work.
3. Use a wire stripper to remove the covering from the wires.

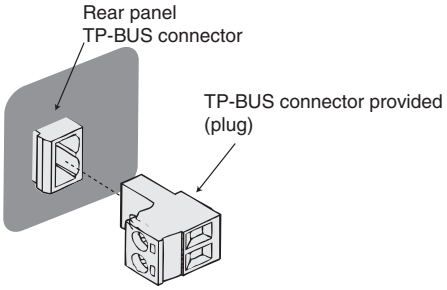
   Remove 7 mm of the covering. Use the strip gauge that is indicated on the top panel of the unit or the strip gauge of Fig. 7-2.
4. Insert the wires into the connectors. See Fig. 7-2 (b) for the unit at each end of the bus. See Fig. 7-2 (c) for units in the middle of the bus.

   TP-BUS has no polarity. You do not have to match the polarities between units.
5. Use the screwdriver to turn the connector screw and fix the wires in place.
6. Check that the wires do not come loose, that the wires are not shorted, and that the conducting sections of the wires are not touching the chassis.

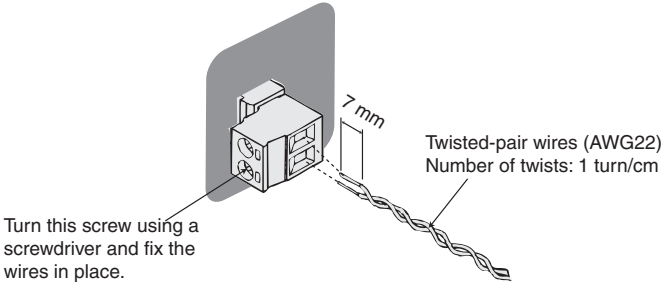
   Communication is not possible if the wires are shorted. If the wires are touching the chassis, the PWR or other devices that are connected may burn.
7. Likewise, connect the wires to the connectors of all devices that are to be connected.
8. Attach a TP-BUS core to the power supply controller (PIA4810 or PIA4830).

   For the attachment procedure, see the operation manual of the PIA4810 or the PIA4830.

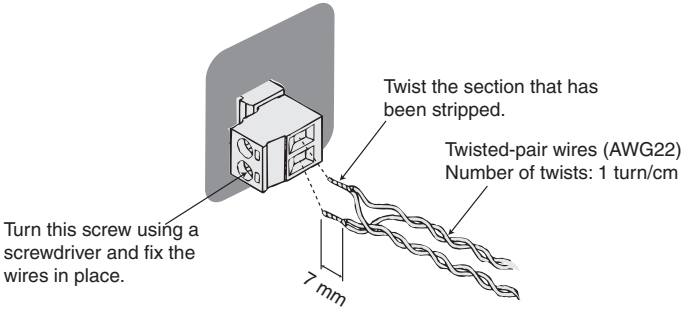




(a) Insert the plug



(b) Connect the devices at each end of the bus



(c) Connect the devices in the middle on the bus

Fig. 7-2 TP-BUS connector connection

7.2.1 Setting the Remote Control

■ Setting the node address

Assign a node address to each device on the TP-BUS for the power supply controller to identify the devices that are connected on the TP-BUS.

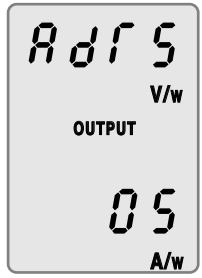


Fig. 7-3 Display of node address “05”

1. Turn the output off.
2. Press the ADDRESS switch.
   The display shows “Adrs”, and the ammeter shows the value.
3. Turn the setting knob to set the desired node address (05 to 36).
   Do not connect devices having the same node address on the same TP-BUS.
4. Turn the POWER switch off.
   The node address is assigned when the POWER switch is turned back on. If you exit from the node address setting before turning off the POWER switch, the setting is cancelled.

NOTE

- Allow at least 10 seconds between power cycles. If you turn on the POWER switch at a short interval, the node address setting will be incomplete.

Remote Control Setup Procedure

Turn on the termination (TERMN) on the devices at each end of the bus. If the termination is not set properly, communications become unstable and erroneous operation may result.

See Page 4-23

1. Set the CV control source and CC control source of all devices that are to be connected to panel control (C-1: 0 and C-2: 0) in the CONFIG settings.

   The factory default setting is panel control.

2. Turn on the TERMIN switch on the power supply controller.

   For setting the TERMIN switch, see the operation manual of the PIA4810 or the PIA4830.

See Page 4-23 Page 7-3

3. Turn on the termination (C-7: 1) in the CONFIG settings on the PWRs at the end of the bus.

4. Turn off the termination (C-7: 0) in the CONFIG settings on the PWRs other than those at the end of the bus.

   By factory default, the termination setting is off.

5. Set the node address of all devices that are to be connected.

The devices are now ready for remote control.

7.3 Device Messages

Device messages refer to program messages and response messages that a device supports.

The device messages that the power supply controller supports for the PWR series power supplies are described below.

Program message

A program message consists of a header and program data.

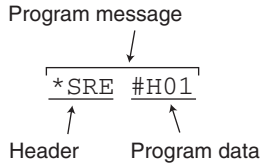


Fig. 7-4 Program message structure (*SRE example)

Special symbols and characters

Special symbols and characters used in this manual to describe the program and response messages are defined in Table 7-1.

Table 7-1 Definitions of special symbols and characters

Symbols or Characters	Description
< >	Denotes program data. Do not include the enclosing characters in the actual program.
{ }	Denotes program data. Characters and numbers delimited by "|" in braces indicate that one of the items is to be selected. Do not include the enclosing characters in the actual program.

NOTE
- If the program data format is hexadecimal, prefix the program data with "#H."

7.3.1 Registers and General Purpose Messages

*CLS

Resets each bit in the status byte register, fault register, and error register to 0.

Register	Each Bit
Status byte register	0
Fault register	0
Error register	0

Program message

```
*CLS
```

*IDN

Queries the model name and the ROM version of the power supply controller.

This message is not available on the PIA4810/4830 with ROM version is 2.19 or earlier. Use the PIA4810/4830 version 2.20 or later.

Program message

```
*IDN?
```

Response message

Returns the model name and ROM version of the power supply controller in response to *IDN? as follows:

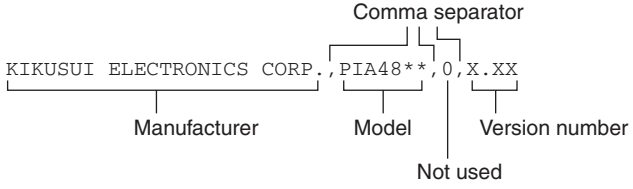


Fig. 7-5 Example of an *IDN? response

*RST

Performs the same process as when GPIB bus line message DCL or SDC is received. It is also used to perform the same process when DCL is received via the RS232C.
*RST is an equivalent command message to CLR.
This command message initializes the program data of the following messages, resets each bit of the following registers to 0, and turns off the output.

Header	Program Data (Initial Value)
TRM	0
FUNMASK	0h
HEAD	0
SILENT	1
*SRE	0h

Register	Each Bit
Status byte register	0
Fault register	0
Error register	0

Program message

```
*RST
```

*SRE

See Page 7-27

Sets or resets each bit of the service request enable register or queries the contents of the register.

Program message

```
*SRE <VALUE>
*SRE?
```

Parameter

Data format:	Hexadecimal or decimal value
Setting:	0 to 255 or 00h to FFh
Resolution:	1 or 1h

(ex) Set the service request enable register to 01h.

```
*SRE #H01
```

Response message

Returns the contents of the service request enable register in decimal notation in response to *SRE?.

(ex) Set the service request enable register to 01h.

```
Returns 001.
```

*STB

See Page 7-27

Queries the contents of the status byte register.

Program message

```
*STB?
```

Response message

Returns the contents of the status byte register in decimal notation in response to *STB?.

(ex) Set the service request enable register to 01h.

```
Returns 032.
```

CLR

Performs the same process as when GPIB bus line message DCL or SDC is received. It is also used to perform the same process when DCL is received via the RS232C.

CLR is an equivalent command message to *RST.

This command message initializes the program data of the following messages, resets each bit of the following registers to 0, and turns off the output.

Header	Program data (initial value)
TRM	0
FUNMASK	0h
HEAD	0
SILENT	1
*SRE	0h

Register	Each Bit
Status byte register	0
Fault register	0
Error register	0

Program message

```
CLR
```

DELIMITER

Specifies or queries the response message terminator. EOI, a GPIB uni-line message, is valid only for GPIB communications.

DELIMITER is a message used by our conventional PIA3200 Power Supply Controller. It can also be used on the PIA4800 series. However, if you are writing new programs, use TRM (same as DELIMITER) instead.

Program message

```
DELIMITER {0|1|2|3}
DELIMITER?
```

Parameter

Setting:	0:	CR+LF+EOI (default)
	1:	LF+EOI
	2:	EOI
	3:	CR+EOI

(ex) Set the service request enable register to 01h.

```
DELIMITER 1
```

Response message

Returns the current response message terminator in response to DELIMITER?.

(ex) Set the service request enable register to 01h.

```
Returns 1.
```

ERR

See Page 7-29

Queries the contents of the error register.

The logical sum of each bit of error information is stored in the error register. The error register is reset when it is read using the ERR? message.

Program message

```
ERR?
```

Response message

Returns the contents of the error register in response to *ERR?.

(ex) Set the service request enable register to 01h.

```
Error register bit 0 is set.
```

FAU

See Page 7-27

Queries the contents of the fault register.

The fault register is a register used to latch the events that are indicated in the status register.

Program message

```
FAU?
```

Response message

Returns the contents of the fault register in decimal notation in response to FAU?.

(ex) Set the service request enable register to 01h.

```
Returns 004.
```

FUNMASK

See Page 7-27

Sets or resets each bit of the fault unmask register or queries the contents of the register.
To latch the contents of the events that occur in the status register, set the corresponding bit.

Program message

```
FUNMASK <VALUE>
FUNMASK?
```

Parameter

Data format:	Hexadecimal or decimal value
Setting:	00h to FFh or 0 to 255 (initial value is 0h or 0)
Resolution:	1h or 1

Response message

Returns the contents of the fault unmask register in decimal notation in response to FUNMASK?.

(ex) When bit 1 of the fault unmask register is set

```
Returns 002.
```

HEAD

Specifies whether to attach headers and unit data to the read back data or queries the setting.

Program message

```
HEAD {0|1}
HEAD?
```

Parameter

Setting:	0:	Not attach headers and unit data (default).
	1:	Attach headers and unit data.

Response message

Returns the preset value of the HEAD message in response to HEAD?.

(ex) Set the service request enable register to 01h.

```
Returns 1.
```

NODE

Specifies the node address and turns on the LOCK switch (equivalent to LOCK ON of the LOCK command message) or queries the node address.

Program message

```
NODE <ADDRESS>
NODE?
```

Parameter

Data format:	Integer
Setting:	5 to 36

Response message

Returns the specified node address in response to NODE?.
If you issue NODE? when the node address is not specified, “000” is returned.

SILENT

Sets whether to return acknowledge messages in response to messages delimited by response message terminators when controlling the unit via the RS232C interface or queries the setting.

Acknowledge messages return either OK or ERROR. To receive acknowledge messages, the RS232C must be set to full-duplex[1] operation.

Program message

```
SILENT {0|1}
SILENT?
```

Parameter

Setting:	0:	Return acknowledge messages.
	1:	Not return acknowledge messages (default).

Response message

Returns the preset value of the SILENT message in response to SILENT?.

(ex) Set the service request enable register to 01h.

```
Returns 1.
```

1. Communication system that allows data to be sent in both directions at all times between two points. For details on how to set full-duplex operation, see the operation manual for your PC.

STS

See Page 7-27

Queries the contents of the status register. The set bits retain the status until the cause is cleared.

Program message

```
STS?
```

Response message

Returns the contents of the status register in decimal notation in response to STS?.

(ex) Set the service request enable register to 01h.

```
Returns 008.
```

TRM

Specifies or queries the response message terminator.

Program message

```
TRM {0|1|2|3}
TRM?
```

Parameter

Setting:	0:	CR+LF+EOI (default)
	1:	LF+EOI
	2:	EOI (valid only when using the GPIB)
	3:	CR+EOI

(ex) Set the service request enable register to 01h.

```
TRM 1
```

Response message

Returns the current response message terminator in response to TRM?.

(ex) When the response message terminator is set to LF + EOI

```
Returns 1.
```

UNMASK

See Page 7-27

Sets or resets each bit of the service request enable register or queries the contents of the register.

When issuing SRQs for events such as power-on and errors, the corresponding bit is set.

UNMASK is a message used by our conventional PIA3200 Power Supply Controller. It can also be used on the PIA4800 series. However, if you are writing new programs, use *SRE (same as UNMASK) instead.

Program message

```
UNMASK <VALUE>
UNMASK?
```

Parameter

Data format:	Hexadecimal or decimal value
Setting:	00h to FFh or 0 to 255 (default value is 0h or 0)
Resolution:	1h or 1

Response message

Returns the contents of the service request enable register in decimal notation in response to UNMASK?.

(ex) When bit 7 of the service request enable register is set

```
Returns 128.
```

7.3.2 Output Setup Messages

IOUT

Queries the output current value.

Program message

```
IOUT?
```

Response message

Returns the output current value in response to IOUT?.

(ex) When the output current is 12.34 A

```
Returns 12.34.
```

ISET

Sets the output current and turns on the LOCK switch (equivalent to LOCK ON of the LOCK command message) or queries the setting.

Program message

```
ISET <VALUE>
ISET?
```

Parameter

Data format:	Real number
Setting:	Minimum value: Minimum value of the connected PWR series power supply
	Maximum value: Maximum value of the connected PWR series power supply
Resolution:	Minimum resolution of the connected PWR series power supply

Response message

Returns the preset current value in response to ISET?.

(ex) When the preset current value is 12.34 A

```
Returns 12.34.
```

OUT

Turns on/off the output and turns on the LOCK switch (equivalent to LOCK ON of the LOCK command message).

Program message

```
OUT {0|1}
```

Parameter

Setting:	0:	Output off (default)
	1:	Output on

POUT

Queries the output power value.

Program message

```
POUT?
```

Response message

Returns the output power value in response to POUT?.

(ex) When the output power is 12.34 W

```
Returns 12.34.
```

POW

Turn the POWER switch off.

Program message

```
POW
```

VOUT

Queries the output voltage value.

Program message

```
VOUT?
```

Response message

Returns the output voltage value in response to VOUT?.

(ex) When the output voltage is 12.34 V

```
Returns 12.34.
```

VSET

Sets the output voltage and turns on the LOCK switch (equivalent to LOCK ON of the LOCK command message) or queries the preset output voltage.

Program message

```
VSET <VALUE>
VSET?
```

Parameter

Data format:	Real number
Setting:	Minimum value: Minimum value of the connected PWR series power supply
	Maximum value: Maximum value of the connected PWR series power supply
Resolution:	Minimum resolution of the connected PWR series power supply

Response message

Returns the preset voltage value in response to VSET?.

(ex) When the preset voltage is 12.34 V

```
Returns 12.34.
```

7.3.3 Protection Function Setup Messages

LOCK

Enables (LOCK OFF) or disables (LOCK ON) the switch and setting knob operations on the front panel.
The LOCK switch is turned on in the LOCK ON condition. LOCK ON can also be cleared using the LOCK switch on the front panel.

Program message

```
LOCK {0|1}
```

Parameter

Setting:	0:	LOCK OFF (setting knob operations enabled)
	1:	LOCK ON (setting knob operations disabled)

OCSET

Sets or queries the OCP trip point.

Program message

```
OCSET <VALUE>
OCSET?
```

Parameter

Data format:	Real number
Setting:	Minimum value: Approx. 10 % of the rated output current of the connected PWR series power supply
	Maximum value: Approx. 176 % (L type) or 110 % (H type) of the rated output current of the connected PWR series power supply
Resolution:	Minimum resolution of the connected PWR series power supply

Response message

Returns the preset value of the OCP trip point in response to OCSET?.

(ex) Set the service request enable register to 01h.

```
Returns 12.34.
```

OVSET

Sets or queries the OVP trip point.

Program message

```
OVSET <VALUE>
OVSET?
```

Parameter

Data format:	Real number	
Setting:	Minimum value:	Approx. 10 % of the rated output voltage of the connected PWR series power supply
	Maximum value:	Approx. 110 % of the rated output voltage of the connected PWR series power supply
Resolution:	Minimum resolution of the connected PWR series power supply	

Response message

Returns the preset value of the OVP trip point in response to OVSET?.

(ex) When the OVP trip point is 12.34 V

```
Returns 12.34.
```

7.3.4 List of Messages

Table 7-2 Registers and general purpose messages

Program Message		Function
Header	Data	
*CLS		Resets the registers.
*IDN?		Queries the model name of the power supply controller.
*RST		Resets program data and registers to initial values (same as CLR).
*SRE	0 to 255	Sets or resets the service request enable register (same as UNMASK).
*SRE?		Queries the contents of the service request enable register (same as UNMASK?)
*STB?		Queries the contents of the status byte register.
CLR		Resets program data and registers to initial values (same as *RST).
DELIMITER	0, 1, 2, 3	Specifies the response message terminator (same as TRM).
DELIMITER?		Queries the response message terminator (same as TRM?).
ERR?		Queries the contents of the error register.
FAU?		Queries the contents of the fault register.
FUNMASK	0 to 255	Sets or resets the fault unmask register.
FUNMASK?		Queries the contents of the fault unmask register.
HEAD	0, 1	Specifies headers and units.
HEAD?		Queries the value specified by the HEAD message.
NODE	5 to 36	Specifies the node address.
NODE?		Queries the node address.
SILENT	0, 1	Switches the acknowledge message during RS232C control.
SILENT?		Queries the value specified by the SILENT message.
STS?		Queries the contents of the status register.
TRM	0, 1, 2, 3	Specifies the response message terminator (same as DELIMITER).
TRM?		Queries the response message terminator (same as DELIMITER?).
UNMASK	0 to 255	Sets or resets the service request enable register (same as *SRE).
UNMASK?		Queries the contents of the service request enable register (same as *SRE?)

Table 7-3 Output setup messages

Program Message		Function
Header	Data	
IOUT?		Queries the output current value.
ISET	Model-dependent	Sets the output current
ISET?		Queries the preset current value.
OUT	0, 1	Turns on/off the output.
POUT?		Queries the output power value.
POW		Turn off the POWER switch.
VOUT?		Queries the output voltage value.
VSET	Model-dependent	Sets the output voltage.
VSET?		Queries the preset voltage value.

Table 7-4 Protection function setup messages

Program Message		Function
Header	Data	
LOCK	0, 1	Disables or enables the operations of switches on the front panel.
OCSET	Model-dependent	Sets the OCP trip point
OCSET?		Queries the OCP trip point.
OVSET	Model-dependent	Sets the OVP trip point
OVSET?		Queries the OVP trip point.

7.3.5 Register

Fig. 7-6 illustrates the structure of the registers that the power supply controller supports.

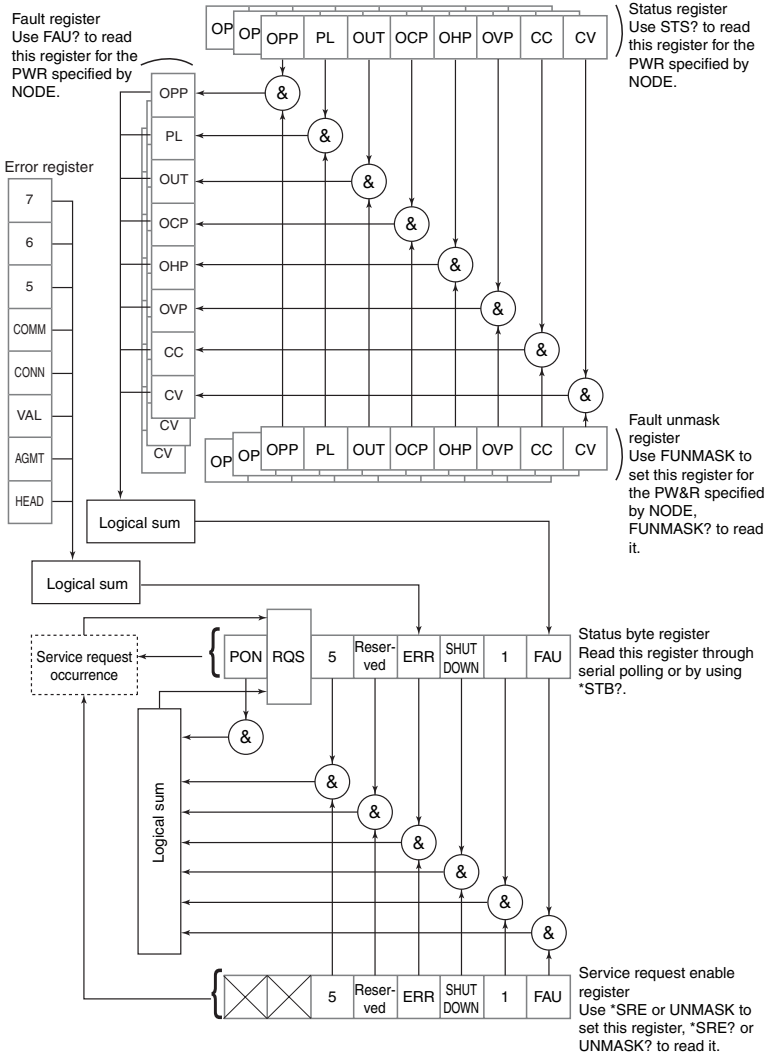


Fig. 7-6 Register structure

Table 7-5 Functions of the status register, fault register, and fault unmask register

Bit		Description
7	OPP	Indicates that the overpower protection (OPP) has tripped.
6	PL	Indicates that the PWR is operating under power limitation (PL).
5	OUT	Indicates that output is turned on.
4	OCP	Indicates that the overcurrent protection (OCP) has tripped.
3	OHP	Indicates that the overheat protection (OHP) has tripped.
2	OVP	Indicates that the overvoltage protection (OVP) has tripped.
1	CC	Indicates that the output is operating in constant current (CC) mode.
0	CV	Indicates that the output is operating in constant voltage (CV) mode.

Table 7-6 Functions of the status byte register and service request enable register

Bit		Description
7	PON (Power ON)	Indicates that the power supply controller has been turned on.
6	RQS (Request)	Set as a proof that the service request was generated. It is reset by reading this bit through serial polling.
5	Not used	Not used
4	Reserved	The software utility provided uses this bit.
3	ERR (Error)	Indicates that there is an error.
2	SHUT DOWN	Indicates that the shutdown signal has been applied.
1	Not used	Not used
0	FAU (Fault)	Indicates that one of the bits of the fault mask register of the connected device has been set.

Table 7-7 Functions of the error register

Bit		Description
7	Not used	Not used
6	Not used	Not used
5	Not used	Not used
4	COMM (Communication)	Indicates communication error.
3	CONN (Connection)	Indicates that an unidentified device has been accessed.
2	VAL (Value)	Indicates out-of-range error.
1	AGMT (Argument)	Indicates that the number of program data following the program header is incorrect. (Argument error)
0	HEAD (Header)	Indicates header error.

7.4 Sample Program

Below is a sample program for controlling the PWR series power supply from the PIA4830 via the GPIB interface. The GPIB board complies with the NI-488.2 specifications by National Instruments and the programming language is Visual Basic by Microsoft Corporation.

Other software programs related to the PWR can be downloaded from Kikusui's website (http://www.kikusui.co.jp/en/download/).

NOTE

- If you are using VBA such as Excel, array of controls cannot be used.
  You must change the following lines

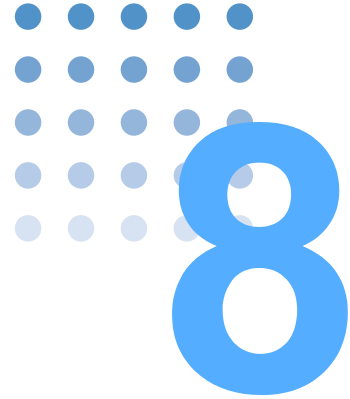
  txtVolt(iPSno-6).Text=Left(strBuff,ibcnt)
  txtCurr(iPSno-6).Text=Left(strBuff,ibcnt)

  as follows:

  txtVolt1.Text=Left(strBuff,ibcnt)
  txtCurr1.Text=Left(strBuff,ibcnt)

```
Option Explicit
Dim hGPIB As Integer
Private Sub cmdRead_Click()                ' Show the voltmeter and
                                           ' ammeter values of two
                                           ' PWR400Ls in a text box.
Dim iPSno As Integer
Dim strBuff As String

Call ibwrt(hGPIB, "TRM 2")                 ' Set the terminator to
                                           ' EOI.

For iPSno = 6 To 7
Call ibwrt(hGPIB, "NODE " + Str$(iPSno))   ' Specify the PWR address.
Call ibwrt(hGPIB, "VOUT?")                 ' Specify the voltmeter
                                           ' value.
strBuff = Space$(100)                      ' Allocate buffer.
Call ibrd(hGPIB, strBuff)                  ' Read from GPIB.
txtVolt(iPSno - 6).Text = Left(strBuff, ibcnt)
                                           ' Show the voltage value in
                                           ' the text box.

Call ibwrt(hGPIB, "IOUT?")                 ' Specify the ammeter
                                           ' value.
strBuff = Space$(100)                      ' Allocate buffer.
Call ibrd(hGPIB, strBuff)                  ' Read from GPIB.
```

```
txtCurr(iPSno - 6).Text = Left(strBuff, ibcnt)
                                          ' Show the current value in
                                          ' the text box.
 Next

End Sub
Private Sub cmdSet_Click()                ' fSet 5 V and 1 A to two
                                          ' PWR400Ls.

Dim iPSno As Integer

For iPSno = 6 To 7
Call ibwrt(hGPIB, "NODE " + Str$(iPSno))  ' Specify the PWR address.
Call ibwrt(hGPIB, "VSET 5")               ' Set 5 V.
Call ibwrt(hGPIB, "ISET 1")               ' Set 1 A.
Call ibwrt(hGPIB, "OUT 1")                ' Turn on PWR output.
Next

End Sub


Private Sub Form_Load()                   ' Device configuration

                                          ' <<Controller>>
                                          ' PIA4830

                                          ' <<Power supply>>
                                          ' 2 PWR400Ls
                                          ' Set the PWR addresses to
                                          ' 6 and 7.


Call ibfind("DEV1", hGPIB)                ' Set the GPIB address of
                                          ' the PIA4830 to 1.

End Sub
```



Maintenance

This chapter describes maintenance and inspection of the PWR.

8.1 Inspection

Periodic inspection is essential to maintain the initial performance of the PWR over an extended period.

Check for tears in the power cord insulation, cracks in the plug, and breaks in the terminal block.

⚠WARNING • **Tears in the insulation coating of the power cord may cause electric shock or fire. If a tear is found, stop using it immediately.**

To purchase accessories or options, contact your Kikusui agent or distributor.

8.1.1 Cleaning

⚠WARNING • **Possible electric shock. When performing maintenance work, be sure to turn off the POWER switch and remove the power cord plug or turn off the switchboard.**

Cleaning the Panels

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

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

Cleaning the dust filter

Dust filters are furnished on the inside of the louver and at the bottom of the operation panel. Periodically clean the filter to prevent clogging.

⚠CAUTION

- Clogged dust filters hinder the cooling of the inside of the unit and can cause malfunction and shortening of the service life.
- When the PWR is in operation, air is sucked through the dust filter to cool the inside. If moisture is present in the dust filter, the temperature or humidity inside the PWR increases and may cause a malfunction.

Dust filter inside the louver

1 Pull down the top section of the louver while pulling the bottom step toward you.

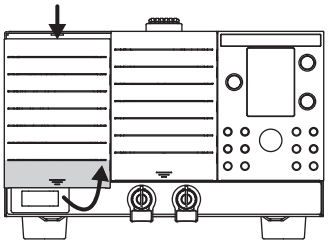


Fig. 8-1 Louver removal

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

Dispose of foreign particles and dust from the dust filter using a vacuum cleaner. If the filter is extremely dirty, clean it using a water-diluted neutral detergent and dry it completely.

3 Attach the dust filter to the louver.

Attach it so that the dust filter fits inside the hooks of the louver.

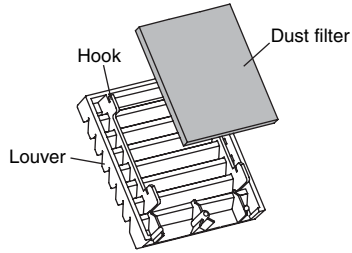


Fig. 8-2 Dust filter attachment

4 Align and set the hooks of the louver to the panel grooves. While pressing the fourth level from the bottom, slide the louver upward to attach it to the panel.

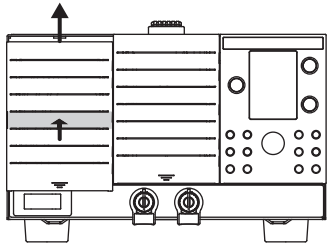


Fig. 8-3 Louver attachment

Dust filter below the operation panel

This dust filter cannot be removed. Dispose of foreign particles and dust from the filter using a vacuum cleaner.

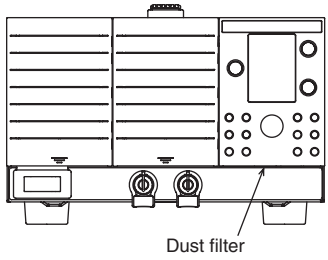


Fig. 8-4 Dust filter below the operation panel

8.2 Calibration

The PWR is shipped after carrying out appropriate calibrations. We recommend periodic calibration to maintain the performance over an extended period.

For calibration, contact your Kikusui agent or distributor.

If you are going to calibrate the PWR yourself, follow the procedures below. All of the calibration items of the PWR are described.

8.2.1 Calibration Overview

The following four calibration items are available.

- Output voltage
- Output current
- OVP
- OCP

Be sure to perform calibration on both the offset and full scale. The PWR outputs approximately 10 % of the rated output during offset calibration and approximately the rated output during full scale calibration.

Test equipment required

For calibration, the following equipment is necessary.

- DC voltmeter (DVM) with measuring accuracy of 0.02 % or better.
- Shunt (see Table 8-1).

Table 8-1 Recommended shunt

Model		Shunt	
		Rating	Tolerance
400 W type	PWR400L	50 A / 50 mV (1 mΩ)	< 0.1 %
	PWR400M	10 A / 50 mV (5 mΩ)	
	PWR400H	5 A / 50 mV (10 mΩ)	
800 W type	PWR800L	100 A / 50 mV (0.5 mΩ)	
	PWR800M	20 A / 50 mV (2.5 mΩ)	
	PWR800H	5 A / 50 mV (10 mΩ)	
1600 W type	PWR1600L	200 A / 50 mV (0.25 mΩ)	
	PWR1600M	50 A / 50 mV (1 mΩ)	
	PWR1600H	10 A / 50 mV (5 mΩ)	

Environment

Perform calibration under the following environment.

- Temperature: 23 °C ± 5 °C
- Relative humidity: 80 %rh or less

To minimize the calibration error due to initial drift, warm up the PWR for at least 30 minutes before calibration. Warm up the DVM and shunt for their appropriate time.

8.2.2 Voltage Calibration

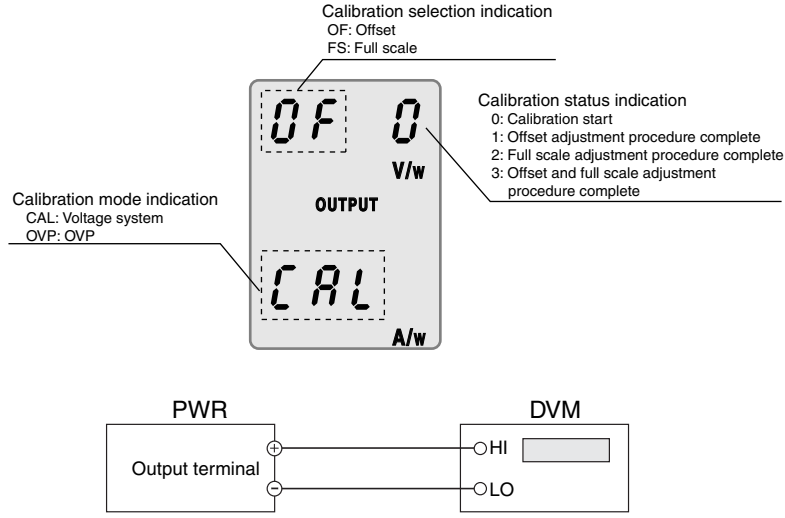


Fig. 8-5 Panel display example and connection for voltage calibration

Be sure to carry out the calibration items to the last step. If you move to a different type of calibration in the middle of another calibration or if you turn the POWER switch off, the calibration is invalid.

To exit from the calibration procedure, turn off the POWER switch.

Calibration of the output voltage offset and full scale

1. Turn the POWER switch off, and connect a DVM to the output terminal.
2. While holding down the SET switch, turn on the POWER switch.

   The ammeter shows “CAL.” Hold down the SET switch until “CAL” appears. Warm up the equipment adequately including the DVM.
3. Press the VOLTAGE switch to enter the output voltage offset calibration mode.

   The voltmeter shows “OF 0.”
4. Turn the OUTPUT switch on, and turn the setting knob so that the DVM reading is equal to 10 % of the rated output voltage.

   The PWR outputs approximately 10 % of the rated output voltage. Turning the setting knob while holding down the SHIFT switch increases the resolution.
5. Turn off the OUTPUT switch.

   The offset is calibrated, and the voltmeter shows “OF 1.”
6. Press the VOLTAGE switch to enter the output voltage full scale calibration mode.

   The voltmeter shows “FS 1.”
7. Turn the OUTPUT switch on, and turn the setting knob so that the DVM reading is equal to the rated output voltage.

   The PWR outputs approximately 100 % of the rated output voltage. Turning the setting knob while holding down the SHIFT switch increases the resolution.
8. Turn off the OUTPUT switch.

   The full scale is calibrated, and the voltmeter shows “FS 3.”
9. Press the SET switch to store the calibration value.

   The calibration values for offset and full scale are stored, and the voltmeter returns to “FS 0.”

Calibration of the OVP (overvoltage protection) offset and full scale

Calibrate the OVP after completing the calibration of the voltage. To continue with the OVP calibration after the voltage calibration, start from step 3 .

See Fig. 8-5

1. Turn the POWER switch off, and connect a DVM to the output terminal.

2. While holding down the SET switch, turn on the POWER switch.

   The ammeter shows “CAL.” Hold down the SET switch until “CAL” appears. Warm up the equipment adequately including the DVM.

3. Press the OVP switch and then the VOLTAGE switch to enter the OVP offset calibration mode.

   The ammeter shows “OVP,” and the voltmeter shows “OF 0”.

4. Turn on the OUTPUT switch.

   The ON indicator blinks, and the calibration starts automatically. When the calibration is complete, the POWER switch is turned off. (This takes 30 s to 60 s.)

5. While holding down the SET switch, turn on the POWER switch.

   Hold down the SET switch until “CAL” appears.

6. Press the OVP switch and then the VOLTAGE switch to enter the OVP full scale calibration mode.

   The ammeter shows “OVP,” and the voltmeter shows “FS 0”.

7. Turn on the OUTPUT switch.

   The ON indicator blinks, and the calibration starts automatically. When the calibration is complete, the POWER switch is turned off. (This takes 30 s to 60 s.)

8.2.3 Current Calibration

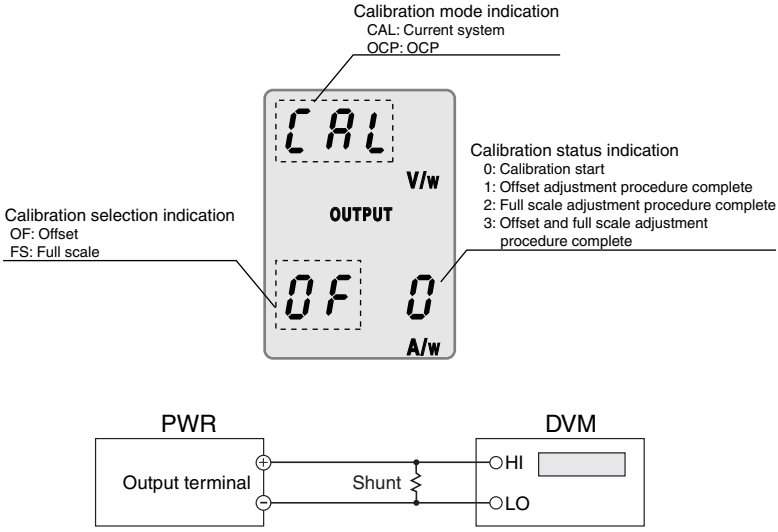


Fig. 8-6 Panel display example and connection for current calibration

Be sure to carry out the calibration items to the last step. If you move to a different type of calibration in the middle of another calibration or if you turn the POWER switch off, the calibration is invalid.

To exit from the calibration procedure, turn off the POWER switch.

Calibration of the output current offset and full scale

1. Turn the POWER switch off, and connect a shunt and a DVM to the output terminal.

2. While holding down the SET switch, turn on the POWER switch.

   The voltmeter shows “CAL.” Hold down the SET switch until “CAL” appears. Warm up the equipment adequately including the DVM and shunt.

3. Press the CURRENT switch to enter the output current offset calibration mode.

   The ammeter shows “OF 0.”

4. Turn the OUTPUT switch on, and turn the setting knob so that the DVM reading is equal to 10 % of the rated output current.

   The PWR outputs approximately 10 % of the rated output current. Turning the setting knob while holding down the SHIFT switch increases the resolution.

5. Turn off the OUTPUT switch.

   The offset is calibrated, and the ammeter shows “OF 1.”

6. Press the CURRENT switch to enter the output current full scale calibration mode.

   The ammeter shows “FS 1.”

7. Turn the OUTPUT switch on, and turn the setting knob so that the DVM reading is equal to the rated output current.

   The PWR outputs approximately 100 % of the rated output current. Turning the setting knob while holding down the SHIFT switch increases the resolution.

8. Turn off the OUTPUT switch.

   The full scale is calibrated, and the ammeter shows “FS 3.”

9. Press the SET switch to store the calibration value.

   The calibration values for offset and full scale are stored, and the ammeter returns to “FS 0.”

Calibration of the OCP (overcurrent protection) offset and full scale

Calibrate the OCP after completing the calibration of the current. To continue with the OCP calibration after the current calibration, start from step 3 .

See Fig. 8-6

1 Turn the POWER switch off, and connect a shunt and a DVM to the output terminal.

2 While holding down the SET switch, turn on the POWER switch.

The voltmeter shows “CAL.” Hold down the SET switch until “CAL” appears. Warm up the equipment adequately including the DVM and shunt.

3 Press the OCP (SHIFT+OVP) switch and then the CURRENT switch to enter the OCP offset calibration mode.

The voltmeter shows “OCP,” and the ammeter shows “OF 0”.

4 Turn on the OUTPUT switch.

The ON indicator blinks, and the calibration starts automatically. When the calibration is complete, the POWER switch is turned off. (This takes 60 s to 90 s.)

5 While holding down the SET switch, turn on the POWER switch.

Hold down the SET switch until “CAL” appears.

6 Press the OCP (SHIFT+OVP) switch and then the CURRENT switch to enter the OCP full scale calibration mode.

The voltmeter shows “OCP,” and the ammeter shows “FS 0”.

7 Turn on the OUTPUT switch.

The ON indicator blinks, and the calibration starts automatically. When the calibration is complete, the POWER switch is turned off. (This takes 60 s to 90 s.)

8.3 Troubleshooting

If you have problems operating the PWR, check whether any of the items below apply to your case. In some cases, the problem can be solved quite easily.

See Page 4-32

If none of the items apply to your case, we recommend that you initialize the PWR to factory default condition. If the remedy does not correct the problem, contact your Kikusui agent or distributor.

■ The power does not turn on.

Check Item	Cause and Remedy	See Page
Is the wiring to the L, N, and GND of the AC INPUT terminal correct?	Connect it correctly.	2-8
Is the power cord is broken?	Replace the power cord with a new one.	2-8

■ Output does not turn on even when the OUTPUT switch is turned on.

Check Item	Cause and Remedy		See Page
Is the output voltage set to 0 V, and the output current set to 0 A?	Set the output voltage and output current to appropriate values.		4-13
Are you performing output on/off control using an external contact?	Yes	Turn the output on using the external contact.	5-18
	No	Set the external control logic setting of the output on/off to “turn the output on with a high signal” (C-6: 0).	4-23
Is the CV/CC control source set to external control?	Set it to panel control (C-1: 0 and C-2: 0).		4-23

■ The ALM indicator illuminates when the OUTPUT switch is turned on.

Check Item	Cause and Remedy	See Page
Is the OVP trip point set less than or equal to the output voltage?	Set the OVP trip point to a voltage greater than or equal to the output voltage.	4-18
Is the OCP trip point set less than or equal to the output current?	Set the OCP trip point to a current greater than or equal to the output current.	4-19
Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off remote sensing (C-3: 0) in the CONFIG settings.	4-23
Is the polarity of remote sensing cable connection reversed?	The polarity of the remote sensing cable may be reversed, or the ends may be shorted. Check the load wire.	4-29
Are you using remote sensing with a long load wire?	Set up the environment so that the voltage drop in the load wire is within the compensation voltage range (0.6 V for a single line).	4-29
Is the control cable loose in the external control?	Connect it correctly.	Chapter 5
Is the external voltage excessive in the external control?	Apply the correct voltage.	5-10 5-14
Is the internal temperature is abnormally high?	The overheat protection function is activated. Check the operating environment. The dust filter may be clogged, or the fan may be broken. Check them.	2-4

■ The ALM indicator illuminates when the load is changed.

Check Item	Cause and Remedy	See Page
Is a large external voltage applied such as with a battery load?	The overvoltage protection function or the overcurrent protection function may be activated. Check them. The PWR may be overloaded. Check the load.	4-15
Is the actual output is higher than the preset voltage shown on the panel?		
Is a special load is connected?		

■ The ALM indicator blinks.

Check Item	Cause and Remedy	See Page
Did the load resistance change?	The POWER LIMIT function was activated as a result of the change in the load resistance. This is not a malfunction.	4-22
Are you using the PWR in the extended operating area?	The ALM indicator blinks when operating in the extended operating area. This is not a malfunction.	4-11

■ Unable to set the output voltage or output current.

Check Item	Cause and Remedy	See Page
Are you trying to set a voltage higher than the OVP trip point?	Change the OVP trip point.	4-18
Are you trying to set a current higher than the OCP trip point?	Change the OCP trip point.	4-19

■ Unable to operate the panel switch.

Check Item	Cause and Remedy	See Page
Is the LOCK switch illuminated?	Release the panel operation lock.	4-28

■ The output ripple is large.

Check Item	Cause and Remedy	See Page
Is the input voltage outside the range?	Supply a voltage that is within the input voltage range.	9-3
Is there a source of strong magnetic or electrical field nearby?	Take measures such as moving the PWR away from such generating sources and using twisted cables.	–
Is the external voltage noise is large during external control?	Take measures against noise.	–
Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off remote sensing (C-3: 0) in the CONFIG settings.	4-23

■ The output is unstable.

Check Item	Cause and Remedy	See Page
Is the operation mode switching from CV to CC or CC to CV?	Change the setting (output voltage or output current) that is limiting the output to a value greater than the present setting. If the preset value is at maximum, you must use a power supply with a larger output voltage or current.	4-13
Are you using master-slave operation?	The performance degrades slightly during master-slave parallel operation.	Chapter 6
Is the remote sensing function turned on?	If you are not using the remote sensing function, turn off remote sensing (C-3: 0) in the CONFIG settings.	4-23
Did 30 minutes pass since the power was turned on?	Warm up (power turned on) the PWR for at least 30 minutes.	–
Are both CV and CC indications illuminated?	If the output is oscillating when using remote sensing, insert a capacitor across the load. The internal circuitry may have malfunctioned. Immediately stop the use of the PWR and request repairs.	4-29
Does the sensing wire or load wire have poor contact or is the cable broken?	Turn off the POWER switch and check the wiring.	3-7 4-29
Does the load current have peaks or is it pulse-shaped?	The peak value may be exceeding the preset current. Increase the preset current or increase the current capacity.	4-13

■ The power turns off immediately even when it is turned on.

Check Item	Cause and Remedy	See Page
Is the output status setting at power-on set to “output on at power-on” (C-4: 1)?	The protection function is activated. Turn the POWER switch on while holding down the OUTPUT switch to power up with the output temporarily turned off. Eliminate the cause that is activating the protection function.	4-15 4-23

■ The PWR cannot be controlled remotely.

Check Item	Cause and Remedy	See Page
Is the CV/CC control source set to external control?	Set it to panel control (C-1: 0 and C-2: 0).	4-23

Specifications

This chapter lists the specifications.

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

- The load is a pure resistance.
- The warm-up time is 30 minutes (with current flowing).
- After warm-up is complete, the PWR must be calibrated correctly according to the procedures given in the operation manual in a 23 °C ± 5 °C environment.
- typ: A typical value. It does not guarantee the performance.
- rtg: Indicates the rated value.
- rdng: Indicates the read value.
- The PWR is capable of operating in a wide range of output voltage and output current combinations within the rated output power. However, the current (or voltage) that can be delivered at the rated output voltage (or rated output current) is limited by the rated output power.
- The current (voltage) that can be output at the rated output voltage (or rated output current) is as follows:

  Maximum output current at the rated output voltage is equal to the rated output power divided by the rated output voltage
  Maximum output voltage at the rated output current is equal to the rated output power divided by the rated output current
- Rated load and no load are defined as follows:

  During constant voltage operation
  (Set the preset current to a value greater than the maximum output current at the rated output voltage)

  Rated load: Refers to a load with a resistance that makes the current that flows when the rated output voltage is applied to be 95 % to 100 % of the maximum output current at the rated output voltage.

  No load: Refers to a load at which no output current flows or an open load (no load is connected).

  During constant current operation
  (Set the preset voltage to a value greater than the maximum output voltage at the rated output current)

  Rated load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 95 % to 100 % of the maximum output voltage at the rated output current. The output voltage of the PWR including the voltage drop in the load wire must not exceed the maximum output voltage at the rated output current.

  No load: Refers to a load with a resistance that makes the voltage drop when the rated output current is supplied to be 10 % of the maximum output voltage or 1 V, whichever is greater, at the rated output current.
- The specifications of the PWR are defined for output terminal on the rear panel. Those on the front panel may not satisfy the specifications.

Common specifications

Common Specifications			
AC input			
	Nominal input rating[*1]		100 Vac to 240 Vac. 50 Hz to 60 Hz, single phase.
	Input voltage range[*1]		85 Vac to 250 Vac.
	Hold-up time for power interruption (MIN)		10 ms (at 50 % load). 5 ms (at rated load).
Protection function			
	OVP (Overvoltage protection)	Protection action	Turns the output off or trips the breaker.[*2] OVP is indicated and ALM illuminates.
		Selectable range	10 % to 110 % of the rated output voltage.
		Setting error	±(Rated output voltage × 1.5 %).
	OCP (Overcurrent protection)	Protection action[*3]	Turns the output off or trips the breaker.[*2] OCP is indicated and ALM illuminates.
		Selectable range L type	10 % to 176 % of the rated output current.
		Selectable range M/H type	10 % to 110 % of the rated output current.
		Setting error	±(Rated output current × 3 %).
	POWER LIMIT	Protection action[*4]	Power limit at approx. 105 % of the rated output power. The output voltage/current varies depending on the load. ALM blinks.
	OPP (Overpower protection)	Protection action	Turns off the output or trips the breaker when a given time elapses with the output exceeding the power limit[*2] OPP is indicated and ALM illuminates.
		Value (fixed)	Greater than or equal to approx. 110 % of the rated output power.
	OHP (Overheat protection)	Protection action[*5]	Turns off the output. OHP is indicated and ALM illuminates.

*1. 100 Vac/200 Vac systems, operable without switching

*2. Select whether to trip the breaker (C-8: 0/1) when an alarm is detected in the CONFIG settings.
The specified protection action is common to OVP, OCP, and OPP. It cannot be set separately for OVP, OCP, and OPP.
The protection function recovers after correcting the abnormal condition and turning on the POWER switch.

*3. Protection is not provided for the peak discharge current that is emitted from the built-in capacitor at the output end of the PWR caused by abrupt changes in the load.

*4. The specifications of the output voltage or output current are not met in the POWER LIMIT operating area.
Phenomena such as overshoot and ringing may occur when a switch occurs from constant voltage or constant current operation to power limit operation or vice versa.

*5. The protection function recovers after correcting the abnormal condition and turning on the POWER switch.

Common Specifications			
Display function			
Voltmeter	Maximum display	L type	99.99 (fixed decimal point).
		M/H type	999.9 (fixed decimal point).
	Display error		±(0.2 % of rdng + 5 digits) at 23 °C ± 5 °C.
Ammeter	Maximum display	Models with a rating less than 10 A	9.999 (fixed decimal point).
		Models with a 10 A rating or greater	99.99 (fixed decimal point).
		Models with a 100 A rating or greater	999.9 (fixed decimal point).
	Display error		±(0.5 % of rdng + 5 digits) at 23 °C ± 5 °C.
Wattmeter PWR DPSL[*1]			The red LED by the unit (voltage or current) on the display illuminates.
	Maximum display	400W/800W type	999.9 (displayed on the voltmeter or ammeter).
		1600W type	9999 (displayed on the voltmeter or ammeter).
	Display error		Not defined. (Displays the product of the current and voltage).
Operation display	OUTPUT ON/OFF		Output on: ON (green) illuminates. Output off: OFF (green) illuminates.
	CV operation		CV illuminates (green).
	CC operation		CC illuminates (red).
	ALM operation[*2]		ALM illuminates[*3] (red).
Signal output			
Monitor signal output[*4]	VMON (Voltage)	At rated voltage output	10.00 V ± 0.25 V.
		At 0 V output	0.00 V ± 0.25 V.
	IMON (Current)	At maximum current output[*5]	10.00 V ± 0.25 V.
		At 0 A output	0.00 V ± 0.25 V.
Status signal output[*4, *6]	OUTON STATUS		Turns on when the output is on.
	CV STATUS		Turns on during CV operation.
	CC STATUS		Turns on during CC operation.
	ALM STATUS[*7]		Turns on when an alarm (OVP, OCP, OHP, OPP, or SHUT) is activated.
	PWR OFF STATUS[*8 , *9]		Turns on for approximately 0.5 to 3 seconds after the POWER switch is turned off.
	PWR ON STATUS[*9, *10]		Turns on when the POWER switch is on.

Common Specifications			
Control function			
Digital control*11			TP-BUS Directly controllable from the PIA4810 or PIA4830.
External analog control*4	EXT-V CV CONT*12 , *13		0 % to 100 % of the rated output voltage in the range of 0 V to 10 V.
	EXT-R CV CONT *12	Normal	0 % to 100 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.
		Fail safe	100 % to 0 % of the rated output voltage in the range of 0 kΩ to 10 kΩ.
	EXT-V CC CONT*13, *14		0 % to 100 % of the maximum output current in the range of 0 V to 10 V.
	EXT-R CC CONT*14	Normal	0 % to 100 % of the maximum output current in the range of 0 kΩ to 10 kΩ.
		Fail safe	100 % to 0 % of the maximum output current in the range of 0 kΩ to 10 kΩ.
	OUTPUT ON/OFF CONT		Turns on when the TTL level signal is high or when it is low.*15
	SHUT DOWN		Turn the output off or trip the breaker when the TTL level signal is high.*16

*1. Power display and measured value display toggle each time you press the SHIFT+VOLTAGE switch or SHIFT+CURRENT switch. The power value (output value) is shown on the voltmeter or ammeter for the power display.
*2. ALM illuminates for approximately 0.5 s to 3 s if the breaker is configured to trip when a protection function is activated (C-8: 0). Other indications are undefined.
*3. ALM blinks when operating in the power limit and extended operating area, but the ALM signal is not output.
*4. J1 connector on the rear panel.
*5. The maximum output current is the rated output current on the M/H type.
*6. Photocoupler open collector output.
Maximum voltage 30 V, maximum current (sink) 8 mA. Insulated from the output and control circuits. Status signals are not mutually insulated.
*7. Turns on for approximately 0.5 to 3 s if the breaker is configured to trip when a protection function is activated (C-8: 0).
*8. Turns on when the POWER switch is turned off manually or when the breaker trips.
*9. Select PWR OFF STATUS (C-9: 1) or PWR ON STATUS (C-9: 0) in the CONFIG settings. The selected signal is output to pin 22 of the J1 connector.
*10. Turn on when the input power supply is normal and the POWER switch is on.
*11. TP BUS connector on the rear panel.
*12. CV external voltage control. Select the control source in the CONFIG settings. The setting error is ±5 % of the rated output voltage or ±5 % of the maximum output current.
*13. The input impedance is approximately 30 kΩ.
*14. CC external voltage control. Select the control source in the CONFIG settings. The setting error is ±5 % of the rated output voltage or ±5 % of the maximum output current. The maximum output current is the rated output current on the M/H type.
*15. Select whether to turn on the output at a high signal (C-6: 0) or low signal (C-6: 1) in the CONFIG settings.
*16. Select whether to trip the breaker (C-8: 0/1) when an alarm is detected in the CONFIG settings.

Common Specifications			
General			
	Environmental conditions	Operating conditions	Indoor use, Overvoltage Category II.
		Operating temperature*1	0 °C to +50 °C. With output current derating. L type: 45 °C or higher M/H type: 40 °C or higher
		Operating humidity	20 %rh to 85 %rh (no condensation).
		Storage temperature*2	-25 °C to +70 °C.
		Storage humidity*2	0 %rh to 90 %rh (no condensation).
		Altitude	Up to 2 000 m.
	Cooling system		Forced air cooling using a fan.*3
	Grounding polarity		Negative grounding or positive grounding possible.
	Isolation voltage		L/M type: ±600 Vmax. H type: ±1 000 Vmax.
	Withstand voltage	Across the primary side of the transformer and chassis	No abnormalities at 1 500 Vac for 1 minute.
		Across the primary and secondary sides of the transformer	
		Across the secondary side of the transformer and chassis	L/M type: No abnormalities at 600 Vdc for 1 minute. H type: No abnormalities at 1 000 Vdc for 1 minute.
	Insulation resistance	Across the primary side of the transformer and chassis	500 Vdc, 30 MΩ or more. (at a humidity of 70 %rh or less)
		Across the primary and secondary sides of the transformer	L/M type: 500 Vdc, 30 MΩ or more. H type: 1 000 Vdc, 30 MΩ or more. (at a humidity of 70 %rh or less)
		Across the secondary side of the transformer and chassis	
	Safety*4		Complies with the requirements of the following directives and standards. Low Voltage Directive 73/23/EEC EN61010-1 Class I Pollution degree 2
	Electromagnetic Compatibility (EMC)*4, *5		Complies with the requirements of the following directives and standards. EMC Directive 89/336/EEC EN61326 EN61000-3-2 EN61000-3-3 Applicable condition All of the wires and wires connected to the PWR are less than 3 m in length.

Common Specifications			
General (cont.)			
Accessories	Operation Manual		1 pc.
	Power cord*6	400 W type	SVT3 18AWG: 1 pc. with 3 P plug and connector. cable length 2.4 m.
		800 W type	SJT3 14AWG: 1 pc. with 3 P plug and connector. cable length 3 m.
		1600 W type	VCT3 5.5 mm^2: 1 pc. without plug and connector. cable length: 3 m. wire color: black, white, green/yellow or green. Cable clamp: 1 set.
	OUTPUT terminal cover		1 set.
	TP BUS connector		MSTB 2.5/2-ST-5.08 : 1 pc.
	M4 output terminal screws		M4 x 8 : 2 pcs.
	M8 output terminal screws		M8 x 16 : 2 sets (bolts, nuts, and spring washers)

*1. 100 % of the rated output current at an ambient temperature of +45 °C (L type) or 40 °C (H type). Decreases linearly down to 80 % of the rated output current at an ambient temperature of +50 °C.
*2. Under packaged condition.
*3. With thermal-sensing control (FAN control).
*4. Not applicable to custom order models.
*5. Only on models that have CE marking on the panel.
*6. The power cord that comes standard with the unit is for a rated voltage of 125 Vac (250 Vac for the 1600 W type).
The PWR operates using a nominal supply voltage in the range of 100 Vac to 240 Vac without switching. However, if the 400 W or 800 W type is used under a supply voltage outside the 100 Vac to 120 Vac range, an appropriate rated power cord must be prepared.
The power cord included in the package may vary from the specifications due to the shipment destination.

Model-specific specifications (L type)

			PWR400L	PWR800L	PWR1600L
Output specifications					
Rating			400.0 W	800.0 W	1600 W
	Rated output voltage		80.00 V	80.00 V	80.00 V
	Rated output current		25.00 A	50.00 A	100.0 A
Voltage	Maximum preset voltage (typ)*1		105 % of rtg		
	Setting accuracy*2 , *3		0.1 % of rtg + 10 mV		
	Source effect*3, *4		0.05 % of rtg + 3 mV		
	Load effect*5 , *3		0.05 % of rtg + 5 mV		
	Transient response*6		1 ms	1.5 ms	2 ms
	Ripple noise*3	(p-p)*7	60 mV	80 mV	120 mV
		(RMS)*8	10 mV	15 mV	20 mV
	Rise time (MAX)*9		100 ms [50 ms] (rated load) 100 ms [50 ms] (no load)		
	Fall time (MAX)*10		100 ms [40 ms] (rated load) 250 ms [125 ms] (no load)		
	Temperature coefficient (MAX)*11		100 ppm/°C (during external analog control)		
Current	Maximum preset current (typ)*12		40.0 A	80.0 A	160.0 A
	Setting accuracy*2, *3		0.5 % of rtg + 20 mA	0.5 % of rtg + 40 mA	0.5 % of rtg + 80 mA
	Source effect*3,*4		0.1 % of rtg + 10 mA		
	Load effect*3, *13		0.1 % of rtg + 10 mA		
	Ripple noise (RMS)*8		40 mA	80 mA	160 mA
	Temperature coefficient (typ)*11		200 ppm/°C (during external control)		
	Maximum output current (typ)*14	Continuous	30.00 A	60.00 A	120.0 A
		Intermittent	40.00 A	80.00 A	160.0 A
Parallel/serial operation					
Master-slave parallel operation*15			Up to 5 units including the master unit (same models only).		
Master-slave series operation*16			Up to 2 units including the master unit (same models only).		

*1. The maximum preset voltage is provided for establishing a rated output voltage setting. It does not guarantee power supply to the load exceeding the rated output voltage.
*2. The difference between the actual output voltage (or output current) and the preset value under constant voltage (or constant current) operation.
*3. Within the rated output current.
*4. Output voltage (or output current) fluctuation with respect to 10 % fluctuation of the nominal input voltage (ex. 100 Vac) under constant voltage (or constant current) operation.

*5. Output voltage fluctuation when the output voltage is set to the rated output voltage and the load is changed from rated load to no load (open load) under constant voltage operation.

*6. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output voltage is set to the rated output voltage and the output current is changed from 100 % to 50 % or 50 % to 100 % of the maximum output current at the rated output voltage under constant voltage operation.
The output voltage when the output current is 100 % is used as a reference.

*7. At a measurement frequency bandwidth of 10 Hz to 20 MHz.

*8. At a measurement frequency bandwidth of 5 Hz to 1 MHz.

*9. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.
Set the output current to the rated value. Values inside brackets are typical values.

*10. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.
Set the output current to the rated value. Values inside brackets are typical values.

*11. At an ambient temperature range of 0 °C to 50 °C. The temperature characteristics of the external analog control signal are excluded.

*12. To set the current to a value greater than 105 % of the rated output current, turn the setting knob while holding down the SHIFT switch. You do not have to hold down the SHIFT switch if you are lowering the current down from a value greater than 105 % of the rated output current.

*13. Output current fluctuation when the output current is set to the rated output current and the load is changed from rated load to no load under constant current operation.

*14. The range between the rated output current and the maximum output current (maximum preset current) is the extended operating area. Specifications such as the power supply fluctuation, load fluctuation, ripple noise, and transient response are not met in the extended operating area. The ALM indicator blinks when operating in the extended operating area. In this case, the alarm signal is not output.
Continuous extended operating area (up to 120 % of the rated output current)
Continuous output is possible. However, at ambient temperatures greater than or equal to 30 °C, the output current must be derated with respect to the temperature.
Intermittent extended operating area (120 % to 160 % of the rated output current)
The maximum output duration is limited to 10 minutes. Pause duration of at least twice the output duration is required.
For detail, see section “4.4.2 Extended operating area (L type only).”

*15. The difference in the output current between the master unit and the slave unit is within approximately 3 % of the rating.

*16. The difference in the output voltage between the master unit and the slave unit is within approximately 3 % of the rating.

		PWR400L	PWR800L	PWR1600L
Input specifications				
Current (MAX)*1	100 VAC	6.5 A	13.0 A	26.0 A
	200 VAC	3.3 A	6.5 A	13.0 A
Inrush current (MAX)*2		35 Apeak	70 Apeak	140 Apeak
Power (MAX)*1		650 VA	1300 VA	2600 VA
Power factor (typ)*3		0.980		
Efficiency (MIN)*4		70 %		
		PWR400L	PWR800L	PWR1600L
General				
Weight*5		Approx. 5 kg	Approx. 8 kg	Approx. 15 kg
Dimensions		See Outline Drawing.		

*1. Under rated load. Excludes the extended operating area.
*2. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).
*3. Standard value at an input voltage of 100 Vac under rated load. Excludes the extended operating area.
*4. At an input voltage of 100 Vac under rated load. Excludes the extended operating area.
*5. Unit only. Does not include accessories.

Model-specific Specifications (M type)

			PWR400M	PWR800M	PWR1600M
Output specifications					
Rating			400.0 W	800.0 W	1600 W
	Rated output voltage		320.0 V	320.0 V	320.0 V
	Rated output current		6.250 A	12.50 A	25.000 A
Voltage	Maximum preset voltage (typ)*1		105 % of rtg		
	Setting accuracy*2 , *3		0.1 % of rtg + 10 mV		
	Source effect*3, *4		0.05 % of rtg + 3 mV		
	Load effect*5 , *3		0.05 % of rtg + 5 mV		
	Transient response*6		4 ms	8 ms	12 ms
	Ripple noise*3	(p-p)*7	90 mV	140 mV	190 mV
		(RMS)*8	15 mV	20 mV	25 mV
	Rise time (MAX)*9		160 ms [80 ms] (rated load) 160 ms [80 ms] (no load)		
	Fall time (MAX)*10		560 ms [280 ms] (rated load) 2200 ms [14000 ms] (no load)		
	Temperature coefficient (MAX)*11		100 ppm/°C (during external control)		
Current	Maximum preset current (typ)*12		105 % of rtg		
	Setting accuracy*2, *3		0.5 % of rtg + 5 mA	0.5 % of rtg + 10 mA	0.5 % of rtg + 20 mA
	Source effect*3A*4		0.1 % of rtg + 10 mA		
	Load effect*3, *13		0.1 % of rtg + 10 mA		
	Ripple noise (RMS)*8		25 mA	35 mA	50 mA
	Temperature coefficient (typ)*11		200 ppm/°C (during external control)		
Parallel/serial operation					
Master-slave parallel operation*14			Up to 5 units including the master unit (same models only).		
Master-Slave Series Operation			Not allowed		
Input specifications					
Current (MAX)*15		100 VAC	6.25 A	12.5 A	25.0 A
		200 VAC	3.13 A	6.25 A	12.5 A
Inrush current (MAX)*16			35 Apeak	70 Apeak	140 Apeak
Power (MAX)*15			625 VA	1250 VA	2500 VA
Power factor (typ)*17			0.980		
Efficiency (MIN)*18			70 %		

	PWR400M	PWR800M	PWR1600M
General (cont.)			
Weight*19	Approx. 5 kg	Approx. 8 kg	Approx. 15 kg
Dimensions	See Outline Drawing.		

*1. The maximum preset voltage is provided for establishing a rated output voltage setting. It does not guarantee power supply to the load exceeding the rated output voltage.
*2. The difference between the actual output voltage (or output current) and the preset value under constant voltage (or constant current) operation.
*3. Within the rated output current.
*4. Output voltage (or output current) fluctuation with respect to ±10 % fluctuation of the nominal input voltage (ex. 100 Vac) under constant voltage (or constant current) operation.
*5. Output voltage fluctuation when the output voltage is set to the rated output voltage and the load is changed from rated load to no load (open load) under constant voltage operation.
*6. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output voltage is set to the rated output voltage and the output current is changed from 100 % to 50 % or 50 % to 100 % of the maximum output current at the rated output voltage under constant voltage operation.
The output voltage when the output current is 100 % is used as a reference.
*7. At a measurement frequency bandwidth of 10 Hz to 20 MHz.
*8. At a measurement frequency bandwidth of 5 Hz to 1 MHz.
*9. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.
Set the output current to the rated value. Values inside brackets are typical values.
*10. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.
Set the output current to the rated value. Values inside brackets are typical values..
*11. At an ambient temperature range of 0 °C to 50 °C. The temperature characteristics of the external analog control signal are excluded.
*12. The maximum preset current is provided for establishing a rated output voltage current. It does not guarantee power supply to the load exceeding the rated output current.
*13. Output current fluctuation when the output current is set to the rated output current and the load is changed from rated load to no load under constant current operation.
*14. The difference in the output current between the master unit and the slave unit is within approximately 3 % of the rating.
*15. Under rated load.
*16. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).
*17. Standard value at an input voltage of 100 Vac under rated load.
*18. At an input voltage of 100 Vac under rated load.
*19. Unit only. Does not include accessories.

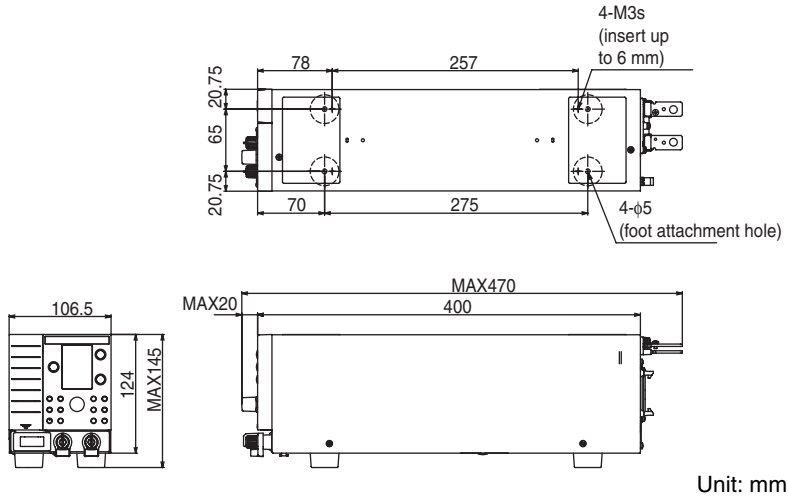
Model-specific specifications (H type)

			PWR400H	PWR800H	PWR1600H
Output specifications					
Rating			400.0 W	800.0 W	1600 W
	Rated output voltage		650.0 V	650.0 V	650.0 V
	Rated output current		2.000 A	4.000 A	8.000 A
Voltage	Maximum preset voltage (typ)*1		105 % of rtg		
	Setting accuracy*2 , *3		0.1 % of rtg + 10 mV		
	Source effect*3, *4		0.05 % of rtg + 3 mV		
	Load effect*5 , *3		0.05 % of rtg + 5 mV		
	Transient response*6		6 ms	7 ms	8 ms
	Ripple noise*3	(p-p)*7	140 mV	210 mV	280 mV
		(RMS)*8	20 mV	30 mV	40 mV
	Rise time (MAX)*9		260 ms [130 ms] (rated load) 260 ms [130 ms] (no load)		
	Fall time (MAX)*10		640 ms [340 ms] (rated load) 2600 ms [1600 ms] (no load)		
	Temperature coefficient (MAX)*11		100 ppm/°C (during external control)		
Current	Maximum preset current (typ)*12		105 % of rtg		
	Setting accuracy*2, *3		0.5 % of rtg + 20 mA	0.5 % of rtg + 40 mA	0.5 % of rtg + 80 mA
	Source effect*3A*4		0.1 % of rtg + 10 mA		
	Load effect*3, *13		0.1 % of rtg + 10 mA		
	Ripple noise (RMS)*8		10 mA	20 mA	40 mA
	Temperature coefficient (typ)*11		200 ppm/°C (during external control)		
Parallel/serial operation					
Master-slave parallel operation*14			Up to 5 units including the master unit (same models only).		
Master-Slave Series Operation			Not allowed		
Input specifications					
Current (MAX)*15		100 VAC	6.0 A	12.0 A	24.0 A
		200 VAC	3.0 A	6.0 A	12.0 A
Inrush current (MAX)*16			35 Apeak	70 Apeak	140 Apeak
Power (MAX)*15			600 VA	1200 VA	2400 VA
Power factor (typ)*17			0.980		
Efficiency (MIN)*18			70 %		

		PWR400H	PWR800H	PWR1600H
General (cont.)				
	Weight*19	Approx. 5 kg	Approx. 8 kg	Approx. 15 kg
	Dimensions	See Outline Drawing.		

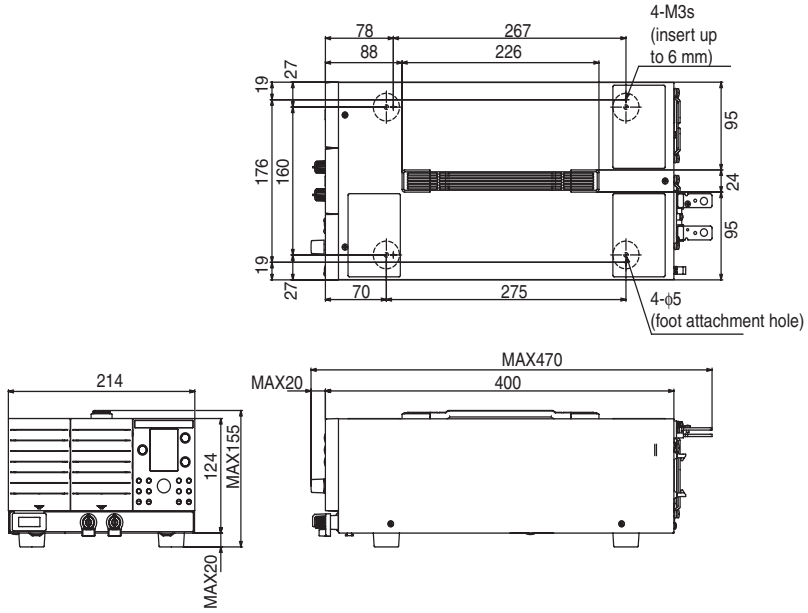
*1. The maximum preset voltage is provided for establishing a rated output voltage setting. It does not guarantee power supply to the load exceeding the rated output voltage.
*2. The difference between the actual output voltage (or output current) and the preset value under constant voltage (or constant current) operation.
*3. Within the rated output current.
*4. Output voltage (or output current) fluctuation with respect to ±10 % fluctuation of the nominal input voltage (ex. 100 Vac) under constant voltage (or constant current) operation.
*5. Output voltage fluctuation when the output voltage is set to the rated output voltage and the load is changed from rated load to no load (open load) under constant voltage operation.
*6. The time it takes for the output voltage fluctuation to recover from outside 0.1 % + 10 mV of the output voltage setting to within 0.1 % + 10 mV when the output voltage is set to the rated output voltage and the output current is changed from 100 % to 50 % or 50 % to 100 % of the maximum output current at the rated output voltage under constant voltage operation.
The output voltage when the output current is 100 % is used as a reference.
*7. At a measurement frequency bandwidth of 10 Hz to 20 MHz.
*8. At a measurement frequency bandwidth of 5 Hz to 1 MHz.
*9. The time it takes for the output voltage to rise from 10 % to 90 % of the rating when the output is turned on.
Set the output current to the rated value. Values inside brackets are typical values.
*10. The time it takes for the output voltage to fall from 90 % to 10 % of the rating when the output is turned off.
Set the output current to the rated value. Values inside brackets are typical values..
*11. At an ambient temperature range of 0 °C to 50 °C. The temperature characteristics of the external analog control signal are excluded.
*12. The maximum preset current is provided for establishing a rated output voltage current. It does not guarantee power supply to the load exceeding the rated output current.
*13. Output current fluctuation when the output current is set to the rated output current and the load is changed from rated load to no load under constant current operation.
*14. The difference in the output current between the master unit and the slave unit is within approximately 3 % of the rating.
*15. Under rated load.
*16. Excludes the charge current component that flows through the capacitor of the internal EMC filter circuit immediately after the POWER switch is turned on (within approximately 1 ms).
*17. Standard value at an input voltage of 100 Vac under rated load.
*18. At an input voltage of 100 Vac under rated load.
*19. Unit only. Does not include accessories.

Outline Drawing



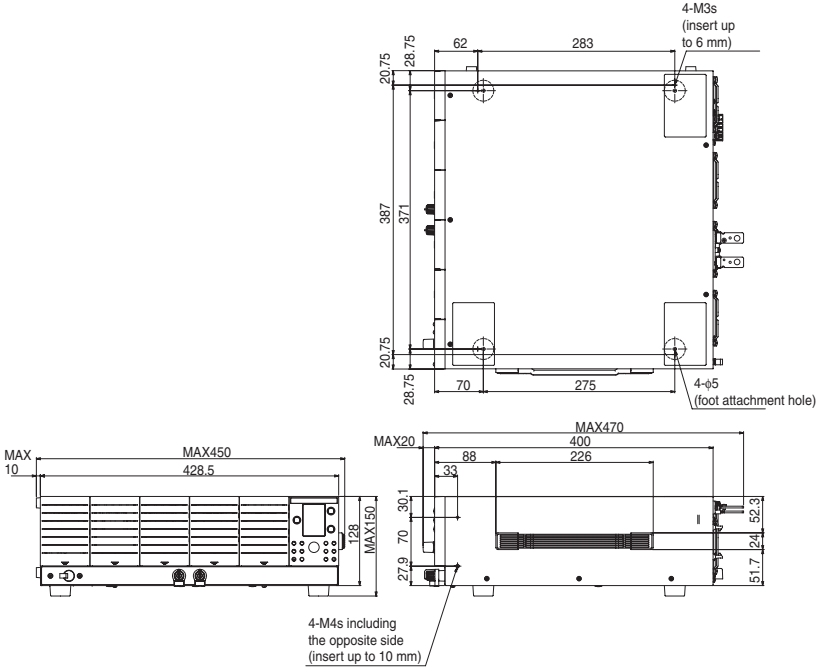
Unit: mm

Fig. 9-1 400 W type outline drawing



Unit: mm

Fig. 9-2 800 W type outline drawing



Unit: mm

Fig. 9-3 1600 W type outline drawing

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