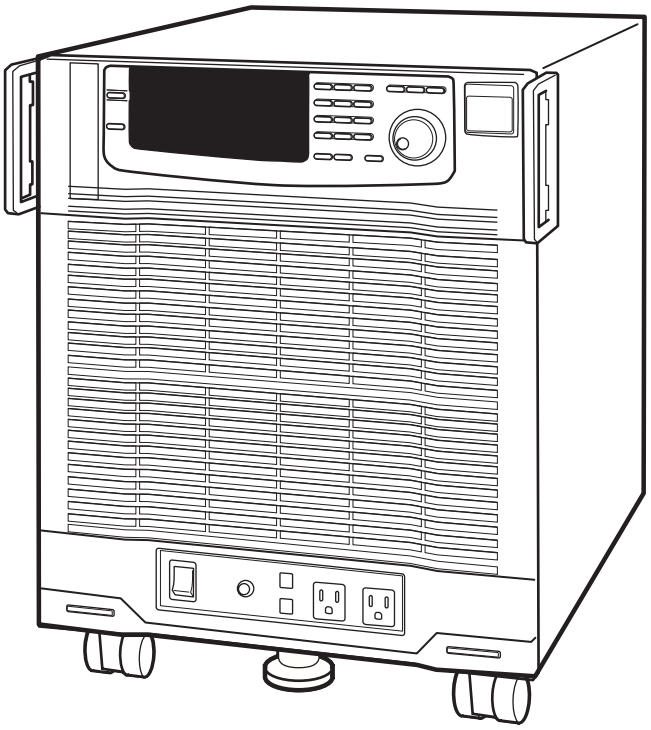
Part No. Z1-002-732, IB00394A
Oct. 2008

OPERATION MANUAL

AC POWER SUPPLY PCR-LA Series

PCR 500LA
PCR1000LA
PCR2000LA
PCR4000LA
PCR6000LA



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.

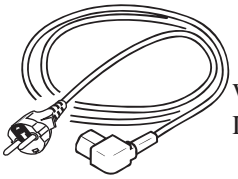
This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

Supplied Input Power Cables

The PCR-LA Series AC Power Supplies intended for the European market are supplied with input power cables that differ from those of the PCR-LA AC power supplies intended for other regions.
The following denotes the input power cables supplied with the product and describes the differences in their handling precautions.
In terms of the input power cable(s), the following information on the product concerned should take precedence over the information on the product contained in the relevant section of this Operation Manual.

PCR500LA

This model is supplied with the heavy PVC jacketed three-core cable (with a plug and inlet receptacle) shown in the figure at the right.



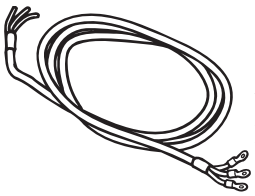
Wire size: 1.5 mm^2
Length: 3 m

[85-AA-0005]

⚠WARNING • Do not use this cable to connect the AC power supply to a 100-V AC line. The cable's current capacity is not sufficient for use on the 100-V AC line.

PCR1000LA

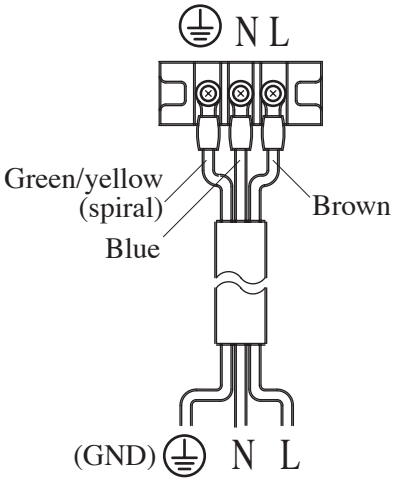
This model is supplied with the heavy PVC jacketed three-core cable shown in the figure at the right.



Wire size: 1.5 mm^2
Length: 3 m

[91-87-5761]

NOTE • The colors of the wires of this cable differ from those of the cables shown in Fig. 2-7 on Page 2-9. Replace the illustration in Fig. 2-7 with the figure at the right.

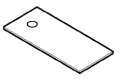


PCR1000LA

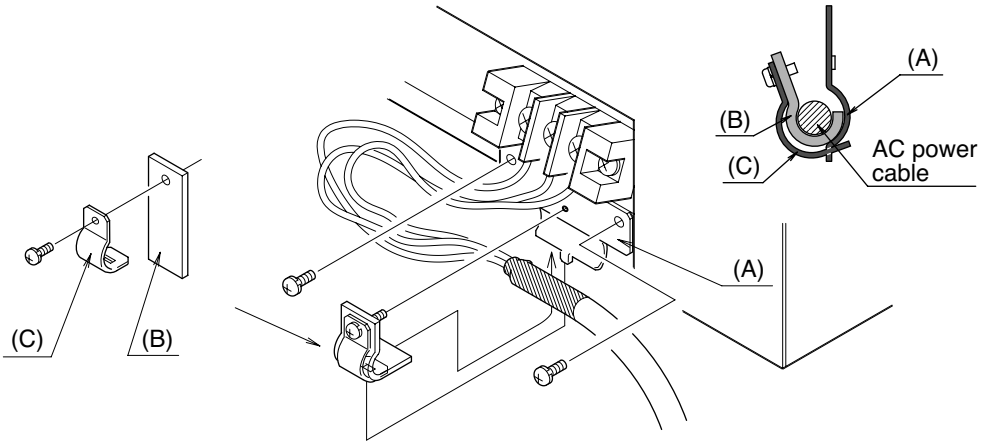
⚠WARNING • Do not use this cable to connect the AC power supply to a 100-V AC line. The cable's current capacity is not sufficient for use on the 100-V AC line.

Rubber sheet for the Cable Clamper

This rubber sheet differs from the type of rubber sheet in Fig. 2-2 on Page 2-2. As for the installation, replace the illustration in Fig. 2-11 on Page 2-12 with the figure at the below.

[R3-000-034] 

Using the provided M3 screw, put the screw through the hole of parts (B) and (C), and place the input power cable to wrap round on the rubber sheet.



PCR2000LA

The input power cable is provided by a Kikusui distributor/agent.

The colors of the wires of the cable supplied with the product may differ from those of the cables shown in Fig. 2-7 on Page 2-9.

For more information on the input power cable, contact your Kikusui distributor/agent.

PCR4000LA

The input power cables are provided by a Kikusui distributor/agent.

The colors of the cables supplied with the product may differ from those of the cables shown in Fig. 2-7 on Page 2-9. For more information on the input power cables, contact your Kikusui distributor/agent.

⚠ Safety Symbols

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

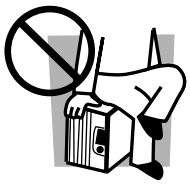
	**Indicates that a high voltage (over 1000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.**
DANGER	**Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.**
	**Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.**
	**Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.**
	**Shows that the act indicated is prohibited.**
	**Is placed before the sign "DANGER," "WARNING," or "CAUTION" to emphasize these. When this symbol is marked on the product, see the relevant sections in this manual.**
	**Protective conductor terminal.**
	**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 are safety precautions to be observed in order to avoid fire hazard, electric shock, accidents, and other failures. It is not possible to predict all potential hazards; however, the following describes all known possible hazardous conditions. Keep them in mind and make sure that all of them are observed properly.

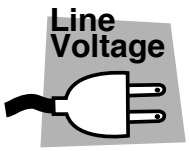
Users

- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If it is handled by disqualified personnel, personal injury may result. Be sure to handle it under supervision of qualified personnel (those who have electrical knowledge.)



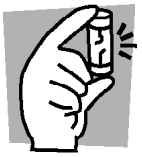
Purposes of use

- Do not use the product for purposes other than those described in the operation manual.
- This product is a regulated AC power-supply unit. It is different from a commercial AC line.
- Do not connect an electrical appliance that operates on commercial AC line to this AC power supply as a load.
- This product is not designed or manufactured for home use or for general consumers.



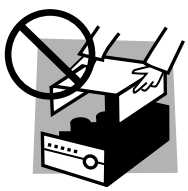
Input power

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



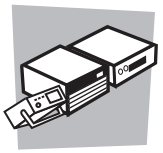
Fuse

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



Cover

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



Installation

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

Relocation

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

Operation

- Check that the AC input voltage setting and the fuse rating are satisfied and that there is no abnormality on the surface of the power cable. Be sure to unplug the power cable or stop applying power before checking.
- If any abnormality or failure is detected in the products, stop using it immediately. Unplug the power cable or disconnect the power cable from the switchboard. Be careful not to allow the product to be used before it is completely repaired.
- For output wiring or load cables, use connection cables with larger current capacity.
- Do not disassemble or modify the product. If it must be modified, contact Kikusui distributor/agent.

Maintenance and checking

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

Service

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

Arrangement of this manual

This Operation Manual is made up of the following sections.

Chapter 1 General

Describes the AC power supply overview and features.

Chapter 2 Installation and Preparation for Use

Describes the procedures necessary for unpacking the AC power supply for preparation prior to use.

Chapter 3 Basic Operations

Describes the basic operations of the AC power supply.

Chapter 4 Applied Operations

Describes applied operations such as switching of the output display and the protective functions.

Chapter 5 Part Names and Their Functions

Denotes the names of switches, displays, terminals, and other parts on the front and rear panels of the AC power supply.

To gain an understanding of the contents of each ⚠ (alert mark) indicated on the panels of the product, read through this chapter.

Chapter 6 RS-232C and GPIB

Describes RS-232C Control and GPIB Control. The use of GPIB Control requires the optional IB03-PCR-LA (GPIB Interface).

Chapter 7 Maintenance

Describes the maintenance procedures for the AC power supply. Also explains the remedies for possible malfunctions encountered during use of the power supply.

Chapter 8 References and Descriptions

Summarizes the technical descriptions of the functions and performance of the AC power supply.

Chapter 9 Descriptions of RS-232C and GPIB Messages

Describes the RS-232C and GPIB messages.

Chapter 10 Optional Equipment

Describes the options of the PCR-LA-series AC power supplies.

Chapter 11 Specifications

This chapter provides the electrical and mechanical specifications of the unit, along with its operating characteristics.

Appendix

This Operation Manual is made up of the following sections.

Contents

Chapter 1 General

Describes the AC power supply overview and features.

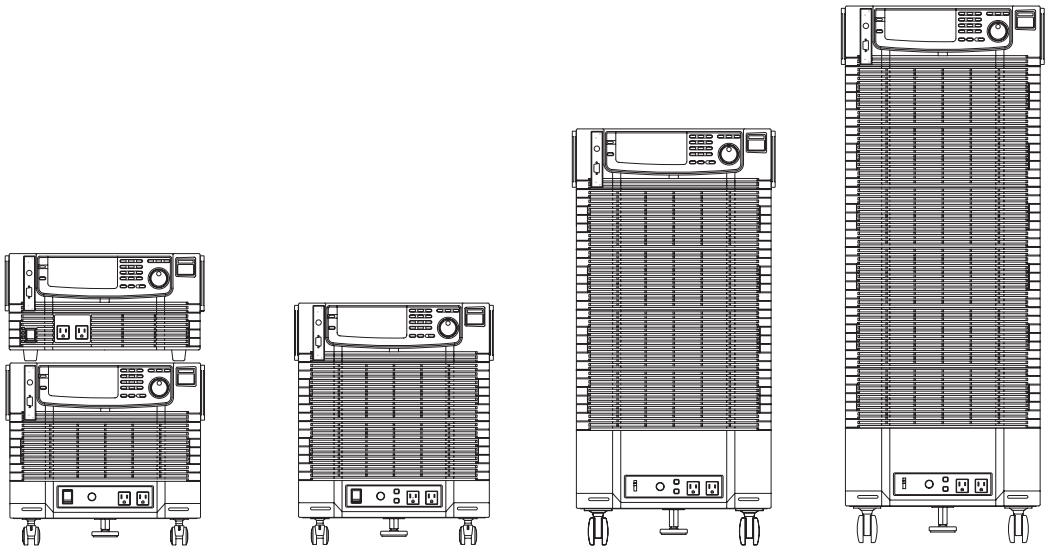
1.1 Outline of the Product

The PCR-LA series is an extension of the PCR-L-series power supplies, which are known for their time-tested performances. Through the combination of a high-speed linear amplifier and an arbitrary waveform synthesizer, the PCR-LA series can achieve AC power of high purity. As it is equipped with the power-supply-environment simulation function and measuring function, it can be used for power-supply-environment testing. For the input power, a converter with power factor correction has been adopted to suppress harmonic currents.

1.2 Full Line-up of the PCR-LA Series

The PCR-LA series is of the single-phase output type and includes the following models:

Model name	Rated output capacity (maximum output current)
PCR500LA	500 VA (5 A for 100 V output, 2.5 A for 200 V output)
PCR1000LA	1 kVA (10 A for 100 V output, 5 A for 200 V output)
PCR2000LA	2 kVA (20 A for 100 V output, 10 A for 200 V output)
PCR4000LA	4 kVA (40 A for 100 V output, 20 A for 200 V output)
PCR6000LA	6 kVA (60 A for 100 V output, 30 A for 200 V output)



PCR500LA
PCR1000LA

PCR2000LA

PCR4000LA

PCR6000LA

Fig.1-1 PCR-LA Series

Relationship to earlier PCR-L-series product

Products in the PCR-LA series generally may not be combined with earlier PCR-L-series products, including options. For details on the options, see Chapter 10, Optional Equipment.

1.3 Features

The PCR-LA series has the following functions in addition to the high-performance constant voltage and constant frequency (CV and CF) functions.

■ A Variety of AC Power Supply Simulations*

The PCR-LA series is capable of performing simulations of power line abnormalities such as voltage interruption and voltage dip. Voltage-peak clipping and the superimposing of harmonics are representative examples of waveform output other than sine waves. These are the basic functions for conducting power-supply-environment testing.

■ Measurements of Various Items

In addition to output voltage rms and current rms, peak voltage and peak current, power, and power factor*, the harmonic components of output currents can be analyzed (up to the 39th order)*.

■ Sequence*

Allows output voltage, frequency, and/or waveforms to change with respect to time. This allows the automation of power-supply-environment testing.

■ DC Outputs

The PCL-LA series offers DC output and AC + DC output*, which allows the AC power supply to also be used in a wide range of fields, including chemistry and physics.

■ Variable Output Impedance*

The output impedance can be varied, enabling simulation of an actual power line.

■ Sensing and Regulation Adjustment*

Even when a load is installed in a remote location, the AC power supply can compensate for a voltage drop to stabilize the voltage (rms value) at a loaded end.

■ Provision for Transformer Load

The DC offset voltage of an output is minimized. This suppresses biased magnetization in a transformer or slide transformer (AC-S mode).

■ Output-phase Count-switching System of a Large Capacity

Single-phase/single-phase, three-wire switching systems and single-phase/three-phase switching systems are available. A desired system can be configured based on a single-phase output machine.

To use a function marked *, the RS-232C Control provided as standard for the product or a separate option is required. For the options, see Chapter 10, Optional Equipment.

1.4 Overview of the Control Section

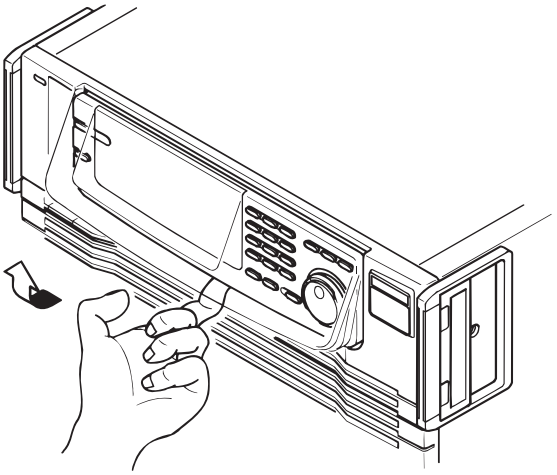
This section briefly describes the control panel used for operation of the AC power supply singly or in a combined system.

To use a function marked *, the RS-232C Control provided as standard for the product or a separate option is required. For the options, see Chapter 10, Optional Equipment.

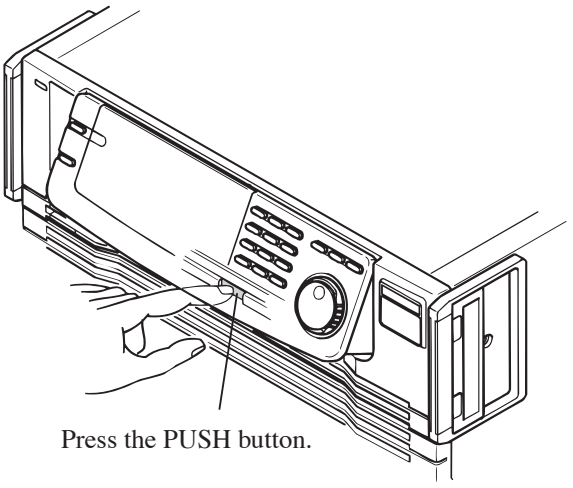
■ Operation Using the Control Panel

In this operation, the user uses the keys and Jog/Shuttle knob on the control panel to set various parameters. The AC power supply has a key lock function to prevent a set value from being accidentally modified. The control panel can be pulled out and tilted into an inclined position, thereby improving the operability of a low-profile model.

For pulling out the control panel (in two steps)



For retracting the control panel



■ Operation Using the Remote Controller*

In this operation, the user uses the keys and JOG/SHUTTLE knob on the remote controller to set various parameters. The remote controller has a key lock function to prevent a set value from being accidentally modified. A dedicated cable is used to connect it to the AC power supply.

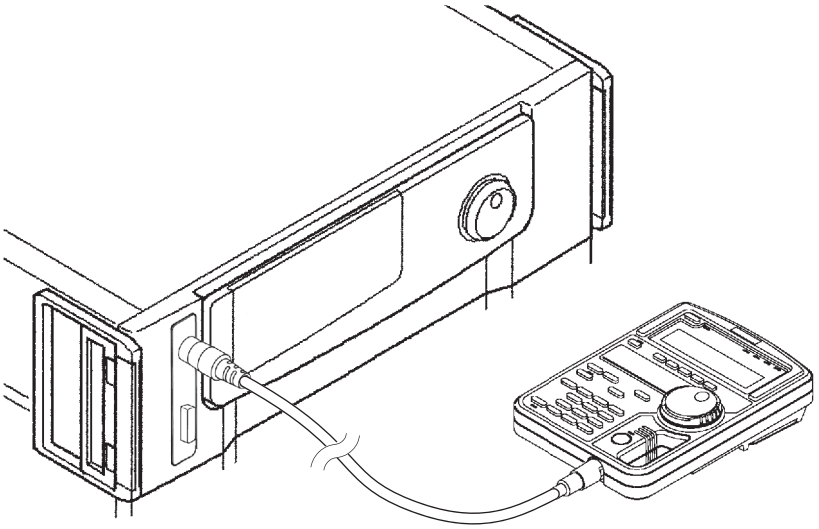


Fig. 1-2 Connecting the Remote Controller to the AC Power Supply

■ External Communications Interface*

This feature allows the AC power supply to be controlled through the use of a personal computer. The RS-232C Control is provided for the product as standard, while the GPIB Interface is an option.

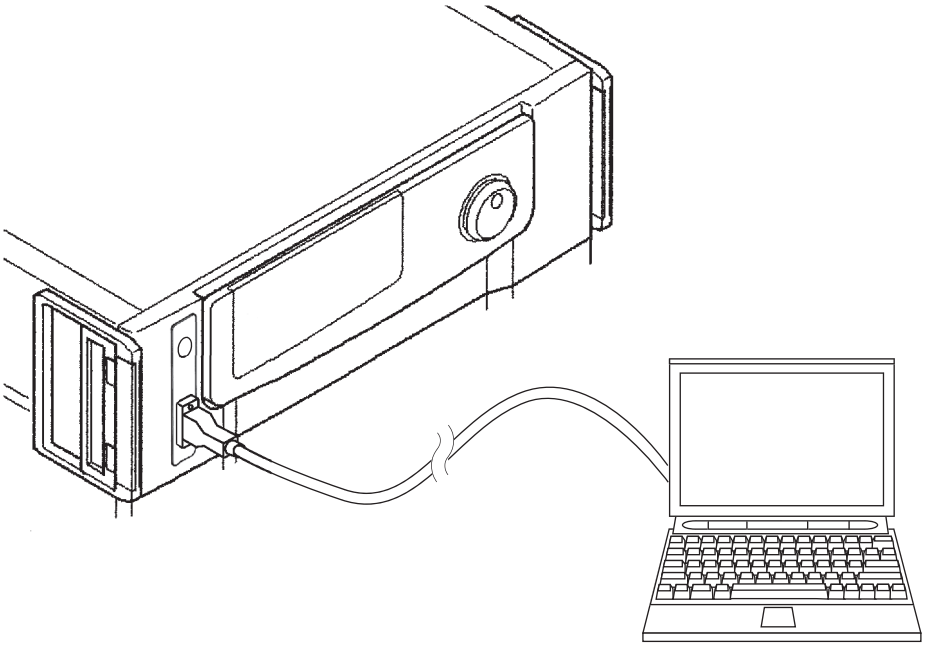


Fig. 1-3 Connecting a PC to the AC Power Supply

■ Parallel Operations*

In this operation, identical models of the PCR-LA series are connected in parallel. Up to five units can be connected. A connected slave is operated by setting various parameters on the master unit. It is also possible to achieve this operation using the remote controller or through remote control via a PC.

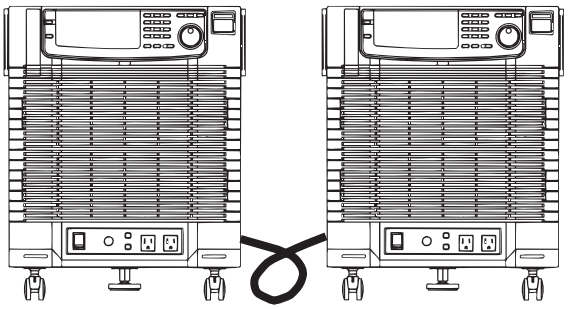


Fig. 1-4 Parallel Connection of the PCR-LA Series

1.5 Operation Manual and ROM Version

This Operation Manual applies to products equipped with ROM of version 3.4x.

When making an inquiry about the product, please provide us with the following information:

- Model name
- ROM version
- Serial number and revision number (indicated on the lower rear of the product)

For the procedure for checking the ROM version, see “2.6 Power ON”.

2

Chapter 2 Installation and Preparation for Use

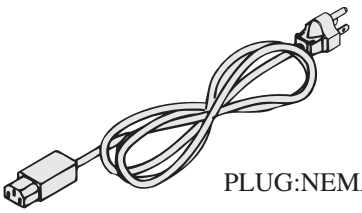
Describes the procedures necessary for unpacking the AC power supply for preparation prior to use.

2.1 Check at Unpacking

The AC power supply should be checked upon receipt for damage that might have occurred during transportation. Also check if all accessories have been provided. Should the product be damaged or any accessory missing, notify your Kikusui distributor/agent.

NOTE

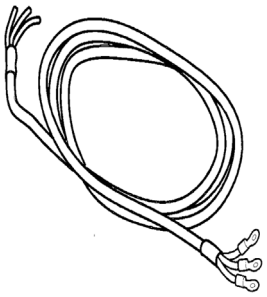
- We recommend that all packing materials be saved, in case the product must be transported at a later date.



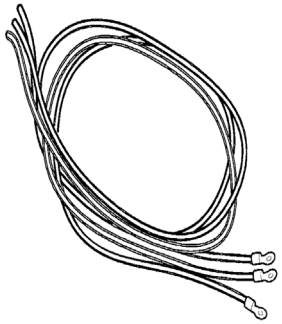
PLUG:NEMA5-15

The rated voltage of the power cable provided is 125 V AC.

Input power cable dedicated for the PCR500LA. [85-10-0740]
This cable must not be used for other devices.

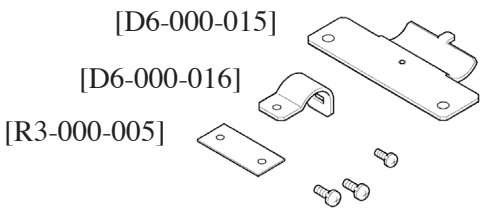


Input power cable for the PCR1000LA [91-87-5762]

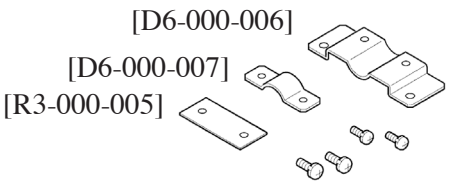


Input power cables for the PCR2000LA [91-87-6316], PCR4000LA [91-87-6317], and PCR6000LA [91-87-6317]

Fig.2-1 Input Power Cables

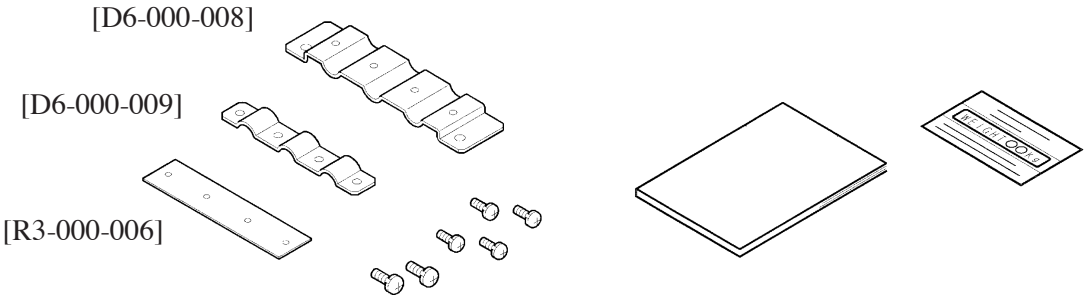


Cable clamper for the PCR1000LA



Cable clamper for the PCR2000LA

Fig. 2-2



Cable clampers for the PCR4000LA and PCR6000LA

Operation Manual [Z1-002-732]

Weight seal
PCR500LA [A8-000-003]
PCR1000LA [A8-000-008]
PCR2000LA [A8-000-009]
PCR4000LA [A8-000-010]
PCR6000LA [A8-000-011]

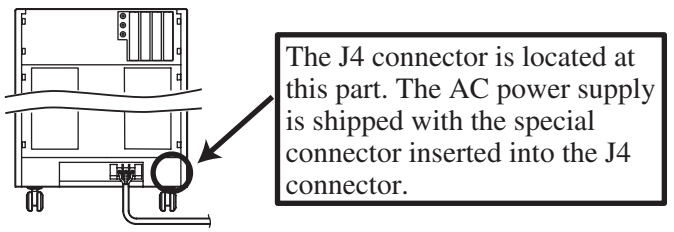
Fig. 2-3 Cable Clampers and Other Accessories

■ Lists of Accessories

	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Input power cable	Heavy PVC jacketed three-core cable. (With a three-pronged plug and inlet receptacle) 1	Heavy PVC jacketed three-core cable 1	Single-core cable 3		
Wire size	2 mm^2	5.5 mm^2	8 mm^2	22 mm^2	
Length	3 m				
Cable clamper	None	1 set			
		M3 fixing screw: 1 pc. M4 fixing screw: 2 pcs.	M3 fixing screw: 2 pcs. M4 fixing screw: 2 pcs.	M3 fixing screw: 4 pcs. M4 fixing screw: 2 pcs.	
Operation Manual	1 Copy				
Weight seal	1 Sheet				

NOTE

- For the PCR2000LA, PCR4000LA, and PCR6000LA, check that a special connector (for short-circuiting specific terminals) has been inserted into connector J4 at the lower rear of the PCR-LA power supply. If this connector is not inserted, the power cannot be turned ON.



- Connectors J1 to J4 at the lower rear of the PCR-LA power supply are used for the optional OT01-PCR-LA/2 or -LA/3 output terminal kit.

2.2 Precautions on Installation

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

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

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

■ Avoid locations subject to high temperatures or exposed to direct sunlight.

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

Operating temperature range: 0 to 50°C (32 to 122°F)

Storage temperature range: -10 to 60°C (14 to 140°F)

■ Avoid humid locations.

Do not locate the power supply in a high-humidity location such as near a boiler, humidifier, or water supply.

Operating humidity range: 20 to 80 % R.H. (no condensation allowed)

Storage humidity range: 90 % R.H. or less (no condensation allowed)

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

■ Do not install the AC power supply in a corrosive atmosphere.

Do not install the power supply in a corrosive atmosphere or one containing sulfuric-acid mist or the like, as doing so may cause corrosion of conductors or improper connector contacts in the power supply, resulting in a malfunction or failure that could potentially lead to a fire.

However, modification may allow the power supply to cope with such an atmosphere. If the power supply is to be used in such an atmosphere, consult your Kikusui distributor/agent.

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

Dirt and dust in the power supply may result in electric shock or fire.

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

The power supply employs a forced air-cooling system. It takes in air from intake ports located on its sides and front, and exhausts it form the rear. Provide sufficient space around the power supply so that the intake ports and exhaust port are always completely unobstructed.

Always provide 20 cm or more space between the air intake and exhaust port and the wall (or interference).

Hot air (approx. 30°C (54°F) higher than the ambient temperature) is exhausted from the exhaust port. Do not place heat-sensitive articles near the exhaust port.

■ Do not place any object on the AC power supply.

Heavy objects, in particular, placed on the AC power supply could lead to a malfunction.

■ **Do not install the AC power supply on a tilted surface or in a location subject to vibration.**

The power supply may fall, resulting in damage or injury.

■ **Do not use the AC power supply in locations affected by strong magnetic or electric fields, or where it will be exposed to waveform distortion or noise in the input power.**

Placing the power supply in such a location may result in a malfunction.

■ **Do not use the AC power supply in locations where there is a sensitive measuring instrument or receiver.**

Such instrument or device may be affected by noise generated by the power supply.

When fixing the power supply in an installation location:

The AC power supply has casters on its bottom to enable it to be moved easily. To prevent the power supply from being accidentally moved during use, lock the stopper to fix the AC power supply in the installation location. (Note that model PCR500LA has no stoppers or casters.)

Using the stopper:

1. The stopper is raised by turning it counterclockwise as viewed from above, and lowered by turning it clockwise.
2. After the AC power supply is moved, turn the stopper clockwise until the power supply is fixed.
3. Lock the casters.

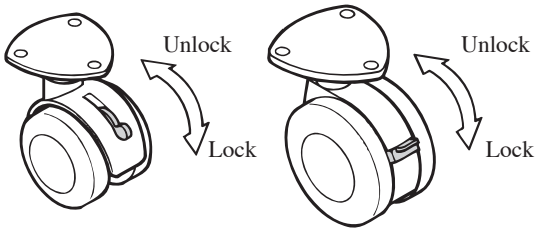


Fig. 2-4 Locking a Caster

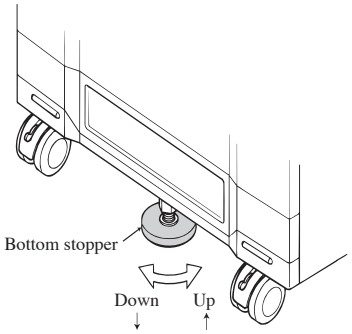


Fig. 2-5 Operating a Stopper

2.3 Moving Precautions

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

■ Turn the POWER switch OFF.

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

■ Disconnect all wiring connected.

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

■ Raise the stoppers.

When the power supply is fixed in an installation location using the stoppers, release (raise) them. Moving it without raising them may cause it to fall, resulting in injury. (Note that the PCR500LA has no stoppers or casters.)

■ Unlock the casters.

■ The AC power supply should not be moved by one person.

When the power supply is moved, it should be carried by two or more persons. In particular, take great care when moving the power supply in an inclined or stepped location.

Hold the power supply by its bottom.

Check the power supply's weight beforehand. The weight is indicated at the lower rear of the power supply.

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

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

When moving the power supply, do not lay it with its side up or place it upside-down.

■ When lifting the AC power supply, do not use the grips.

The grips are provided only for use in moving the power supply, and will not support the power supply's weight. When the power supply is lifted, the bottom of the front-panel and rear-panel sections should be held by two or more persons.

How to Handle the Grips:

1. To shift a grip, simultaneously slide the two locks to the UNLOCK direction. This makes the grip movable.
2. Pull a grip toward you or push it forward until you hear a clicking sound.

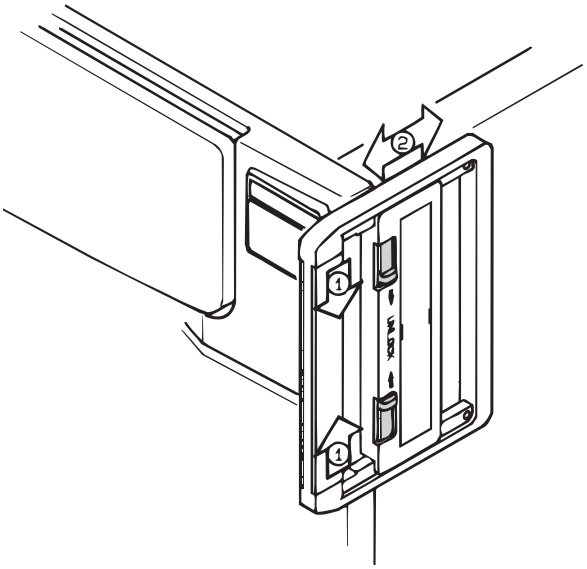


Fig. 2-6 Operating a Grip

2.4 Grounding

Using the supplied cable (provided as an input power cable), connect GND on the INPUT terminal board of the AC power supply to the dedicated ground terminal (Fig. 2-7). For model PCR500LA, use the dedicated input power cable with the plug and receptacle. Connect the three-pronged plug securely.

⚠ WARNING

- Be sure to ground the power supply. Not grounding the power supply may cause electric shock, which could result in injury or death.
- Connect a grounding wire to an electrical ground (safety ground) or in compliance to the grounding requirements called for by the Electrical Codes and Regulations applicable in your area.

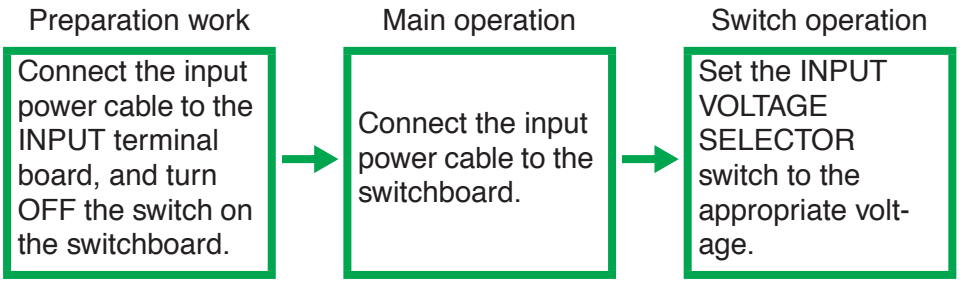
⚠ CAUTION

- If no grounding is provided, a malfunction may result from external noise and/or the power supply may generate a large amount of noise.

2.5 Input Connections

Outline of the connection procedure

Turn off the switch on the switchboard, and then connect the input power cable. Set the INPUT VOLTAGE SELECTOR switch to the appropriate voltage in accordance with the input voltage range. The operations of the INPUT terminal board, the input power cable, the INPUT VOLTAGE SELECTOR switch, and a cable clamper will be described after the connection procedure is described.



⚠ WARNING

- The PCR1000LA, PCR2000LA, PCR4000LA, and PCR6000LA are categorized as permanently connected equipment. Be sure to connect these power supplies to the switchboard.
- There is a possibility of electric shock, which could result in injury or death. To prevent electric shock, turn OFF the switch on the switchboard (to cut off the power feed from the switchboard) and then connect the input power cable.
- Connection of the input power cable to the switchboard must be carried out by qualified personnel.
- Install the input power cable such that the distance between the power supply and the switch on the switchboard is within 3 m. This procedure facilitates operation of the switch on the switchboard in the event of emergency.
  If the distance to the switch on the switchboard is to be 3 m or more, install the input power cable with a separate switch provided within 3 m from the power supply. For such a switch, use one with two poles that can be disconnected simultaneously.

Connection procedure

1. Remove the terminal box cover from the rear of the power supply, and connect the provided input power cable to the INPUT terminal board as shown in Fig. 2-7.
2. Turn off the switch on the switchboard.
3. Connect the input power cable to the switchboard.

   The switchboard end of the input power cable is not provided with terminals. For termination, attach a crimp-style terminal to each wire that meets the terminal screws of the switchboard to be connected, and then securely connect the wires to the terminal screws (Fig. 2-7). Connection must be performed by qualified personnel.
4. Select the INPUT VOLTAGE SELECTOR switch in accordance with the input voltage range (Fig. 2-10).

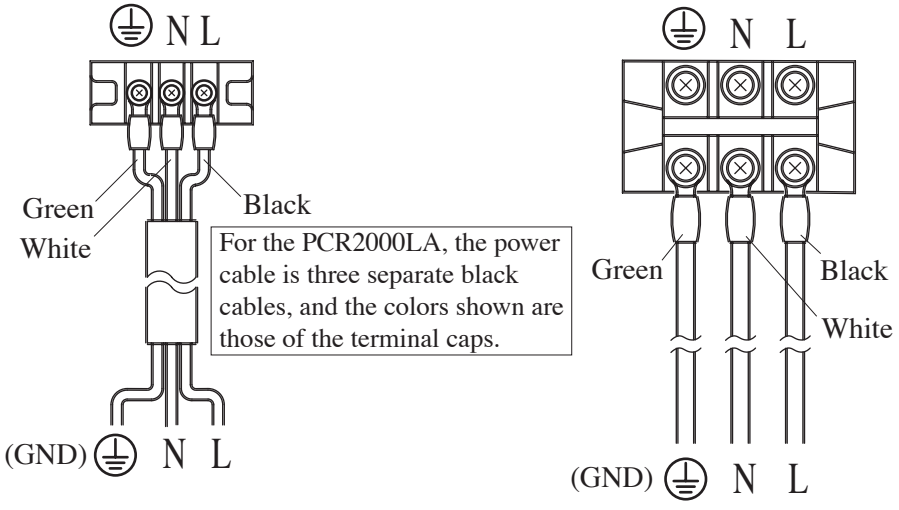
   This step is not required for the PCR6000LA since it has no INPUT VOLTAGE SELECTOR switch.
5. Install the cable clamper provided, and fix the input power cable securely (Fig. 2-11).

   The PCR500LA has no cable clamper, as its input power cable has a receptacle.
6. Put the cover removed in step 1 back on.

INPUT Terminal Board

The figure below shows the INPUT terminal board on the rear of the AC power supply (PCR1000LA, PCR2000LA, PCR4000LA, or PCR6000LA).

Model PCR500LA has an inlet receptacle.



PCR1000LA, PCR2000LA PCR4000LA, PCR6000LA

Fig. 2-7 Connecting the Input Power Cable(s) to the INPUT Terminal Board

Input Power Cable

■ Connection to the switchboard

If the polarity (L, N, and ⏚) of the switchboard is unknown, always have it inspected by qualified personnel or chief electrical technician.

If the input power cable provided cannot be used due to conditions at the installation site or for another reason, please consult the qualified personnel or chief electrical technician, and select the wire size (nominal conductor cross section) of the cable to be used in accordance with local electrical codes. For more information, see "8.2 Requirements of the Input Power Cable".

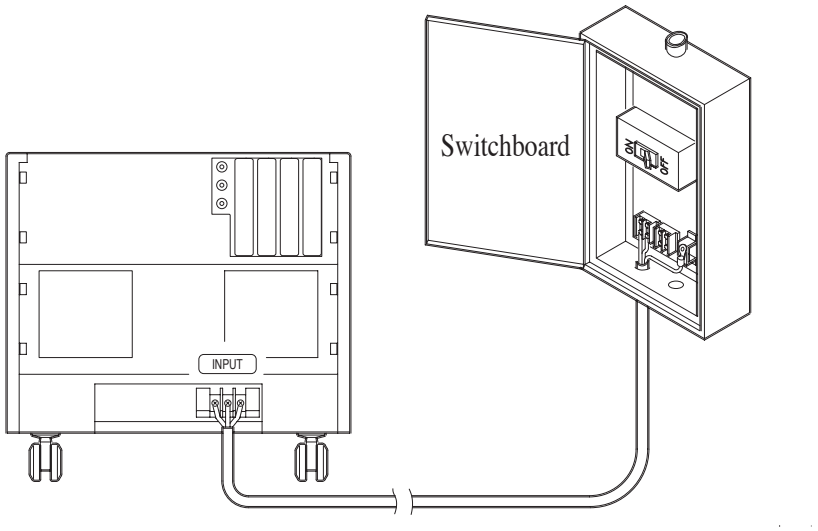
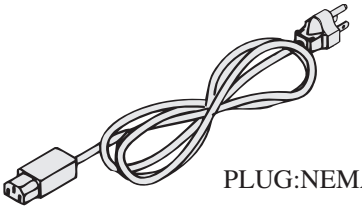


Fig. 2-8 Input Power Cable (on the Switchboard Side)

⚠CAUTION
- Be sure to use the switch on the switchboard. If the switchboard does not have such a switch, install a new one.
- Tighten the terminal screws securely. Improper tightening of a terminal screw may result in cable disconnection or overheating at the connection, which could pose a danger.
- Be sure to use crimp-style terminals for the cable that meet the screw terminals in the switchboard.
- Do not connect the input power cable to the OUTPUT terminal board. Otherwise, a malfunction may occur.

■ Input power cable for the PCR500LA

The input power cable for the PCR500LA has a three-pronged plug. This plug cannot be connected to a two-terminal wall outlet.



The rated voltage of the power cable provided is 125 V AC.

Input power cable dedicated for the PCR500LA. [85-10-0740]
This cable must not be used for other devices.

Fig. 2-9 Input Power Cable with a Three-pronged Plug

⚠ CAUTION

- Connection to a two-terminal wall outlet may cause electric shock, as the current capacity is insufficient and grounding is not provided.
- The rated voltage of the provided input power cable with a three-pronged plug (Fig. 2-9) is 125 V AC. If the AC power supply is used at the line voltage of a 200 V system, replace the cable with one meeting the input voltage.
- An appropriate input power cable must be selected by an expert technician. If it is difficult to obtain the input power cable, contact your Kikusui distributor/agent.

Do not use the input power cable provided with the AC power supply as a power cable for another device.

INPUT VOLTAGE SELECTOR

The INPUT VOLTAGE SELECTOR is located at the center of the terminal box. It is a lock-type toggle switch. Pull the knob to select the input voltage.

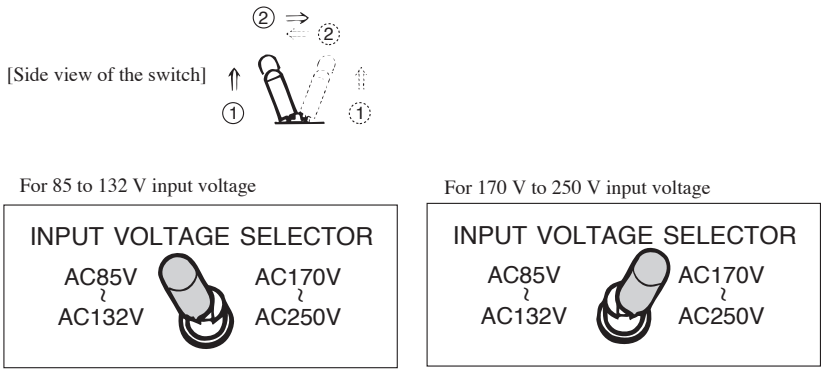


Fig. 2-10 INPUT VOLTAGE SELECTOR

⚠ CAUTION

- Do not switch the INPUT VOLTAGE SELECTOR while power is fed to the power supply. Otherwise, a malfunction may occur.

Cable Clampers

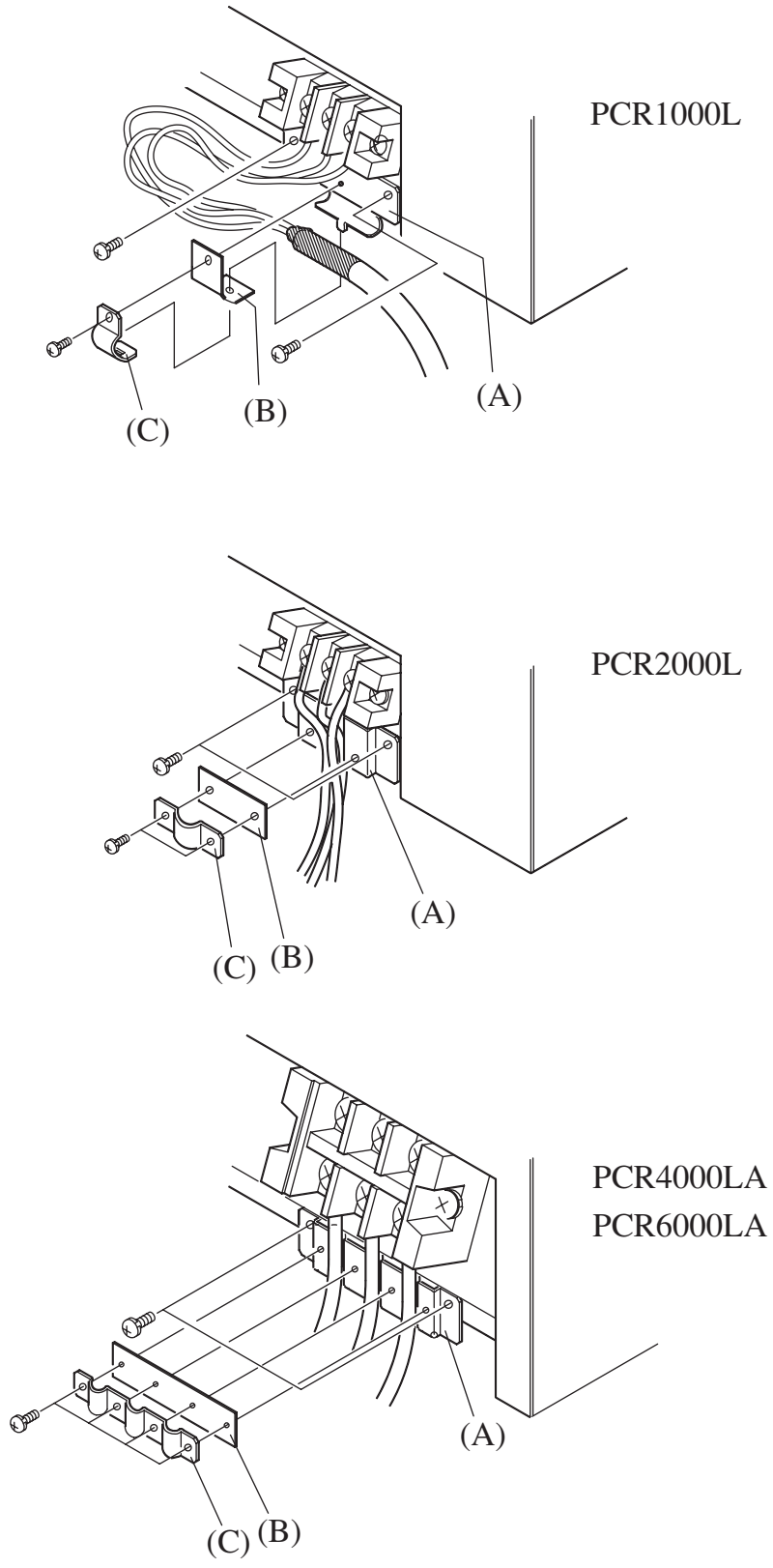


Fig. 2-11 Installing a Cable Clamper

■ Cable-Clamper Installation Procedure

1. Mount part (A) onto the power supply by using the provided M4 screws.
2. Lay the provided input power cable(s) on the recessed section(s) of part (A).
3. Using the provided M3 screws, fasten parts (B) and (C) onto part (A).

⚠ CAUTION

- If the cable clamper is not used to securely fix the input power cable to the power supply, application of excessive force to the INPUT terminal board may damage the terminal board or disconnect a cable wire, resulting in an electrical short or shock.
- If a cable other than the provided power cable is used, the cable clamper may not fit such cable.

2.6 Power ON

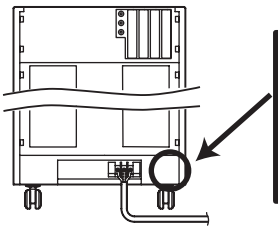
Outline of the power-on procedure

Turn on the power with a load disconnected. Check the version. Confirm that no alarm has been issued.

Preparation work	Main operation	Operation of the power supply
Check to confirm that the input power cable has been connected.	Turn the POWER switch ON.	Displays the version information and then enters the Home Position.

NOTE

- For the PCR2000LA, PCR4000LA, and PCR6000LA, check that a special connector (for short-circuiting specific terminals) has been inserted into connector J4 at the lower rear of the PCR-LA power supply. If this connector is not inserted, the power cannot be turned ON.



The J4 connector is located at this part. The AC power supply is shipped with the special connector inserted into the J4 connector.

- Connectors J1 to J4 at the lower rear of the PCR-LA power supply are used for the optional OT01-PCR-LA/2 or -LA/3 output terminal kit.

Power-on Procedure

1. Turn the POWER switch of the AC power supply OFF.
2. Check that the input power cable is correctly connected.
3. Check that no output cable is connected to the OUTPUT terminal board of the power supply.
4. Check that no load is connected to the OUTPUT outlets at the lower front of the power supply.
5. Turn on the switch on the switchboard. For model PCR500LA, connect the plug of the input power cable to the wall outlet.

   This causes the LINE lamp on the lower front of the of the power supply to light up.

The PCR500LA does not have a LINE lamp.

If the LINE lamp does not light up, the AC power supply is assumed to be faulty. Turn OFF the switch on the switchboard, and contact your Kikusui distributor/agent.

6. Turn the POWER switch of the power supply ON.

If there is noise, an bad odor, fire, or smoke coming from the power supply when the power is fed, immediately turn OFF the switch on the switchboard or disconnect the input power cable plug from the outlet.

7. Check whether the display of the control panel becomes as shown in the following figures.

Fig. 2-12: Version Display Screen

Fig. 2-13: Home-Position Display

The following display examples are those of the PCR1000LA (the display status differs slightly by model).

8. If no error occurs after completing the above steps, the power ON operation check is complete.

■ Version display

The AC power supply displays version information for several seconds. During this time, "SELF TEST" blinks (the power supply is conducting an internal check). The version appears as V3. XX (XX: numerics) in the current display area. The frequency display area displays a sub-version.

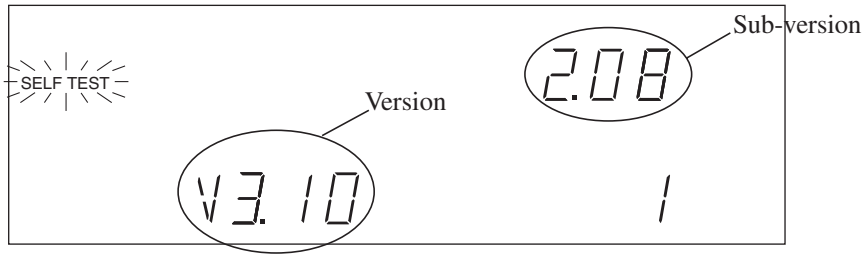


Fig. 2-12 Version Display Screen

■ Home Position action

After the version information is displayed, if no abnormality is detected by the internal check, the power supply enters the Home Position. For the Home Position, refer to "3.1 Basics of Panel Operation". In this case, if "ALARM" lights up, an alarm has occurred. If the ALARM indication lights up and "Err X" (X: numeric) appears, refer to "4.6 Protective Functions".

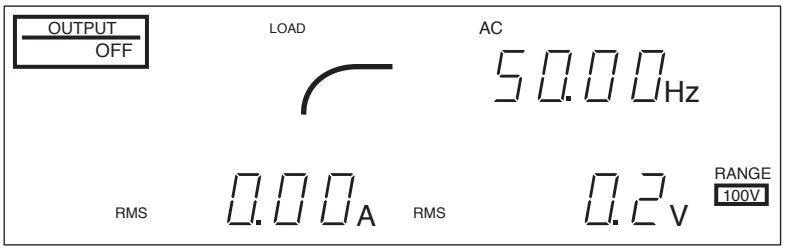


Fig. 2-13 Home-Position Display

NOTE

- When the POWER switch is turned ON, all indications on the control panel are momentarily lit up. If this condition (lighting of all indications) remains even after a few seconds have elapsed, turn the POWER switch OFF and wait for more than 5 seconds before turning it ON again.

2.7 Operation Check

Outline of the operation check procedure

First, the "initial setup status" and "performance of reset" are described. The check is performed without connection of a load. Turn the output ON/OFF with the frequency fixed to 50 Hz. Set the voltage to 30 V. Switch the voltage range with the voltage set as is. Finally, turn the output OFF to complete the operation check.

If "ALARM" lights up during an operation check, an alarm has been issued. In such a case, see "4.6 Protective Functions".

Preparation work	Main operation	Operation of the power supply
Do not connect a load. Perform the reset procedure.	Press the key switches or use JOG. Set the voltage and use the OUTPUT key to turn the output ON/OFF.	The control panel's display unit operates. The power supply enters a status in which it is capable of supplying outputs.

Knowledge Necessary for Operation Check

■ Initial setup status

The status when the power is first turned ON after purchase (factory shipment status) is referred to as the "initial setup status." To enter the initial setup status from another status, perform the following reset procedure. The figure below shows the display condition of the control panel in the initial setup status.

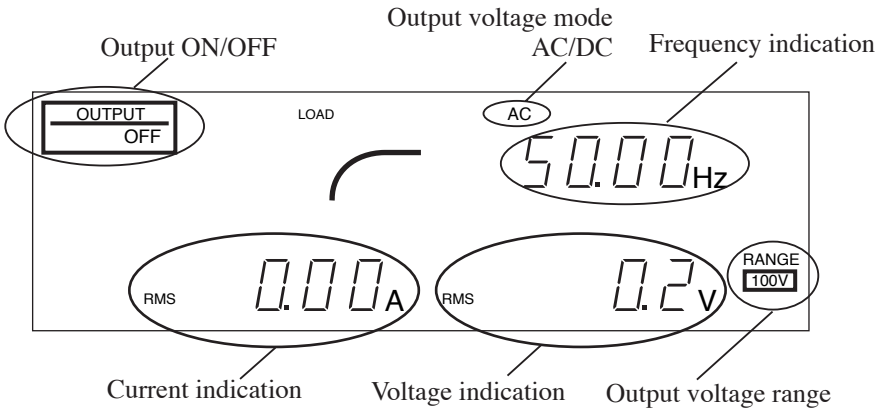


Fig. 2-14 Initial Setup Status

The following shows the main settings in the initial setup status.

OUTPUT ON/OFF	OFF
Output voltage mode	AC
Frequency	50.00 Hz
Output voltage range	100 V
Voltage setting	0.0 V_{RMS}
Voltage indication mode	Approx. 0 V_{RMS}
Current and power indication mode	Approx. 0 A_{RMS}

■ Performing a reset

To return the AC power supply to the factory shipment status during use, perform a reset to enter the initial setup status.

Procedure:

1. Turn the POWER switch ON to select the Home Position.

   The status immediately after the POWER switch is turned ON is referred to as the "Home Position" (regardless whether the OUTPUT is ON/OFF). To return to the Home Position from another status, press the ESC key.

2. Press the RESET (SHIFT, 6) key.

   "RESET" and "ENT" on the control panel blink:

   In this operation manual, keyboard entry operation using SHIFT is represented as follows:

RESET (SHIFT, 6) = pressing of the SHIFT key (not necessary to hold down) to light up “SHIFT” on the control panel, followed by pressing of the “6” key.

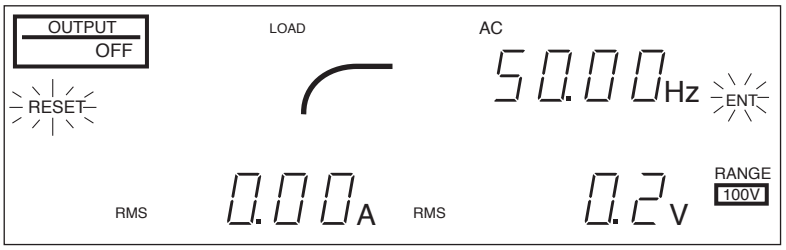


Fig. 2-15 Blinking of RESET and ENT

3. Press SHIFT key followed by ENT key (SHIFT, ENT).

   This activates the reset function, making the power supply enter the initial setup status.

NOTE

- (SHIFT, ENT) is a special keyboard entry operation. Performing a reset causes the AC power supply to enter the initial setup status. Thus, for reset operation only, the SHIFT and ENT keys are required rather than simply pressing the ENT key, so that a reset cannot be made inadvertently.

Operation Check

■ Setting the voltage using JOG (30 V: voltage setting mode)

1. Perform the reset procedure to make the AC power supply enter the initial setup status.
2. Press the “V” key (to enter the voltage setting mode).

   This causes the voltage display area to be encircled by a frame, and “SET” to light up.
3. Turn JOG clockwise to set the voltage value to 30.0 V (it is not necessary to press the ENT key).

   If the voltage value is increased by too much, turn JOG counterclockwise to reduce the voltage.

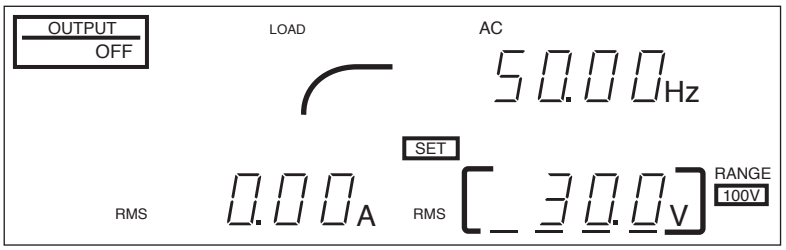


Fig. 2-16 Encircling of the Voltage Display Area by a Frame and Display of Settable Areas

■ Turning OUTPUT ON/OFF

4. Press the ESC key (to exit the voltage setting mode).

   Both the frame and "SET" go off, and only "RMS" is lit. The "30.0 V" voltage indication changes to approx. 0 V (because OUTPUT is OFF). This status displays the output voltage rms.

5. Press the OUTPUT key once.

   This causes "OUTPUT ON" to be displayed, and the voltage indication to change between 29.7 V and 30.3 V. In this status, 30 V is fed to the power supply's OUTPUT terminal board.

6. Press the OUTPUT key once.

   This causes "OUTPUT OFF" to be displayed, and the voltage indication to change to approx. 0 V.

NOTE

- If the voltage indication is abnormal in any step, the power supply is assumed to be defective; contact your Kikusui distributor/agent. In the following procedure, operate keys as described in step 4 when checking a voltage value.

■ Switching the voltage range (100 V → 200 V) and turning OUTPUT ON/OFF

7. Press the RANGE (SHIFT, 7) key.

   This causes "ENT" and "200 V" below RANGE to blink.

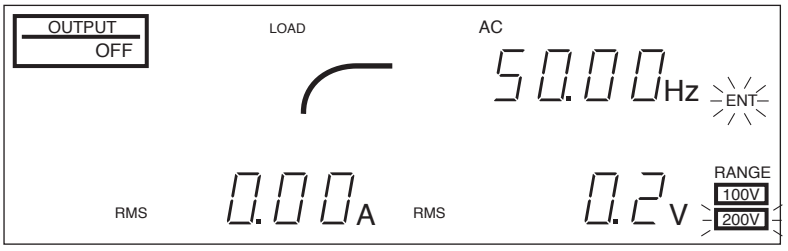


Fig. 2-17 Switching the Voltage Range (100 V → 200 V)

8. Press the ENT key.

   This causes "100 V" below RANGE to go off and "200 V" to light up.

9. Press the OUTPUT key once.

   This causes "OUTPUT ON" to be displayed, and the voltage indication to change between 29.7 V and 30.3 V. In this condition, 30 V is fed to the power supply's OUTPUT terminal board.

10. Press the OUTPUT key once.

    This causes "OUTPUT OFF" to be displayed, and the voltage indication to change to approx. 0 V.

■ Setting the voltage using keys and turning OUTPUT ON/OFF in the voltage setting mode

11. Press the “V” key (to enter the voltage setting mode).
12. Press “0” and ENT, in that order.
    This sets the voltage to 0 V.
13. Press the OUTPUT key once.
    This causes “OUTPUT ON” to appear, and the voltage indication to change between 0.0 V and 0.8 V.
14. Press the OUTPUT key once.
    This causes “OUTPUT OFF” to be displayed.

■ Returning the voltage range to the original range (200 V →100 V) and finally turning OUTPUT ON/OFF

15. Press the ESC key (to exit the voltage setting mode).
    This causes “SET” and the frame to go off.
16. Press the RANGE (SHIFT, 7) key.
    This causes “ENT” and “100 V” below RANGE to blink.

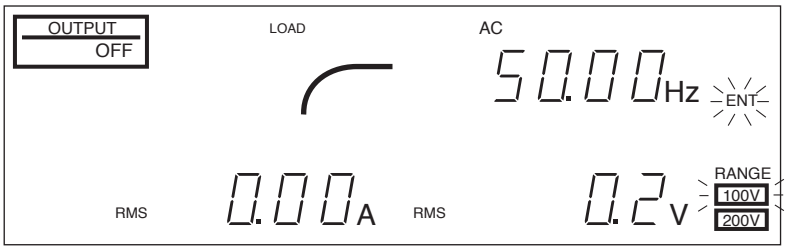


Fig. 2-18 Switching the Voltage Range (200 V → 100 V)

17. Press the ENT key.
    This causes “200 V” below RANGE to go off and “100 V” to light up.
18. Press the OUTPUT key once.
    This causes “OUTPUT ON” to be displayed, and the voltage indication to change between 0.0 V and 0.5 V.
19. Press the OUTPUT key once.
    This causes “OUTPUT OFF” to appear.
20. This completes the operation check procedure.

2.8 Connecting a Load

The maximum current that can be obtained from the AC power supply differs by model. It also changes depending on the power supply's voltage mode and the type or status of a load. A sufficient output power capacity should be secured with respect to the capacity of the load. The following shows the maximum output current (in the AC mode) by model. For more information, see "8.4 Outputs and Loads".

Table2-1 Maximum Output Current in the AC mode (AC Rms Value)
(In the case of output voltage of 1 V to 100 V/2 V to 200 V and a load power factor of 0.8 to 1.0)

Output voltage range	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
100 V	5 A	10 A	20 A	40 A	60 A
200 V	2.5 A	5 A	10 A	20 A	30 A

Connection to the OUTPUT Terminal Board

⚠WARNING
- Touching the output terminal may result in electric shock. When connecting to the OUTPUT terminal board, be sure to turn the POWER switch OFF and disconnect the input power plug or shut off the power from the switchboard.
- When the POWER switch is ON, dangerous voltage is present across the output terminal and chassis even when the OUTPUT is OFF (OUTPUT OFF is displayed).

There are two types of safety covers on the rear of the AC power supply. One of them is large and is a terminal box cover for the entire terminal box. The other is small and is installed to the OUTPUT terminal board. This safety cover is a protective plate that prevents contact with a terminal not in use. When wires are connected to the OUTPUT terminals, the protective plate is not used. In such a case, it should be attached at a specified location.

1. Turn the POWER switch OFF and disconnect the input power plug from the wall outlet or shut off the power from the switchboard.
2. Remove the terminal box cover.
3. Remove the protective plate located on the lower surface of the OUTPUT terminal board.

   Referring to Fig. 2-20, install the protective plate at the specified location.
4. Securely connect the output cables for a load to the OUTPUT terminal board.

   If the load has a grounding (GND) terminal, be sure to connect a grounding wire from this terminal to the G terminal of the power supply's OUTPUT terminal board. In such a case, the grounding wire should always have a wire size at least as great as that of the output cables.

5. Put the terminal box cover removed in step 2 back on.

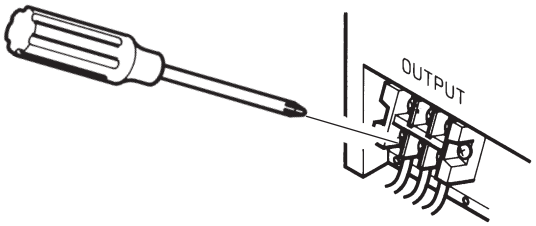
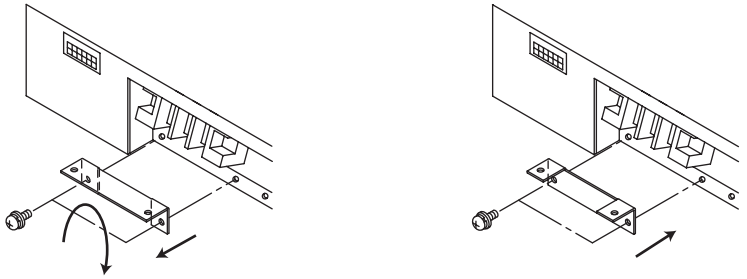


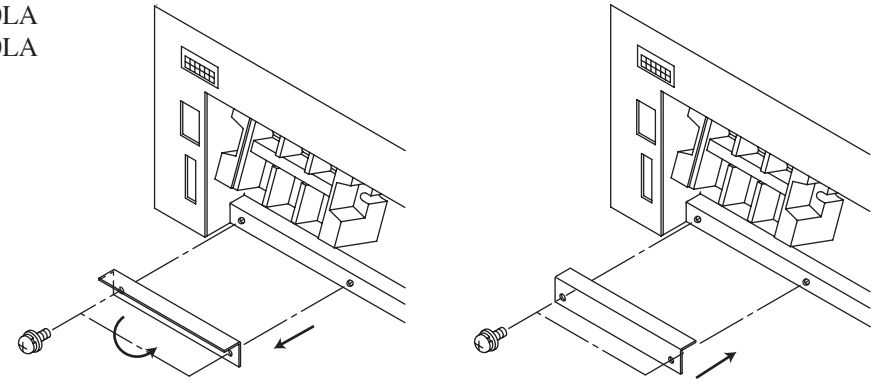
Fig. 2-19 Connection to the OUTPUT Terminal Board

PCR1000LA
PCR2000LA



① Remove the protective plate. ② Turn the plate and mount it upside down.

PCR4000LA
PCR6000LA



① Remove the protective plate. ② Rotate the plate 180 around a vertical axis and mount it.

Fig. 2-20 Installing the Protective Plate

⚠CAUTION

- Terminals L and N of the OUTPUT terminal board are isolated from the line voltage, so their polarity will not cause any safety problems. However, because the polarity is relevant in the synchronized mode (synchronous with the line voltage) or the DC mode, check the load polarity prior to connection. Grounding can be provided at either L or N.

NOTE

- For the wire size of the output cables, refer to the table in "8.2 Requirements of the Input Power Cable", according to the output current.
- For the DC mode, use terminal N as a reference and use L as + for positive output or as - for negative output.

Method in Which a Switch Is Installed between the OUTPUT Terminal Board and the Load

There may be cases in which the load is distant from the AC power supply and the AC power supply is controlled via a remote controller (RC03-PCR-LA or RC04-PCR-LA) or remote interface (RS-232C or GPIB).

If you wish to connect the load away from the AC power supply in such condition, furnish a switch between the OUTPUT terminal board and the load and turn the switch off to prevent electric shock. The terminal at the load end of the switch is used as an OUTPUT terminal board (Fig. 2-21).

Other procedures are the same as described in "Connection to the OUTPUT Terminal Board."

The remote controller (RC03-PCR-LA or RC04-PCR-LA), RS-232C control, or GPIB control can turn the OUTPUT OFF, but not the POWER switch. To prevent electric shock when connecting the load, furnish a switch between the OUTPUT terminal block and the load, and turn the switch off.

⚠WARNING

- There is a possibility of electric shock. When installing a switch between the OUTPUT terminal block and the load, be sure to turn the POWER switch OFF and disconnect the input power plug or shut off the power from the switchboard.
- The current rating of the switch must be greater than or equal to the maximum current indicated in Table 2-1.
- For the switch circuit, use a two-pole switch that cuts off L and N wires simultaneously.
- There is a possibility of electric shock. Be sure to turn the switch off before connecting the load to the terminal at the load end of the switch.
- There is a possibility of electric shock. Do not touch the switch terminals when the OUTPUT is ON.

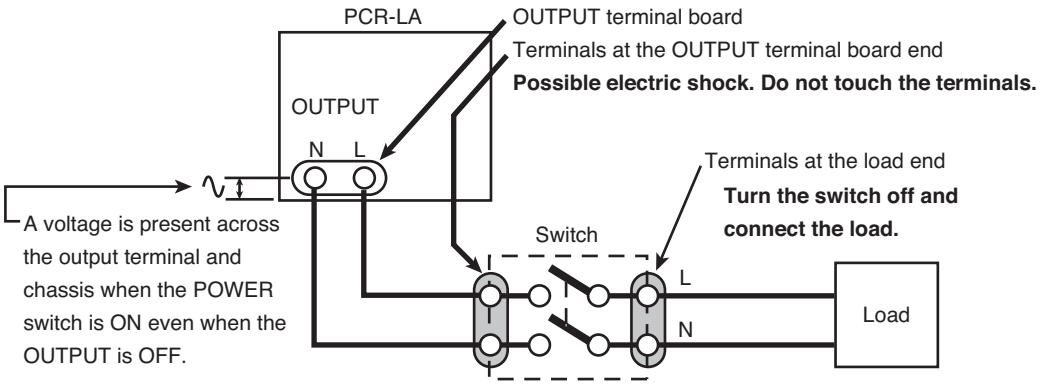


Fig. 2-21 Switch between the OUTPUT Terminal Board and the Load

Connection to an OUTPUT Outlet

1. Turn the POWER switch OFF and disconnect the input power plug from the outlet or shut off the power from the switchboard.
2. Connect the output cable for the load to one of the OUTPUT outlets on the front panel.

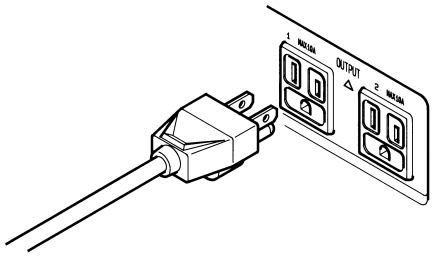


Fig. 2-22 Connection to an OUTPUT Outlet

■ **The OUTPUT outlets are dedicated to the power plugs shown in the figure below.**

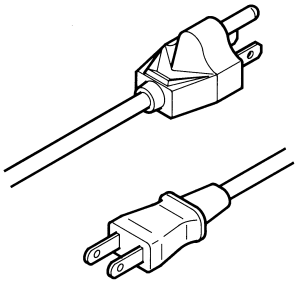


Fig. 2-23 Configuration of the Power Plug

■ Current capacity of the OUTPUT outlets

The AC power supply's output can be obtained from both the OUTPUT terminal board on the rear panel and the OUTPUT outlets on the front panel. When using an OUTPUT outlet, pay attention to the following.

⚠ CAUTION

- The maximum rated voltage of the OUTPUT outlets is 125 V AC.
  Maximum output voltage: 125 V (rms) AC
  Maximum output current: 10 A (rms) AC
- Do not connect a load when the AC power supply outputs a voltage exceeding the above limit or is in the DC mode. Otherwise, a malfunction may occur.

■ The maximum output current obtained from one OUTPUT outlet is 10 A (rms) AC.

- The maximum output current differs by model.
  PCR500LA: 5 A (rms) AC for a total of two outlets
  PCR1000LA: 10 A (rms) AC for a total of two outlets
  PCR2000LA: 10 A (rms) AC for one outlet
  PCR4000LA: 10 A (rms) AC for one outlet
  PCR6000LA: 10 A (rms) AC for one outlet

For model PCR2000LA, PCR4000LA, or PCR6000LA, if current exceeding the specified current value flows, the CIRCUIT BREAKER to the left of the OUTPUT outlets may open. This causes the red button to project from the CIRCUIT BREAKER. In such a case, see "4.6 Protective Functions".

NOTE

- The maximum output current may be less than these values, depending on the output voltage, frequency, and load power factor.

  Example: For the PCR1000LA, the maximum output current for a total of two OUTPUT outlets becomes 7.61 A when the output voltage is 115 V, the load power factor is 0.7, and the output frequency is 50 Hz. Under these conditions, if an output current of 5 A flows from one outlet, only 2.61 A is obtained from the other outlet. For the load power factor, see "8.4 Outputs and Loads".
- An OUTPUT outlet may partially decrease performance.

3

Chapter 3 Basic Operations

Describes the basic operations of the AC power supply.

3.1 Basics of Panel Operation

The following three terms are used in the descriptions of operations here. Keeping them in mind will help increase your understanding of operations.

Home Position (Status)

The status immediately after the POWER switch is turned ON is referred to as the "Home Position" (regardless whether the OUTPUT is ON/OFF). To return to the Home Position from another status, press the ESC key.

Shift Key Operation

When the SHIFT key is pressed, "SHIFT" on the control panel lights up; when the key is pressed again, "SHIFT" goes off (toggle action).

Pressing a key when "SHIFT" is lit activates the function written in blue letters below the corresponding key.

■ Representation of SHIFT key operation in this manual

Example: KEYLOCK (SHIFT, 4)

This represents pressing of the SHIFT key (not necessary to hold down) followed by pressing of the "4" key.

ENT Wait (Status)

The condition in which the ENT key has not yet been pressed to accept an operation result is referred to as "ENT wait." In this case, "ENT" on the control panel blinks. If you want to reject the operation result, press the ESC key to cancel.

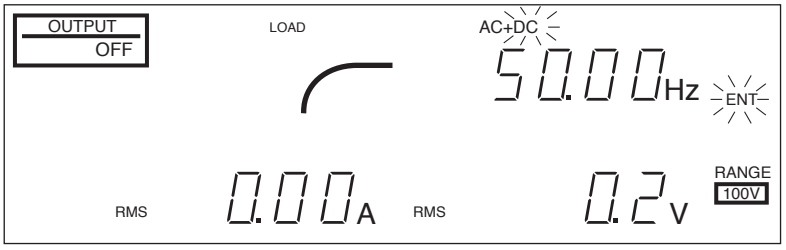


Fig.3-1 ENT Wait

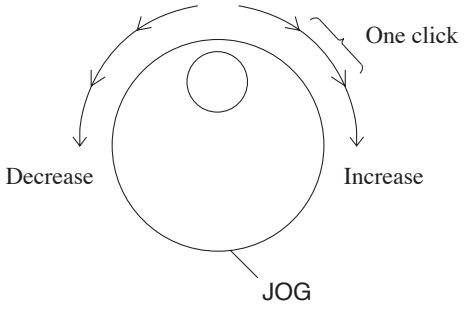
3.1.1 How to Use JOG and SHUTTLE

Numeric Setting

■ Numeric setting using JOG

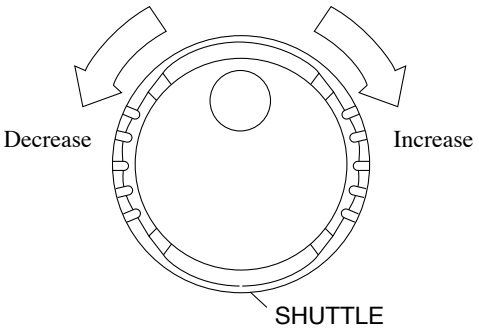
Turn JOG clockwise to increase the displayed value, or counterclockwise to decrease it. The displayed value is accepted as a set value whenever changed (pressing the ENT key is not necessary).

JOG is useful in making fine set-value adjustments. Any value exceeding the allowable range is ignored.



■ Numeric setting using SHUTTLE

Turn SHUTTLE clockwise and hold it to increase the displayed value continuously, or turn it counterclockwise and hold it to decrease the value continuously. Return SHUTTLE to the neutral position to stop the set-value change. The displayed value is accepted as a set value whenever changed (pressing the ENT key is not necessary).



Turning SHUTTLE to a greater angle increases the speed at which the numeric change is made.

The numeric-change speed can be varied in four steps.

SHUTTLE is useful for changing the set value to an approximate desired value.

Any value exceeding the allowable range will be ignored.

NOTE

- When SHUTTLE is used, the set value may be increased or decreased to too great an extent due to the rapid speed at which it changes.
- Do not turn JOG and SHUTTLE simultaneously. Otherwise, the changing of numeric values may be disabled or the numeric change speed may decrease.

⚠ CAUTION

- Outputting a voltage or frequency exceeding the specified range may damage the load connected to the AC power supply or expose the operator to danger. Therefore, be sure to set the voltage and frequency limit values in advance. For more information on this, see “4.2 Limit Value Setting”.

3.1.2 How to Use the Digit Function

■ Specifying the least significant digit for the setting of numerics

The digit function allows digits higher than that specified to be changed using JOG SHUTTLE when the voltage or frequency is set. This function is useful for making step changes in the voltage or frequency setting.

■ Operation procedure

Take the following steps in the voltage or frequency setting mode. (The setting mode is the status in which the frame that encircles the voltage or frequency display area is lit, which is obtained by pressing the "V" or "F" key.) The digit function for voltage is available only when "SET" is lit.

1. Press the DIGIT (SHIFT, .) key.

   This causes the cursor (part of the frame) to blink at the specified variable digit, and to select the digit mode. This mode allows the digit at which the cursor blinks and a higher digit to be changed.

   Each time the DIGIT (SHIFT, .) key is pressed, the cursor moves to the left. Pressing the DIGIT (SHIFT, .) key when the cursor is at the most significant digit causes the cursor to return to the least significant digit.

2. Press the DIGIT (SHIFT, .) key the required number of times to move the cursor to the desired digit.
3. Using JOG/SHUTTLE, set numerics.
4. To exit the digit function, press the ESC key.

NOTE

- Entering a numeric using the numeric keys causes the digit function to be cancelled. Numerics can be entered using the numeric keys, regardless whether the cursor is at the specified digit.
- For the frequency setting, the position of the decimal point changes between 99.99 Hz and 100.0 Hz. Therefore the display position of the specified digit changes.

3.1.3 Key-lock Function

The key-lock function prevents key operations through the control panel. This function prevents the set values from being changed accidentally when the output voltage or frequency is to be fixed and used.

OUTPUT can be turned ON/OFF even in the key-lock mode.

In the initial setup status, the key-lock mode is cancelled.

Key-lock Procedure

1. Press the ESC key to select the Home Position.
2. Press the KEYLOCK (SHIFT, 4) key.
   This activates the key-lock mode, causing "KEYLOCK" to light up.
3. To cancel the key-lock mode, press the KEYLOCK (SHIFT, 4) key again.

When an optional function is used, the control panel will automatically enter the key-lock mode.

Use of an optional function (see NOTE below) added by the Remote Controller (RC03-PCR-LA or RC04-PCR-LA), GPIB Interface, or RS-232C Control causes the control panel to automatically enter key-lock mode. In this case, key-lock mode cannot be cancelled using the KEYLOCK (SHIFT, 4) key. The procedure for canceling key-lock mode differs depending on whether a Remote Controller (RC03-PCR-LA or RC04-PCR-LA) is used, as opposed to the GPIB Interface or RS-232C Control.

■ Key-lock cancellation procedure

When using the Remote Controller (RC03-PCR-LA or RC04-PCR-LA):

1. Press the ESC key on the Remote Controller to return to the Home Position.
   This automatically cancels key-lock mode.

When using the GPIB Interface or RS-232C Control:

1. Use the HOME command to return to the Home Position.
2. Press the GP-IB (SHIFT, F) key to cancel the remote status.

Optional functions:

The optional functions include power line abnormality simulation, sequence, special waveform output, output ON/OFF phase, output impedance, regulation, and the like. For more information on the optional functions, see Chapter 10, Optional Equipment.

NOTE

- When the control panel is in key-lock mode, which is activated using the KEY-LOCK key, using an optional function causes the control panel to enter a status in which it is doubly locked by the key-lock function. In such cases, press the ESC key or use the HOME command to select the Home Position, and then press the KEYLOCK key again to cancel key-lock mode.

3.1.4 Storing the Contents of Settings Immediately before the POWER Switch is Turned OFF

The AC power supply stores the following values or items. When the POWER switch is turned ON, the power supply starts up with the same values that were in effect immediately before the POWER switch was turned OFF.

Output voltage and frequency set values

Output-voltage range (100 V/200 V)

Limit values for output voltage, frequency, and current

Output-voltage mode (AC/DC)

Display mode of voltage, current, and power

Key-lock status

NOTE

- The storage interval is set to 10 sec. in consideration of the life of the storage memory. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

3.2 Output ON/OFF

Feeding and Shutting off Power to a Load

Using the OUTPUT key, switching between the output ON condition (in which power is fed to the load) and the output OFF condition (in which no power is fed to the load) is possible (toggle action).

■ Control panel display

Output ON/OFF is displayed on the control panel as follows.

Output ON status: "OUTPUT ON" lights up.

Output OFF status: "OUTPUT OFF" lights up.

■ Status immediately after the POWER switch was turned ON

Immediately after the POWER switch has been turned ON, output is OFF.

■ Cases when the protective function has activated

If the AC power-supply protective function has activated, the output is switched to OFF. For more information on this, see "4.6 Protective Functions".

■ Setting of the output phase as the ON/OFF timing

You cannot set the output phase as the ON/OFF timing from the front panel. To set the output phase as the ON/OFF timing, the RS-232C Control provided as standard for the product or a separate option is required. For details, see Chapter 9, Descriptions of RS-232C and GPIB Messages, or "10.8 Output ON/OFF Phase Setting".

Principle of Output ON/OFF

This AC power supply does not cut off output from the internal circuits mechanically using switches and relays, but rather increases output impedance electrically to turn the output off. This allows output to be turned ON/OFF in a smooth waveform without producing any contact chatter.

■ Output is in high-impedance state when it is OFF.

In the high-impedance condition, the impedance (resistance R_{OFF}) value is approximately as follows.

- For the 100 V output range: R_{OFF} = approx. 8 / N [kΩ]
- For the 200 V output range: R_{OFF} = approx. 32 / N [kΩ]

"N" indicates the value equivalent to the PCR-LA series rated output capacity [kVA].

Example: Impedance in the PCR2000LA's 200 V output range

R_{OFF} = approx. 32 / 2 [kΩ] = approx. 16 [kΩ]

3.3 Output Voltage Setting

To set the output voltage, the following three items are to be determined.

1. **Output voltage mode (AC, AC-S, or DC)**
2. **Output voltage range (100 V/200 V)**
3. **Output voltage value**

When the POWER switch is turned ON, the AC power supply starts up with the settings that were in effect immediately before the POWER switch was turned OFF.

3.3.1 Setting the Output Voltage Mode (AC, AC-S, or DC)

Three Output Voltage Modes

The AC power supply has the following three output-voltage modes. Select one according to the type of voltage to be output.

AC voltage output mode (AC mode)

AC coupled output mode (AC-S mode)

DC voltage output mode (DC mode)

The AC mode is used for general AC output, the AC-S mode is used when the DC offset voltage of a transformer or the like becomes a problem, and the DC mode is used for DC output. For more information on the AC-S mode, see “8.6 Differences between the AC and AC-S Modes”.

Display of the Output Voltage Mode

The output voltage mode is displayed on the control panel as follows:

■ **AC voltage output mode (AC mode)**

“AC” lights up and the frequency is displayed (at the location indicated by the arrows in the figure).

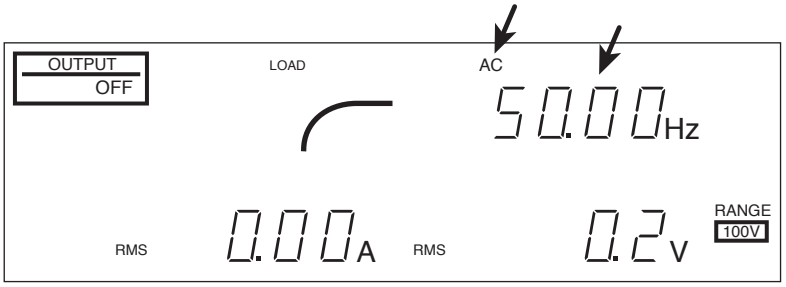


Fig. 3-2 AC Mode

■ AC coupled output mode (AC-S mode)

"AC" lights up and the frequency is displayed. "S-MODE5" lights up (at the location indicated by the arrows in the figure).

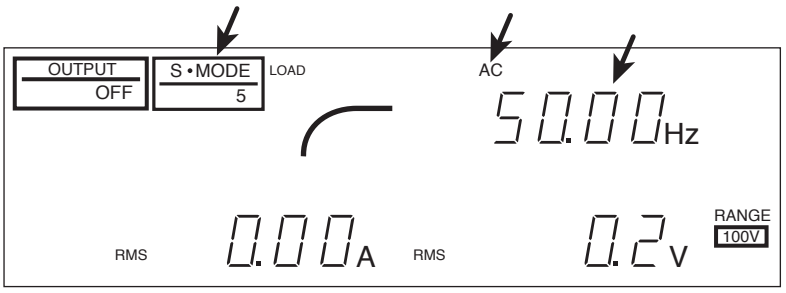


Fig. 3-3 AC-S Mode

■ DC voltage output mode (DC mode)

"dc" is displayed in the frequency display area (at the location indicated by the arrow in the figure).

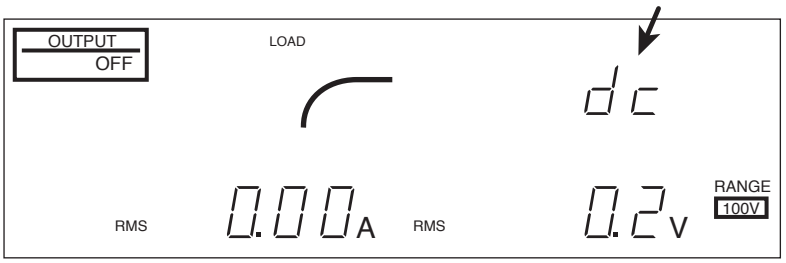


Fig. 3-4 DC Mode

Output Voltage Mode Switching Procedure

Outline of the switching procedure

The output voltage mode is switched with OUTPUT turned OFF. Switch to each mode sequentially.

Preparation work	Main operation	Operation of the power supply
Press the ESC key to select the Home Position.	Press the AC/DC (SHIFT, 8) key.	Each time the AC/DC (SHIFT,8) key is pressed, the output voltage mode changes to AC, AC-S, DC, and then back to AC.

Switch the output voltage mode from the AC mode to AC-S mode and then to DC mode, sequentially.

1. When “OUTPUT ON” is lit, press the OUTPUT key to turn the output OFF.
2. Press the ESC key to select the Home Position.
3. Press the AC/DC (SHIFT, 8) key.
4. Press the ENT key to accept the output voltage mode.
5. Each time steps 3 and 4 are performed, the output voltage mode changes as follows:

Mode switching and display change

AC mode → AC-S mode: “AC” and “S-MODE5” blink.

AC-S mode → DC mode: “AC” and “S-MODE5” light continuously and “+DC” blinks.

DC mode → AC mode: “+DC” lights continuously and “AC” blinks.

NOTE

- The output voltage mode can be changed only when OUTPUT is OFF in the Home Position.
- In the initial setup status, the AC power supply is in the AC voltage output mode (AC mode).

AC + DC Mode

This mode allows the AC power supply to output a voltage waveform in which AC is superimposed on DC. Use of this mode requires the RS-232C Control provided as standard for the product or a separate option. For more information on this, see Chapter 9, Descriptions of RS-232C and GPIB Messages, or “10.9 AC + DC Mode”.

NOTE

- The output voltage mode will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

3.3.2 Setting the Output Voltage Range (100 V/200 V)

The AC power supply has two output voltage ranges: a 100 V range and a 200 V range. These ranges can be selected as necessary. The output-voltage range is displayed on the control panel as follows.

100 V range: “100 V” below RANGE lights up.

200 V range: “200 V” below RANGE lights up.

Symptom1: Selection of the Output Voltage Range

■ AC mode and AC-S mode

The 100 V range is used when the output voltage is set in the range of 0 V to 152.5 V.

The 200 V range is used when the output voltage is set in the range of 0 V to 305.0 V.

■ DC mode

The 100 V range is used when the output voltage is set in the range of -215.5 V to +215.5 V.

The 200 V range is used when the output voltage is set in the range of -431.0 V to +431.0 V.

NOTE

- With switching from the 100 V range to the 200 V range, a set output voltage value will be held.
- With switching from the 200 V range to the 100 V range, there may not be cases in which a set output voltage value is held. If the voltage set value exceeds 152.5 V, it is forced to be 0 V. This is due to the fact that the set value exceeds the setting range of the 100 V range.

Output Voltage Range Switching Procedure

Outline of the switching procedure

The output voltage range is switched with OUTPUT turned OFF. Switch it to each range alternately.

Preparation work	Main operation	Operation of the power supply
Press the ESC key to select the Home Position. →	Press the RANGE (SHIFT, 7) key. →	The AC power supply changes to the 200 V range when in the 100 V range or to the 100 V range when in the 200 V range.

■ Operation in the AC mode

The following procedure switches the output voltage range from the 100 V range to the 200 V range and then from the 200 V range to the 100 V range.

The procedure applies to the AC-S or DC mode.

1. When “OUTPUT ON” is lit, press the OUTPUT key to turn the output OFF.
2. Press the RANGE (SHIFT, 7) key.

   The control panel display changes as shown below, in accordance with the existing output voltage range.

   In the 100 V range: “100 V” lights up continuously and “200 V” blinks.

   In the 200 V range: “200 V” lights up continuously and “100 V” blinks.
3. Press the ENT key to accept the output voltage range.

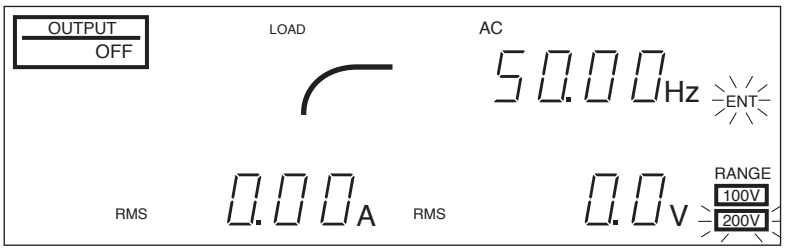


Fig. 3-5 For Switching from the 100 V Range to the 200 V Range. Before a New Setting is Accepted, “200 V” Blinks.

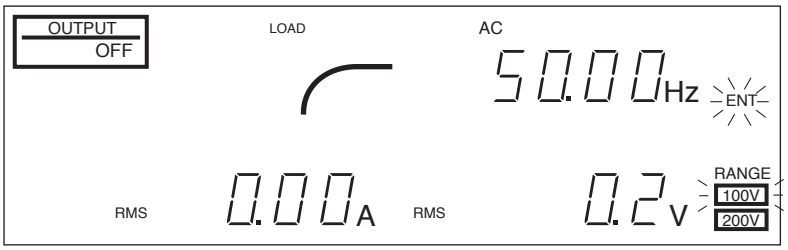


Fig. 3-6 For Switching from the 200 V Range to the 100 V Range. Before a New Setting is Accepted, “100 V” Blinks.

NOTE

- The output voltage range can be changed only when OUTPUT is OFF.
- In the initial setup status, the power supply is in the 100 V range.
- The maximum output current value changes in accordance with the output voltage range. The maximum output current value for the 200 V range is half that of the 100 V range. Select the range after carefully checking the specifications of the AC power supply.
- The output voltage range will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

3.3.3 Setting the Output Voltage

The output voltage can be set regardless whether the OUTPUT is ON/OFF. To protect the load, it is recommended that the output voltage be set with OUTPUT turned OFF. Setting of an output voltage with "OUTPUT ON" lit is useful for when the existing voltage is raised or lowered.

Setting range:

The setting range differs depending on the output voltage range.

■ AC mode and AC-S mode

In the 100 V range, the output voltage can be set in the range of 0 V to 152.5 V.

In the 200 V range, the output voltage can be set in the range of 0 V to 305.0 V.

■ DC mode

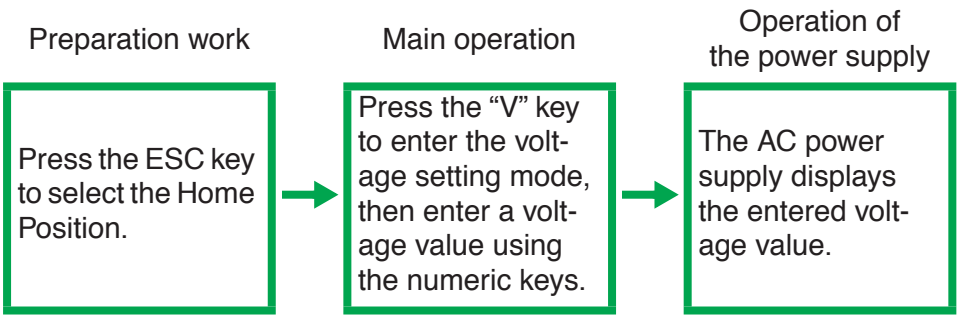
In the 100 V range, the output voltage can be set in the range of -215.5 V to +215.5 V.

In the 200 V range, the output voltage can be set in the range of -431.0 V to +431.0 V.

Setting Procedure (for OUTPUT OFF)

Outline of the setting procedure

Set the output voltage with OUTPUT turned OFF. The following is a case in which the power supply is operated in the AC mode.



■ Operation in the AC mode

The procedure applies to the AC-S or DC mode.

1. Press the ESC key to select the Home Position.
2. Press the "V" key to enter the voltage setting mode.

This causes “SET” and the frame that encircles the voltage display area to light up, indicating that setting can be performed.

3. Use the numeric keys (0 to 9) to enter a voltage value, and press the ENT key to confirm it.

   If a voltage that exceeds the specified range is set and the ENT key is pressed, that value is ignored and the display returns to the step-2 status.

4. To cancel operation during entry using the numeric keys and return to step 2, press the ESC or CLR key during ENT wait.

5. To exit the voltage setting mode, press the ESC key or the “F” key (for the setting frequency).

Fig. 3-7 Voltage Display Area

■ Operation in the DC mode

The procedure is the same as that for the AC-S mode. In the DC mode, you set the polarity.

1. Press the ESC key to select the Home Position.
2. Press the AC/DC (SHIFT, 8) key.

   This causes the polarity (+/-) to appear at the left of the voltage display area.

3. To change the polarity, press the +/- (SHIFT, 0) key.
4. Use the numeric keys (0 to 9) to enter a voltage value, and press the ENT key to confirm it.

Setting Procedure (for OUTPUT ON)

There are two methods of setting the output voltage: by observing the set value and by observing the output value.

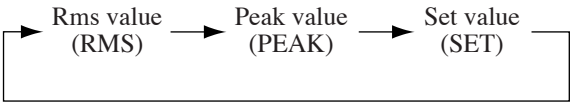
Method of setting through observation of the set value

1. Set an appropriate voltage value with OUTPUT turned OFF.
2. Turn OUTPUT ON.
3. Press the V MODE (SHIFT, V) key.

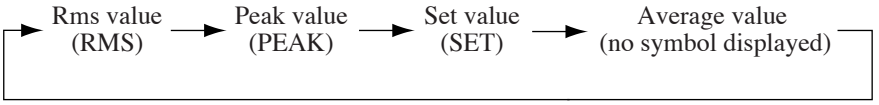
   Each time this key is pressed, the voltage display mode changes as shown below.

   For more information on the voltage display mode, see “4.1 Output Display Switching”.

For the AC or AC-S mode



For the DC mode



4. Press the V MODE (SHIFT, V) key repeatedly until "SET" is lit.
5. Press the "V" key to enter the voltage setting mode.
   This causes the frame that encircles the voltage display area to light up, allowing the output voltage to be set through observation of the set value.
6. Use the numeric keys (0 to 9) to enter a voltage value, and press the ENT key to confirm it.

NOTE

- The power supply can enter the voltage setting mode only in the Home Position or the frequency setting mode.
- In the initial setup status, the output voltage set value shows 0.0 V for the AC mode, AC-S mode, or DC mode.
- In the AC mode, the output voltage can be set from 0.0 V. However, the actual output voltage does not fall below 0.1 V to 0.6 V (the value varies in accordance with the output voltage range or temperature).

⚠ CAUTION

- Outputting a voltage exceeding the specified range may damage the load connected to the AC power supply or expose the operator to danger. Therefore, be sure to set the voltage limit value in advance. For more information on this, see "4.2 Limit Value Setting".
- Because the AC power supply's output impedance is very low, current may flow even when the output voltage is set to 0.0 V, depending on the load. To prevent current from flowing or during connection of a load, always turn OUTPUT OFF or turn the POWER switch OFF.

Setting Procedure Using JOG/SHUTTLE

This procedure differs depending on ON/OFF of OUTPUT. For the operations of JOG/SHUTTLE, see "3.1.1 How to Use JOG and SHUTTLE".

■ For OUTPUT OFF

In the voltage setting mode, JOG/SHUTTLE can be used to make settings in the same way as the numeric keys.

■ For OUTPUT ON

The output voltage can be set through observation of the set value or through observation of the output value.

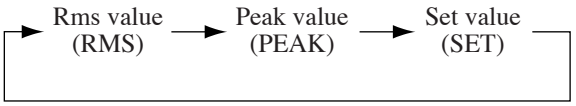
Method of setting through observation of the set value:

1. Set an appropriate voltage value when "OUTPUT OFF" is lit.
2. Turn OUTPUT ON.
3. Press the V MODE (SHIFT, V) key.

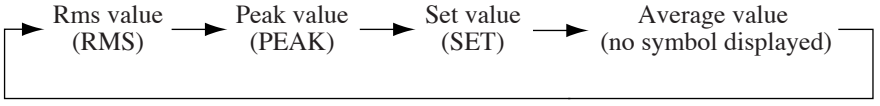
   Each time this key is pressed, the voltage display mode changes as shown below.

   For more information on the voltage display mode, see "4.1 Output Display Switching".

   For the AC or AC-S mode

   For the DC mode

4. Press the V MODE (SHIFT, V) key repeatedly until "SET" is lit.
5. Press the "V" key to enter the voltage setting mode.

   This causes the frame that encircles the voltage display area to light up, allowing the output voltage to be set through observation of the set value.
6. Using JOG/SHUTTLE, increase or decrease the voltage value.

Method of setting through observation of the output value:

Perform steps 1 to 3 in the procedure for setting through observation of the set value, and then follow steps 4 to 6 below.

4. Select a key other than SET to cancel the operation of the V MODE (SHIFT, V) key.
5. Press the “V” key.

   This causes the frame that encircles the voltage display area to light up, allowing the output voltage to be set through observation of the output value.
6. Using JOG/SHUTTLE, increase or decrease the voltage value.

NOTE

- In the method of setting the output voltage through observation of the output value, the output terminal voltage is displayed. Because the display response rate is slow with this method, there is a danger of excessively increasing or decreasing the output voltage value through the use of JOG/SHUTTLE. Turn the knob slowly until you get a sense of the display response rate.
- The output voltage setting will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

3.4 Frequency Setting

Frequency Setting

The AC and AC-S modes allow frequency setting. The power supply can enter the frequency setting mode only when it is in the Home Position or the voltage setting mode. The frequency can be set regardless whether the OUTPUT is ON/OFF. To protect the load, it is recommended that the frequency be set with OUTPUT turned OFF. In the initial setup status, the frequency is set to 50.00 Hz.

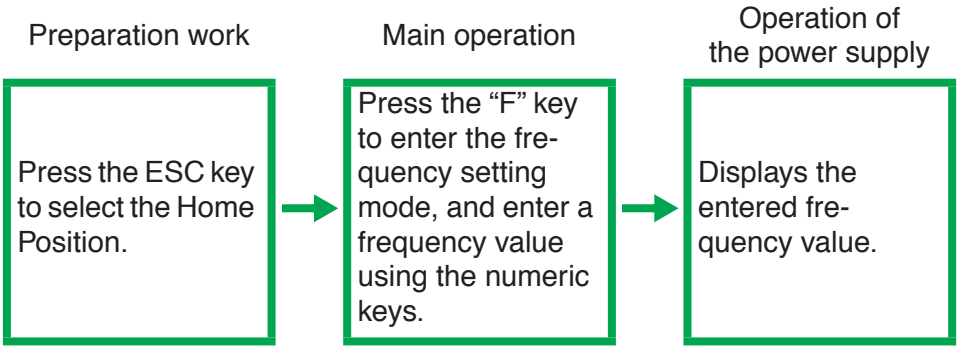
Setting Range

The frequency can be set in the range of 1.00 Hz to 999.9 Hz.

Frequency Setting Procedure

Outline of the frequency setting procedure

Set the frequency with OUTPUT turned OFF.



1. Press the ESC key to select the Home Position.
2. Press the "F" key to enter the frequency setting mode.

   This causes the frame that encircles the frequency display area to light up, indicating that setting can be performed.
3. Use the numeric keys (0 to 9) to enter a frequency value, and press the ENT key to confirm it.

   Frequency setting can also be performed using JOG/SHUTTLE. For more information on this, see "3.1.1 How to Use JOG and SHUTTLE". If an attempt is made to set a frequency exceeding the specified range, that value is ignored and the display returns to the step-2 status.
4. To exit the frequency setting mode, press the ESC key or "V" key (when setting the voltage).

Fig. 3-8 Frequency Display Area

⚠ CAUTION

- Outputting a frequency exceeding the specified range may damage the load connected to the AC power supply or expose the operator to danger. Therefore, be sure to set the frequency limit value in advance. For more information on this, see “4.2 Limit Value Setting”.

NOTE

- The power supply’s performance differs between the AC and AC-S modes in the lower-frequency range. For details, see “8.6 Differences between the AC and AC-S Modes”, and 11.1, Specifications of the Unit.
- The frequency setting will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

Chapter 4 Applied Operations

Describes applied operations such as switching of the output display and the protective functions.

4.1 Output Display Switching

The power supply indicates the output status using either of the following display modes. The power supply is capable of displaying AC, DC, voltage, load current, power, frequency, and the load level.

The display modes can be broadly classified into two types: voltage display mode and current/power display mode. The voltage display mode is further separated into "set voltage display" and "measured voltage display." The current/power display mode indicates only measured values.

1. Voltage display mode
   - Set voltage display
   - Measured voltage display
2. Current/power display mode
   - Measured current display

For all items of the display unit, see "5.1.2 Control Panel Display Unit".

NOTE

- The display mode will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

4.1.1 Switching the Voltage Display Mode

The voltage display modes are provided in the table below. A unit corresponding to the relevant mode will be indicated.

Voltage display mode	Display symbol
Rms value display (RMS)	RMS
Peak value display (PEAK)	PEAK
Average value display: Available only in the DC mode	None
Set voltage display (SET)	SET

Details on the voltage display mode are given in "8.7 Voltage Display Modes and Measurement Methods".

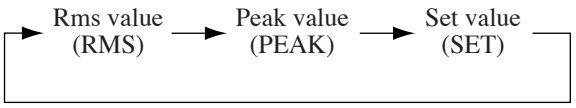
Fig.4-1 Voltage Display Area

Switching Procedure

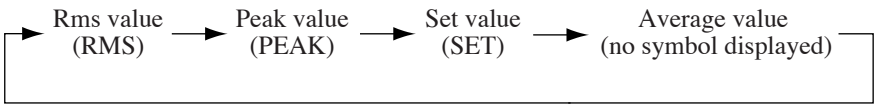
Press the V MODE (SHIFT, V) key.

Each time the V MODE (SHIFT, V) key is pressed, the voltage display mode changes as follows:

For the AC or AC-S mode



For the DC mode



4.1.2 Switching the Current/Power Display Mode

The current/power display modes are provided in the table below. A unit corresponding to the relevant mode will be indicated.

Current/power display mode	Display symbol
Current rms value display (RMS)	RMS
Current peak value display (PEAK)	PEAK
Average current value display: Available only in the DC mode	None
Power display (W)	W

Details on the current/power display mode are given in “8.8 Current/Power Display Modes and Measurement Methods”.

Fig. 4-2 Current/Power Display Area

■ Switching procedure

Press the I MODE (SHIFT, I) key.

Each time the I MODE (SHIFT, I) key is pressed, the current/power display mode changes as follows:

For the AC or AC-S mode

Rms value (RMS) → Peak value (PEAK) → Power value (W) →

For the DC mode

Rms value (RMS) → Peak value (PEAK) → Power value (W) → Average value (no symbol displayed) →

LOAD Level Meter

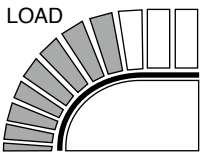


Fig. 4-3 LOAD Level Meter

The LOAD level meter detects the current flowing in a load, and displays the ratio of the load current value to the rated current value in bar-graph form. This level meter should be used roughly as a reference in determining the available load current.

■ When a limit value is set

As to the full scale of the LOAD level meter, if a limit value smaller than the rated current value is set, that limit value has precedence over the rated current value.

For more information on this, see “4.2 Limit Value Setting”, and “8.10 Examples of LOAD Level Meter Operations”.

4.2 Limit Value Setting

Setting limit values in advance according to the conditions of a load to be connected prevents the occurrence of problems with the load. The AC power supply allows setting of the following three types of limit values.

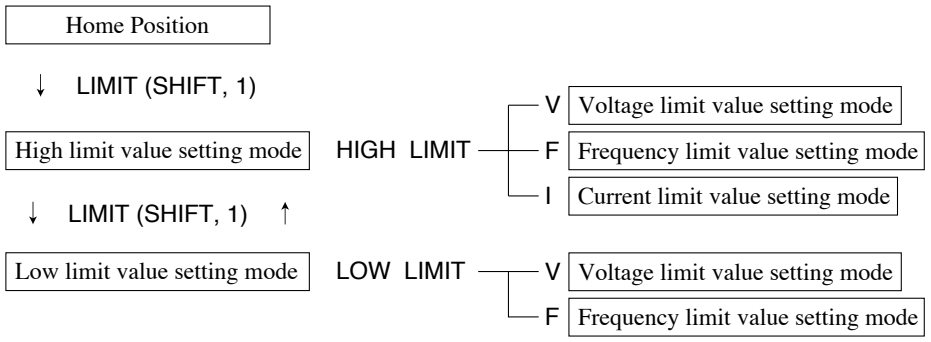
1. Voltage limit values
2. Frequency limit values
3. Current limit value

In this manual, limit values are defined as follows:

Voltage limit value	Limits the voltage setting range. There are high and low limit values.
Frequency limit value	Limits the frequency setting range. There are high and low limit values.
Current limit value	The high limit value of the output current rms. If the current exceeds the high limit, the output will be turned OFF.
Limit value	Generic name of each noted limit value

If the output current of the AC power supply becomes greater than that of the normal operating status due to a problem with the load, the load may be burnt out. If the wires for the load are thin, a wire may be burnt out. To prevent such problems, a current limit value should be set. For the selection of wires, see "8.2 Requirements of the Input Power Cable".

■ Outline of setting limit values



NOTE

- Limit values will be stored. The automatic storage interval is 10 sec. If the POWER switch is turned OFF immediately after a setting is changed, there may be cases in which the power supply does not store such a setting.

4.2.1 Voltage Limit Values

■ AC voltage (AC and AC-S modes) and DC voltage (DC and AC + DC modes)

High and low voltage limits can be set for both AC voltage (in the AC and AC-S modes) and DC voltage (in the DC and AC + DC modes).

Setting a limit value in the AC or AC-S mode establishes an AC limit value; setting a limit value in the DC or AC + DC mode establishes a DC limit value.

For details on the AC + DC mode, see Chapter 9, Descriptions of RS-232C and GPIB Messages, “10.9 AC + DC Mode”, or the operation manual of the relevant option.

■ Voltage limit value settable range

The table below shows the specific values for each mode.

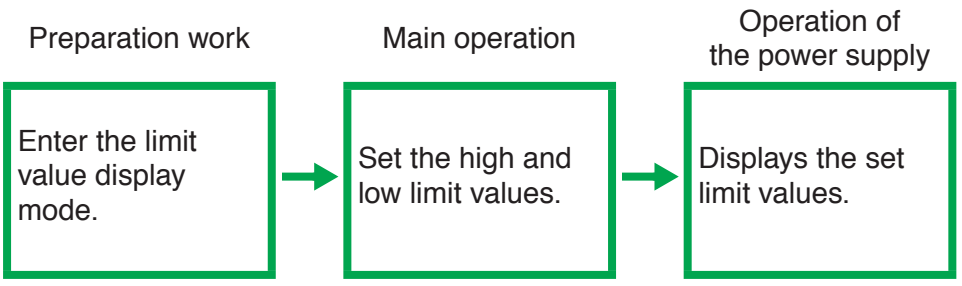
Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V	AC 0 [Vrms]	AC 305.0 [Vrms]
	100 V		
DC mode or AC + DC mode	200 V	DC -431.0 [V]	DC +431.0 [V]
	100 V		

The initial setup status (factory shipped setting) is the same as specified above. Once the limit values are set, the output voltage can not be entered when it exceed the setting range of limit value, however 0 V can be entered by the key operation even when the output exceeds the setting range of limit value. If a value that exceeds the high-voltage limit or is below the low limit value is entered, that value will be ignored and the previous value will be used.

Setting Procedure

Outline of the setting procedure

A limit value can be set regardless whether the OUTPUT is ON/OFF. Enter the limit value display mode from the Home Position, and set limit values. After they are set, return to the Home Position.



1. Press the ESC key to select the Home Position.
2. Press the LIMIT (SHIFT, 1) key to enter the limit value display mode.
   This causes "HIGH" and "LIMIT" to light up, and the high limit values of voltage, frequency, and current to be displayed.
3. Press the "V" key to enter the voltage limit value setting mode.
   In this case, the power supply is in the high limit value setting mode.
   The frame that encircles the voltage display area lights up, indicating that setting can be performed.
4. Set the high limit value using the numeric keys or JOG/SHUTTLE.

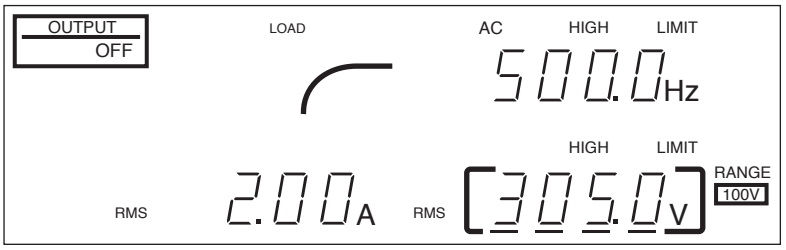


Fig. 4-4 Voltage High Limit Value Setting

5. Press the LIMIT (SHIFT, 1) key to enter the low limit value setting mode.
   This causes "LOW LIMIT" to light up.
6. Press the "V" key to enter the voltage limit value setting mode.
7. Set the low limit value.

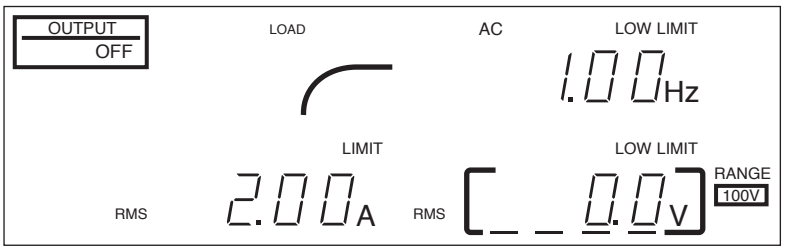


Fig. 4-5 Voltage Low Limit Value Setting

8. Press the ESC key to turn OFF the frame that encircles the voltage display area.
9. Press the ESC key again to exit the voltage limit value setting mode.

■ Switching between the high and low limit values

In the voltage limit value setting mode, pressing the LIMIT (SHIFT, 1) key allows switching between the high and low limit value setting modes.

High limit value setting mode	HIGH LIMIT
↓ LIMIT (SHIFT, 1) ↑	
Low limit value setting mode	LOW LIMIT

■ Limit values can be set even in the OUTPUT ON condition.

The limit values can be set in accordance with steps 1 to 7.

Moving to Another Limit Value Setting Mode

Pressing the “F” key allows you to move to the frequency limit value setting mode.

Pressing the “I” key allows you to move to the current limit value setting mode. However, the low limit value setting mode does not allow switching to the current limit value setting mode even when the “I” key is pressed. This is due to the fact that there is no low limit value for the current limit.

Pressing the ESC key returns the status to the limit value display mode, and pressing the ESC key again returns it to the Home Position.

4.2.2 Frequency Limit Values

■ Frequency limit value settable range

The frequency limit value settable range is the maximum variable range of the AC power supply. The table below shows specific values for each mode.

Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V	1.00 [Hx]	999.9 [Hx]
	100 V		
DC mode	200 V	Setting not possible	
	100 V		
AC + DC mode	200 V	Settings in the AC or AC-S mode are enabled.	
	100 V		

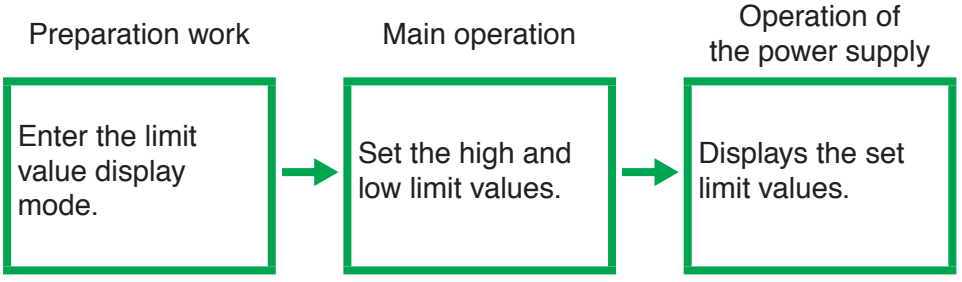
The initial setup status (factory shipped setting) is the same as that specified above.

Once the limit values are set, a frequency exceeding the limit value setting range cannot be entered.

Setting Procedure

Outline of the setting procedure

Limit values can be set regardless whether the OUTPUT is ON/OFF.
Enter the limit value display mode from the Home Position, and set limit values. After making these settings, return to the Home Position.



1. Press the ESC key to select the Home Position.
2. Press the LIMIT (SHIFT, 1) key to enter the limit value display mode.
   This causes “HIGH” and “LIMIT” to light up, and the high limit values of voltage, frequency, and current to be displayed.
3. Press the “F” key to enter the frequency limit value setting mode.
   In this case, the AC power supply is in the high limit value setting mode.
   The frame that encircles the frequency display area lights up, indicating that setting can be performed.
4. Set the high limit value using the numeric keys or JOG/SHUTTLE.

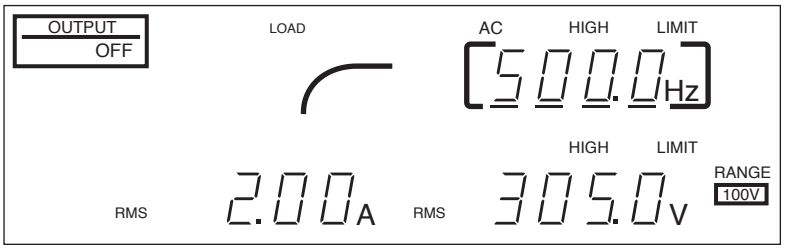


Fig. 4-6 Frequency High Limit Value Setting

5. Press the LIMIT (SHIFT, 1) key to enter the low limit value setting mode.
   This causes “LOW LIMIT” to light up.
6. Set the low limit value.

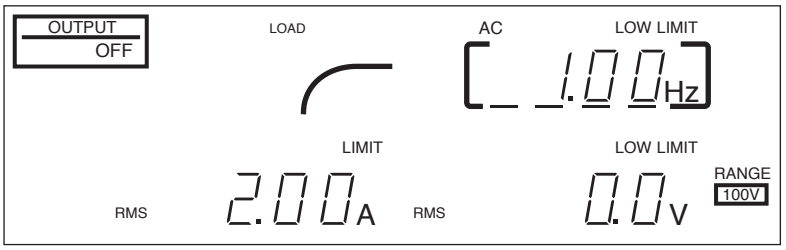


Fig. 4-7 Frequency Low Limit Value Setting

7. Press the ESC key to turn OFF the frame that encircles the frequency display area.
8. Press the ESC key again to exit the frequency limit value setting mode.

■ Switching between the high and low limit values

In the frequency limit value setting mode, pressing the LIMIT (SHIFT, 1) key allows switching between the high and low limit value setting modes.

High limit value setting mode	HIGH LIMIT
↓ LIMIT (SHIFT, 1) ↑	
Low limit value setting mode	LOW LIMIT

Moving to Another Limit Value Setting Mode

Pressing the “V” key allows you to move to the voltage limit value setting mode.

Pressing the “I” key allows you to move to the current limit value setting mode. However, the low limit value setting mode does not allow switching to the current limit value setting mode even when the “I” key is pressed. This is due to the fact that there is no low limit value for the current limit.

Pressing the ESC key returns the status to the limit value display mode, and pressing the ESC key again returns it to the Home Position.

4.2.3 Current Limit Values

■ AC current (AC and AC-S modes) and DC current (DC and AC + DC modes)

A high current limit can be set for both AC current (in the AC and AC-S modes) and DC current (in the DC and AC + DC modes).

Setting the limit value in the AC or AC-S mode establishes an AC limit value; setting the limit value in the DC and AC + DC modes establishes a DC limit value.

For more information on the AC + DC mode, see Chapter 9, Descriptions of RS-232C and GPIB Messages, “10.9 AC + DC Mode”, or the operation manual of the relevant option.

■ Current limit value settable range

The current limit value settable range is 10 % to 110 % of the rated maximum output current in the modes shown in the table below. The current limit value should be set in rms. If there is a limitation on the output current due to the output voltage or frequency value set, such limitation has precedence over the set current limit value. For more information on this, see “8.4 Outputs and Loads”.

Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V	Not settable	AC 1.1 x I_{AC} [Arms]
	100 V		
DC mode or AC + DC mode	200 V	Not settable	DC 1.1 x I_{DC} [A]
	100 V		

Rated maximum output current

Model name	I_{AC}	I_{DC}
PCR500LA	5	2.5
PCR1000LA	10	5
PCR2000LA	20	10
PCR4000LA	40	20
PCR6000LA	60	30

The initial setup status (factory shipped setting) is the same as that specified above.

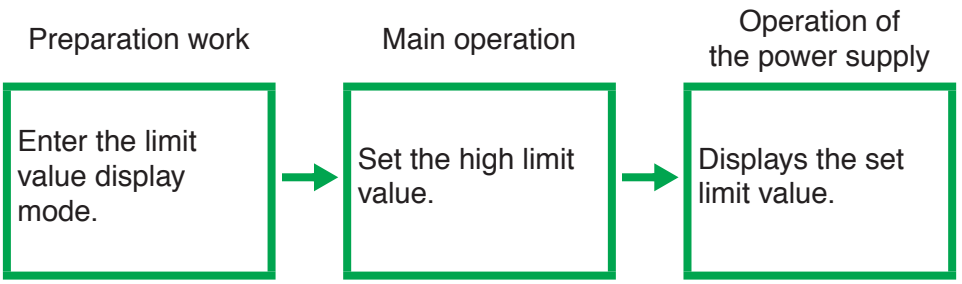
■ Current limiting action

If a current exceeding the current limit value flows, the control panel's "OVER-LOAD" indication lights up and the output voltage drops. If this condition continues for approx. 10 sec. in the AC or AC-S mode or approx. 1 sec. in DC mode, the output will automatically be turned OFF. This current limiting function is activated based on the rms current. Thus, it does not have a direct bearing on the maximum peak current drawn by a capacitor-input rectifying load.

Setting Procedure

Outline of the setting procedure

A limit value can be set regardless whether the OUTPUT is ON/OFF. Enter the limit value display mode from the Home Position, and set the limit value. After setting it, return to the Home Position.



1. Press the ESC key to select the Home Position.
2. Press the LIMIT (SHIFT, 1) key to enter the limit value display mode.
   This causes "HIGH" and "LIMIT" to light up, and the high limit values of the present frequency and current to be displayed. The current limit has only a high limit value.
3. Press the "I" key to enter the current limit value setting mode.
   This causes the frame that encircles the current display area to light up, indicating that setting can be performed.
4. Set the limit value using the numeric keys or JOG/SHUTTLE.

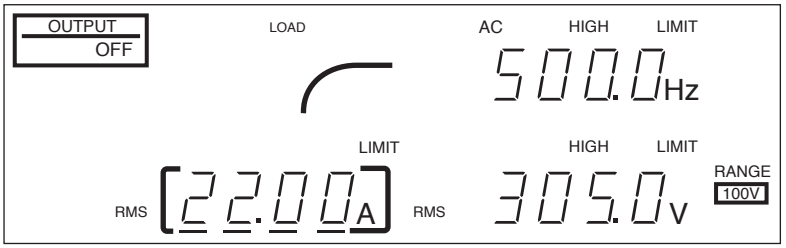


Fig. 4-8 Current Limit Value Setting

5. Press the ESC key to turn OFF the frame that encircles the current display area.
6. Press the ESC key again to exit the current limit value setting mode.

Moving to Another Limit Value Setting Mode

Pressing the “V” key allows you to move to the voltage high limit value setting mode.

Pressing the “F” key allows you to move to the frequency high limit value setting mode.

Pressing the ESC key returns the status to the limit value display mode, and pressing the ESC key again returns it to the Home Position.

LOAD Level Meter

When the current limit value is set, the control panel’s LOAD level meter displays the current limit value as the full scale. Note that if the rated current is lower than the current limit value, the rated current is treated as the full scale. For more information on this, see “8.10 Examples of LOAD Level Meter Operations”.

4.3 Memory Function

This function allows the voltage and frequency set values to be stored in the memory in advance for subsequent reading out and setting. This feature is convenient for writing frequently used voltage and frequency set values into the memory. The memory function allows the output voltage and frequency set values to be written as a set into the memory for later reading out and setting. In the DC mode, only voltage can be read from and written into the memory. The memory allows nine sets of voltage and frequency to be set for the AC and AC-S modes, and nine voltages to be set for the DC mode. The read/write memory addresses are 1 to 9. For details such as the initial setup status, see "8.12 Applied Use of the Memory Function".

Procedure for Writing to the Memory

■ Preparation

1. Select the output voltage mode (AC/DC).
2. Set the voltage (and frequency) to be stored.
   Set only the voltage for the DC mode.
   Set both the voltage and frequency for the AC or AC-S mode.
3. Press the ESC key to select the Home Position.

■ Writing

4. Press the STORE (SHIFT, MEM) key.
5. Press any of the keys from 1 to 9 to select the write-destination memory address.
   This can also be achieved by turning JOG/SHUTTLE.
   This causes "Ad. X" (X: number) to appear in the current display area, and "STORE" to blink.

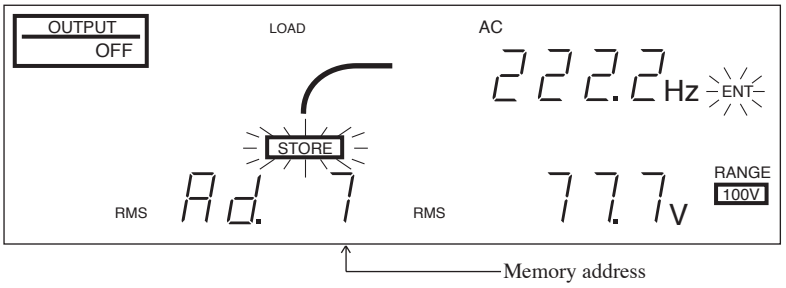


Fig. 4-9 Writing to the Memory

6. Press the ENT key to confirm the selection or press the ESC key to cancel the selection.
   When the ENT key is pressed, the voltage (and frequency) are written (as a set) to the memory.
   - Only voltage is written in the DC mode.
   - Both voltage and frequency are written in the AC or AC-S mode.

Memory Read Procedure

■ Preparation

1. Select the output voltage mode (AC/DC).
2. Press the ESC key to select the Home Position.

■ Readout

3. Press the MEM key.
4. Press any of the keys from 0 to 9 to select the memory address from which data is to be read.

   This can also be achieved by turning JOG/SHUTTLE.

   This causes “Ad. X” (X: number) to appear in the current display area. The voltage and frequency stored in the relevant memory address are read and displayed in the respective voltage and frequency display areas.

   - Only voltage is read in the DC mode.
   - Both voltage and frequency are read in the AC or AC-S mode.

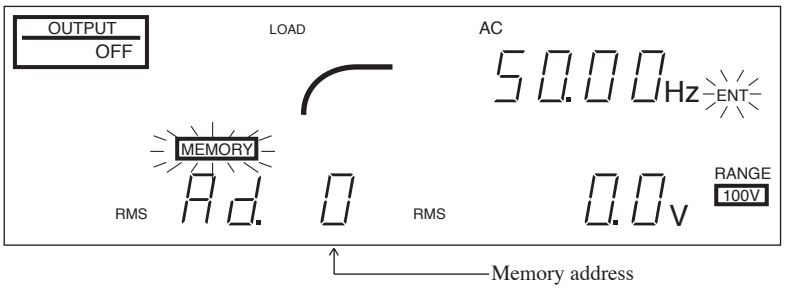


Fig. 4-10 Reading Data from the Memory

5. Press the ENT key to accept the read value(s) as the set value(s). Press the ESC key to cancel it (them).

NOTE

- Use of the Remote Controller (RC04-PCR-LA), GPIB Interface (IB03-PCR-LA), or RS-232C Control allows a maximum of 99 sets of memory-stored data to be read or written. In this case, memory addresses 1 to 9 can be accessed from both the control panel and the optional device. For more information on this, see “10.10 Expansion of the Memory Function”, or the operation manual of the relevant option.

4.4 Synchronous Function

The synchronous function synchronizes the AC power supply's output voltage frequency and phase to 50 or 60 Hz of the line voltage.

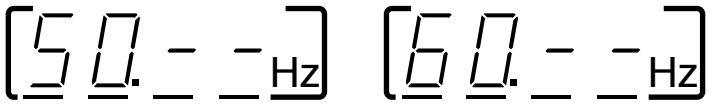
In the synchronous mode, the frequency limiting function is not available.

When the POWER switch is turned OFF, the synchronous mode is cancelled.

Synchronous Mode Setting Procedure

1. Press the ESC key to select the Home Position.
2. Press the SYNC (SHIFT, 9) key.

   This activates the synchronous mode, causing "SYNC" to blink. The AC power supply attempts to synchronize the output voltage frequency and phase with the frequency of the line voltage. Several seconds later, "SYNC" lights up, indicating that the frequency and phase have synchronized with the frequency of the line voltage. The synchronized frequency (50 Hz or 60 Hz) is displayed in the frequency display area.



3. To exit the synchronous mode, press the SYNC (SHIFT, 9) key.

Frequency Applied When the Synchronous Mode is Cleared

■ When the frequency in the synchronized condition (50 Hz or 60 Hz) is within the frequency limit range

The frequency will be set to the synchronized frequency of 50 Hz or 60 Hz.

■ When the frequency in the synchronized condition (50 Hz or 60 Hz) exceeds the frequency limit range

The frequency limiting function is activated.

If the frequency in the synchronized condition (50 Hz or 60 Hz) is lower than the low limit, it is set to the low limit value.

If the frequency in the synchronized condition (50 Hz or 60 Hz) is higher than the high limit, it is set to the high limit value.

4.5 Sensing Function

This function is used to connect a load at a distant location from the AC power supply and stabilize the voltage at that point (sensing point). The power supply's "sensing function" differs significantly from the "remote sensing (function for instantaneously correcting voltage in real time)" of general DC power supplies.

The sensing function employs the method of using the AC power supply's output voltage measuring function to measure voltage at the sensing point, and automatically correcting any insufficiencies in the voltage. With this method, the performance is inferior in terms of voltage stability, output voltage response in the event of a sudden change in load current, and waveform quality (distortion factor) in comparison with those in general use.

The power supply's sensing function can be used in the AC, AC-S, and DC modes. In the DC mode, it is also inferior in terms of performance to the remote sensing function of general DC power supplies. For more information on the sensing function, see "8.11 Method of the Sensing Function".

NOTE

- The output voltage cannot be changed when the sensing function is in use. In this case, set the output voltage in advance and then activate the sensing function.

Procedure for Use of the Sensing Function

Outline of the use procedure

Turn the POWER switch OFF, then connect a sensing point to the SENSING terminal board.

Preparation work	Main operation	Operation of the power supply
Connect a sensing point to the SENSING terminal board.	Press the SENSING (SHIFT, 5) key.	"SENSING" lights up.

⚠WARNING

- There is a possibility of electric shock, which could result in injury or death. Before connecting the load and sensing cables to the power supply, turn the POWER switch OFF and disconnect the input power plug from the outlet, or cut off the power feed from the switchboard.

■ Connection method

1. Make the connections specified below.

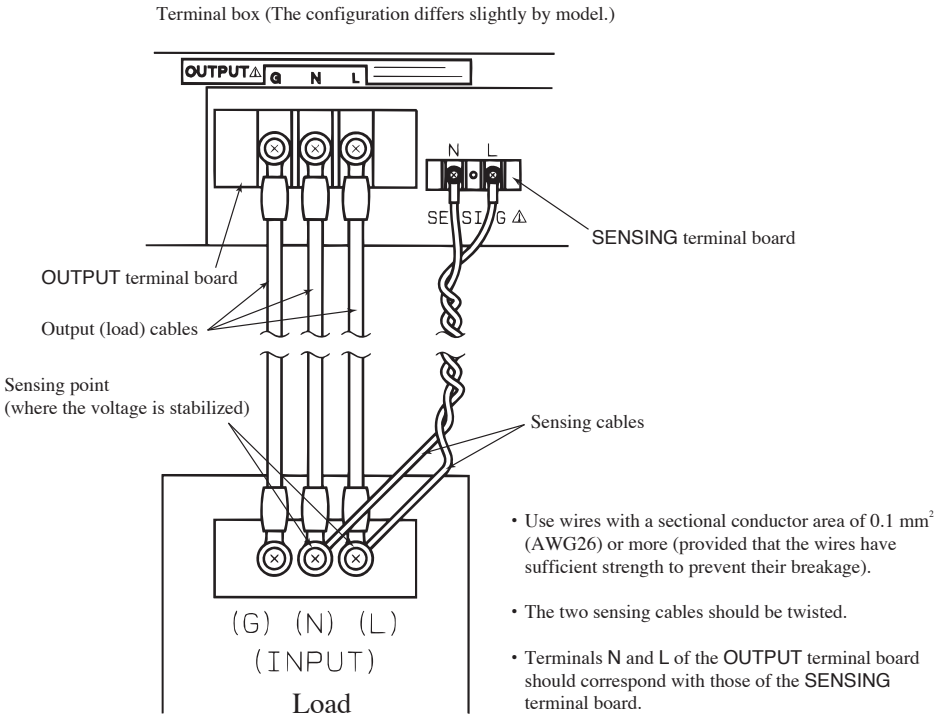


Fig. 4-11 Sensing-Terminal-Board Connection

⚠ WARNING • Remove and attach the terminal box cover to the power supply securely, in order to prevent electric shock.

■ Setting

2. Set the voltage and frequency to be stabilized at the sensing point. For the DC mode, set only the voltage.
3. Press the ESC key to select the Home Position.
4. Press the SENSING (SHIFT, 5) key.
   This causes the sensing function to activate and the word "SENSING" to light up.
5. To cancel the sensing function, press the SENSING (SHIFT, 5) key.

Steps to be Taken in the Event of an Alarm during Use of the Sensing Function

■ Condition under which an alarm occurs and action taken in the event of it

If there is a difference of approx. 10 % or more between the voltage at the sensing point and that at the output terminal of the AC power supply, an alarm will occur a few seconds later in the form of an intermittent buzzer, and the word "SENSING" will blink on the display. Simultaneously, the output will be turned OFF to protect the load.

If the above condition occurs, take the appropriate measures, such as using thicker, shorter output wires to connect the AC power supply to the load, in order to minimize the wire voltage drop as much as possible.

NOTE

- As the AC power supply's output voltage set value becomes smaller, so does the detected voltage. If the power supply's output voltage set value is small, take the appropriate measures, such as using thicker, shorter output wires to connect the AC power supply to the load, in order to minimize the wire voltage drop as much as possible.

■ Clearing the alarm

To clear the alarm, turn the POWER switch OFF or press the ALM CLR (SHIFT, CLR) key.

4.6 Protective Functions

Types of the Protective Functions and Alarm Occurrence

The AC power supply has the protective functions specified below. The occurrence of an alarm includes the lighting of "ALARM" and the lighting of "ALARM" involving an overload.

Protective function	Type
Protection against exceeding the input voltage rating range	Error 5 occurs.
Internal overheat protection	Alarm 2 occurs.
Internal circuit protection	Alarms 1, 4, and 5 occur.
Overload protection (current limiting function)	"OVERLOAD" lights up and alarm 6 occurs.
Internal overload protection (internal semiconductor protection)	"OVERLOAD" lights up and alarm 3 occurs.
Sensing error detection	Alarm 7 occurs.
Power-unit ID error detection	Alarm 8 occurs.

If any of the protective functions is activated, the output is always cut off.

4.6.1 Steps to be Taken in the Event of an Alarm

If an alarm occurs, an intermittent buzzer tone will sound and "ALARM" will light up or "Err X" (X: number) will be displayed (for an Err X display, no buzzer sounds). In such a case, the protective function relevant to the cause of the error will operate to prevent an escalation of the problem and to protect the connected load from breakage.

NOTE

- If an alarm occurs, the AC power supply always turns the output OFF. There may not be a problem in the power supply, depending on the alarm type. In such a case, clear the alarm and use the power supply as usual.

Steps to be Taken if ALARM Lights Up

1. Always turn the POWER switch OFF.
2. Wait for more than 5 seconds after turning the POWER switch OFF, then turn the switch ON again.

   If no alarm occurs, the AC power supply can continue to be used.

   If an alarm occurs again, check the type of alarm in accordance with the SELF TEST described below, and take the appropriate steps to deal with such an alarm.

■ Alarm-type checking procedure (SELF TEST)

3. While "ALARM" is lit, press the SELF TEST (SHIFT, 3) key.

   This will cause "No. X" to appear in the current display area and "Ad. X" to appear in the voltage display area.

   "No. X" is the number of an alarm number (Table 4-2), "Ad. X" is the number of a power unit in the AC power supply (Table 4-1).
4. Turn JOG. This will cause the content of the current display area and that of the voltage display area to change.

   Then, read the alarm number area when "Ad." is appears.
5. Take measures corresponding to the displayed alarm number in accordance with Table 4-2.

   Note that it is only necessary to clear alarm 8 to use the power supply.

■ Alarm 8 clear procedure

6. Press the ALM CLR (SHIFT, CLR) key.

   Clearing an alarm will cause the output voltage set value to become 0 V.
7. When the intermittent buzzer stops and the alarm indication goes off, press SELF TEST (SHIFT, 3) again to check the alarm type.

   Check for an alarm from "Ad. 1" to the last Ad. number (the last Ad. number will differ by model).

   If there is no alarm, the AC power supply can continue to be used.

If this check results in an alarm for all numbers, the power supply can no longer be used. Contact your Kikusui distributor/agent.

Ad. Numbers to be displayed by SELF TEST

Table 4-1 Ad. Numbers

Ad. No.	Model concerned
0	All sections of the AC power supply
1	PCR1000LA
1 to 2	PCR2000LA
1 to 4	PCR4000LA
1 to 6	PCR6000LA

The power units are numbered sequentially from the top down.

Alarm Numbers area indicated by SELF TEST

Table 4-2 Alarm Numbers Area and Remedy/Description

Alarm No.	Remedy/Description
0	No alarm
1	The internal circuit protection has activated. Contact your Kikusui agent.
2	The internal temperature is expected to be abnormally high. Wait approx. 10 minutes with the power ON. If the alarm continues, perform the procedure specified in “2.5 Input Connections”. If the alarm goes off, the power supply may be installed improperly. Check the description in “2.2 Precautions on Installation”. If nothing wrong is found in either of these steps, immediately stop using the power supply and contact your Kikusui agent.
3	The internal semiconductor protective function has activated. See “8.5 Overload Protective Functions”.
4	The internal circuit protective function has activated. Immediately stop using the AC power supply and contact your Kikusui agent.
5	
6	The current limiting function has activated. See “8.5 Overload Protective Functions”.
7	The sensing function has been used improperly. See “4.5 Sensing Function”. The output voltage may become +10 % or more of the set value. If the alarm cannot be cleared by correcting the use of the sensing function, immediately stop using the power supply and contact your Kikusui agent.
8	The power unit concerned may have been removed. Perform the Alarm 8 clear procedure.

NOTE • When requesting a repair, inform us of this alarm number.

Check to be Performed if "Err X" is Displayed

If an error occurs, the control panel will continue displaying "Err X" (X: number). If an Err display appears, always turn the POWER switch OFF and take steps in accordance with Table 4-3.

Table 4-3 Err Numbers and Remedies

Err X	Remedy
1	All internal power units are defective. Immediately stop using the AC power supply and contact your Kikusui agent.
2	An error has occurred in internal signal communication. Turn the POWER switch OFF and wait for more than 5 seconds, then turn the switch ON again. If no Err occurs, the power supply can continue to be used. If Err occurs again, contact your Kikusui agent.
4	An error has occurred in the AC power supply. Turn the POWER switch OFF and wait for more than 5 seconds, then turn the switch ON with the MEM key held down. Then, perform a reset. This causes the power supply to enter the initial setup status.
5	The input voltage is out of the rated range. See "2.5 Input Connections".
Other numbers	Contact your Kikusui agent.

Clearing an Alarm to Use the AC Power Supply Temporarily

If an "Ad." number (power-unit number) at which an alarm has occurred is present together with an "Ad." number at which no alarm has occurred, clear the alarm; the power supply can then be used temporarily. In this case, the output will be limited as specified below.

■ Available power and current

Obtain the available power and current using the following equation.

Regard the number of Ad.s at which no alarm occurs, as Na.

Regard the number of Ad.s based on the total number of power units in the model concerned, as Nb.

Available power = rated power of the model concerned x Na / Nb

Available current = rated current of the model concerned x Na / Nb

Example: For PCR6000LA, Nb = 6

If the number of Ad.s at which no alarm occurs is 2, Na = 2. Then

Available power = 6000 x 2 / 6 = 2000 [W]

Available current = 60 x Na / Nb (100 V range) = 20 [A]

NOTE

- The above method is for temporary use of the AC power supply. For a power unit in which an alarm has occurred, the remedies specified in Table 4-2 and Table 4-3 have precedence over this method.

4.6.2 Lighting of "ALARM" Involving an Overload

If an overload recurs, the output will be turned OFF, causing an intermittent buzzer tone to sound and "OVERLOAD" to light up. This indicates that alarm 3 or 6 has occurred and that the overload protective function has activated. There are the following two types of protective actions:

■ Overload protection (current limiting function)

This function is activated if the AC power supply's output current exceeds the current limit value (maximum setting: 1.1 times the rated output current). If a current exceeding the current limit flows in a load, "OVERLOAD" will light up and the output voltage will drop. If this condition continues for either approx. 10 sec. (in the AC or AC-S mode) or approx. 1 sec. (in the DC mode), this function will automatically turn the output OFF. For more information on this function, see "4.2.3 Current Limit Values".

■ Internal overload protection (internal semiconductor protection)

This function protects the semiconductors in the AC power supply. As long as the use method of the AC power supply agrees with the specifications, the internal semiconductor protective function will not normally activate. However, in the event of an instantaneous overcurrent such as an inrush current, the internal semiconductor protective function will activate; if such a status continues for a few seconds, an overload will occur.

Even if the internal semiconductor protective function is activated, an overload will not occur for a few seconds. However, the output voltage waveform will be distorted during this period due to activation of the semiconductor protective function.

Even if no overload occurs, frequent operation of the internal semiconductor protective function may cause a problem in the AC power supply.

NOTE

- The time required for the overload protective function to start operating differs depending on the status of the overload. It starts to operate within 3 to 11 seconds.
- If the internal semiconductor protective function has activated, always provide an interval of more than 1 minute before turning OUTPUT ON again. When the cause of the activation of the internal semiconductor protective function is eliminated, the internal semiconductor protective function is automatically cancelled. Turning the OUTPUT ON while this protective function is activated may not only disable the cancellation of an overload, but cause a failure. Similarly, when the internal semiconductor protective function is activated, clearing an alarm will not cancel an overload.

Cause-of-Overload Checking Procedure and Remedy

■ Cause-checking procedure

Whether an overload is caused by activation of the current limiting function or the internal semiconductor protective function can be checked by the following procedure.

1. While the output is OFF and "OVERLOAD" is lit, press the SELF TEST (SHIFT, 3) key.

   This will cause "No. X" (X: number) to appear in the current display area and "Ad. X" (X: number) to appear in the voltage display area.

2. Turn JOG. This will cause the content of the current display area and that of the voltage display area to change. Then, when "Ad.0" appears, read the alarm number.

   No. 3: The internal semiconductor protective function is activated.

   No. 6: The current limiting function is activated.

■ Remedy

Eliminate the cause of the overload. Press the OUTPUT key again.

This will cancel the overload display status and turn the output ON. If the cause of the overload has not been eliminated, the overload will recur.

NOTE

- If an overload occurs, always eliminate its cause, then press the OUTPUT key. Frequent recurrence of overload may cause a problem.

4.6.3 Steps to be Taken if the CIRCUIT BREAKER Opens

For the PCR2000LA, PCR4000LA, or PCR6000LA, if more than 10 A (rms) of output current flows from one OUTPUT outlet, the CIRCUIT BREAKER at the left of the OUTPUT outlets may open. This causes the red button to project from the CIRCUIT BREAKER. In such a case, take the following steps:

1. Turn the POWER switch OFF.
2. Push the red CIRCUIT BREAKER button.

   CIRCUIT BREAKER 1 corresponds to OUTPUT outlet 1 and CIRCUIT BREAKER 2 to OUTPUT outlet 2.
3. Adjust the load so that the output current is 10 A (rms) or less.

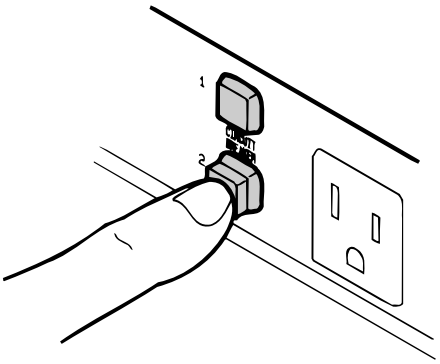


Fig. 4-12 Pushing CIRCUIT BREAKER back in

NOTE

- The total value of the output current obtained from the two OUTPUT outlets and the OUTPUT terminal board cannot exceed the rated output current.
- If the output current exceeds the rated value, the overload protective function is activated.

  Example: For the PCR4000LA, if an output current of 10 A flows through each of the two OUTPUT outlets when the output voltage is 100 V (100 V range), the load power factor is 1, and the output frequency is 50 Hz, the maximum output current of the OUTPUT terminal board becomes 20 A (= 40 A - 10 A - 10 A).

5

Chapter 5 Part Names and Their Functions

Denotes the names of switches, displays, terminals, and other parts on the front and rear panels of the AC power supply.

To gain an understanding of the contents of each ⚠ (alert mark) indicated on the panels of the product, read through this chapter.

5.1 Front Panel

5.1.1 Control Panel Operating Section

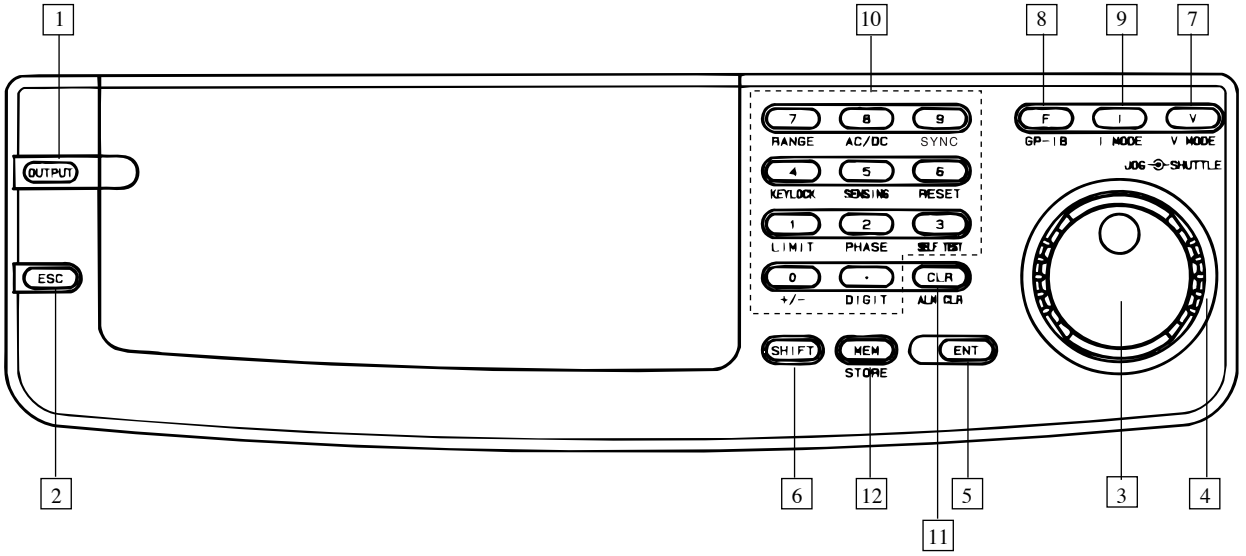


Fig.5-1 Control Panel

[1] OUTPUT

Selects output ON/OFF (each time this switch is pressed, OUTPUT ON/OFF is switched alternately). The output status is indicated by the ON/OFF indication at the upper left of the control panel. Immediately after the POWER switch is turned ON, output is OFF.

Because this key is sufficiently protected against chattering, it may not respond to usage in which the unit is turned ON and OFF repeatedly.

[2] ESC

Moves you up the hierarchy from each function toward the Home Position, or cancels an operation that requires pressing the ENT key.

[3] JOG

Used to set numbers for the voltage and frequency, for example. This is a rotary encoder with 10 clicks per rotation. The encoder increases the set value when it is turned clockwise and decreases the set value when it is turned counterclockwise.

[4] SHUTTLE

Used to set numbers for the voltage and frequency, for example.

The change speed can be set to one of four levels, depending on the angle to which the SHUTTLE is turned. The set value increases when the SHUTTLE is turned clockwise and decreases when it is turned counterclockwise.

[5] ENT

Confirms key operations. ENT blinks during ENT wait.

[6] SHIFT

Enables the function set out in blue letters below each key.

To use a function, press SHIFT followed by the relevant key. When SHIFT is pressed, SHIFT on the display panel lights up.

[7] V

Selects the voltage setting mode or the voltage limit setting mode. When any of these modes is selected, the frame that encircles the voltage display area lights up.

V MODE (SHIFT, V)

Switches the voltage display mode. The voltage display mode includes the set voltage (SET), rms value (RMS), peak value (PEAK), and average value (AVE). (The average value display mode is available only in the DC mode.)

[8] F

Selects the frequency setting mode or the frequency limit setting mode. When any of these modes is selected, the frame that encircles the frequency display area lights up.

GP-IB (SHIFT, F)

Used to change the option setting when an option is used. For more information, see the operation manual for each option.

[9] I

Selects the current limit setting mode. When the mode is selected, the frame that encircles the current display area lights up.

I MODE (SHIFT, I)

Switches the current display mode. The current display mode includes the rms value (RMS), peak value (PEAK), power (W), and average value (AVE). (The average value display mode is available only in the DC mode.)

[10] 0, 1, ... 9 (numeric keys), and "."

Used to directly enter the voltage, current, and frequency values. (.: decimal point)

A value entered is confirmed when the ENT key is pressed or is canceled when the ESC key is pressed.

+/- (SHIFT, 0)

Switches the DC mode voltage polarity (+/-)

LIMIT (SHIFT, 1)

Selects the limit value display mode for voltage, frequency, and current.

When this mode is selected, the LIMIT above the current display area and the HIGH LIMIT or LOW LIMIT above the voltage display area or frequency display area lights up. The frame that encircles one of these display areas lights up.

PHASE (SHIFT, 2)

Not used for single operations of the AC power supply. This feature is used for three-phase operations.

SELF TEST (SHIFT, 3)

Used to select the self-test mode in the event of an alarm or overload. In the self-test mode, SELF TEST on the control panel lights up. At the same time, the current display area indicates “No. X” , while the voltage display area indicates “Ad. X” . “X” represents a number.

KEYLOCK (SHIFT, 4)

Selects the key-lock mode. In the key-lock mode, KEY LOCK on the control panel lights up and all keys except the KEYLOCK (SHIFT, 4) and OUTPUT keys are disabled.

SENSING (SHIFT, 5)

Selects the sensing mode. To enter the sensing mode, connect the sensing wires to the sensing terminals, set the voltage, and then press this key. The sensing mode allows no voltage change and causes SENSING to light up.

RESET (SHIFT, 6)

Resets the AC power supply. When a reset is made, all set values return to their initial setup status (factory shipment status).

- Use the SHIFT key to reset, and press the ENT key to confirm it.

RANGE (SHIFT, 7)

Switches the output voltage range. “100 V” below the RANGE indication lights up in the 100 V range, while “200 V” lights up in the 200 V range. When RANGE (SHIFT, 7) are pressed, the range indication to be selected blinks. Pressing the ENT key will accept the range selection.

AC/DC (SHIFT, 8)

Switches to the AC mode, AC-S mode, or DC mode. For the AC and AC-S modes, “AC” above the frequency display area lights up. In the AC-S mode, “S-MODE5” also lights up. In the DC mode, “dc” appears in the frequency display area.

- When AC/DC (SHIFT, 8) are pressed, the mode to be selected blinks. Pressing the ENT key will accept the mode selection.

In the AC + DC mode, “AC+DC” on the control panel lights up.

- For more information on the AC + DC mode, see Chapter 9, Descriptions of RS-232C and GPIB Messages, “10.9 AC + DC Mode”, or the operation manual of the relevant option.

SYNC (SHIFT, 9)

Performs synchronous operation. When the power supply enters synchronous operation, SYNC on the control panel lights up.

DIGIT (SHIFT, .)

Selects the digit mode that enables arbitrary and higher digits to be changed in the voltage setting or frequency setting mode. In the digit mode, part (cursor) of the frame that encircles the voltage display area or frequency display area blinks, thereby allowing the relevant and higher (left of the relevant digit) digits to be changed.

- Each time the DIGIT (SHIFT, .) key is pressed, the cursor moves to the left.

[11] CLR

Cancels the set value and calls the previous value.

ALM CLR (SHIFT, CLR)

Clears the alarm status in the event of an alarm.

[12] MEM

Reads voltage (and frequency) value(s) from the memory. Pressing the MEM key and then any of the 0 to 9 keys to select a memory address will cause “Ad. X” (X: memory address) to appear in the current display area, and will read the voltage and frequency stored in the memory address into the voltage display area and frequency display area.

- Pressing the ENT key accepts and sets the voltage (and frequency) read.

STORE (SHIFT, MEM)

Writes the voltage (and frequency) value (or values) into the memory. Set the voltage (and frequency) to be stored, and press the STORE (SHIFT, MEM) key. Then, press any of the 1 to 9 keys to select the memory address, then press the ENT key. This will store the value or values in the memory.

5.1.2 Control Panel Display Unit

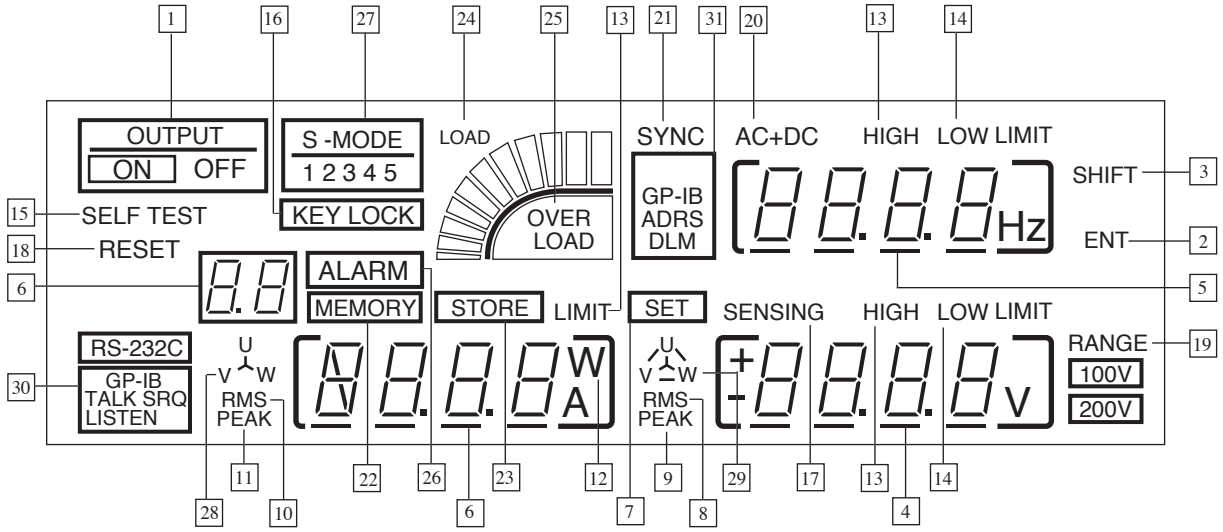


Fig. 5-2 Control Panel Display Unit

[1] OUTPUT ON/OFF

ON lights up when the output is ON, and OFF lights up when it is OFF. Immediately after the POWER switch is turned ON, output is OFF. Each time the OUTPUT key is pressed, output ON/OFF changes alternately.

[2] ENT

Blinks prior to operation or before a set value is confirmed.

The status in which ENT is blinking is referred to as “ENT wait.”

[3] SHIFT

Lights up when the SHIFT key is pressed.

[4] Voltage display area

Displays a voltage value, etc.

[5] Frequency display area

Displays a frequency value, etc.

[6] Current display area

Displays a current value, etc.

If the output power display is 10 kW or more, “E3” is displayed.

[7] SET

Lights up when the set voltage is displayed in the voltage display area.

[8] RMS

Lights up when the value displayed in the voltage display area is rms.

[9] PEAK

Lights up when the value displayed in the voltage display area is the peak value.

[10] RMS

Lights up when the value displayed in the current display area is rms.

[11] PEAK

Lights up when the value displayed in the current display area is the peak value.

[12] W

Lights up when the value displayed in the current display area is the value indicating power.

[13] HIGH LIMIT

Lights up when the high limit setting mode is selected.

[14] LOW LIMIT

Lights up when the low limit setting mode is selected.

[15] SELF TEST

Blinks in the self-test mode.

In the self-test mode, the current display area displays “No.” and a number, while the voltage display area displays “Ad.” and a number.

[16] KEYLOCK

Lights up in the key-lock mode. In the key-lock mode, no keys other than the KEYLOCK (SHIFT, 4) and OUTPUT keys can be used. This indication will also light up when the Remote Controller is used to perform an optional function.

[17] SENSING

Lights up in the sensing mode.

The sensing mode disables voltage changes.

[18] RESET

Blinks together with ENT when the SHIFT key is pressed followed by pressing of the RESET key.

Pressing of the SHIFT key followed by pressing of the ENT key in this status resets the power supply, returning all set values to the initial setup status (factory shipment status).

[19] RANGE

Displays the output voltage range.

“100 V” below the RANGE indication lights up when the 100 V range is selected, while “200 V” lights up when the 200 V range is selected.

[20] AC+DC

Displays the output voltage mode.

"AC" lights up in the AC or AC-S mode, and "DC" lights up in the DC mode. In addition, "AC+DC" lights up in the AC + DC mode.

For more information on the AC + DC mode, see Chapter 9, Descriptions of RS-232C and GPIB Messages, "10.9 AC + DC Mode", or the operation manual of the relevant option.

[21] SYNC

Lights up during execution of synchronous operation.

This indication will blink during transfer to synchronous operation.

[22] MEMORY

Blinks during execution of memory write/read.

[23] STORE

Blinks up when data is written into the memory.

[24] LOAD

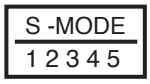
Displays the ratio of a load current value to the rated current value for reference

[25] OVERLOAD

Lights up if an overload (overcurrent) occurs. If this condition continues for a few seconds, the output is turned OFF and an alarm is issued, sounding an intermittent buzzer tone.

[26] ALARM

Lights up when the intermittent buzzer tone is generated in the event of an alarm.



[27] S-MODE

Lights up together with the corresponding number under the conditions specified below. When any of the following functions is used, the setup at that time will be backed up and the corresponding number remains lit until the relevant function is exited.

1: A power line abnormality simulation or sequence is being run.

2: The output impedance has been set.

3: Any of waveform banks 1 to 14 has been selected.

4: The output ON/OFF phase has been set.

5: AC-S mode

[28] U-V-W

Displays the phase corresponding to the current or power display in three-phase or single-phase three-wire operation.

[29] U--V--W

Displays the phase corresponding to the phase voltage or line voltage display in three-phase or single-phase three-wire operation.

RS-232C
GP-IB
TALK SRQ
LISTEN

[30] RS-232C,GP-IB:TALK,SRQ,LISTEN

Lights up when the RS-232C Control or GPIB Interface is used.

GP-IB
ADRS
DLM

[31] GP-IB:ADRS,DLIM

Lights up when an address or response message terminator (delimiter) is set up for the GPIB Interface.

5.1.3 Upper Part of the Front Panel

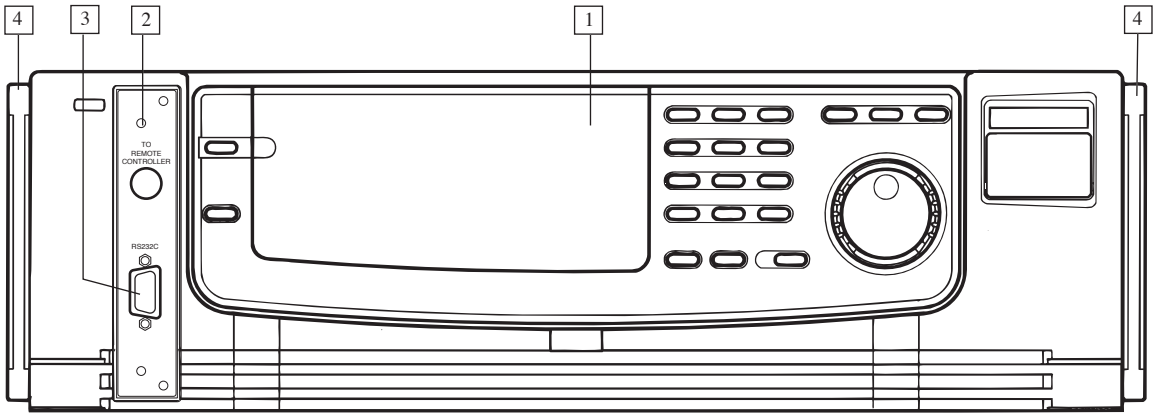


Fig. 5-3 Upper Part of the Front Panel

[1] Control panel

[2] TO REMOTE CONTROLLER

Connect the cable of the Remote Controller (RC03-PCR-LA or RC04-PCR-LA) to this terminal.

[3] RS-232C

Connect the RS-232C Control cable (9-pins, cross) to this terminal.

[4] Grips

Only the PCR500LA can be carried by holding the grips. However, for the PCR1000LA, PCR2000LA, PCR4000LA, and PCR6000LA, use the grips to move the power supply along an area of the floor that is flat and even only.

⚠WARNING • Never attempt to use the grips to lift the PCR1000LA, PCR2000LA, PCR4000LA, or PCR6000LA.

5.1.4 Lower Part of the Front Panel

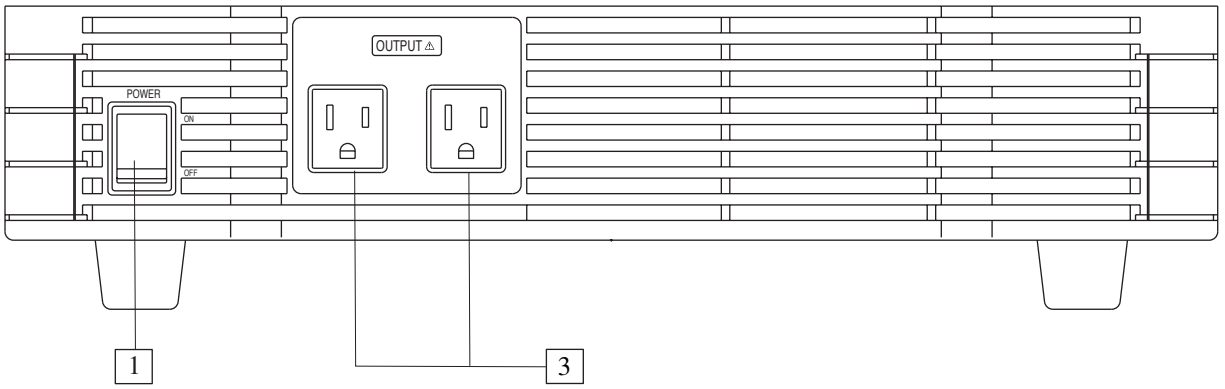


Fig. 5-4 PCR500LA

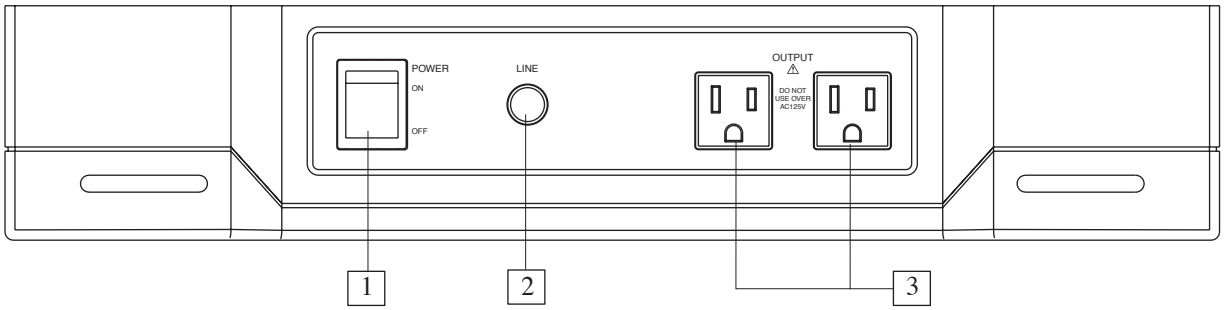


Fig. 5-5 PCR1000LA

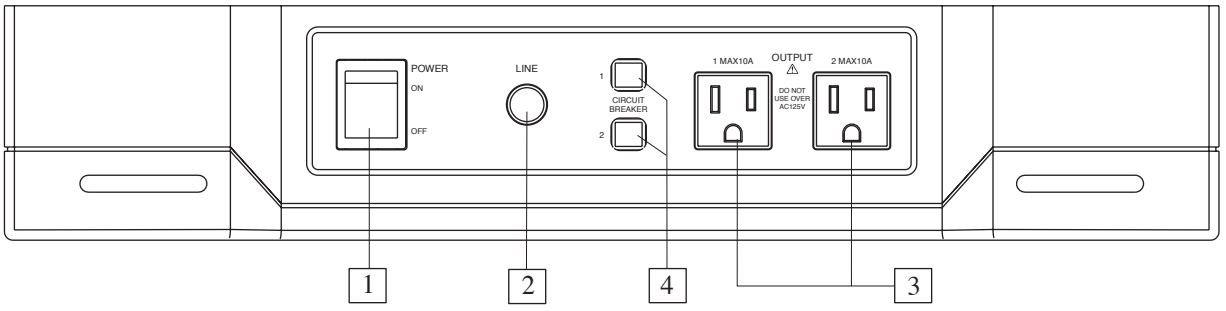


Fig. 5-6 PCR2000LA

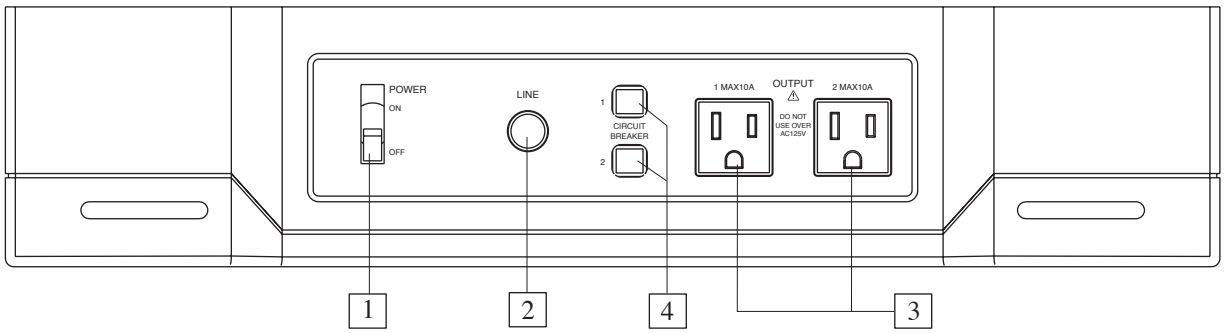


Fig. 5-7 PCR4000LA/PCR6000LA

[1] POWER

The AC power supply's POWER switch

For the PCR500LA, PCR1000LA, and PCR2000LA, pressing the upper part of the switch turns the POWER switch ON, while pressing the lower part turns the switch OFF. For the PCR4000LA and PCR6000LA, throwing the lever up turns the POWER switch ON, while throwing the lever down turns the switch OFF. The AC power supply stores the values specified below. When the POWER switch is turned ON, the power supply starts up with the set values in effect immediately before the POWER switch was turned OFF.

Output voltage and frequency set values

Output voltage range (100 V/200 V)

Output voltage, frequency, and current limit values

Output voltage mode (AC/DC)

Voltage, current, and power display modes

Key-lock status

[2] LINE lamp

The PCR500LA has no LINE lamp. This lamp lights up when the line voltage is fed to the INPUT terminal board.

⚠ WARNING • There is a possibility of electric shock, which could result in injury or death. The LINE lamp will light up regardless whether the POWER switch is ON/OFF. Because voltage is applied to the INPUT terminal board when this lamp is lit, never attempt to touch the INPUT terminal board.

[3] OUTPUT outlets

Used to obtain output from the front panel

⚠ CAUTION • The maximum current available is 10 A (rms) AC, and the maximum voltage is 125 V (rms) AC. Obtaining an output exceeding any of these values may cause a problem.

[4] CIRCUIT BREAKER

In the PCR2000LA, PCR4000LA, and PCR6000LA, flowing an output current of 10 A (rms) or more through one OUTPUT outlet may interrupt the CIRCUIT BREAKER to the left of the OUTPUT outlets. This will cause the red button to project from the CIRCUIT BREAKER, thereby interrupting the circuit. In such a case, perform the procedure in "4.6 Protective Functions".

5.1.5 Air Intake, Casters, and Others

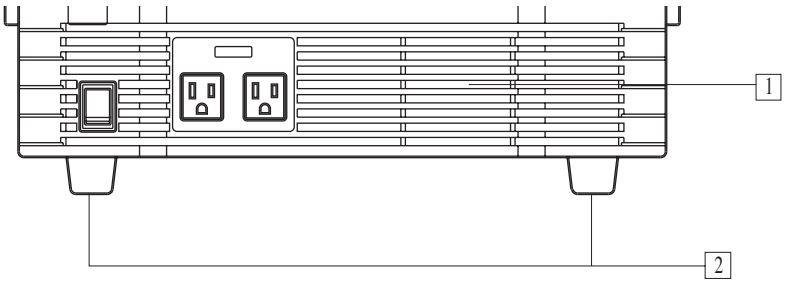


Fig. 5-8 PCR500LA

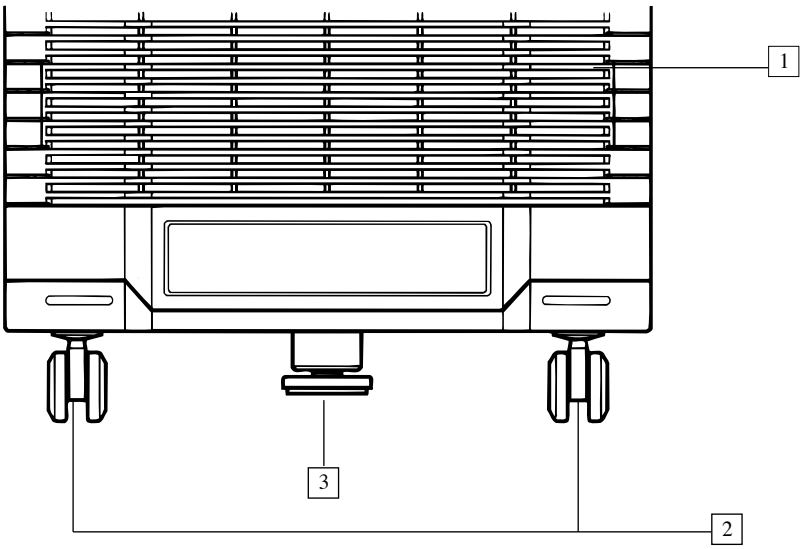


Fig. 5-9 PCR1000LA/PCR2000LA

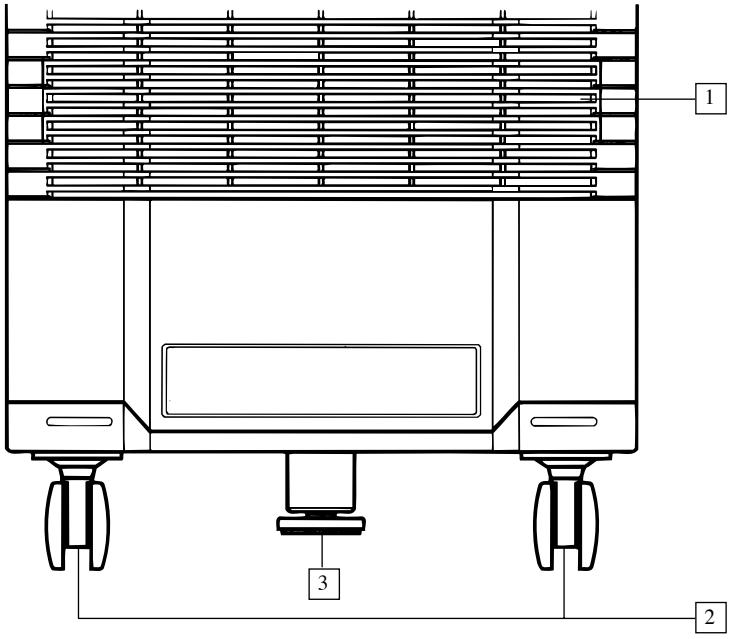


Fig. 5-10 PCR4000LA/PCR6000LA

[1] Air intake

For cooling the inside of the AC power supply. The built-in air filters require periodic cleaning.

[2] Rubber feet/casters

The PCR500LA has rubber feet. The PCR1000LA, PCR2000LA, PCR4000LA, and PCR6000LA have four casters that allow the AC power supply to be moved in any direction. The casters have a lock that temporarily fixes the power supply to the floor.

⚠CAUTION • To fix the AC power supply, always use the stopper described below, together with caster locks.

[3] Stoppers

Used to fix the AC power supply to a flat floor. Be sure to use the stoppers when installing the power supply.

5.2 Rear Panel

5.2.1 Upper Part of the Rear Panel

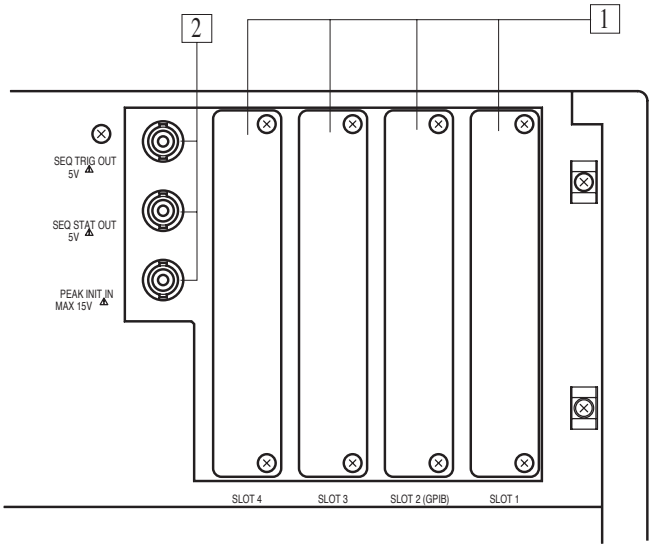


Fig. 5-11 Slots in the Upper Part of the Rear Panel

[1] SLOT1, SLOT2, SLOT3, and SLOT4

Used for insertion of an optional board

[2] BNC connectors

These connectors become functional when RS-232C Control or an option is being used.

For more information, see “8.9 Measurement of Power Factor, VA, and Peak Holding Current” and “8.15 Sequence Operation”.

5.2.2 Lower Part of the Rear Panel

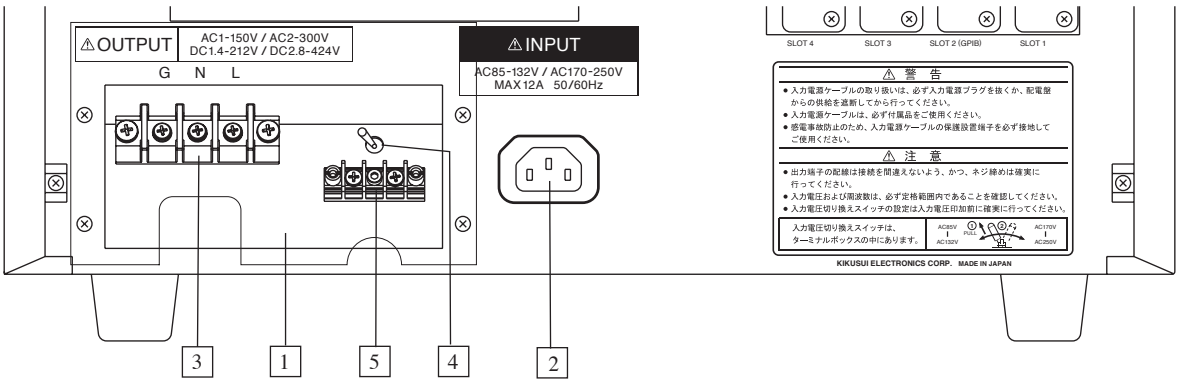
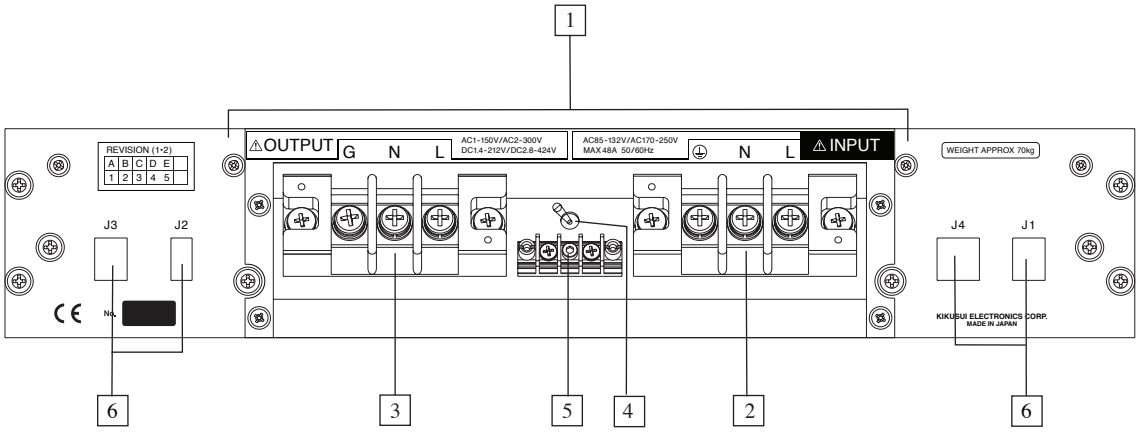


Fig. 5-12 PCR500LA



The PCR1000LA does not have the J1 to J4 connectors.

Fig. 5-13 PCR1000LA/PCR2000LA

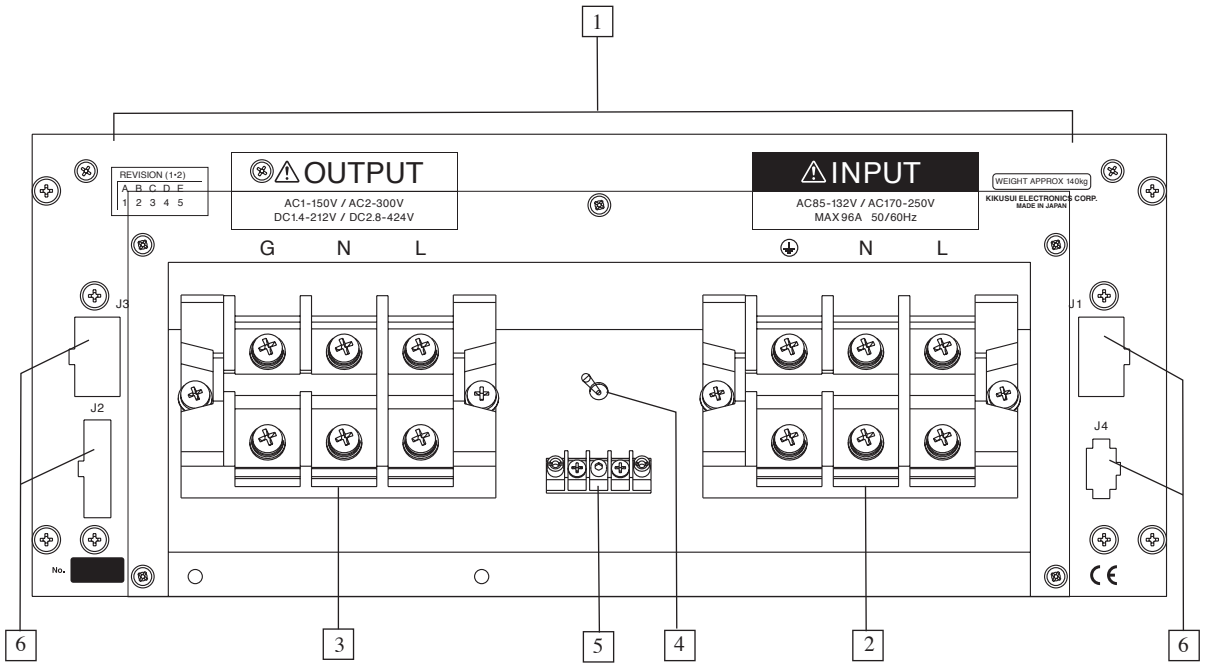


Fig. 5-14 PCR4000LA/PCR6000LA

[1] Terminal box

Incorporates the INPUT, OUTPUT, and SENSING terminal boards, as well as the INPUT VOLTAGE SELECTOR switch.

[2] INPUT terminal board

Used for input connections

⚠WARNING • Before connecting the input power cable, be sure to disconnect the power plug from the outlet, or cut off the power feed from the switchboard.

[3] OUTPUT terminal board

Used to connect a load

⚠WARNING • Before connecting an output cable, be sure to disconnect the input power plug from the outlet or cut off the power feed from the switchboard.

[4] INPUT VOLTAGE SELECTOR

The PCR6000LA has no INPUT VOLTAGE SELECTOR switch. This selector switch should be manipulated in accordance with the input voltage range. The selector is a lock-type toggle switch. Pull the knob to select the input voltage.

[5] SENSING terminal board

Used to connect sensing cables for use of the sensing function

[6] J1, J2, J3, J4

The PCR1000LA has these connectors. These are used to extend the AC power supply's functionality. They are not generally used.

5.2.3 Exhaust Port(s)

The exhaust port or ports are provided to cool the inside of the AC power supply using air.

⚠WARNING • Install the AC power supply at least 20 cm from the wall, and do not place any object within 20 cm from the exhaust port.

The figures below show the exhaust ports of the PCR500LA and PCR1000LA. The PCR2000LA, PCR4000LA, and PCR6000LA have different numbers of exhaust ports.

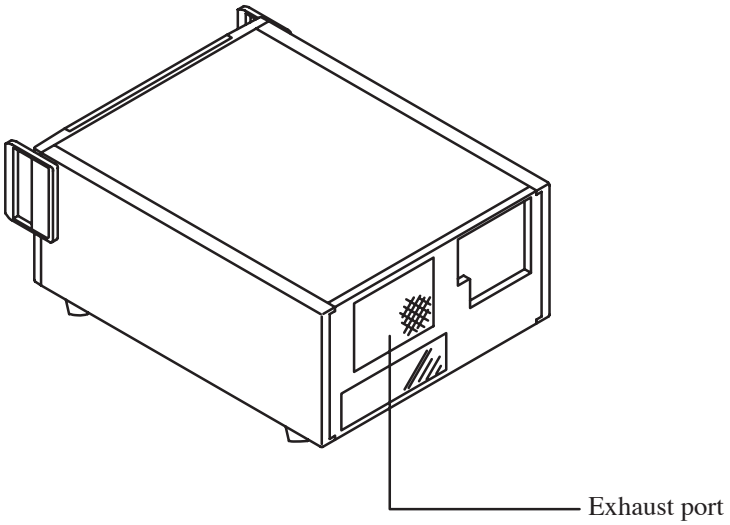


Fig. 5-15 PCR500LA

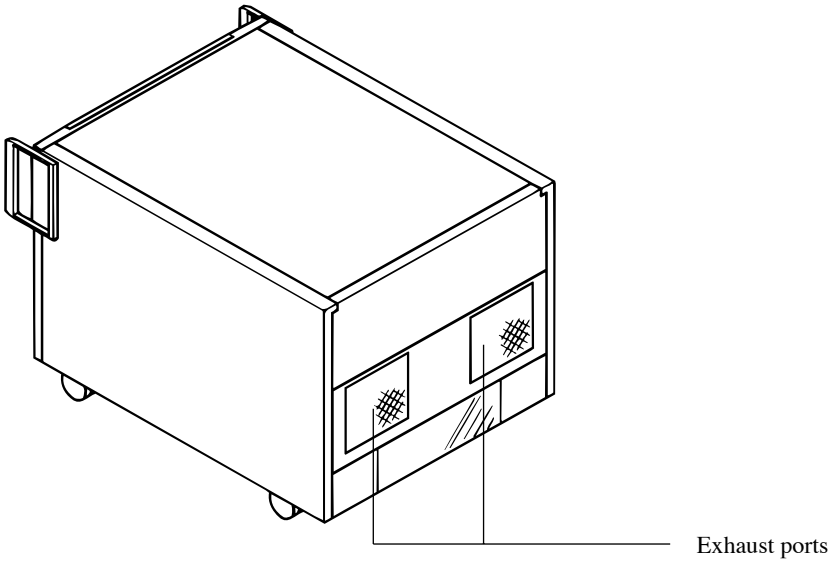


Fig. 5-16 PCR1000LA

6

Chapter 6 RS-232C and GPIB

Describes RS-232C Control and GPIB Control. The use of GPIB Control requires the optional IB03-PCR-LA (GPIB Interface).

6.1 Functional Description

The PCR-LA-series RS-232C Control or GPIB Control (optional) enables the following functions to be performed.

Power line abnormality simulation (interruption simulation)

The AC power supply allows simulation of interruption, fast voltage drop (dips), or fast voltage rise (pops). This function is used to test switching power supplies or electronics devices. For more information, see “8.14 Power Line Abnormality Simulation”.

Sequence operation

Specifying sequence operation by combining output voltage and frequency or other factors with time setting allows automatic operation. For more information, see “8.15 Sequence Operation”.

Harmonic current analysis function

Harmonic current analysis is available for output current from the AC power supply. Because the measurement method employed is simplified, it does not meet IEC or other standards. To conduct standard-compliant measurements, use our HA01F-PCR-L harmonics analyzer.

Special waveform output

This function allows the AC power supply to output any waveforms other than sine waves. The “peak-clipped waveform” in which the peak of a sine wave is suppressed is provided as standard. In addition, if user-defined waveform data is transferred to the power supply, a waveform can be output. For more information, see “8.18 Special Waveform Output”.

Output Impedance Setting

The AC power supply has output impedance (output resistance) of nearly 0 Ω; the commercial power supply system has impedance (resistance) of several mΩ to several Ω. When an option is connected, the power supply allows the output impedance to vary. This allows simulation of an environment similar to that of an actual commercial power line. In GPIB Control, the AC power supply can operate in the same status continuously with the IB03-PCR-LA option removed, as long as the setting conditions remain the same.

Measurements of Power Factor, VA, and Peak Holding Current

The AC power supply can conduct three measurements: power factor, VA, and peak holding current. With peak holding current measurement, the peak current is measured until the AC power supply receives a peak clear signal or message. Thus, this function is useful for measurement of a load inrush current observed at power-on, for example.

Output ON/OFF phase setting

Output ON/OFF phase setting is available individually. The set values will be stored in the PCR-LA power supply. In GPIB Control, the AC power supply can operate in the same status continuously with the IB03-PCR-LA option removed, as long as the setting conditions remain the same. For more information, see "8.20 Output ON/OFF Phase Setting".

AC + DC mode

This function allows the AC power supply to output a voltage waveform in which the AC voltage is superimposed on the DC voltage. For more information, see "8.21 AC + DC Mode".

Expansion of the memory function

The AC power supply allows nine sets of voltage and frequency settings to be stored in the memory (memory numbers 1 to 9), enabling data to be read as necessary. In RS-232C Control or GPIB Control, the power supply can accommodate a maximum of 99 sets of voltage and frequency set values in the memory.

To read the set values stored in the memory, the AC power supply or Remote Controller (RC03-PCR-LA or RC04-PCR-LA) should be used. Note that the memory numbers that can be read from the power supply or when the RC03-PCR-LA is used are 0 to 9 (0: initial setting). RS-232C Control or GPIB Control allows only data writing to the memory.

6.2 Combination with Other Options

A variety of options are provided for the PCR-LA-series power supplies. For more information on these options, see Chapter 10, Optional Equipment. Please note the RS-232C Control and GPIB Interface (optional) cannot be used together with the Remote Controller (RC03-PCR-LA or RC04-PCR-LA).

6.3 Preparation for RS-232C Control

6.3.1 Hardware Required

The following hardware is required to perform RS-232C Control.

- A computer used to control the AC power supply
  (Personal computer, sequencer, or other devices)
- RS-232C cable (9-pin, cross type)

6.3.2 Connecting the RS-232C Cable

Turn OFF the POWER switches of all devices including the AC power supply that make up an RS-232C system. Connect the RS-232C cable to the RS-232C connector on the front panel of the power supply.

6.3.3 RS-232C Settings

In RS-232 control, it is necessary to match communications parameters with those of the computer, and to set the response message terminator. The factory shipped settings are as shown below.

Table 6-1 Factory Shipped Settings

Communications parameters	Baud rate	19200 bps
	Stop bit	1 bit
	Data length	8 bits
	Parity	None
Response message terminator	CRLF	

NOTE

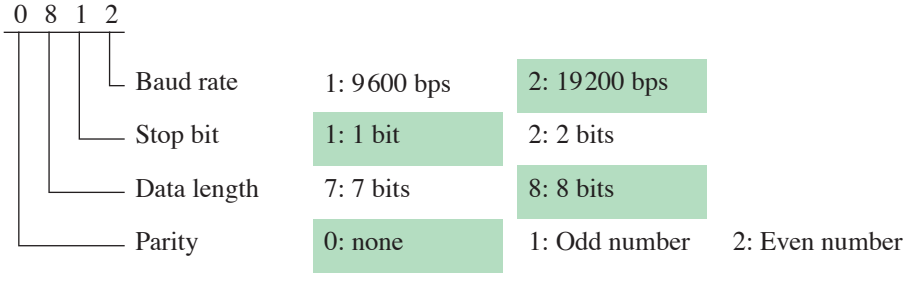
- The factory shipped settings partially differ from those of earlier PCR-L-series products. If the communication environment of the PCR-L series is used as is, be sure to check the settings.

To set any parameter to a value other than those specified in Table 6-1, perform the procedure specified below.

Setting the RS-232C Control Communications Parameters

1. Turn the POWER switch of the AC power supply ON.
2. Press the ESC key to select the Home Position.
3. Press the GPIB (SHIFT, F) key.

   This causes a four-digit number to appear in the frequency display area of the control panel. This number represents the RS-232C communications parameters. The number is set to “0812” at factory shipment.



The shaded items show the initial set values.

4. Using the numeric keys, enter communications parameters in four digits.

   For example, to set the baud rate to 19200 bps, the stop bit to 1 bit, the data length to 7 bits, and the parity to an odd number, enter "1712."

5. Press the ENT key to confirm the entry, and then press the ESC key to complete setting.

The set communications parameters will be enabled when the AC power supply is turned ON next.

Setting the RS-232C Response Message Terminator (Delimiter)

A terminator indicating the end of a response message is referred to as a "response message terminator." The factory shipped setting is CRLF.

This can be modified using the TERM command message.

For information on the TERM command message, see Page 9-9 "TERM".

6.3.4 RS-232C Flow Control

Xon/Xoff control enables control of sending and receiving of the AC power supply. These control codes are executed by DC (device control) codes.

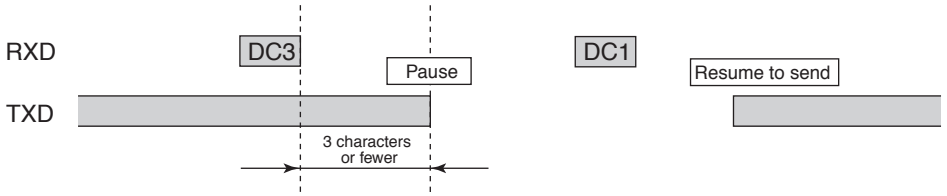
Table 6-2 DC (device control) Codes

	Function	ASCII code
DC1	Request to send	11h
DC3	Request to stop sending	13h

NOTE

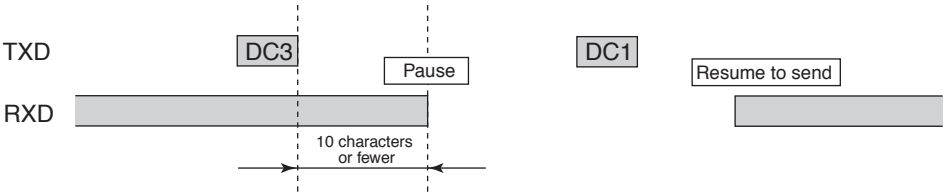
- If the AC power supply is equipped with the GPIB Interface option (IB03-PCR-LA), GPIB Control has precedence over RS-232C Control, thereby disabling RS-232C Control (the RS-232C Control communications parameters cannot be set).

Transmission control from the RS-232C terminal to the PCR-LA power supply



The PCR-LA power supply will pause transmission within three characters after receiving DC3.

Transmission control from the PCR-LA power supply to the RS-232C terminal



The RS-232C terminal should pause transmission within 10 characters after receiving DC3.

Fig.6-1 Transmission Control between the RS-232C Terminal and the PCR-LA Power Supply

6.4 Preparation for GPIB Control (Option)

6.4.1 Hardware Required

The following hardware is required to perform GPIB Control.

- A computer used to control the AC power supply
  (Personal computer, workstation, or GPIB card)
- GPIB cable
  Kikusui also sells GPIB cables. If you require them, contact your Kikusui distributor/agent.

  GPIB cable, 1 m (part number: 92080)

  GPIB cable, 2 m (part number: 92070)

  GPIB cable, 4 m (part number: 92090)
- IB03-PCR-LA (option: GPIB Interface)
  For more information on this option, see Chapter 10, Optional Equipment, and “10.1 Option Types and Option Combinations”.

6.4.2 Connecting the GPIB Cable

Turn OFF the POWER switches of all devices, including the AC power supply, that make up a GPIB system.

Connect the GPIB cable to the GPIB connector of the IB03-PCR-LA GPIB INTERFACE option installed in the AC power supply.

6.4.3 GPIB Setting

With GPIB Control, it is necessary to set the GPIB address and the response message terminator.

The factory shipped settings are as shown below.

Table 6-3 Factory Shipped Settings

GPIB address	1
Response message terminator	CRLF+EOI

To set any parameter to a value other than those specified in Table 6-3, perform the procedure specified below.

Setting the GPIB Address

1. Turn the POWER switch of the AC power supply ON.
2. Press the ESC key to select the Home Position.
3. Press the GPIB (SHIFT, F) key.

   This causes a number to appear in the frequency display area of the control panel, and "GP-IB ADRS" to the left of it to light up.

   This number represents the GPIB address.

   The number is set to "1" at factory shipment.
4. Using the numeric keys, enter the GPIB address (0 to 30).
5. Press the ENT key to confirm the entry, and then press the ESC key to complete setting.

The set GPIB address will be enabled when the AC power supply is turned ON next.

Setting the GPIB Response Message Terminator (Delimiter)

A terminator indicating the end of a response message is referred to as a "response message terminator."

1. Turn the POWER switch of the AC power supply ON.
2. Press the ESC key to select the Home Position.
3. Press the GPIB (SHIFT, F) key twice.

   This causes a number to appear in the frequency display area of the control panel, and "GP-IB DLIM" to the left of it to light up.

   This number represents the response message terminator.

   The number is set to "0" at factory shipment.

Table 6-4 Relationship between Number Displayed and Terminator

Number	Response Message Terminator	
0	CRLF+EOI	Factory shipped setting
1	CR+EOI	
2	LF+EOI	
3	EOI	

CR: Carriage Return

LF: Line Feed

EOI: End or Identify

4. Using the numeric keys, JOG, or SHUTTLE, enter the response message terminator number.
5. Press the ENT key to confirm the entry, and then press the ESC key to end setting.

The set response message terminator will be enabled when the AC power supply is turned ON next.

This response message terminator can be modified using the TERM command message.

For information on the TERM command message, see Page 9-9 "TERM".

6.5 Setting Command Compatibility with the PCR-L

The PCR-LA series provides command compatibility with the PCR-L series (conventional product). However, some of the GPIB and RS-232C response messages are incompatible with the PCR-L series. To provide command compatibility with the PCR-L series, follow the procedure specified on the next page to set the PCR-L mode.

There are the following two modes for setting command compatibility with the PCR-L.

- PCR-LA mode: PCR-LA standard condition
- PCR-L mode: Status of compatibility with the PCR-L

1. Turn the POWER switch of the AC power supply ON.
2. Press the ESC key to select the Home Position.
3. Press the GP-IB (SHIFT, F) key twice. If the GPIB interface option (IB03-PCR-LA) has been installed, press it three times.

   Then, "LA" or "L" is displayed in frequency display area of the control panel.

   The "LA" indication represents the PCR-LA mode, while the "L" indication represents the PCR-L mode.

4. Press the "0" or "1" numeric key.

   "0" indicates the PCR-LA mode and "1" denotes the PCR-L mode.

5. Press the ENT key to accept the mode, then press the ESC key.

NOTE

- Command compatibility with the PCR-L is set to the PCR-LA mode at factory shipment. If the compatibility setting is modified after the above procedure is performed, the new setting will be stored.
- Setting of command compatibility with the PCR-L cannot be modified by any means other than the above. Even if a reset is performed to bring the AC power supply into the initial setup status, the mode cannot be changed.

■ Differences between the PCR-LA and PCR-L Modes

GPIB and RS-232C Commands	PCR-LA Mode	PCR-L Mode
Response message in response to the following *1	Returns “0” or “1”	Returns “000” or “001”
Response message in response to ACDC? or TERM?	Returns “0,” “1,” “2,” or “3”	Returns “000,” “001,” “002,” or “003”
Response message in response to MEMSTOxx?, FSTOxx?, or VSTOxx?	Does not include “xx” (memory number)	Includes “xx” (memory number)
Response message in response to STB?	Returns bit 0, 1, 2, 3, 4, 5, and/or 6	Returns bit 0, 1, 2, 3, 5, and/or 6. Bit 4 (DSB) is not returned. *2
Response message in response to ERR?	Returns bit 0, 1, 2, and/or 3	Returns bit 0, 1, and/or 7 *3

*1. HEAD?, OUT?, RANGE?, SYNC?, FFT?, SIMMODE?, INT?, RUNNING?, and SEQPAUSE?

*2. See “ Status Byte Register” on Page 9-55 .

*3. See “ Error Register” on Page 9-57 .

6.6 Messages and Terminators

This section designates and describes the items in this manual that relate to communication between the computer (controller) and the PCR-LA power supply (device). See Fig. 6-2 below.

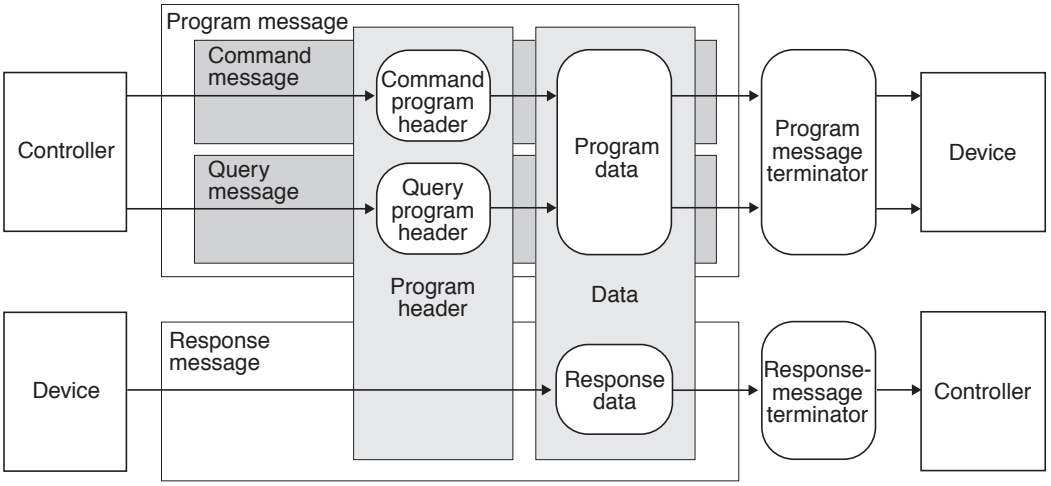


Fig. 6-2 Messages and Terminators

6.6.1 Messages

Commands sent from the computer to the PCR-LA power supply are referred to as "program messages." Responses sent from the power supply to the computer are designated "response messages."

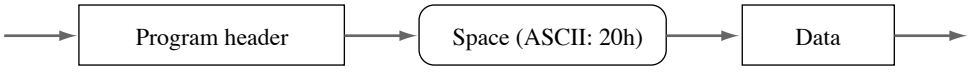
Each message consists of the program header section and data section.

Program Message

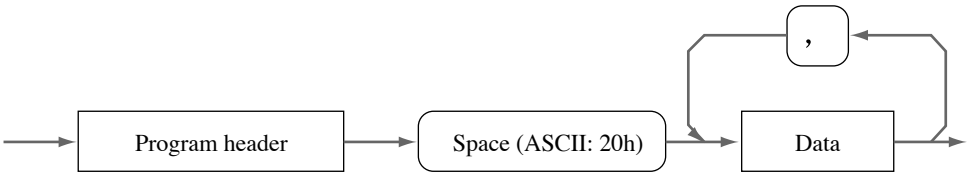
Program messages are further divided into a command message and query message. A command message executes a specific function of the PCR-LA AC power supply or modifies settings, while a query message inquires about the setting or status of the power supply.

Writing a Program Message

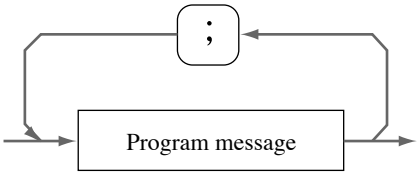
- Space (ASCII: 20h) is required between the program header and data sections.



- If there are multiple pieces of data, use a comma "," (ASCII: 2Ch) to link them.



- Program messages are concatenated using a semicolon ";" (ASCII: 3Bh).



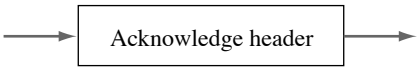
- A program message may consist of either upper- or lower-case letters.

NOTE

- When writing data in hexadecimal representation, append "#H" to it.
  The #H format is supported by register-related program messages only.
  Example: To write decimal number 10 as a hexadecimal number, write it as "#H0A."
- Appending "@" to the end of a program message or query message holds off GPIB until the message concerned is complete. Note that, for a command message terminator consisting of only EOI, "@@" should be appended. The hold-off status is specific to the IB03-PCR-LA GPIB Interface.

Acknowledge Message (RS-232C)

An acknowledge message is specific to RS-232C Control and is information sent from the PCR-LA power supply to the controller. It informs the controller of the completion of processing of a program message.



The acknowledge message is an ASCII-code character string consisting of the header only. It has the following two types:

- OK Normal end
- ERROR Occurrence of an abnormality such as a syntax error, etc.

The SILENT command message can be used to set whether to return an acknowledge message. For more information, see Page 9-9 "TERM".

6.6.2 Terminators

A terminator indicating the end of a program message is referred to as a “program message terminator,” while a terminator indicating the end of a response message is designated a “response message terminator.”

- **Program message terminator**

  Any of those in the table below can be used. Presetting is not necessary.

Table 6-5 Program Message Terminators

RS-232C	GPIB
CRLF	CRLF+EOI
CR	CR+EOI
LF	LF+EOI
	EOI

- **Response message terminator**

  For more information on this, see Page 9-9 “TERM” for RS-232C and Page 6-8 “Setting the GPIB Response Message Terminator (Delimiter)” for GPIB.

6.7 Messages and Registers

The program messages and response messages supported by the PCR-LA power supply are referred to as “device messages.” Device messages show at Chapter 9, Descriptions of RS-232C and GPIB Messages.

Special Symbols and Characters

The special symbols and characters for writing a program message or response message that are used in this manual are defined below.

Table 6-6 Definition of Special Symbols and Characters

Symbol and Character	Description
< >	The characters or numbers enclosed by these brackets are program data. In actual programs, do not add these brackets.
{ }	If characters or numbers are enclosed by these brackets and separated by “|”, one of them should be selected. In actual programs, do not insert the brackets.
<NR1>	Indicates an integer This is described in detail in IEEE Standard 488.2, Standard Digital Interface for Programmable Instruments.
<NR2>	Indicates a real number This is described in detail in IEEE Standard 488.2, Standard Digital Interface for Programmable Instruments.
<NR3>	Indicates an exponent This is described in detail in IEEE Standard 488.2, Standard Digital Interface for Programmable Instruments.
<HEX>	Indicates a hexadecimal This is described in detail in IEEE Standard 488.2, Standard Digital Interface for Programmable Instruments.

Chapter 7 Maintenance

Describes the maintenance procedures for the AC power supply. Also explains the remedies for possible malfunctions encountered during use of the power supply.

7.1 Maintenance

⚠WARNING • There is a possibility of electric shock, which could result in injury or death. Always turn OFF the POWER switch followed by the switch on the switchboard.

7.1.1 Cleaning the Panel Surface

When the panel becomes soiled, wet a piece of soft cloth with a water-diluted neutral detergent and wipe the panel gently.

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

7.1.2 Cleaning the Air-intake Filters

The inside of the louver on the front panel is equipped with air-intake filters. Clean these filters periodically before they become extremely clogged.

⚠CAUTION • If an air-intake filter becomes clogged, the internal cooling effects of the AC power supply degrade, which may cause a problem or shorten life.

1. Press the latches at both ends of the louver, and pull the entire louver to remove it from the AC power supply.

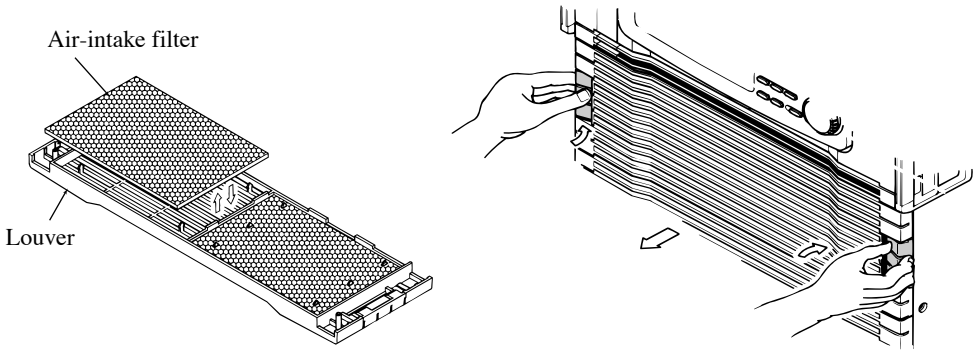


Fig.7-1 Removing the Louver and Air-intake Filters

2. Remove the air-intake filters from the inside of the louver, and clean them.

Using a vacuum cleaner, remove any dust or dirt from the filters. If a filter is extremely dirty, clean it using a neutral detergent diluted with water, and then dry it thoroughly.

⚠ CAUTION

- While it is in operation, the AC power supply sucks air through the air-intake filters to cool the inside of the power supply. Thus, if an air-intake filter is wet, the humidity inside the power supply will rise, which may cause a problem.

3. Install the air-intake filters in the louver.
4. Check the top and bottom of the louver (the top part has guide pins). Hold both ends of the louver, then align the guide pins with the power supply's guide holes.

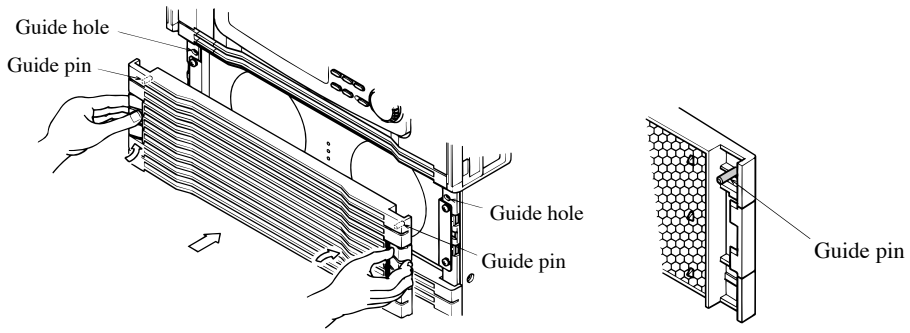


Fig. 7-2 Installing the Louver

5. By pushing the latches of the louver, attach the louver to the power supply.

7.2 Malfunctions and Causes

This section describes some symptoms of possible malfunctions encountered during use of the AC power supply, along with appropriate remedies. We provide seven typical symptoms and possible check items for each; you simply find the relevant item. Ideally, you will be able to eliminate these symptoms without difficulty. When you find a relevant item, follow the corresponding remedy. If this does not solve or improve the problem or if no relevant item can be located, contact your Kikusui distributor/agent.

Symptom 1: The LINE lamp does not light up.

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the rated voltage is being applied to the INPUT terminal board.	No	- The input power cable has been improperly connected. - The input power cable has been broken.	Check to confirm that the input power cable is not damaged and that the wires are securely connected to the terminals.
	Yes	- The AC power supply is defective.	Immediately turn OFF the switch on the switchboard. Stop using the AC power supply and contact your Kikusui agent to request repairs.

Symptom 2: The control panel display unit does not light up even when the POWER switch is turned ON.

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the rated voltage is being applied to the INPUT terminal board.	No	- The input power cable has been improperly connected. - The input power cable has been broken.	Check to confirm that the input power cable is not damaged and that the wires are securely connected to the terminals.
	Yes	The special connector (for short-circuiting specific connectors) has not been inserted into connector J4 at the lower rear of the AC power supply.	For the PCR2000LA, PCR4000LA, or PCR6000LA, insert the special connector into connector J4 at the lower rear of the AC power supply. The equipment is shipped with the special connector inserted into the J4 connector.
		- The AC power supply is defective.	Immediately turn OFF the switch on the switchboard. Stop using the AC power supply and contact your Kikusui agent to request repairs.

Symptom 3: Some of or all of the sections of the control panel do not operate.

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the key-lock mode has been activated.	Yes	- The key-lock function has activated.	Cancel the key-lock function. See “3.1.3 Key-lock Function”.
	No	- The AC power supply is defective.	Immediately stop using the AC power supply, and contact your Kikusui agent to request repairs.
Check whether the input voltage is within the rated range.	Yes	- The AC power supply is abnormal.	Immediately stop using the AC power supply, and contact your Kikusui agent to request repairs.
	No	- The input voltage is improper.	Check the input voltage.
Check whether ALARM is lit.	Yes	- A problem occurred in or outside the AC power supply.	Check the type of the alarm. See “4.6.1 Steps to be Taken in the Event of an Alarm”.
Check for the existence of a device generating a large amount of noise near the AC power supply.	Yes	- Malfunction occurred due to noise.	Locate the AC power supply away from the noise-generating source.
Check whether RS-232C or GPIB (IB03-PCR-LA) Control has been performed.	Yes	- The AC power supply is under external control.	Normal status
Check whether the voltage and frequency are within the limit ranges.	No	- The limit value setting is inappropriate.	Set the correct limit values. See “4.2 Limit Value Setting”.

Symptom 4: ALARM lights up

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the fan has stopped.	Yes	- The overheat protection (alarm 2) has activated due to a defective fan.	Immediately stop using the AC power supply, and contact your Kikusui agent to request repairs.
Check whether an exhaust port or air intake is blocked.	Yes	- The overheat protection (alarm 2) has activated. - The air-intake filters are clogged.	Locate the AC power supply at least 20 cm from the wall, and do not place any object within 20 cm of the exhaust port. Clean the air-intake filters to eliminate clogging.
Check whether the ambient temperature exceeds 50°C.	Yes	- The overheat protection (alarm 2) has activated.	Use the AC power supply at an ambient temperature of below 50°C. Install a load generating heat away from the power supply.

Symptom 5: The control panel display is not normal.

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the input voltage is within the rated range.	No	- The input voltage is abnormal.	Check the input voltage.
Check for the existence of a device generating a large amount of noise near the AC power supply.	Yes	- Malfunction occurred due to noise.	Locate the AC power supply away from the noise-generating source.
Check whether the S-MODE is lit (not including S-MODE5).	Yes	- The setting established for use of an option has been held.	Cancel the key-lock function and perform a reset. This causes the settings to return to the initial setup status. See the reset procedure specified in "2.7 Operation Check", and "3.1.3 Key-lock Function".

Symptom 6: The output voltage waveform is distorted.

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether OVERLOAD is lit.	Yes	- The internal overload protection (alarm 3) has activated.	An overload may have occurred. Check the load.
	No	- The AC power supply is defective.	Immediately stop using the AC power supply and contact your Kikusui agent to request repairs.

Symptom 7: The output current cannot be obtained (OVERLOAD is lit).

Check item		Possible cause	Remedy
Location and condition of the item concerned	Check results		
Check whether the output voltage range is correct.	No	- The output voltage range is in the 200 V range.	Set the correct output voltage range.
Check whether the load power factor is low.	Yes	- The internal circuit protection has activated. - A load having a capacitor input-type rectifier circuit or a nonlinear load has been connected.	Improve the load power factor. See "8.4 Outputs and Loads".
Check whether the current limit has been properly set.	No	- The current limit value setting is inappropriate.	Set the correct current limit value. See "4.2 Limit Value Setting".
Check whether the AC power supply is in the DC mode.	Yes	- In the DC mode, rated output current is half of that in the AC mode.	An overload may have occurred. Check the load.

Chapter 8 References and Descriptions

Summarizes the technical descriptions of the functions and performance of the AC power supply.

8.1 Relationship to Earlier PCR-L-series Products

Products in the PCR-LA series generally cannot be combined with earlier PCR-L-series products, including options. For details on the options, see Chapter 10, Optional Equipment.

8.2 Requirements of the Input Power Cable

Use the input power cable provided with the product. This cable is suited for the capacity of the product. If the cable length to the switchboard is too short, the customer should provide an extension cable. In such cases, use a cable with a wire size (nominal conductor cross section) greater than that specified in the table below.

Wire size [mm^2]	AWG	(Reference cross section) [mm^2]	Allowable current (*) [A] (Ta = 30°C)	Kikusui-recommended current [A]
0.9	18	(0.82)	17	-
1.25	16	(1.31)	19	-
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

* Based on “Allowable Currents for Low Voltage Indoor Wiring” in article 172 of the Technical Standard for Electric Facilities in Japan

The values in the above table are for a typical single-core cable. Values differ depending on the cable covering (insulator) and material (allowable temperature) used, or whether or not they are multi-core cables. For cables other than those specified in the table, please consult with the qualified personnel.

Use a grounding cable equal to or greater in size as the cables for the L and N terminals. A thin grounding cable may result in problems.

Check the current capacity of the line voltage (such as the power outlet or switchboard). Insufficient current capacity may cause abnormally high temperatures at the power input point, or may trip a circuit breaker.

8.3 Output Impedance When Output Is OFF

This power supply does not cut off output from internal circuits mechanically using switches and relays. Instead, it increases the output impedance electronically to turn the output off. This allows output to be turned ON/OFF without producing any contact chatter. When output is OFF, the output is in a high-impedance state. In addition, the output voltage of the power supply approaches 0 V.

Output is in a high impedance state when it is OFF.

In this condition, the impedance (resistance R_{OFF}) is basically as follows.

- For the 100 V output range:
  R_{OFF} = approx. 8 / N [kΩ]
- For the 200 V output range:
  R_{OFF} = approx. 32 / N [kΩ]

"N" indicates a value equivalent to the PCR-LA series rated output capacity [kVA].

Example: Impedance in the PCR2000LA's 200 V output range

R_{OFF} = approx. 32 / 2 [kΩ] = approx. 16 [kΩ]

NOTE

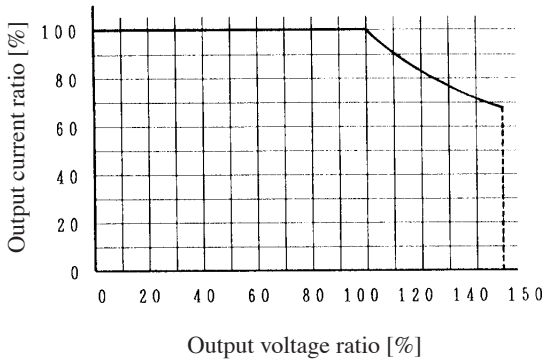
- Because the noted impedance is present even when output is OFF, if the load is a battery or the like, a slight current may flow into the power supply, causing discharge.

8.4 Outputs and Loads

Rated Output Current in AC and AC-S Modes

■ For linear loads

The rated AC output current obtained from the AC power supply is limited by the conditions of the power supply output voltage, load power factor, and output frequency, as shown in the graphs (Fig. 8-1 to Fig. 8-3).



- The output current ratio shows the percentage obtained when the maximum rated output current is regarded as 100 %.
- The output voltage ratio shows the percentage obtained when 100 V/200 V output voltage is regarded as 100 % for the 100 V/200 V output range.

Fig.8-1 Output Voltage Ratio vs. Rated Output Current: AC Mode

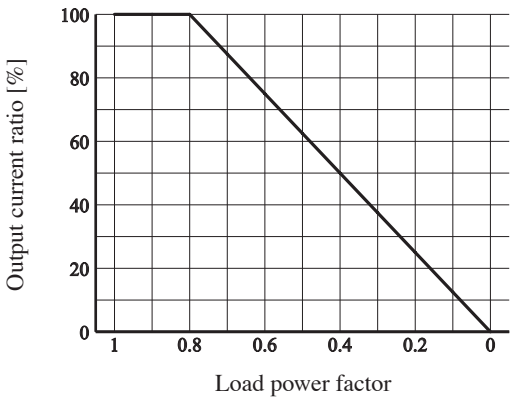


Fig. 8-2 Load Power Factor vs. Rated Output Current

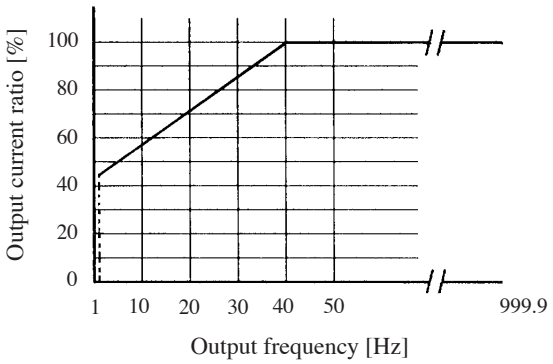


Fig. 8-3 Output Frequency vs. Rated Output Current

■ Obtaining the rated output current for the PCR1000LA

Example 1: Where the output voltage is 115 V (100 V range), the load power factor is 0.7, and the output frequency is 25 Hz.

From the graphs (Fig. 8-1 to Fig. 8-3):

- The output current percentage at an output voltage of 115 V is 87 %. ---------- (a)
- The output current percentage at a load power factor of 0.7 is 87.5 %. ---------- (b)
- The output current percentage at an output frequency of 25 Hz is 78 %. ---------- (c)

Based on conditions (a) and (b), the output current percentage at an output voltage of 115 V and a load power factor of 0.7 is (a) x (b) = 76.1 [%]. When this value is compared with (c), it is found to be lower than (c); the rated output current is limited by the value obtained by (a) x (b). Thus, the maximum output current percentage is 76.1 % obtained by (a) x (b).

For the PCR1000LA, because the output current available with respect to 100 % output current percentage in the 100 V output range is 10 A, the rated output current under the above conditions is 10 x 0.761 = 7.61 [A].

Example 2: Where the output voltage is 240 V (200 V range), the load power factor is 0.65, and the output frequency is 15 Hz

From the graphs (Fig. 8-1 to Fig. 8-3):

- The output current percentage at an output voltage of 240 V is 83 %. ---------- (a)
- The output current percentage at a load power factor of 0.65 is 81 %. ---------- (b)
- The output current percentage at an output frequency of 15 Hz is 64 %. ---------- (c)

Based on conditions (a) and (b), the output current percentage at an output voltage of 240 V and a load power factor of 0.65 is (a) x (b) = 67.2 [%]. When this value is compared with (c), (c) is found to be lower; the rated output current is limited by the value of (c). Thus, the maximum output current percentage is 64 %.

For the PCR1000LA, because the output current available for 100 % output current percentage in the 200 V output range is 5 A, the rated output current under the above conditions is 5 x 0.64 = 3.2 [A].

For both examples 1 and 2, the control panel's LOAD level meter indicates the limited output current as the full scale.

If the AC power supply is used beyond the conditions of the rated output current specified above, the power supply protective function is activated, which may cause the output voltage to drop or to be cut off altogether.

■ For loads having a capacitor input-type rectifier circuit

When electronic devices having a capacitor input-type rectifier circuit are used as loads for this power supply, a peak current several times greater than the output current rms flows near the peak output voltage as the output current.

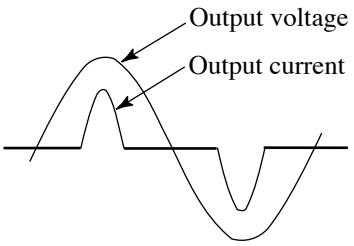


Fig. 8-4 Waveform of Capacitor Input-type Rectifier Circuit

In this case, the maximum output peak current must not exceed four times the maximum rated current (rated output capacity [VA]/100 [V] (for the 100 V range) or rated output capacity [VA]/200 [V] (for the 200 V range)). In addition, the output current rms should not exceed the rated output current value calculated when the load power factor is 1, as in the case of the liner load noted above.

If the AC power supply is used at a current exceeding the rated output current (peak or rms) specified above, the power supply protective function is activated, which may distort the output voltage waveform or cut off the output. However, the output voltage (set value) must be a constant voltage to supply the above-specified maximum peak current without distortion. It may distort the voltage waveform and current waveform if the output voltage set value is suddenly changed (raised). In optional power line abnormality simulation or sequence operations, a change in output voltage may similarly distort the waveform. If the output voltage set value is a constant value in OUTPUT ON, the power supply can supply the maximum peak current without distortion.

■ For loads that draw an inrush current

For the loads specified below, an inrush current (several to several tens of times greater than the normal current) may flow during several to several tens of cycles of output frequency when voltage is applied to such a load or when the voltage changes suddenly.

Transformers and slide transformers

When voltage is applied to a transformer or slide transformer, an inrush current of a maximum of several tens to hundreds of times greater than the normal current may flow during several cycles, depending on the voltage application timing or the state of biased magnetization.

Motors and lamp loads

When voltage is applied to a motor or lamp load, an inrush current of several to several tens of times greater than the normal current may flow during several tens to hundreds of cycles.

For loads having a capacitor input-type rectifier circuit

For electronics devices with a capacitor input-type rectifier circuit in a power input block, if a protective (limiting) circuit against an inrush current is not provided, an inrush current several tens to hundreds of times greater than the normal current may flow during several cycles.

The AC power supply is capable of feeding a maximum output peak current up to four times greater than the maximum output rms current for a load having a capacitor input-type rectifier circuit. For other loads, the power supply can supply an instantaneous peak current for approx. 5 seconds (this may differ depending on the current waveform, output voltage, and output frequency). For example, the instantaneous peak current that can be supplied when the output voltage is 100 V and the output frequency is 50 Hz is specified in the table below.

Load power factor	Instantaneous peak current percentage* [%]
1.0	200
0.9	160
0.8	150
0.6	140
0.4	120
0.2	110

* The values in the table above show the output current percentage where the PCR-LA-series maximum output current is regarded as 100 %.

If an inrush current exceeding the specified peak current flows, the power supply protective function is activated, which may distort the output voltage waveform or cut off the output.

■ For loads in which a surge occurs

Loads (such as a fluorescent lamp) subject to surges when voltage is applied or the voltage changes suddenly may cause the AC power supply to malfunction. In such cases, install a noise filter in the output circuit.

■ For special loads

If a capacitor is directly connected to the OUTPUT terminal board or OUTPUT outlet, the output waveform may be distorted. In such cases, connect a capacitor to the loaded side of the output wiring.

■ For loads having a small saturation magnetic flux density

To conduct power supply simulations and other functions, the AC power supply incorporates a DC amplifier. Thus, the DC offset voltage (approx. 100 mV) may be superimposed on AC output in the AC mode. If a load such as a transformer having a small saturation magnetic flux density is connected to the output, an excessive current may flow. In such cases, use the AC-S mode.

DC Mode

The rated DC output current obtained from this power supply is limited by the power supply's output voltage, as shown in the graph (Fig. 8-5).

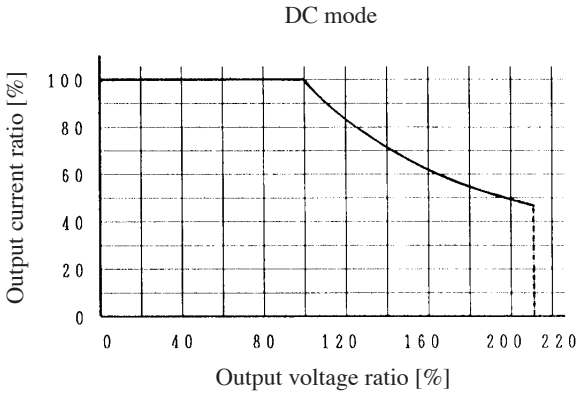


Fig. 8-5 Output Voltage Ratio vs. Rated Output Current: DC Mode

Use of the AC power supply at an output current exceeding the rated DC output current activates the power supply protective function, which may cause the output voltage to drop or to be cut off.

The output current ratio shows the percentage obtained when the maximum rated current in the DC mode is regarded as 100 %.

The output voltage ratio shows the percentage obtained when output voltage of 100 V/200 V is regarded as 100 % for the 100 V/200 V DC output range, respectively.

8.5 Overload Protective Functions

The AC power supply has two types of overload protective functions: the current limiting function and the internal semiconductor protective function.

Current Limiting Function

This function is activated if the AC power supply's output current exceeds the current limit value (maximum setting: 1.1 times the rated output current). If a current exceeding the current limit flows in a load, "OVERLOAD" will light up and the output voltage will drop. If this condition continues for either approx. 10 sec. (in the AC or AC-S mode) or approx. 1 sec. (in the DC mode), this function will automatically turn the output OFF.

Internal Semiconductor Protective Function

This function protects the semiconductors in the AC power supply. As long as the use method of the AC power supply agrees with the specifications, the internal semiconductor protective function will not normally activate. However, in the event of an instantaneous overcurrent such as an inrush current, the internal semiconductor protective function will activate; if such a status continues for a few seconds, an overload will occur.

Even if the internal semiconductor protective function is activated, an overload will not occur for a few seconds. However, the output voltage waveform will be distorted during this period due to activation of the semiconductor protective function.

Even if no overload occurs, frequent operation of the internal semiconductor protective function may cause a problem in the AC power supply.

■ Causes of and Remedies for Overload Status

If the internal semiconductor protective function is activated, take the following remedies. In such cases, wait more than 1 minute before resuming operations.

When the cause of the activation of the internal semiconductor protective function is eliminated, the internal semiconductor protective function is automatically cancelled. Turning the OUTPUT ON while this protective function is activated may not only disable cancellation of an overload, but will cause a failure. Similarly, when the internal semiconductor protective function is activated, clearing an alarm will not cancel an overload.

For a linear load

Overload actuating condition		Remedy
Gradual output current increase	- If the voltage drops as shown in Fig. 8-6(a), the current limiting function has activated. - If the output voltage waveform is distorted as shown in Fig. 8-6(b-1), (b-2), the internal semiconductor protective function has activated.	- If the current limit value is set low, change the set value. - If the rated current has been exceeded, reduce the load capacity. - If the power factor is low (lagged phase), use a phase-advancing capacitor to increase the power factor.
Rapid output current increase	- If the output voltage waveform is distorted as shown in Fig. 8-6(b-1), (b-2) and (c), the internal semiconductor protective function has activated.	- If the power factor is low (lead phase), use dummy resistance in parallel to the load to increase the power factor.

For a load having a capacitor input-type rectifier circuit

Overload actuating condition		Remedy
Output current increase	- If the voltage drops as shown in Fig. 8-6(a), the output current (rms value) has exceeded the current limit value. That is, the current limiting function has activated.	- If a current limit value has been set, change the set value. - If the rated current has been exceeded, reduce the load capacity.
	- If the output voltage waveform is distorted as shown in Fig. 8-6(c), the output peak current has activated the internal semiconductor protective function.	- Reduce the peak current.

For a load that draws an inrush current

Overload actuating condition		Remedy
At voltage application to a load or at sudden voltage change	- If the voltage waveform is distorted as shown in Fig. 8-6(c), an inrush current has activated the internal semiconductor protective function.	- Reduce the inrush current.

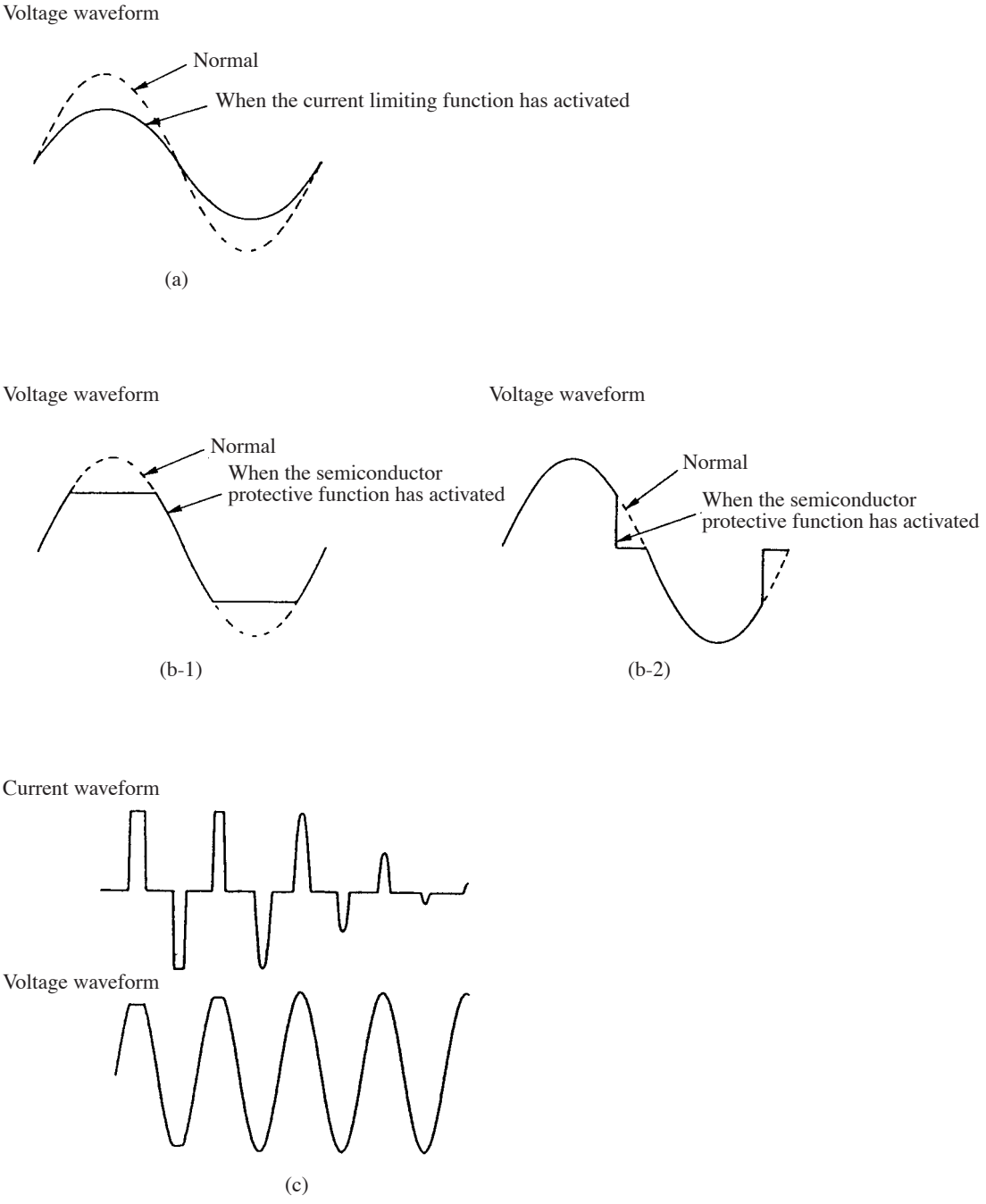


Fig. 8-6 Overload Actuating Condition (a), (b-1), (b-2), (c)

8.6 Differences between the AC and AC-S Modes

To implement DC output, power line abnormality simulations, or other functions, the AC power supply incorporates a DC amplifier.

In the AC mode, an AC signal (AC REF) generated in the power supply is directly input to the DC amplifier. Thus, this AC REF signal can be faithfully power-amplified and output. At the same time, however, a DC voltage component contained in the AC REF signal is also amplified and output (the DC offset voltage is directly superimposed on the AC output voltage). Because this DC offset voltage is only several 100 mV (1/1000 of the AC output voltage value), there is no problem with general loads. However, an unexpected excitation (biased magnetization) current may flow in a transformer/slide transformer with small saturation magnetic flux density or the like.

In AC-S mode, the AC REF signal is AC-coupled to the DC amplifier. Thus, the DC offset voltage becomes several 10 mV or less, thereby suppressing biased magnetization in a transformer or slide transformer.

Note that the output voltage is slightly reduced in the low-frequency zone, as input to the amplifier is AC-coupled. This results in a frequency characteristics within ±1 % with 200 Hz as the reference in the range of 40 Hz to 999.9 Hz.

Moreover, be aware that performance is limited when an option is used to perform a power line abnormality simulation or special waveform output. For more information on this, see the operation manual of the relevant option.

8.7 Voltage Display Modes and Measurement Methods

■ Two voltage display modes

Set voltage display: Displays the currently set voltage

Measured voltage display: Displays the current output voltage measured value by one of three measurement methods

■ Three sampling methods

The displayed output voltage value is calculated from 256 points of data obtained through sampling of the output voltage. The following three sampling methods can be used for the set frequency.

1. Set frequency between ≥ 1 Hz and < 16 Hz

256 points are sampled in one period of waveform in real time. Because data for calculation is obtained in one period of waveform, the measurement window is one period.

2. Set frequency between ≥ 16 Hz and < 256 Hz

Sixteen points are sampled in one period of waveform. This sampling is repeated 16 times, and 256 points of data are obtained. Because 16 periods of waveform are required to obtain data for calculation, the measurement window is 16 periods.

3. Set frequency between ≥ 256 Hz and < 1 kHz

One point is sampled in one period of waveform. This sampling is repeated 256 times, and 256 points of data are obtained. Because 256 periods of waveform are required to obtain data for calculation, the measurement window is 256 periods.

■ Three measurement methods

The output voltage measurement method includes rms value measurement, peak value measurement, and average value measurement. One of these measurement methods should be set for voltage measurement. The features of these measurement methods are as follows:

1. Rms value measurement (RMS)

The rms value is calculated from 256 points of data obtained through sampling of a waveform.
- This measurement method is available for both AC and DC modes.

2. Peak value measurement (PEAK)

The maximum absolute value is calculated from 256 points of data obtained through sampling of a waveform.
- The peak voltage display provides an absolute value with no polarity sign.
- The peak value is reset after every measurement cycle.

  Because measurement is performed through the sampling of a waveform, the peak that occurred between sampling points cannot be measured.
- This measurement method is available for both AC and DC modes.

3. Average value measurement (AVE)

The average value is calculated from 256 points of data obtained through the sampling of a waveform.
- This measurement method is available only for the DC mode.

8.8 Current/Power Display Modes and Measurement Methods

The displayed output current value is calculated from 256 points of data obtained through sampling of the output current. The sampling methods are the same as those for measurement of the output voltage.

The methods by which the output current can be measured include rms value measurement, peak value measurement, average value measurement, and power mea-

surement. One of these methods should be set for current/power measurements. The features of these measurement methods are as follows:

Current rms value measurement (RMS)

The rms value is calculated from 256 points of data obtained through the sampling of a waveform.

- This measurement method is available for both AC and DC modes.

Peak current measurement (PEAK)

Peak current values are measured by continuously determining the peak value through the use of an analog peak holding circuit.

- The peak current display indicates an absolute value with no polarity sign.
- The peak value is reset after every measurement cycle.
- The measurement method is available for both AC and DC modes.

Average current measurement (AVE)

The average value is calculated from 256 points of data obtained through the sampling of a waveform.

- This measurement method is available only for the DC mode.

Power measurement (W)

The power value is calculated from 256 points of data obtained through the sampling of voltage and current waveforms.

- This measurement method is available for both AC and DC modes.

8.9 Measurement of Power Factor, VA, and Peak Holding Current

Use of RS-232C Control enables display of the peak holding current. The following describes the differences between the peak value measurement and peak holding value measurement.

■ Peak value measurement

Peak value measurement is a measurement method in which the peak value is cleared after every measurement cycle. The AC power supply's peak value measurement uses an analog peak holding circuit to measure the peak current value in order to obtain the maximum absolute value of that data. Thus, the peak current display indicates an absolute value with no positive or negative sign. The peak value can be measured in any of the AC, AC-S, DC, and AC + DC modes.

■ Peak holding value measurement

Peak holding current measurement is a measurement method in which the maximum peak current is held until the power supply receives a peak clear signal. This function is useful in measuring an inrush current of load observed at power-on, in addition to other cases. The AC power supply's peak holding value measurement uses an analog peak holding circuit to measure the peak current value in order to

obtain the maximum absolute value of that data. Thus, the peak current display indicates an absolute value with no positive or negative sign. The peak holding value can be measured in any of the AC, AC-S, DC, and AC + DC modes. The response capability of the analog peak holding circuit can capture a peak that continues for approx. 50 μs or more. It cannot correctly capture a peak shorter than this duration.

The peak current is largely dependent on the current supply capability of the PCR-LA power supply. Thus, the output capacity of the PCR-LA power supply must have sufficient surplus for a load.

Clearing a peak: Using RS-232C Control

Send a peak clear message through the RS-232C Control.

Clearing a peak: Using peak initial signal

Clearing a peak: Peak initial signal

Short-circuit an input to the PEAK INIT IN terminal (BNC connector) on the rear of the AC power supply. The input should be short-circuited for two output current measurement cycles (approx. 1 to 2 seconds) or more. When the PEAK INIT IN terminal is open, approx. 5 V is applied to the circuit. Moreover, the impedance (resistance) of the circuit to be short-circuited should be 50 Ω or less.

> The BNC connectors are isolated from the power supply's INPUT terminal board and OUTPUT terminal board. Note that the common line of each of the PEAK INIT IN, SEQ TRG OUT, and SEQ STAT OUT signals is not isolated, as it is shared in the power supply. In addition, it is not isolated from the internal circuit of the slots.

8.10 Examples of LOAD Level Meter Operations

The AC power supply's LOAD level meter detects a current flowing in a load to display (for rough reference purposes) the ratio of the load current value to the rated current value. The current flowing in a load varies depending on the load connected. The output current should be derated in accordance with the output voltage, frequency, and load power factor in the AC mode and AC-S mode, or in accordance with the output voltage in the DC mode; the rated current value changes in accordance with the load condition. Therefore, obtaining an accurate ratio of the load current value to the rated current value is difficult. Below are some display examples of the PCR1000LA's LOAD level meter.

To display derating in the rated output current caused by setting of the output voltage

Example: For 100 V output voltage (in the 100 V range)

→ The rated current of 10 A is displayed as the full scale.

For 150 V output voltage (in the 100 V range)

→ The rated current of 6.67 A is displayed as the full scale.

To display the change in the rated output current caused by the output voltage range

Example: For the 100 V range

→ The rated current of 10 A is displayed as the full scale.

For the 200 V range

→ The rated current of 5 A is displayed as a full scale.

To display derating in the rated output current caused by the output frequency

Example: For 50 Hz

→ The rated current of 10 A is displayed as the full scale.

For 5 Hz

→ The rated current of 5 A is displayed as the full scale.

To display the change in the rated output current caused by the output voltage mode (AC/DC)

Example: For the AC mode

→ The rated current of 10 A is displayed as the full scale.

For the DC mode

→ The rated current of 5 A is displayed as the full scale.

To display the current limit set value as the rated output current

Example: For a current limit of 5 A

→ The rated current of 5 A is displayed as the full scale.

To display the value at which the power supply's internal semiconductor protective circuit is operating, as the rating

Example: For loads with a power factor of 0.4

→ A rated current of approx. 5 A is displayed as the full scale.

8.11 Method of the Sensing Function

The sensing function is used to connect a load at a distant location distant from the AC power supply and stabilize the voltage at that point (sensing point). However, the power supply's "sensing function" differs significantly from the "remote sensing (function for instantaneously correcting voltage in real time)" of general DC power supplies. The AC power supply can output both AC and DC power, but AC power is given priority. Because an AC power supply outputs AC voltage, no large-capacity capacitors can be connected to the output end. Therefore, performing remote sensing in the same way as ordinary DC power supplies results in an unstable power supply.

The sensing function employs the method of using the AC power supply's output voltage measuring function to measure voltage at the sensing point, and automatically correcting any insufficiencies in the voltage. With this method, the performance is inferior in terms of voltage stability, output voltage response in the event

of a sudden change in load current, and waveform quality (distortion rate) in comparison with those in general use.

The power supply's sensing function can be used in the AC, AC-S, and DC modes. In the DC mode, it is also inferior in terms of performance to the remote sensing function of general DC power supplies.

8.12 Applied Use of the Memory Function

This function allows the voltage and frequency set values to be stored in the memory in advance for subsequent reading out and setting. This feature is convenient for writing frequently used voltage and frequency set values into the memory. The memory function allows the output voltage and frequency set values to be written as a set into the memory for later reading out and setting. In the DC mode, only voltage can be read from and written into the memory. The memory allows nine sets of voltage and frequency to be set for the AC and AC-S modes, and nine voltages to be set for the DC mode. The read/write memory addresses are 1 to 9.

The following table shows the data sets in the memory in the initial setup status.

	Available in the AC and AC-S modes		Available in the DC mode
Memory address	AC voltage (V)	Frequency (Hz)	DC voltage (V)
0	0.0	50	0.0
1	0.0	50	0.0
2	0.0	50	0.0
3	0.0	50	0.0
4	0.0	60	0.0
5	0.0	60	0.0
6	0.0	60	0.0
7	0.0	400	0.0
8	0.0	400	0.0
9	0.0	400	0.0

Because the AC power supply stores data in its memory, the stored values can be retrieved as desired.

- Memory address 0 is for readout only.

8.13 Expansion of the Memory Function

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows a maximum of 99 sets (memory addresses) of memory-stored data to be read or written. Read/write of the memory is also possible in the AC + DC mode, allowing AC voltage and DC voltage stored at the same memory address to be output simultaneously.

8.14 Power Line Abnormality Simulation

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows the AC power supply's output to be interrupted, swelled quickly (pop), or dipped quickly (dip) to conduct power line abnormality simulations.

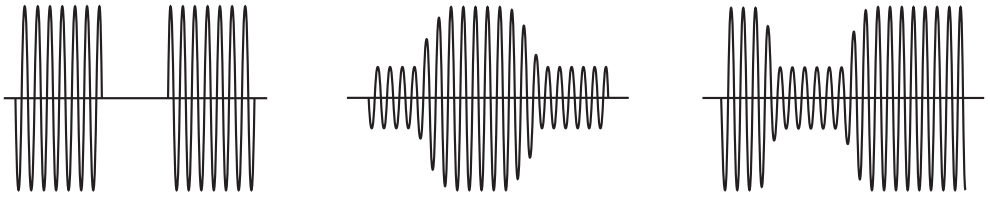


Fig. 8-7 Examples of Waveforms

8.15 Sequence Operation

Sequence operation is the action of retrieving and outputting settings of combinations of output voltage, frequency, time, and other factors that have been stored in advance, in sequence (by address specification). Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows the AC power supply to perform automatic operation by sequence operation.

AC voltage change characteristics

Changing of the frequency or AC voltage linearly over a set time is referred to as "ramp." In this operation, the frequency or AC voltage changes to the set value stored in the address specified for ramp over the time specified for ramp, starting at the value set to an address previous to the address specified for ramp. The action of changing the frequency or AC voltage stepwise is referred to as "step." In this mode, the frequency or AC voltage changes stepwise from the value stored in an address previous to the address specified for step to the value set in the address specified for step.

Specification of ramp and step

Address "0" cannot be specified for ramp. Specification of the start address for ramp will be ignored during execution, and the frequency or AC voltage will change stepwise.

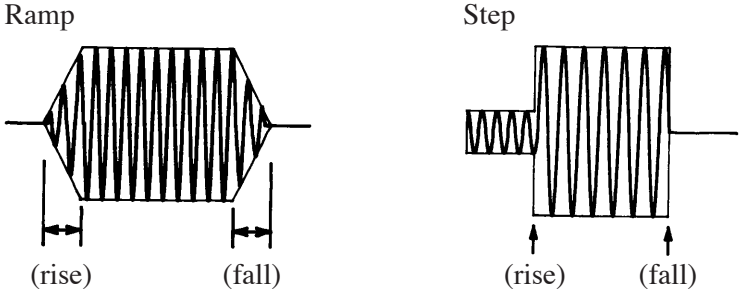


Fig. 8-8 Ramps and Steps

8.16 Status Signal and Trigger Signal

Status signal

The status signal outputs while the period of time set for the T2, T3 and T4 (if T2=T4=0, this case applies T3) in the Power Line Abnormality Simulation or the setting time of address in the Sequence Operation. Parameter settings for the time "T2, T3 and T4 of the Power Line Abnormality Simulation" can be referred to the "9.7.1 Parameter Messages".

When a status signal is specified to be ON, the signal "L" is output to the SEQ STAT OUT terminal (BNC connector) on the rear of the PCR-LA series. When a status signal is specified to be OFF, the signal "H" is output. "H" is approximately 5 V, and the "L" is approximately 0 V.

The BNC connectors are isolated from the INPUT terminal board and the OUTPUT terminal board of the PCR-LA series. Note that the common line of each signal for the PEAK INIT IN, SEQ TRG OUT, and SEQ STAT OUT are not isolated, because they are internally shared in the unit of PCR-LA series. And the internal circuits of Slot's are also not isolated. There is a slight time difference (approx. 100 μs) between the status-signal outputs and the actual output changes.

NOTE

- The status signal may output when any change occurred in the parameter setting under the Power Line Abnormality Simulation or in the sequence setting under the Sequence Operation.

Trigger signal

The trigger signal outputs while the Sequence Operation is executed.

When a trigger signal is specified to be ON, the signal "L" is output to the SEQ TRIG OUT terminal (BNC connector) on the rear of the PCR-LA series for several tens of μs at the instant the value set in that address is reached. When a status signal is specified to be OFF, the signal "H" is output. "H" is approximately 5 V, and the "L" is approximately 0 V.

The BNC connectors are isolated from the INPUT terminal board and the OUTPUT terminal board of the PCR-LA series. Note that the common line of each signal for the PEAK INIT IN, SEQ TRG OUT, and SEQ STAT OUT are not isolated, because they are internally shared in the unit of PCR-LA series. And the internal circuits of Slot's are also not isolated. There is a slight time difference (approx. 100 μs) between the status-signal outputs and the actual output changes.

NOTE

- The trigger signal may output when any change occurred in the condition of sequence.

8.17 Harmonic Current Analysis Function

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows harmonics in the output current to be analyzed. Because the measurement method employed is simplified, it does not meet IEC or other standards. For standard-compliant measurements, use our HA01F-PCR-L Harmonics Analyzer.

8.18 Special Waveform Output

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows the AC power supply to output any waveform other than sine waves. The "peak-clipped waveform" in which the peak of a sine wave is suppressed is provided as standard. This function can be used for not only a variety of electronics devices, but also chemical experiments and production equipment. To use this feature, set a waveform in the waveform banks in the special waveform setting mode, and switch the waveform banks in the special waveform output mode to output waveforms.

Waveform banks

The AC power supply stores output voltage waveform data in the internal memory, and D/A converts this data to produce a reference waveform of the output voltage. One waveform area of the memory that stores waveform data is referred to as a "waveform bank." The memory has banks of 15 waveforms. The memory banks are assigned numbers W00 to W14, allowing a waveform to be selected using these numbers. Bank W00 contains sine waves used as the reference voltage waveform of the AC power supply. It is not possible to rewrite the contents of bank W00. In the initial setup status, the same waveform as that in W00, i.e., a sine wave, is stored in all waveform banks.

Crest factor

The crest factor is the ratio between the rms value and the peak value of an AC waveform.

Crest factor = peak value / rms value

When a waveform is a sine wave, the crest factor becomes 1.41. For the voltage waveform of a commercial power line, its peak is suppressed and the crest factor is 1.2 to 1.4.

8.19 Output Impedance Setting

The AC power supply has output impedance (output resistance) of nearly 0 Ω; the commercial power supply system has impedance (resistance) of several mΩ to several Ω. Using the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller, the power supply allows the output impedance to vary. This enables simulation of an environment similar to that of an actual commercial power line. This function is backed up inside the power supply. Therefore, once a setting is made, the power supply can operate under the same conditions continuously, as long as the setting conditions remain the same.

8.20 Output ON/OFF Phase Setting

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows output ON/OFF phase setting to be made separately. This function is backed up inside the AC power supply. Therefore, once a setting is made, the power supply can operate under the same conditions continuously as long as the setting conditions remain the same.

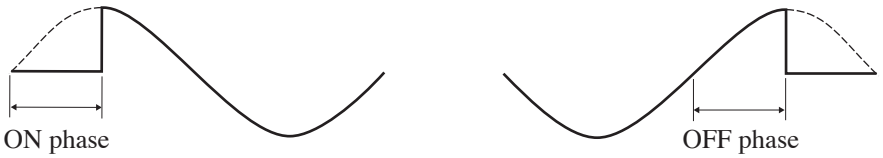


Fig. 8-9 Example of Waveform

8.21 AC + DC Mode

Use of the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller allows the AC + DC output voltage mode to be used in addition to the AC, AC-S, and DC modes. The AC + DC mode is for superimposing DC voltage on AC voltage and vice-versa.

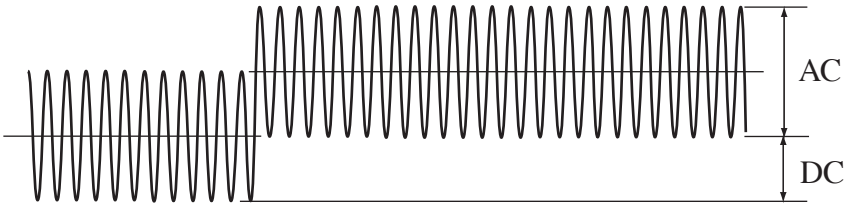


Fig. 8-10 Example of a Waveform

8.22 Hierarchy of Control Panel Keying Operation

The Home Position is the highest layer for each output voltage mode (AC, AC-S, DC). Each function is further layered.

When any of the functions are used, you will be taken one level higher toward the Home Position (direction of the original condition) each time the ESC key is pressed. Finally, you will be brought to the Home Position.

It is recommended that you return to the Home Position if you become uncertain of your location during operation. The number of times the ESC key is pressed to return to the Home Position depends on the layer on which you are located on at that time. If the ESC key is pressed when you are already at the Home Position, a beep sounds.

9

Chapter 9 Descriptions of RS-232C and GPIB Messages

Describes the RS-232C and GPIB messages.

NOTE

- The PCR-LA series provides command compatibility with the PCR-L series (conventional product). However, there are some GPIB and RS-232C response messages that are incompatible with the PCR-L. To provide command compatibility with the PCR-L, the compatibility setting must be set to the PCR-L mode. For the procedure for setting it, see "6.5 Setting Command Compatibility with the PCR-L".
- There are the following two modes for setting command compatibility with the PCR-L.

  PCR-LA mode: PCR-LA standard condition

  PCR-L mode: Status of compatibility with the PCR-L

9.1 Register-related and General-purpose Device Messages

This section describes the device messages used to set, reset, or inquire about each register, or to specify the terminator and the common device messages in each mode. Register-related program-message program data must be rewritten in hexadecimal representation. A response message returns the contents in decimal representation.

*CLS

Clears all registers and sets the service request enable register (initial value: #H00), device-status enable register (initial value: #H0F), and fault unmask register (initial value: #HFC) to the initial values.

Program message

• Syntax

Command message: `*CLS`

*IDN?

Inquires about the model name and the ROM version of the AC power supply

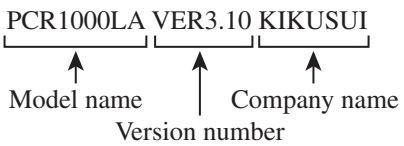
Program message

• Syntax

Query message: `*IDN?`

Response message

Returns the model name of the power supply as shown in the display example below, in response to `*IDN?`



ALMCLR

Resets an alarm in the AC power supply. If an alarm occurs, messages may not function properly, with the exception of the ALMCLR and SELFTEST messages.

Program message

• Syntax

Command message: `ALMCLR`

CLR

Clears all bits of the error register

Program message

• Syntax

Command message: `CLR`

DSE

Sets or resets each bit of the device-status enable register, or inquires about the contents of the register. For more information on the device-status enable register, see "9.11 Registers".

Program message

• Syntax

Command message: `DSE <HEX>`

Query message: `DSE?`

• Program data

Set value: #H00 to #HFF

(Example) To set bit 2 of the device-status enable register

```
DSE #H04
```

Response message

Returns the contents of the device-status enable register in response to DSE?

(Example) When bit 3 of the device-status enable register is set, the response message returns `8`.

DSR?

Inquires about the contents of the device-status register. For more information on the device-status register, see “9.11 Registers”.

Program message

• Syntax

Query message: `DSR?`

Response message

Returns the contents of the device-status register in response to DSR?

(Example) When bit 3 of the device-status register is set, the response message returns `8`.

ERR?

If an error occurs in a program message, the ERR bit (bit 3) of the status byte register is set to “1”. The error will be reset when the status byte register is read by the ERR? message or is cleared using the CLR message. For more information on the error register, see “9.11 Registers”.

Program message

• Syntax

Query message: `ERR?`

Response message

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

In the PCR-LA mode, the response message returns bit 0, bit 1, bit 2, or bit 3.

In the PCR-L mode, bits 2 and 3 out of bits 0, 1, 2, and 3 have not been defined.

If a data error or invalid message is detected, bit 7 is returned.

(Example) When bit 1 (out-of-range error) of the error register is set, the response message returns `2`.

FAU?

Inquires about the contents of the fault register. The fault register will be reset when its contents are read by the FAU? message. For more information on the fault register, see “9.11 Registers”. Permission to generate a FAU bit in the status byte register can be specified using the fault unmask register.

Program message

• Syntax

Query message: `FAU?`

Response message

Returns the contents of the fault register in response to FAU?

When bits 3 and 4 of the fault register are set, the response message returns `24`.

FUNMASK

Sets or resets each bit of the fault unmask register, or inquires about the contents of the register. For more information on the fault unmask register, see "9.11 Registers".

Program message

• Syntax

Command message: `FUNMASK <HEX>`

Query message: `FUNMASK?`

• Program data

Set value: #H00 to #HFF

(Example) To set bits 3 and 4 of the fault unmask register

```
FUNMASK #H18
```

Response message

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

(Example) When bits 3 and 4 of the fault unmask register are set, the response message returns `24`.

HEAD

Sets whether to append a program header and unit to a response message. In addition, inquires about the set value for whether to append a program header and unit to a response message, using the HEAD? message.

Program message

• Syntax

Command message: `HEAD {ON|OFF|1|0}`

Query message: `HEAD?`

• Program data

Data format: Character/integer

Set value:	OFF (0)	Appends no program headers and units (factory shipped setting)
	ON(1)	Appends a program header and unit

(Example) To set "appending a program header and unit to a response message"

```
HEAD 1
HEAD ON
```

Response message

Returns the condition for whether to append a program header and unit to a response message, in response to HEAD?

(Example) When the present setting is "to append a program header and unit to a response message,"
In the PCR-LA mode, the response message returns `HEAD 1`.
In the PCR-L mode, it returns `HEAD 001`.

IDN?

Inquires about the model name and ROM version of the AC power supply

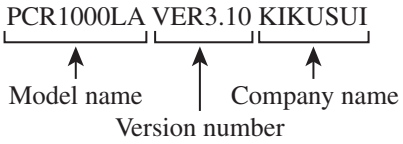
Program message

• Syntax

Query message: `IDN?`

Response message

Returns the model of the power supply as shown in the display example below (in the case of the PCR1000LA) in response to IDN?



NOTE

• IDN? is a query message used to support the programs of earlier PCR-L-series products. To create a new program in the PCR-LA series, use `*IDN?`. A response message generated in response to IDN? inquired from the PCR-LA series returns "PCRXXXXL" as the model.

LOC

Returns control from the remote status to the local status

Program message

• Syntax

Command message: `LOC`

MOD?

Inquires about the contents of the mode register. For more information on the mode register, see "9.11 Registers".

Program message

• Syntax

Query message: `MOD?`

Response message

Returns the contents of the mode register in response to MOD?

(Example) When bits 4 and 5 of the mode register are set, the response message returns `48`.

OPT?

Inquires about the contents of the option card register. For more information on the option card register, see “9.11 Registers”.

Program message

• Syntax

Query message: `OPT?`

Response message

Returns the contents of the option card register in response to OPT?

(Example) When bit 2 of the option card register is set, the response message returns `4`.

*RST/SETINI

Resets the AC power supply to the factory shipped setting. For setting information, see “Initial setup status” in “2.7 Operation Check”.

Note that the following set values will not be cleared, but will be held:

- Values stored in the memory
- Sequence operation parameters
- In the event of an alarm, this device message becomes invalid.
- User-defined waveform data

Program message

• Syntax

Command message: `*RST`
`SETINI`

SELFTEST?

Inquires about the cause of an alarm in the AC power supply, and the location of its occurrence. In the event of an alarm, any messages may not function properly, with the exception of the ALMCLR and SELFTEST messages. If multiple alarms have occurred, use the SELFTEST? message repetitively to inquire each piece of alarm information in sequence. After the final alarm has been inquired, execution of the SELFTEST? message simply returns the final alarm information. For the location of an alarm, the alarm number, and how to handle the alarm, see “4.6.1 Steps to be Taken in the Event of an Alarm”.

Program message

• Syntax

Query message: `SELFTEST?`

Response message

Returns the current alarm status in response to SELFTEST?

(Example) If no alarm has occurred, the response message returns `OK`.

(Example) If alarm No. 4 has occurred in ADR03, the message returns `ADR03, NO4`.

SILENT

Sets whether to return an acknowledge message in response to a message delimited by the response message terminator when RS-232C-based control is performed. Also uses the SILENT? message to inquire about the set value for whether to return an acknowledge message.

The acknowledge message returns either "OK" or "ERROR." To receive the acknowledge message, the RS-232C's communication system should be set to full-duplex communication.

Full-duplex communication: A communication system capable of always flowing data in both directions in data transmission between two parties. For the setting of full-duplex communication, see the PC's operation manual.

Program message

• Syntax

Command message: `SILENT {ON|OFF|1|0}`

Query message: `SILENT?`

• Program data

Data format: Character/integer

Set value:	OFF (0)	An acknowledge message is returned.
	ON (1)	No acknowledge message is returned (factory shipped setting).

(Example) To set to "No acknowledge message is returned"

```
SILENT 1
SILENT ON
```

Response message

Returns the set value of an acknowledge message in response to SILENT?

(Example) When the present setting is "No acknowledge message is returned," the response message returns `1`.

*STB?/STB?

Inquires about the contents of the status byte register. The status byte register will be reset when read by the STB? message. For more information on the status byte register, see "9.11 Registers".

Permission to generate a service request can be specified by the unmask register.

Program message

• Syntax

Query message: `*STB?`
`STB?`

Response message

Returns the contents of the status byte register in response to STB? In the PCR-L mode, bit 4 is masked.

(Example) When bits 2 and 3 of the status byte register are set, the response message returns `12`.

STS?

Inquires about the contents of the status register. For more information on the status register, see "9.11 Registers".

Program message

• Syntax

Query message: `STS?`

Response message

Returns the contents of the status register in response to STS?

(Example) When bits 4 and 5 of the status register are set, the response message returns `48`.

TERM

Sets the response message terminator or inquires about the set value of the response message terminator, using the TERM? message.

The AC power supply allows one of the following four types to be selected as a response message terminator (EOI is available for GPIB only, and EOI cannot be used for RS-232C).

Program message

• Syntax

Command message: `TERM {0|1|2|3}`

Query message: `TERM?`

• Program data

Data format: Integer

Set value:	RS-232C	0	CRLF (Factory shipped setting)
		1	CR
		2	LF
	GPIB	0	CRLF+EOI (Factory shipped setting)
		1	CR+EOI
		2	LF+EOI
		3	EOI

(Example) To set the response message terminator to CR (RS-232C)

`TERM 1`

Response message

Returns the currently set response message terminator in response to TERM?

(Example) When the response message terminator is CR (RS-232),
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

UNMASK

Sets or resets each bit of the unmask register (service request enable register), or inquires about the contents of this register. For more information on the unmask register, see "9.11 Registers".

Program message

• Syntax

Command message: `UNMASK <HEX>`

Query message: `UNMASK?`

• Program data

Set value: #H00 to #HFF

(Example) To set bits 2 and 3 of the unmask register

```
UNMASK #H0C
```

Response message

Returns the contents of the unmask register in decimal representation in response to UNMASK?

(Example) When bits 2 and 3 of the unmask register are set, the response message returns `12`.

9.2 Operation Status Messages

ACDC

Sets each of the AC, AC-S, DC, and AC + DC output modes when output is OFF, or inquires about the currently set mode. The AC, AC-S, DC, and AC + DC modes will be held even when the POWER switch is turned OFF.

Program message

• Syntax

Command message: `ACDC {AC|DC|ACDC|ACS}`

Query message: `ACDC?`

• Program data

Data format: Character/integer

Set value:	AC(0)	AC mode (factory shipped setting)
	DC(1)	DC mode
	ACDC(2)	AC + DC mode
	ACS(3)	AC-S mode

(Example) To set to the DC mode

```
ACDC 1
ACDC DC
```

Response message

Returns the present output voltage mode setting in response to ACDC?

(Example) When the present setting is the DC mode,
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.
In the AC mode, AC+DC mode, and AC-S mode, `000`,`002`, and `003` are returned, respectively.

HOME

Returns you to the Home Position. Even if you are in the lowest hierarchy level, this command immediately returns you to the Home Position, which is on the top level.

Program message

• Syntax
Command message: `HOME`

OFFPHASE

Sets the output OFF phase when the output mode is the AC mode, or inquires about the output OFF phase. For setting, see "8.20 Output ON/OFF Phase Setting". Output OFF phase will be held even when the POWER switch is turned OFF. When output OFF phase has been set, the control panel's [S-MODE] display area indicates "4."

Program message

• Syntax
Command message: `OFFPHASE {<NR1>|FREE}`
Query message: `OFFPHASE?`

• Program data

Data format:	Integer/character	
Set value:	0 to 360	
	FREE	Condition in which no phase has been set
Resolution:	1	
Unit:	deg	

(Example) To set no output OFF phase
`OFFPHASE FREE`

Response message

Returns the present output OFF phase in response to OFFPHASE?

(Example) When the present output OFF phase has not been set, the response message returns `FREE`.

ONPHASE

Sets the output ON phase when the output mode is the AC mode, or inquires about the output ON phase. For setting, see "8.20 Output ON/OFF Phase Setting". Output ON phase will be held even when the POWER switch is turned OFF. When the output ON phase has been set, the control panel's [S-MODE] display area indicates "4."

Program message

• Syntax

Command message: `ONPHASE {<NR1>|FREE}`
Query message: `ONPHASE?`

• Program data

Data format:	Integer/character	
Set value:	0 to 360	
	FREE	Condition in which no phase has been set
Resolution:	1	
Unit:	deg	

(Example) To set the output ON phase to 90 degrees

```
ONPHASE 90
```

Response message

Returns the present output ON phase in response to ONPHASE?
(Example) When the present output ON phase is 90°, the response message returns `90`.

OUT

Sets output ON/OFF or inquires about the present output ON/OFF

Program message

• Syntax

Command message: `OUT {ON|OFF|1|0}`
Query message: `OUT?`

• Program data

Data format:	Character/integer	
Set value:	OFF (0)	Output OFF (factory shipped setting)
	ON (1)	Output ON

(Example) To set output ON

```
OUT 1
OUT ON
```

Response message

Returns the present output setting in response to OUT?

(Example) When the present setting is "output ON,"
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

OUTZ

Sets the output impedance (output resistance) when the output mode is the AC mode, or inquires about the output impedance (output resistance). If the output voltage range is switched while the output impedance has been set, the output impedance set value will be reset to 0 Ω. The output impedance will be held even when the POWER switch is turned OFF. When the output impedance has been set, the control panel's [S-MODE] display area indicates "2."

Program message

• Syntax

Command message: `OUTZ <NR2>`

Query message: `OUTZ?`

• Program data

Set value and resolution:

	Setting range (Ω)		Resolution (Ω)	
	100 V range	200 V range	100 V range	200 V range
PCR500LA	0.0 to 4.0	0.0 to 16.0	40 m	160 m
PCR1000LA	0.0 to 2.0	0.0 to 8.0	20 m	80 m
PCR2000LA	0.0 to 1.0	0.0 to 4.0	10 m	40 m
PCR4000LA	0.0 to 0.5	0.0 to 2.0	5 m	20 m
PCR6000LA	0.000 to 0.333	0.000 to 1.333	3.33 m	13.33 m

Unit: Ω

If program data is between settable steps, the output impedance set value is translated into the maximum value below the program data set value. Use of OUTZPER described on the next page eliminates the need for consideration of the maximum value or resolution.

(Example) If the output voltage range is 100 V in the PCR1000LA, the maximum settable resistance value is 2 Ω and its resolution is 0.02 Ω.

`OUTZ 1.01`

Because this value is between the resolution intervals, the actually set resistance value is 1 Ω, or the maximum value below 1.01.

Response message

Returns the present output impedance setting in response to OUTZ?

(Example) When the present output impedance setting is 1 Ω, the response message returns `1.000`.

(Example) When the present output impedance is not set, the message returns `0.000`.

OUTZPER

Sets the output impedance (output resistance) as a percentage when the output mode is the AC mode. Alternately, it inquires about the output impedance (output resistance) as a percentage. Unlike in the case of the previous OUTZ, there is no need to worry about the setting range or resolution, depending on the model or voltage range.

If the output voltage range is switched while the output impedance has been set, the output impedance set value will be reset to 0 %. The output impedance will be held even when the POWER switch is turned OFF. When the output impedance has been set, the control panel's [S-MODE] display area indicates "2."

Program message

• Syntax

Command message: `OUTZPER <NR1>`

Query message: `OUTZPER?`

• Program data

Set value: 0 to 100

Resolution: 1

Unit: %

(Example) To set the output impedance to 40 %

```
OUTZPER 40
```

Response message

Returns the present output impedance (%) setting in response to OUTZPER?

(Example) When the present output impedance setting is 30 %, the response message returns `30`.

RANGE

Sets the output voltage range when output is OFF, or inquires about the present output range

Program message

• Syntax

Command message: `RANGE {0|1|100|200}`

Query message: `RANGE?`

• Program data

Data format: Character/integer

Set value:	0, 100	100 V range (factory shipped setting)
	1, 200	200 V range

(Example) To set the output voltage range to the 200 V range

```
RANGE 1
RANGE 200
```

Response message

Returns the present output range setting in response to RANGE?

(Example) When the present setting is “100 V range,”
In the PCR-LA mode, the response message returns `0`.
In the PCR-L mode, it returns `000`.

(Example) When the present setting is “200 V range,”
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

* For products of Ver. 3.08 or earlier, the response message returns `100` or `200`.

SYNC

Sets whether to perform synchronous operation when the output mode is the AC mode, or inquires about the set value for whether to perform synchronous operation. For more information on synchronous operations, see “4.4 Synchronous Function”.

Program message

• Syntax

Command message: `SYNC {ON|OFF|1|0}`
Query message: `SYNC?`

• Program data

Data format:	Character/integer	
Set value:	OFF (0)	Synchronous operation is not performed (factory shipped setting).
	ON (1)	Synchronous operation is performed.

(Example) To set “Synchronous operation is made”

```
SYNC 1
SYNC ON
```

Response message

Returns the present synchronous operation setting in response to SYNC?

(Example) When the present setting is “Synchronous operation is performed,”
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

9.3 Output Voltage/Frequency Setting Messages

The AC power supply has the AC, AC-S, DC, and AC + DC modes. Setting of the output voltage can be performed separately for AC voltage and DC voltage.

DCVSET

Sets a DC voltage value or inquires about the DC voltage value. The program data setting range is determined by the output voltage range and voltage limit values. If the power supply receives data out of the allowable range, it ignores that data and sets bit 1 of the error register. The status of the error register can be checked using the ERR? message.

Program message

• Syntax

Command message: `DCVSET <NR2>`

Query message: `DCVSET?`

• Program data

Set value: 0 Always settable

Voltage setting low limit value ≤ set value ≤ voltage setting high limit value

When the DC mode is selected and the output range is the 100 V range, -215.5 V ≤ set value ≤ 215.5 V

When the DC mode is selected and the output range is the 200 V range, -431.0 V ≤ set value ≤ 431.0 V

When the AC + DC mode is selected and the output range is in the 100 V range, AC voltage set value x 1.41 + absolute value of set value ≤ 215.5 V

When the AC + DC mode is selected and the output range is in the 200 V range, AC voltage set value x 1.41 + absolute value of set value ≤ 431.0 V

Resolution: 0.1

Unit: V

(Example) To set the DC voltage to 100 V

```
DCVSET 100
```

Response message

Returns the present DC voltage set value in response to DCVSET?

(Example) When the present DC voltage set value is 100 V, the response message returns `100.0`.

FSET

Sets output frequency or inquires about the output frequency. The program data setting range is determined by the frequency limit values. If the power supply receives data out of the allowable range, it ignores that data and sets bit 1 of the error register. The status of the error register can be checked using the ERR? message.

Program message

• Syntax

Command message: `FSET <NR2>`

Query message: `FSET?`

• Program data

Set value: Frequency low limit value ≤ set value ≤ frequency high limit value

1.00 Hz ≤ set value ≤ 999.9 Hz

Resolution: 0.01 for 1.00 to 99.99

0.1 for 100.0 to 999.9

Unit: Hz

(Example) To set the output frequency to 400 Hz

```
FSET 400
```

Response message

Returns the frequency set value in response to FSET?

(Example) When the present frequency set value is 400 Hz, the response message returns `400`.

VSET/ACVSET

Sets an AC voltage value or inquires about the AC voltage value. The VSET message and ACVSET message operate in exactly the same way. The program data setting range is determined by the output voltage range and voltage limit values. If the power supply receives data out of the allowable range, it ignores that data and sets bit 1 of the error register. The status of the error register can be checked using the ERR? message.

Program message

• Syntax

Command message: `VSET <NR2>`
`ACVSET <NR2>`

Query message: `VSET <NR2>`
`ACVSET <NR2>`

• Program data

Data format: Real number

Set value: 0 Always settable

Voltage setting low limit value ≤ set value ≤ voltage setting high limit value

When the AC mode is selected and the output range is in the 100 V range, 0 ≤ set value ≤ 152.5 V

When the AC mode is selected and the output range is in the 200 V range, 0 ≤ set value ≤ 305.0 V

When the AC + DC mode is selected and the output range is in the 100 V range, Set value x 1.41 + absolute value of the DC voltage set value ≤ 215.5 V

When the AC + DC mode is selected and the output range is in the 200 V range, Set value x 1.41 + absolute value of DC voltage set value ≤ 431.0 V

Resolution: 0.1

Unit: V

(Example) To set the AC voltage to 100 V

```
VSET 100
ACVSET 100
```

Response message

Returns the present AC voltage set value in response to VSET/ACVSET?

(Example) When the present AC voltage set value is 100 V, the response message returns `100.0`.

9.4 Output Measurement Messages

The output measurement messages are used to measure output at the output terminals of the AC power supply or set the measurement mode.

9.4.1 Output Voltage Measurements

VM?

Inquires about the measurement method for the output voltage

Program message

• Syntax

Query message: `VM?`

Response message

Returns the setting of the present output voltage measurement method in response to VM?

(Example) When the present measurement method setting is rms value measurement, the response message returns `VMRMS`.

(Example) When the present measurement method setting is average value measurement, the message returns `VMAVE`.

(Example) When the present measurement method setting is peak value measurement, the message returns `VMPK`.

VMAVE

Sets the output voltage measurement method to average value measurement (enabled in any modes other than the AC and AC-S modes)

Program message

• Syntax

Command message: `VMAVE`

VMPK

Sets the output voltage measurement method to peak value measurement

Program message

• Syntax

Command message: `VMPK`

VMSET

Sets the voltage display to a set value

Program message

• Syntax

Command message: `VMSET`

VMRMS

Sets the output voltage measurement method to rms value measurement (factory shipped setting)

Program message

• Syntax

Command message: `VMRMS`

VOUT?

Inquires about a measured value in effect immediately before the output voltage obtained by the present measurement method. The present measurement method can be checked using the VM? message. The AC power supply's voltage measurement cycle changes depending on the output frequency (from approx. 0.5 to 2 seconds). During this measurement cycle, the same data is returned whenever the VOUT? message is received. Use of the DAV bit (bit 2) of the device-status register allows effective programming.

DESCRIPTION

• Usage of the DAV bit (bit 2) of the device-status register:

Bit 2 of the device-status register represents updating of a measured value. It is reset when a query message for measured values (such as VOUT? and IOUT?) is executed, and it is set when the measured value is updated in the power supply. In the AC power supply, approx. 0.5 to 2 seconds are required for updating of a measured value. Monitoring of the bit of the device-status register allows a program to be created without waiting for the measured value to be updated using a timer.

Program message

• Syntax

Query message: `VOUT?`

Response message

Returns the measured value in effect immediately before the output voltage obtained by the present measurement method, in response to VOUT?

(Example) When the measured value of the present output voltage is 100 V, the response message returns `100.0`.

9.4.2 Output Current Measurements

IM?

Inquires about the measurement method of the output current

Program message

• Syntax

Query message: `IM?`

Response message

Returns the setting of the present output current measurement method in response to IM?

(Example) When the present measurement method setting is rms value measurement, the response message returns `IMRMS`.

(Example) When the present measurement method setting is average value measurement, the message returns `IMAVE`.

(Example) When the present measurement method setting is peak value measurement, the message returns `IMPK`.

(Example) When the present measurement method setting is peak holding value measurement, the message returns `IMPKH`.

IMAVE

Sets the output current measurement method to average value measurement (enabled in any mode other than the AC and AC-S modes)

Program message

• Syntax

Command message: `IMAVE`

IMPK

Sets the output current measurement method to peak value measurement

Program message

• Syntax

Command message: `IMPK`

IMPKH

Sets the output current measurement method to peak holding value measurement

Program message

• Syntax

Command message: `IMPKH`

IMRMS

Sets the output current measurement method to rms value measurement (factory shipped setting)

Program message

• Syntax

Command message: `IMRMS`

IOUT?

Inquires about a measured value in effect immediately before the output current obtained by the present measurement method. The present measurement method can be checked using the IM? message. The AC power supply's current measurement cycle changes depending on the output frequency (from approx. 0.5 to 2 seconds). During this measurement cycle, the same data is returned whenever the IOUT? message is received. Use of the DAV bit (bit 2) of the device-status register allows effective programming.

DESCRIPTION

• Usage of the DAV bit (bit 2) of the device-status register:

Bit 2 of the device-status register represents updating of a measured value. It is reset when a query message for measured values (such as VOUT? and IOUT?) is executed, and it is set when the measured value is updated in the power supply. In the AC power supply, approx. 0.5 to 2 seconds are required for updating of a measured value. Monitoring of the bit of the device-status register allows a program to be created without waiting for the measured value to be updated using a timer.

Program message

• Syntax

Query message: `IOUT?`

Response message

Returns the measured value in effect immediately before the output current obtained by the present measurement method, in response to IOUT?

(Example) When the measured value of the present output current is 10 A, the response message returns `10.0`.

PEAKINIT

Resets the peak holding value

Program message

• Syntax

Command message: `PEAKINIT`

9.4.3 Measurements of Power, Apparent Power, and Power Factor

PF?

Inquires about the power factor when a load is connected. The power factor is obtained through calculation from the measured power value and measured VA value.

Program message

• Syntax

Query message: `PF?`

Response message

Returns the present power factor in response to PF?

(Example) When the present power factor is 0.60, the response message returns `0.60`.

VA?

Inquires about the apparent power when a load is connected. The apparent power is obtained by calculation from the measured rms values of voltage and current.

Program message

• Syntax

Query message: `VA?`

Response message

Returns the present apparent power in response to VA?

(Example) When the present apparent power is 10.00 VA, the response message returns `10.00`.

WATT?

Inquires about the output power when a load is connected

Program message

• Syntax

Query message: `WATT?`

Response message

Returns the present output power in response to WATT?

(Example) When the present output power is 10.0 W, the response message returns `10.0`.

9.4.4 Harmonic Analysis

The AC power supply is capable of conducting harmonic analysis of output current. Because the measurement method employed is simplified, it does not meet IEC or other standards. To conduct standard-compliant measurements, use our HA01F-PCR-L Harmonics Analyzer. When entering the harmonic analysis mode in response to the FFT ON message, the power supply will accept the following messages only.

- Query message
- VSET message
- FSET message
- CURHARMP? message
- FFTHOLD message
- OUT message
- ACVSET message
- CURHARMA? message
- FFT OFF message

To exit the harmonic analysis mode, the FFT-OFF message should be used.

CURHARMA?

Inquires about the value representing in current the harmonics component of each degree. The harmonic analysis measurement cycle varies depending on the output frequency (approx. 1 to 4 seconds). During this measurement cycle, the same data is returned whenever the CURHARMA? message is received. Use of the DAV bit (bit 2) of the device-status register allows effective programming. Prior to execution of this message, the FFT-ON message (Page 9-27 "FFT") should be used to make the power supply enter the harmonic current analysis mode.

DESCRIPTION

- Usage of the DAV bit (bit 2) of the device-status register:

  Bit 2 of the device-status register represents updating of a measured value. It is reset when a query message for measured values (such as VOUT? and IOUT?) is executed, and it is set when the measured value is updated in the power supply. In the AC power supply, approx. 1 to 4 seconds are required for updating of a measured value. Monitoring of the bit of the device-status register allows a program to be created without waiting for the measured value to be updated using a timer.

Program message

- Syntax

  Query message: `CURHARMA {<NR1>|ODD|EVEN|LOW|HIGH}?`

- Program data

  Data format: Character/integer

  Set value: Value 1 to 40

  Returns <NR1>-th order harmonic data only

ODD	Returns harmonic data on the order of odd numbers by separating them with a comma “,”
EVEN	Returns harmonic data on the order of even numbers by separating them with a comma “,”
LOW	Returns 1st- to 20th-order harmonic data by separating them with a comma “,”
HIGH	Returns 21st- to 40th-order harmonic data by separating them with a comma “,”

(Example) To return the 3rd-order harmonic current value
`CURHARMA 3?`

(Example) To return the harmonic current value for the order of odd numbers
`CURHARMA EVEN?`

Response message

Returns the value representing in current the harmonics component of each degree in response to `CURHARMA {<NR1>|ODD|EVEN|LOW|HIGH}?`

(Example) When the 3rd-order harmonic current value is 10.0 A, the response message returns `10.0` in response to `CURHARMA 3?`.

(Example) For harmonic current values for the order of even numbers, the message returns 20 pieces of data.

CURHARMP?

Inquires about the percentage of a harmonic current value, regarding the current value of the basic wave components as 100 %.

The harmonic analysis measurement cycle varies depending on output frequency (from approx. 1 to 4 seconds). During this measurement cycle, the same data is returned whenever the CURHARMP? message is received. Use of the DAV bit (bit 2) of the device-status register allows effective programming. Prior to execution of this message, the FFT-ON message (Page 9-27 "FFT") should be used to make the power supply enter the harmonic current analysis mode.

DESCRIPTION

- Usage of the DAV bit (bit 2) of the device-status register:

  Bit 2 of the device-status register represents updating of a measured value. It is reset when a query message for measured values (such as VOUT? and IOUT?) is executed, and it is set when the measured value is updated in the power supply. In the AC power supply, approx. 1 to 4 seconds are required for updating of a measured value. Monitoring of the bit of the device-status register allows a program to be created without waiting for the measured value to be updated using a timer.

Program message

- Syntax

  Query message: `CURHARMP {<NR1>|ODD|EVEN|LOW|HIGH}?`

- Program data

  Data format: Character/integer

  Set value:

Value	1 to 40 Returns <NR1>-th order harmonic data only
ODD	Returns harmonic data on the order of odd numbers by separating them with a comma ","
EVEN	Returns harmonic data on the order of even numbers by separating them with a comma ","
LOW	Returns 1st to 20th-order harmonic data by separating them with a comma ","
HIGH	Returns 21st to 40th-order harmonic data by separating them with a comma ","

(Example) To return the 3rd-order harmonics value in percentage form

```
CURHARMP 3?
```

(Example) To return the harmonics value for the order of even numbers in percentage form

```
CURHARMP EVEN?
```

Response message

Returns the value representing in percentage form the harmonics component of each degree in response to `CURHARMP {<NR1>|ODD|EVEN|LOW|HIGH}?`

(Example) When the 3rd-order harmonic current value is 20.0 % in percentage form, the response message returns `20.0` in response to `CURHARMP 3?`

(Example) When the harmonic current values for the order of even numbers are measured in percentage form, the message returns 20 pieces of data.

FFT

Sets whether to enter or exit the harmonic current analysis mode, or inquires about whether the power supply is in the harmonic current analysis mode.

Program message

• Syntax

Command message: `FFT {ON|OFF|1|0}`

Query message: `FFT?`

• Program data

Data format:	Character/integer	
Set value:	OFF (0)	Exits the harmonic current analysis mode
	ON (1)	Enters the harmonic current analysis mode

(Example) To enter the harmonic current analysis mode

```
FFT 1
FFT ON
```

Response message

Returns whether the power supply is in the harmonic current analysis mode in response to FFT?

(Example) When the power supply is in the harmonic current analysis mode,
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

FFTHOLD

Pauses FFT calculation and holds harmonic analysis data. When the FFT calculation is paused, the present data is held.

Program message

• Syntax

Command message: `FFTHOLD {ON|OFF|1|0}`

• Program data

Data format:	Character/integer	
Set value:	OFF (0)	Cancels the pause status
	ON (1)	Pauses FFT calculation

(Example) To pause FFT calculation

```
FFTHOLD 1
FFTHOLD ON
```

9.5 Limit Value Setting Messages

9.5.1 Voltage Limit Values

■ Voltage limit value settable range

The voltage limit value settable range is the setting range of the 200 V range in the AC power supply. The table below shows the values in each mode.

Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V 100 V	AC 0 [Vrms]	AC 305.0 [Vrms]
DC mode or AC + DC mode	200 V 100 V	DC -431.0 [V]	DC 431.0 [V]

The initial setup status (factory shipped setting) is the same as those specified above.

ACVHI

Sets or inquires about the AC voltage high limit value (305.0 V at factory shipment)

Program message

• Syntax

Command message: `ACVHI <NR2>`

Query message: `ACVHI?`

• Program data

Set value: 0.0 to 305.0 (only more than ACVLO set value)

Resolution: 0.1

Unit: V

(Example) To set the AC voltage high limit value to 132 V

```
ACVHI 132
```

Response message

Returns the present AC voltage high limit value in response to ACVHI?

(Example) When the present AC voltage limit value is 132.0 V, the response message returns `132.0`.

ACVLO

Sets or inquires about the AC voltage low limit value (0.0 V at factory shipment)

Program message

• Syntax

Command message: `ACVLO <NR2>`

Query message: `ACVLO?`

• Program data

Set value: 0.0 to 305.0 (only less than ACVHI set value)

Resolution: 0.1

Unit: V

(Example) To set the AC voltage low limit value to 200 V

```
ACVLO 200
```

Response message

Returns the present AC voltage low limit value in response to ACVLO?

(Example) When the present AC voltage limit value is 200.0 V, the response message returns `200.0`.

DCVHI

Sets or inquires about the DC voltage high limit value (431.0 V at factory shipment)

Program message

• Syntax

Command message: `DCVHI <NR2>`

Query message: `DCVHI?`

• Program data

Set value: -431.0 to +431.0 (only more than DCVLO set value)

Resolution: 0.1

Unit: V

(Example) To set the DC voltage high limit value to 100 V

```
DCVHI 100
```

Response message

Returns the present DC voltage high limit value in response to DCVHI?

(Example) When the present DC voltage high limit value is 100.0 V, the response message returns `100.0`.

DCVLO

Sets or inquires about the DC voltage low limit value (-431.0 V at factory shipment)

Program message

• Syntax

Command message: `DCVLO <NR2>`

Query message: `DCVLO?`

• Program data

Set value: -431.0 to +431.0 (only less than DCVHI set value)

Resolution: 0.1

Unit: V

(Example) To set the DC voltage low limit value to 0 V

`DCVLO 0`

Response message

Returns the present DC voltage low limit value in response to DCVLO?

(Example) When the present DC voltage low limit value is 0.0 V, the response message returns `0.0`.

9.5.2 Frequency Limit Values

■ Frequency limit value settable range

The Frequency limit value settable range is the maximum variable range of the AC power supply. The table below shows the relevant values in each mode.

Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V	1.00 [Hz]	999.9 [Hz]
	100 V		
DC mode	200 V	Setting not possible	
	100 V		
AC + DC mode	200 V	Settings in the AC or AC-S mode are enabled.	
	100 V		

The initial setup status (factory shipped setting) is the same as those specified above.

FHI

Sets or inquires about the frequency high limit value (999.9 Hz at factory shipment)

Program message

• Syntax

Command message: `FHI <NR2>`

Query message: `FHI?`

• Program data

Set value: 1.00 to 999.9 (only more than FLO set value)

Resolution: 0.01 for 1.00 to 99.99
0.1 for 100.0 to 999.9

Unit: Hz

(Example) To set the frequency high limit value to 47 Hz

```
FHI 47
```

Response message

Returns the present frequency high limit value in response to FHI?

(Example) When the present frequency high limit value is 47.00 Hz, the response message returns `47.00`.

FLO

Sets or inquires about the frequency low limit value (1.00 Hz at factory shipment)

Program message

• Syntax

Command message: `FLO <NR2>`

Query message: `FLO?`

• Program data

Set value: 1.00 to 999.9 (only less than FHI set value)

Resolution: 0.01 for 1.00 to 99.99
0.1 for 100.0 to 999.9

Unit: Hz

(Example) To set the frequency low limit value to 47 Hz

```
FLO 47
```

Response message

Returns the present frequency low limit value in response to FLO?

(Example) When the present frequency low limit value is 47.00 Hz, the response message returns `47.00`.

9.5.3 Current Limit Values

■ Current limit value settable range

The current limit value settable range is 10 % to 110 % of the rated maximum output current in the modes specified in the table below. The current limit value should be set in rms. If there is a limitation on the output current due to the output voltage or frequency value set, such limitation has precedence over the set current limit value. For more information on this, see "8.4 Outputs and Loads".

Output voltage mode	Range	Low limit	High limit
AC mode or AC-S mode	200 V	Not settable	AC 1.1 x I_{AC} [Arms]
	100 V		
DC mode or AC + DC mode	200 V	Not settable	DC 1.1 x I_{DC} [A]
	100 V		

Rated maximum output current

Model name	I_{AC} [Arms]	I_{DC} [A]
PCR500LA	5	2.5
PCR1000LA	10	5
PCR2000LA	20	10
PCR4000LA	40	20
PCR6000LA	60	30

The initial setup status (factory shipped setting) is the same as those specified above.

ACILIM

Sets or inquires about the AC current high limit value

Program message

• Syntax

Command message: `ACILIM <NR2>`

Query message: `ACILIM?`

• Program data

Set value: 10 % to 110 % of the rated maximum current (1.1 times the rating at factory shipment)

(Example) To set the AC current high limit value to 3.0 A

```
ACILIM 3.0
```

Response message

Returns the present AC current high limit value in response to ACILIM?

(Example) When the present AC current high limit value is 3.00 A, the response message returns `3.00`.

DCILIM

Sets or inquires about the DC current high limit value

Program message

• Syntax

Command message: `DCILIM <NR2>`

Query message: `DCILIM?`

• Program data

Set value: 10 % to 110 % of the rated maximum current (1.1 times the rating at factory shipment)

(Example) To set the DC current high limit value to 3.0 A

```
DCILIM 3.0
```

Response message

Returns the present DC current high limit value in response to DCILIM?

(Example) When the present DC current high limit value is 3.00 A, the response message returns `3.00`.

9.6 Memory Setting Messages

This section describes messages used in relation to the memory.

CLRMEMORY

Initializes all contents of memory numbers 1 to 99 (factory shipment status)

ACV: AC voltage 0 V

WB: Waveform bank 0

DCV: DC voltage 0 V

FREQ: Frequency of 50 Hz, 60 Hz, or 400 Hz

Program message

• Syntax

Command message: `CLRMEMORY`

FSTO

Stores the present frequency setting to a specified memory number or inquires about the frequency at a specified memory number. Other set values in the memory number remain the same.

Program message

Command message: `FSTO <NR1>`
Query message: `FSTO <NR1>?`

• Program data
Set value: 1 to 99
Resolution: 1

(Example) To store a frequency of 60 Hz in memory number 5

```
FSET 60
FSTO 5
```

Response message

Returns the frequency in the specified memory number in response to FSTO <NR1>?

(Example) When the frequency in memory number 5 is 60 Hz,
In the PCR-LA mode, the response message returns `60`.
In the PCR-L mode, it returns `5, 60`.

MEMSTO

Stores all data that can be set to the memory in the memory through the specification of memory numbers, or inquires about the contents of a specified memory number. When multiple command messages are set, the omission of a memory number causes the memory number to be automatically increased and assigned. If data other than the memory number is omitted, data set until that time or the data set immediately before will be valid.

Program message

• Syntax
Command message: `MEMSTO <memory number NR1,`
`AC voltage NR2, frequency NR2,`
`waveform bank NR1, DC voltage NR2>`
Query message: `MEMSTO <memory number NR1>?`

• Program data <memory number NR1>
Set value: 1 to 99
Resolution: 1

• Program data <AC voltage NR2>
Set value: 0 to 152.5 for the output 100 V range
0 to 305.0 for the output 200 V range
Resolution: 0.1
Unit: V

• Program data <frequency NR2>
Set value: 1.00 to 999.9
Resolution: 0.01 for 1.00 to 99.99

0.1 for 100.0 to 999.9

Unit: Hz

• Program data <waveform bank NR1>

Set value: 0 to 14 0 is for read only.

Resolution: 1

• Program data <DC voltage NR2>

Set value: 0 to 215.5 for the output 100 V range
0 to 431.0 for the output 200 V range

Resolution: 0.1

Unit: V

(Example) To store AC voltage of 100 V, frequency of 50 Hz, waveform bank 1, and DC voltage of 0 V in memory number 5

```
MEMSTO 5, 100, 50, 1, 0
```

Response message

Returns the contents of the specified memory number in response to MEMSTO <NR1>?

(Example) When the command message inquires about the contents of memory number 1 and the relevant memory area contains AC voltage of 2 V, frequency of 3 Hz, waveform bank 4, and DC voltage of -5 V,
In the PCR-LA mode, the response message returns `2.0, 3.00, 4, -5.0`.
In the PCR-L mode, it returns `1, 2.0, 3.00, 4, -5.0`.

VSTO

Stores the present AC voltage setting into a specified memory number, or inquires about the AC voltage value in the specified memory number. Other set values in the memory number remain the same.

Program message

Command message: `VSTO <NR1>`

Query message: `VSTO <NR1>?`

• Program data

Set value: 1 to 99

Resolution: 1

(Example) To store AC voltage of 110 V in memory number 5

```
ACVSET 110
VSTO 5
```

Response message

Returns the AC voltage in the specified memory number in response to VSTO <NR1>?

(Example) When the AC voltage in memory number 5 is 110 V,
In the PCR-LA mode, the response message returns `110`.
In the PCR-L mode, it returns `5, 110`.

9.7 Power Line Abnormality Simulation Messages

The AC power supply's output can be instantaneously interrupted, swelled quickly (pop), or dipped quickly (dip) to perform a power line abnormality simulation. To perform this simulation, have the AC power supply enter the power line abnormality simulation mode (set the power line abnormality simulation mode to ON) and then set parameters.

SIMMODE

Sets ON/OFF of the power line abnormality simulation mode. This command is enabled when output is OFF.

Program message

• Syntax

Command message: `SIMMODE {ON|OFF|1|0}`

Query message: `SIMMODE?`

• Program data

Data format: Character/integer

Set value:		
	OFF(0)	Sets the power line abnormality simulation mode to OFF (setting at power ON)
	ON(1)	Sets the power line abnormality simulation mode to ON

(Example) To set the power line abnormality simulation mode to ON

```
SIMMODE 1
SIMMODE ON
```

In the power line abnormality simulation mode, there are limitations on the messages that can be accepted. The table below summarizes the messages that can be used in the power line abnormality simulation mode.

When output is OFF		When output is ON
• T1	• T1DEG	• SIMRUN
• T2	• T3	• RUNNING
• T4	• T5	• SIMSTOP
• N	• RPT	• INT
• POL	• VSET	• OUT
• ACVSET	• SIMMODE	• Query message
• T3VSET	• OUT	
• RUNNING	• FSET	
• Query message		

Response message

Returns whether the AC power supply is in the power line abnormality simulation mode in response to `SIMMODE?`

(Example) When the power supply is in the power line abnormality simulation mode, the response message returns the following:
`1` in the PCR-LA mode
`001` in the PCR-L mode

9.7.1 Parameter Messages

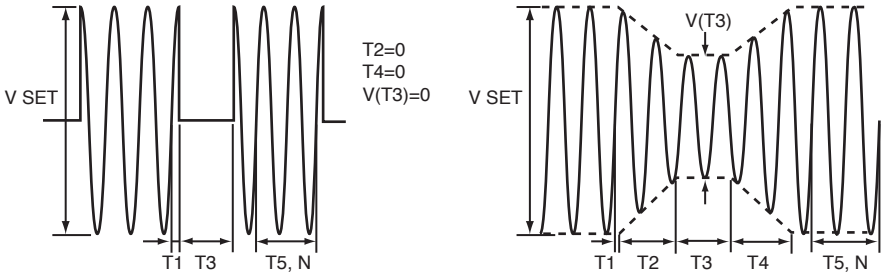


Fig.9-1 Parameter Setting

N

Sets the number of cycles of voltage waveforms from the recovery of the output voltage to the original level to the start of the next power line abnormality simulation. Alternatively, inquires about the number of cycles of voltage waveforms until the start of a power line abnormality simulation.

Program message

• Syntax
Command message: `N <NR1>`
Query message: `N?`

• Program data
Set value: 0 to 999900
Resolution: 1 for up to 9999
10 for 10000 to 99990
100 for 100000 to 999900
Unit: Cycles

(Example) To set the number of voltage waveform cycles until the start of a power line abnormality simulation to 1000 cycles
`N 1000`

Response message

Returns the number of cycles of voltage waveforms until the start of a power line abnormality simulation, in response to N?

(Example) When the number of voltage waveform cycles until the start of a power line abnormality simulation is 1000, the response message returns `1000`.

POL

Sets the voltage polarity applied when a power line abnormality simulation is started, or inquires about the voltage polarity.

Program message

• Syntax

Command message: `POL {PLUS|MINUS}`

Query message: `POL?`

• Program data

Data format: Character/integer

Set value:		
	PLUS(0)	+ polarity
	MINUS(1)	- polarity

(Example) To set the voltage polarity to positive

```
POL 0
POL PLUS
```

Response message

Returns the voltage polarity applied when a power line abnormality simulation is started, in response to POL?

(Example) When the voltage polarity applied when a power line abnormality simulation is started is PLUS (positive), the response message returns `0`.

RPT

Sets the number of repetitions for operations T1 to T5, or inquires about the number of repetitions set. Setting 9999 makes the number of repetitions infinite.

Program message

• Syntax

Command message: `RPT <NR1>`

Query message: `RPT?`

• Program data

Set value:	0 to 9998	
	9999	Infinite
Resolution:	1	

(Example) To set the number of repetitions to 50

```
RPT 50
```

Response message

Returns the number of repetitions for operations T1 to T5 in response to RPT?

(Example) When operations T1 to T5 are repeated five times, the response message returns `5`.

T1

Sets or inquires about the time at which voltage regulation begins. See Fig. 9-1, Parameter Setting.

Program message

• Syntax

Command message: `T1 <NR2>`

Query message: `T1?`

• Program data

Set value: 0.0 to 999.9

Resolution: 0.1

Unit: ms

(Example) To set the time at which voltage regulation begins to 200 ms

```
T1 200
```

Response message

Returns the time at which the present voltage regulation begins, in response to T1?

(Example) When the time at which voltage regulation begins is 100.0 ms, the response message returns `100.0`.

T1DEG

Sets or inquires about the phase at which voltage regulation begins. See Fig. 9-1, Parameter Setting.

Program message

• Syntax

Command message: `T1DEG <NR1>`

Query message: `T1DEG?`

• Program data

Set value: 0 to 360

Resolution: 1

Unit: deg

(Example) To set the phase at which voltage regulation begins to 100 deg

```
T1DEG 100
```

Response message

Returns the phase at which the present voltage regulation begins, in response to T1DEG?

(Example) When the phase at which voltage regulation begins is 90°, the response message returns `90`.

T2

Sets or inquires about the time required by the output voltage to reach regulated voltage V (T3). See Step 9-1, Parameter Setting.

Program message

• Syntax

Command message: `T2 <NR2>`

Query message: `T2?`

• Program data

Set value:	0.0 ms to 99.99 s
Resolution:	1 for up to 9999 ms
	0.01 for 10.00 s to 99.99 s
Unit:	ms for up to 9999 ms
	s for 10.00 s to 99.99 s

(Example) To set the time required by the output voltage to reach regulated voltage V (T3) to 2 s

```
T2 2S
```

Response message

Returns the time required by the present output voltage to reach regulated voltage V (T3) (change time), in response to T2?

(Example) When the time required by the output voltage to reach regulated voltage V (T3) is 2 s, the response message returns `2.00`.

T3

Sets or inquires about the length of time for which the output voltage is at regulated voltage V (T3). If this time is “0”, no power line abnormality simulation is performed. See Fig. 9-1, Parameter Setting.

Program message

• Syntax

Command message: `T3 <NR2>`

• Program data

Set value:	0.0 to 9999
Resolution:	0.1 for up to 999.9
	1 for 1000 to 9999
Unit:	ms

(Example) To set the time for which the output voltage is at regulated voltage V (T3) to 100 ms

```
T3 100
```

Response message

Returns the time for which the output voltage is at regulated voltage V (T3), in response to T3?

(Example) When the time for which the output voltage is at regulated voltage V (T3) is 100 ms, the response message returns `100`.

T3VSET

Sets or inquires about regulated voltage V (T3). Operation is determined as specified below, in accordance with the relationship between this value and the output voltage set value. See Fig. 9-1, Parameter Setting.

- Regulated voltage V (T3) > output voltage set value → Voltage swell (pops)
- Regulated voltage V (T3) < output voltage set value → Voltage dip (dips)
- Regulated voltage V (T3) = 0 V → Interruption

Program message

- Syntax

  Command message: `T3VSET <NR2>`

  Query message: `T3VSET?`

- Program data <AC voltage>

  Set value: 0 to 152.5 for the output 100 V range
  0 to 305.0 for the output 200 V range

  Resolution: 0.1

  Unit: V

(Example) To set regulated voltage V (T3) to 70 V

```
T3VSET 70
```

Response message

Returns regulated voltage V (T3) in response to T3VSET?

(Example) When regulated voltage V (T3) is 70 V, the response message returns `70.0`.

T4

Sets or inquires about the time required by the output voltage to return from regulated voltage V (T3) to the original voltage. See Fig. 9-1, Parameter Setting.

Program message

- Syntax

  Command message: `T4 <NR2>`

  Query message: `T4?`

- Program data

  Set value: 0 ms to 99.99 s

  Resolution: 1 for up to 9999 ms
  0.01 for 10.00 s to 99.99 s

  Unit: ms for up to 9999 ms
  s for 10.00 s to 99.99 s

(Example) To set the time required by the output voltage to return from regulated voltage V (T3) to the original voltage to 100 ms

```
T4 100
```

Response message

Returns the time required by the output voltage to return from regulated voltage V (T3) to the original voltage, in response to T4?

(Example) When the time required by the output voltage to return from regulated voltage V (T3) to the original voltage is 100 ms, the response message returns `100`.

T5

Sets the time from recovery of the output voltage to the original level to the start of the next power line abnormality simulation, or inquires about the time until the next power line abnormality simulation. See Fig. 9-1, Parameter Setting. The AC power supply converts the time into a recovery-cycle value based on the frequency of that time, and takes it as the recovery cycle. Thus, the error between setting of the recovery time and the recovery time of execution results is a maximum of one cycle.

Program message

• Syntax

Command message: `T5 <NR2>`

Query message: `T5?`

• Program data

Set value:	x1	0 ms to 9999 ms
	x10	0.00 to 99.99 s
Resolution:	x1	1 ms
	x10	10 ms
Unit:	ms, s	

(Example) To set the time until the start of a power line abnormality simulation to 200 ms

`T5 200`

Response message

Returns the time required until the start of a power line abnormality simulation in response to T5?

(Example) When the time required until the start of a power line abnormality simulation is 200 ms, the response message returns `200`.

9.7.2 Power Line Abnormality Simulation Start/Stop

INT/RUNNING?

Starts or stops a power line abnormality simulation, or inquires about whether a power line abnormality simulation is being conducted

Program message

• Syntax

Command message: `INT {ON|OFF|1|0}`

Query message: `INT?`
`RUNNING?`

• Program data

Data format:	Character/integer	
Set value:	OFF(0)	Stops a power line abnormality simulation
	ON(1)	Starts a power line abnormality simulation

(Example) To start a power line abnormality simulation

```
INT 1
INT ON
```

Response message

Returns whether a power line abnormality simulation is being conducted, in response to INT? or RUNNING?

(Example) When a power line abnormality simulation is being conducted,
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

NOTE

- If a power line abnormality simulation is being conducted, only the following messages are accepted.

  Query message

  Messages for stopping a power line abnormality simulation

  SIMSTOP message, INT OFF message, and INT 0 message

- The "Power Line Abnormality Simulation Setting Table" attached to this manual is useful for recording power line abnormality simulations.

SIMRUN

Starts a power line abnormality simulation. This command is the same as command message `INT 1`.

Program message

- Syntax

  Command message: `SIMRUN`

SIMSTOP

Stops a power line abnormality simulation. This command is the same as command message INT 0.

Program message

- Syntax

  Command message: `SIMSTOP`

9.8 Sequence Operation Messages

Specifying the sequence operation by combining output voltage, frequency, time setting, and other factors allows the PCR-LA AC power supply to be operated automatically. For the operational description, see “8.15 Sequence Operation”.

NOTE

- Some of the sequence operations may be ignored in the AC or DC mode. In the AC + DC mode, all program messages are available.
- While sequence operation is underway, only the following messages are accepted.

  Query message

  Messages for stopping a sequence

  SEQSTOP message, SEQPAUSE message

When using waveform banks

The waveform switches at the end of a cycle.

During sequence operation, the voltage and frequency change immediately at the specified time, but the waveform bank does not change until the waveform passes through waveform address 1023. To change the voltage and waveform bank simultaneously, the output must be adjusted for a minimum time as defined by the time until one cycle ends after the address switches + 1 ms. For a description of the waveform address, see "WAVE" in “9.9 Special Waveform Messages”.

Fig. 9-2 shows an example of an output waveform when the voltage and waveform bank are changed simultaneously.

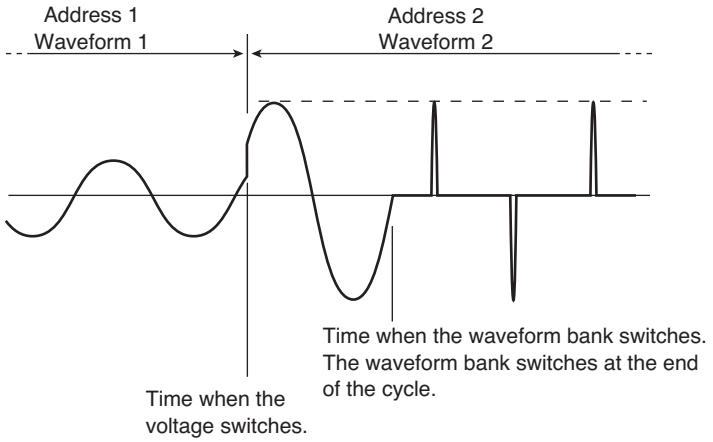


Fig. 9-2 Example of the times when the voltage and waveform bank change.

Because the time when the voltage switches and the time when the waveform bank switches are different, the waveform of address 1 is output using the voltage of address 2 after switching to address 2 for slightly less than a cycle. To prevent this output, waveform 2 (at 0 V for example) is inserted for the time until one cycle ends after the address switches + 1 ms between address 1 and 2.

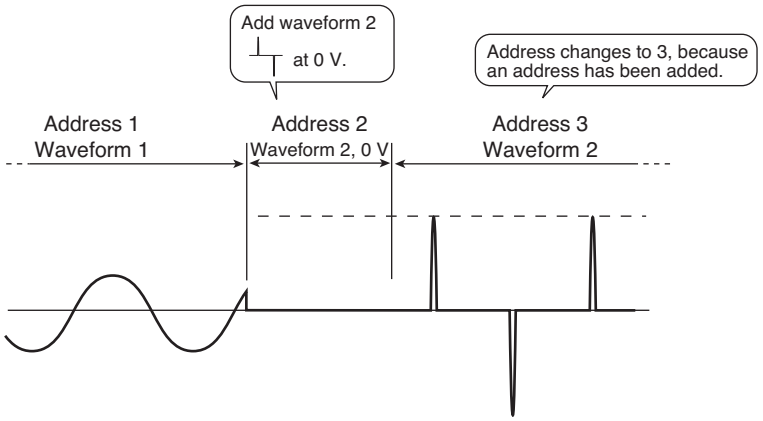


Fig. 9-3 Switching of the waveform whose output has been adjusted.

You can prevent unexpected waveform output by adjusting the output.

SEDIT

Sets or inquires about sequence data. When multiple command messages are set, the omission of a sequence address causes the addresses to be automatically increased and assigned. If data other than sequence addresses is omitted, data set until that time or data set immediately before will be enabled.

Program message

• Syntax

Command message: `SEDIT` <sequence address `NR1,` frequency-changing method `{ON|OFF|1|0},` frequency `NR2,` AC voltage changing method `{ON|OFF|1|0},` AC voltage `NR2,` hour `NR1,` minute `NR1,` second `NR1,` waveform bank `NR1,` output impedance `NR2,` DC voltage `NR2,` status signal `{ON|OFF|1|0},` trigger signal `{ON|OFF|1|0},` output `{ON|OFF|1|0}`>

Query message: `SEDIT` <sequence address `NR1`>`?`

• Program data <sequence address NR1>

Set value: 1 to 99

Resolution: 1

• Program data Frequency-changing method `{ON|OFF|1|0}`, AC voltage changing method `{ON|OFF|1|0}`

Address "0" cannot be used for specification of ramp ON. In addition, specification of ramp ON at the start address will be ignored.

Data format: Character/integer

Set value:		
	ON(1)	Ramp (linear)
	OFF(0)	Step

• Program data <frequency NR2>

Set value: 1.00 to 999.9
Resolution: 0.01 for 1.00 to 99.99
0.1 for 100.0 to 999.9
Unit: Hz

• Program data <AC voltage NR2>

Set value: 0 to 152.5 for the output 100 V range
0 to 305.0 for the output 200 V range
Resolution: 0.1
Unit: V

• Program data <hour NR1>

Set value: 0 to 999
Resolution: 1
Unit: Hour

• Program data <minute NR1>

Set value: 0 to 999
Resolution: 1
Unit: min

• Program data <second NR1>

Set value: 0.001 to 999.999
Resolution: 0.001
Unit: s

• Program data <waveform bank NR1>

Waveform banks should be set in the same way as the WAVEBANK message. In addition, the contents of waveform banks should be set in advance using a WAVEPC message.

Set value: 0 to 14 0 is for read only.
Resolution: 1

• Program data <output impedance NR2>

The output impedance should be set in the same way as the OUTZ message.

Set values and resolution:

	Setting range (Ω)		Resolution (Ω)	
	100 V range	200 V range	100 V range	200 V range
PCR500LA	0.0 to 4.0	0.0 to 16.0	40 m	160 m
PCR1000LA	0.0 to 2.0	0.0 to 8.0	20 m	80 m
PCR2000LA	0.0 to 1.0	0.0 to 4.0	10 m	40 m
PCR4000LA	0.0 to 0.5	0.0 to 2.0	5 m	20 m
PCR6000LA	0.000 to 0.333	0.000 to 1.333	3.33 m	13.33 m

Unit: Ω

• Program data <DC voltage NR2>

Set value: 0 to 215.5 for the output 100 V range
0 to 431.0 for the output 200 V range
Resolution: 0.1
Unit: V

• Program data Status signal {ON|OFF|1|0}

Data format: Character/integer

Set value:		
	OFF (0)	Disables signal output to BNC connector "SEQ STAT OUT"
	ON(1)	Enables signal output to BNC connector "SEQ STAT OUT"

• Program data Trigger signal {ON|OFF|1|0}

Data format: Character/integer

Set value:		
	OFF (0)	Disables signal output to BNC connector "SEQ TRIG OUT"
	ON(1)	Enables signal output to BNC connector "SEQ TRIG OUT"

• Program data Output {ON|OFF|1|0}

Data format: Character/integer

Set value:		
	OFF (0)	Output OFF
	ON(1)	Output ON

(Example) To set frequency ramp ON, a frequency of 56.78 Hz, voltage ramp OFF, AC voltage of 123.4 V, time of 0 h 0 m 10.123 sec, waveform bank 0, output impedance of 0, DC voltage of 10.0 V, status OFF, trigger OFF, and output ON to address 1

```
SEDIT 1,1,56.78,0,123.4,0,0,10.123,0,0,10.0,
0,0,1
```

Response message

(Example) When the sequence data in address 1 is frequency ramp ON, frequency of 56.78 Hz, voltage ramp OFF, AC voltage of 123.4 V, time of 0 h 0 m 10.123 sec, waveform bank 0, output impedance of 0, DC voltage of 10.0 V, status OFF, trigger OFF, and output ON, the response message returns the following in response to SEDIT_1?:

```
1,56.78,0,123.4,0,0,10.123,0,0,10.0,0,
```

NOTE

• The "Sequence Operation Setting Sheet" attached to this manual is useful for setting or recording sequence operations.

SEQEND

Sets a sequence end address or reads the sequence-end-address setting

Program message

Command message: `SEQEND <NR1>`
Query message: `SEQEND?`

• Program data
Set value: 1 to 98
Resolution: 1

(Example) To set the sequence end address to 3
`SEQEND 3`

Response message

Reads the setting of a sequence end address in response to SEQEND?

(Example) When the sequence end address is 3, the response message returns `3`.

SEQLOOP

Sets or inquires about the number of loops

Program message

Command message: `SEQLOOP <NR1>`
Query message: `SEQLOOP?`

• Program data
Set value: 1 to 99999
Resolution: 1

(Example) To set the number of loops to 3
`SEQLOOP 3`

Response message

Returns the number of loops set in response to SEQLOOP?

(Example) When the current number of loops is 20, the response message returns `20`.

SEQPAUSE

Pauses a sequence

Program message

Command message: `SEQPAUSE {ON|OFF|1|0}`
Query message: `SEQPAUSE?`

• Program data
Data format: Character/integer

Set value:	OFF(0)	Resumes a sequence
	ON(1)	Pauses a sequence

(Example) To resume a sequence
```
SEQPAUSE 0
SEQPAUSE OFF
```

Response message

Returns whether a sequence is running in response to SEQPAUSE?

(Example) When the sequence is being paused,
In the PCR-LA mode, the response message returns `1`.
In the PCR-L mode, it returns `001`.

SEQRUN

Runs a sequence

Program message

Command message: `SEQRUN`

SEQSTART

Sets a sequence start address or reads the sequence-start-address setting

Program message

Command message: `SEQSTART <NR1>`
Query message: `SEQSTART?`

• Program data
Set value: 1 to 98
Resolution: 1

(Example) To set the sequence start address to 3
```
SEQSTART 3
```

Response message

Reads the setting of a sequence end address in response to SEQSTART?

(Example) When the sequence end address is 3, the response message returns `3`.

SEQSTOP

Stops a sequence

Program message

Command message: `SEQSTOP`

9.9 Special Waveform Messages

Use of the special waveform command allows any waveforms other than sine waves to be output. The special waveform that can be output as standard is the “peak-clipped waveform,” in which the peak of a sine wave is suppressed. In addition, if user-defined waveform data is transferred to the AC power supply, that waveform can be output. To output a special waveform, set waveforms in the waveform banks in advance, and then switch the waveform banks to output waveforms. The power supply has 15 waveform banks (banks 0 to 14). Bank 0 is dedicated for reference sine waves, which cannot be rewritten. Banks 1 to 14 are user-defined waveform banks, the contents of which can be rewritten without restraints.

The waveform switches at the end of a cycle. For details on the switching, see Page 9-44 “When using waveform banks”.

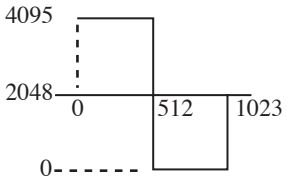
WAVE

Writes data directly into a waveform bank, or inquires about data of a waveform bank.

To write the waveform directly into a waveform bank, set the waveform data to the waveform address derived by dividing a cycle (phase angle of 360 degrees) by 1024. In the initial setup status, all waveform banks contain sine waves.

Only the section of the waveform address in which waveform data is set is changed.

For example, to write a square wave into a waveform bank, set waveform data 4095 into waveform addresses 0 to 511 and waveform data 0 to waveform addresses 513 to 1022. Set waveform data 2048 to waveform addresses 512 and 1023. The square wave of Fig. 9-4 is written to the waveform bank.



Horizontal direction: Waveform address
Vertical direction: Waveform data

Fig. 9-4 Example of a Square Wave Created

The program data can be omitted when setting multiple command messages. If you omit the waveform address, the address is automatically incremented. If you omit the waveform bank and waveform data, the previous values are used.

Program message

Command message: `WAVE <waveform bank NR1,`
`waveform address NR1,`
`waveform data NR1>`

Query message: `WAVE <waveform bank NR1,`
`waveform data NR1>?`

• Program data <waveform bank NR1>

Set value: 0 to 14 0 is for read only.

Resolution: 1

• Program data <waveform address NR1>

Set value: 0 to 1023 — 0 is a phase angle of 0°, while 512 is a phase angle of 180°.

Resolution: 1

Unit: deg

• Program data <waveform data NR1>

Set value: 0 to 4095 — 2048 is the center of the waveform. 0 is the minus peak. 4095 is the plus peak.

Resolution: 1

(Example) To set the waveform data of waveform bank 10 and waveform address 100 to 2048

```
WAVE 10,100, 2048
```

Response message

Returns the waveform data in response to WAVE<waveform bank NR1, waveform address NR1>?

(Example) When the waveform data of waveform bank 1 and waveform address 10 is 100, the response message returns `100` in response to WAVE 1,10?.

WAVEBANK

Selects the waveform bank to be used, or inquires about a waveform bank. For information on the waveform banks, see "8.18 Special Waveform Output".

Program message

Command message: `WAVEBANK <NR1>`

Query message: `WAVEBANK?`

• Program data

Set value: 0 to 14 — 0 is dedicated for SIN waves.

Resolution: 1

(Example) To use waveform bank 10

```
WAVEBANK 10
```

Response message

Returns the current waveform bank in response to WAVEBANK?

(Example) When the waveform bank is 10, the response message returns `10`.

WAVEPC

Sets or inquires about a peak-clipped waveform. This command is available only when output is OFF.

Program message

Command message: `WAVEPC <waveform bank NR1, peak-clipped waveform crest factor NR2>`

Query message: `WAVEPC <waveform bank NR1>?`

• Program data <waveform bank NR1>

Set value: 0 to 14 0 is dedicated for SIN waves.

Resolution: 1

• Program data <peak-clipped waveform's crest factor NR2>

Set value: 1.10 to 1.41

When 1.41 is set, sine waves apply.

Resolution: 0.01

(Example) To set the crest factor of peak-clipped waveforms in waveform bank 3 to 1.2

```
WAVEPC 3,1.2
```

Response message

Returns the crest factor of a peak-clipped waveform in response to `WAVEPC <waveform bank NR1>?`

(Example) When the crest factor of a peak-clipped waveform in waveform bank 2 is 1.23, the response message returns `1.23` in response to WAVEPC 2?.

(Example) When the crest factor of a peak-clipped waveform in waveform bank 3 is a sine wave, the response message returns `1.41` in response to WAVEPC 3?.

9.10 Zero Calibration Command for the Measured Current Value (in Parallel Operation)

When the PD03M-PCR-LA and PD03S-PCR-LA options are used to perform master-slave operations for the first time, there may be an offset (indication of a slight value under no-load condition) in the display of the current, power, power factor, and apparent power, as well as the analyzed harmonic current value, related to current measurements. In such a case, use the following command to perform zero calibration.

CALPARA

Be sure to read through the operation manual of the PD03M/S-PCR-LA.

Conduct zero calibration using the CALPARA message.

Other messages are not accepted until the completion of zero calibration, which requires several tens of seconds. The calibrated value will be stored in the PCR-LA AC power supply. However, re-calibration must be performed depending on changes in ambient temperature or the like.

Program message

• Syntax

Command message: `CALPARA`

9.11 Registers

The AC power supply has 10 internal registers that can be accessed from an external device. Each register consists of 8 bits, and decimal data (0 to 255) will be returned when read out. The following provides an overview of each internal register.

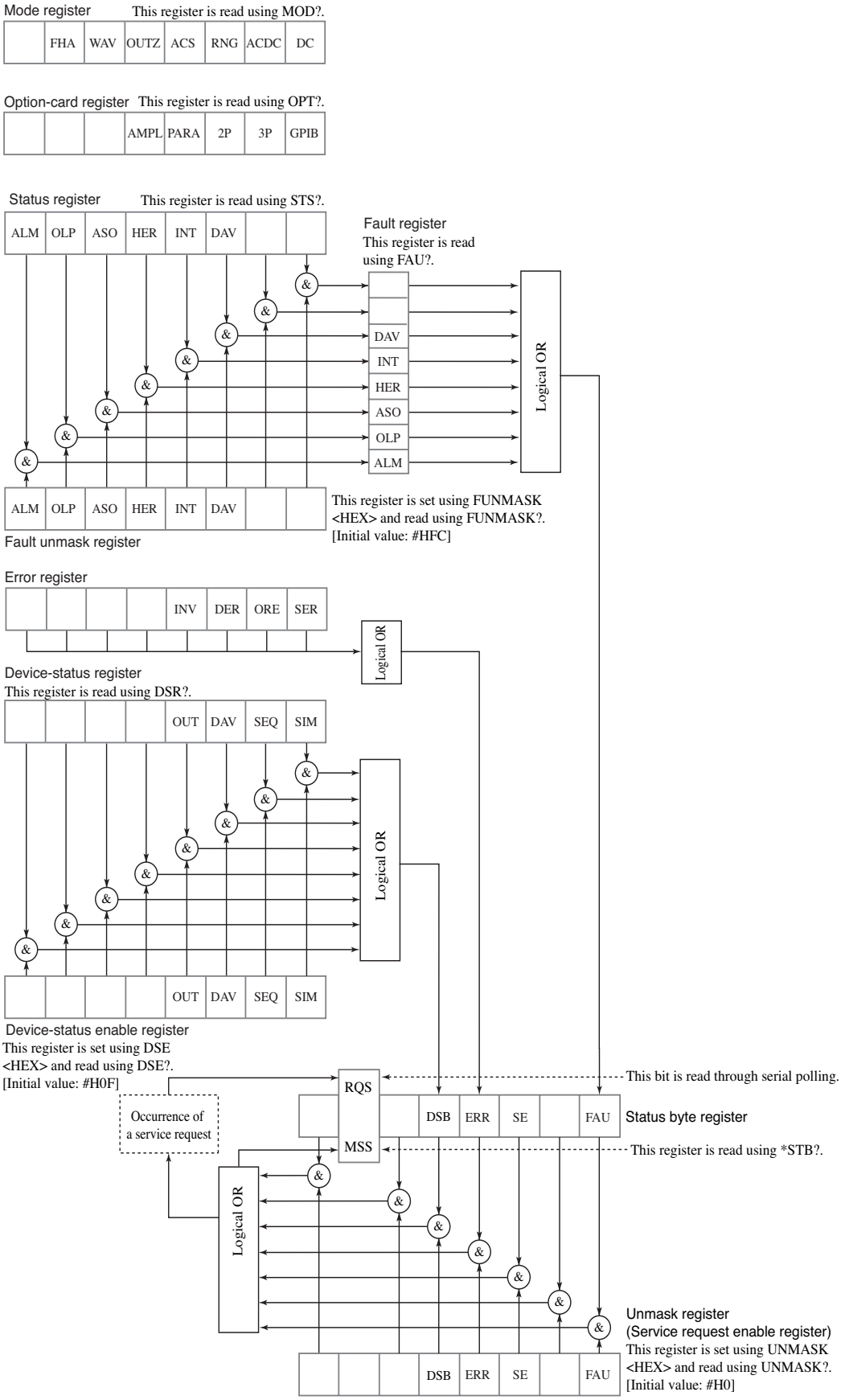


Fig. 9-5 Internal Register

Status Byte Register

Bit		Description
7		Not used
6	RQS	When this bit is set, a service request has been made. It is reset when read by serial polling.
	MSS	This is logical OR of the status byte register and service request enable register. The bit is read using *STB.
5		Not used
4	DSB	Contains a value obtained by masking the value of the device-status register, using the device-status enable register*1
3	ERR	Indicates that a syntax error, etc. has occurred
2	SE	Set to “1” approx. 1 second after a sequence has ended
1		Not used
0	FAU	Contains a value obtained by masking the value of the fault register, using the fault unmask register

*1. This bit is masked in the PCR-L mode.

Unmask Register (Service Request Enable Register) (Initial value: #H0)

Bit		Description
7		Not used
6		Not used
5		Not used
4	DSB	Indicates that the generation of a service request is permitted in the event of DSB
3	ERR	Indicates that the generation of a service request is permitted in the event of a command error
2	SE	Indicates that the generation of a service request is permitted upon completion of a sequence
1		Not used
0	FAU	Indicates that the generation of a service request is permitted if any bit in the fault register is set to “1”

Fault Register, Fault Unmask Register (Initial Value: #HFC), and Status Register

If any bit in the status register is changed to 1 from 0, its applied bit of the fault register is set to 1. (It can be set only when the bit of fault unmask register is installed.) The fault register will be reset when its contents are read by the FAU? message.

If any bit in the fault register is changed to 1 from 0, the FAU bit of the status byte register is set to 1.

Bit		Description
7	ALM	Indicates that another alarm has occurred
6	OLP	Indicates that the current limiting function has activated
5	ASO	Indicates that the internal semiconductor protective circuit has activated
4	HER	Indicates that a hardware error has occurred in the AC power supply
3	INT	Set to “1” for approx. 1 second upon completion of power line abnormality simulation
2	DAV	Indicates that the measured value has been updated
1		Not used
0		Not used

Mode Register

Bit		Description
7		Not used
6	FHA	Indicates that the output ON/OFF phase has been set
5	WAV	Indicates that the waveform has been switched
4	OUTZ	Indicates that the output impedance has been set
3	ACS	AC-S mode
2	RNG	Output voltage range: 200 V range (1)/100 V range (0)
1	ACDC	AC + DC mode
0	DC	DC mode (1)/AC mode (0)

Device-Status Register, Device-Status Enable Register (Initial Value: #H0F)

Bit		Description
7		Not used
6		Not used
5		Not used
4		Not used
3	OUT	Indicates that OUTPUT ON is lit
2	DAV	Indicates that the measured value has been updated
1	SEQ	Sequence operation is running.
0	SIM	Power line abnormality simulation is underway.

Option-Card Register

Bit		Description
7		Not used
6		Not used
5		Not used
4	AMPL	External analog control
3	PARA	Parallel operation
2	2P	Single phase, three wires
1	3P	Three phase
0	GPIB	GPIB

Error Register

Bit		Description
7		In the PCR-L mode, this bit indicates that a data error or invalid message has been detected.
6		Not used
5		Not used
4		Not used
3	INV	Invalid message (Not used in the PCR-L mode)
2	DER	Data error (Not used in the PCR-L mode)
1	ORE	Indicates that an out-of-range error has occurred
0	SER	Syntax error (SYNTAX ERROR)

9.12 Lists of Messages

"W/R" indicates a command message (W) and a query message (R).

The definition of "2P/3P, Sync, AC/AC-S, ... Alarm" in the function columns will be given at the end of this section.

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
1	*CLS	W						Clears registers.											
2	*IDN?	R						KIKUSUI ELECTRONICS CORP., PCR-xxxxLA,0,x.xx											
3	*RST	W						Resets each set value to the factory-shipped setting, with the exception of memory, sequence, alarms, and user-defined waveforms (This command is the same as SETINI.)											*1
4	*STB?	R						Returns a status byte register value. Bit 4 is masked in the PCR-L mode.											
5	ACDC	W	0	3	1			Output-voltage mode 0: AC; 1: DC; 2: AC+DC; or 3: ACS	*1	*1				*1	*1	*1	*1	*1	*1
6	ACDC?	R						Returns output voltage mode 0,1,2,or 3 in the PCR-LA mode,000,001,002,or 003 in the PCR-L mode.											
7	ACILIM	W	†	†	†			Sets AC current limit values. † Differ depending on the model and range	*1							*1	*1	*1	*1
8	ACILIM?	R						Returns AC current limit values.											
9	ACVHI	W	0	305.0	0.1		More than ACVLO set value	Sets an AC voltage high limit value.							*1	*1	*1	*1	*1
10	ACVHI?	R						Returns an AC voltage high limit value.											
11	ACVLO	W	0	305.0	0.1		Less than ACVHI set value	Sets an AC voltage low limit value.							*1	*1	*1	*1	*1
12	ACVLO?	R						Returns an AC voltage low limit value.											
13	ACVSET	W	0	152.5/ 305.0	0.1			Sets an AC voltage value.				*1		*2	*1		*1		*1
14	ACVSET?	R						Returns an AC voltage value.											
15	ALMCLR	W						Clears an alarm.											*2
16	CALPARA	W						Conducts zero calibration of current measurements.											
17	CLR	W						Clears the error register.											*1
18	CLRMEMORY	W						Clears all memory data.								*1	*1	*1	*1
19	CURHARMA N?	R	1	40	1			Returns n-th order harmonic data.										*3	

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
20	CURHARMP N?	R	1	40	1			Returns n-th order harmonic data as a percentage.										*3	
21	CURHARMA ODD?	R						Returns odd-numbered order harmonic data by separating it with ",".										*3	
22	CURHARMP ODD?	R						Returns odd-numbered order harmonics data (as a percentage) by separating it with ",".										*3	
23	CURHARMA EVEN?	R						Returns even-numbered order harmonics data by separating it with ",".										*3	
24	CURHARMP EVEN?	R						Returns even-numbered order harmonics data (as a percentage) by separating it with ",".										*3	
25	CURHARMA LOW?	R						Returns 1st- to 20th-order harmonics data by separating it with ",".										*3	
26	CURHARMP LOW?	R						Returns 1st- to 20th-order harmonics data (as a percentage) by separating it with ",".										*3	
27	CURHARMA HIGH?	R						Returns 21st- to 40th-order harmonics data by separating it with ",".										*3	
28	CURHARMP HIGH?	R						Returns 21st to 40th harmonics data (as a percentage) by separating it with ",".										*3	
29	DCILIM	W	†	†	†			Sets DC current limit values † Differ depending on the model and range.	*1						*1	*1	*1	*1	*1
30	DCILIM?	R						Returns DC current limit values.											
31	DCVHI	W	-431.0	431.0	0.1		More than DCVLO set value	Sets a DC voltage high limit value.	*1						*1	*1	*1	*1	*1
32	DCVHI?	R						Returns a DC voltage high limit value.											
33	DCVLO	W	-431.0	431.0	0.1		Less than DCVHI set value	Sets a DC voltage low limit value.	*1						*1	*1	*1	*1	*1
34	DCVLO?	R						Returns a DC voltage low limit value.											
35	DCVSET	W	-215.5/ -431.0	215.5/ 431.0	0.1			Sets a DC voltage value.	*1		*1				*1	*1	*1	*1	*1
36	DCVSET?	R						Returns a DC voltage value.											
37	DSE	W	0	#HFF				Sets the device-status enable register.											
38	DSE?	R						Clears the device-status enable register.											
39	DSR?	R						Returns a value in the device-status register.											

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
40	ERR?	R						Returns an error code.											
41	FAU?	R						Returns a fault register value.											
42	FFT	W	0/OFF	1/ON				Places the AC power supply in harmonic current analysis mode.		*1		*1	*1		*1	*1	*1		*1
43	FFT?	R						Returns whether the power supply is in harmonic current analysis mode (1) or not (0). In the PCR-L mode, (001) or (000) is returned.											
44	FFTHOLD	W	0/OFF	1/ON				Pauses (ON) or clears (OFF) FFT computation.		*1								*3	
45	FHI	W	1.00	999.9	0.01/ 0.1		More than FLO set value	Sets the output frequency high limit value.							*1	*1	*1	*1	*1
46	FHI?	R						Returns the output frequency high limit value.											
47	FLO	W	1.00	999.9	0.01/ 0.1		Less than FHI set value	Sets the output frequency low limit value.							*1	*1	*1	*1	*1
48	FLO?	R						Returns the output frequency low limit value.											
49	FSET	W	1.00	999.9	0.01/ 0.1			Sets the output frequency.		*1		*1			*1		*1		*1
50	FSET?	R						Returns the output frequency.											
51	FSTO	W	0	99	1		Mem-ory No.	Stores the set frequency in memory.	*3										
52	FSTO xx?	R	0	99	1			Returns the frequency stored in a specified memory number. In the PCR-L mode, a memory number and frequency are returned.											
53	FUNMASK	W	0	#HFF				Sets a fault unmask register value.											
54	FUNMASK?	R						Clears a fault unmask register value.											
55	HEAD	W	0	1				Sets whether to assign the header.											
56	HEAD?	R						Returns whether the header is appended (1) or not (0). In the PCR-L mode, (001) or (000) is returned.											
57	HOME	W						Returns a status to the Home Position.						*1	*1		*1		*1
58	IDN?	R						Returns “PCRxxxxL VERx.xx KIKUSUI”.											
59	IM?	R						Returns the output current measurement mode, which is one of IMRMS, IMPK, IMPKH, and IMAVA.											

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Resolution	Unit	Remarks												
60	IMAVE	W						Sets the output current measurement mode to Ave.			*1								*1
61	IMPK	W						Sets the output current measurement mode to Peak.											*1
62	IMPKH	W						Sets the output current measurement mode to Peak Hold.											*1
63	IMRMS	W						Sets the output current measurement mode to rms.											*1
64	INT	W	0/OFF	1/ON				Starts or stops power line abnormality simulation. This command is the same as SIMSTOP/SIMRUN.	*4	*5	*5	*5	*5	*5	*5	*5	*5	*5	*5
65	INT?	R						Returns whether power line abnormality simulation is being performed (1) or stopped (0). In the PCR-L mode, (001) or (000) is returned.											
66	IOUT?	R						Returns an output current measured value.											
67	LOC	W						Returns control to LOCAL status.						*1					
68	MEMSTO	W	1	99	1		Memory No.	Stores data in memory.	*4						*1	*1	*1		*1
			0	152.5/305.0	0.1		AC voltage												
			1.00	999.9	0.01/0.1		Frequency												
			0	14	1		Bank												
			-215.5/-431.0	215.5/431.0	0.1		DC voltage												
69	MEMSTO xx?	R	0	99	1		Memory No.	Returns the contents of a specified memory number. In the PCR-L mode, a memory number and its contents are returned.	*4										
70	MOD?	R						Returns a mode register value.											
71	N	W	0	9999, 99990, 999900	1		x1 x10 x100	The number of cycles required for the output voltage to recover in order to start power line abnormality simulation (expressing T5 as the number of cycles)				*1	*1		*1		*1	*1	*1
72	N?	R						Returns the number of cycles required for the output voltage to recover in order to start power line abnormality simulation (expressing T5 as the number of cycles).											
73	OFFPHASE	W	0	360	1			Sets the output OFF phase.				*1	*1		*1	*1	*1	*1	*1
74	OFFPHASE?	R						Returns an output-OFF-phase set value.											
75	ONPHASE	W	0	360	1			Sets the output ON phase.				*1	*1		*1	*1	*1	*1	*1
76	ONPHASE?	R						Returns an output-ON-phase set value.											

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Resolution	Unit	Remarks												
77	OPT?	R						Returns an option card register value.											
78	OUT	W	0/OFF	1/ON				Sets output ON/OFF.							*1				*5
79	OUT?	R						Returns output ON status (1) or OFF status (0). In the PCR-L mode, (001) or (000) is returned.											
80	OUTZ	W	0	16.000	†			Sets the output impedance as a resistance value. † Differs depending on the model and range.				*1	*1		*1	*1	*1	*1	*1
81	OUTZ?	R						Returns an output-impedance resistance value.											
82	OUTZPER	W	0	100	1			Sets the output impedance as a %.				*1	*1		*1	*1	*1	*1	*1
83	OUTZPER?	R						Returns the output impedance as a %.											
84	PEAKINIT	W						Clears the peak holding value.											*1
85	PF?	R						Returns a measured power factor value.											
86	POL	W	0/PLUS	1/MINUS				Sets the voltage variation starting polarity.	*6			*1	*1		*1		*1	*1	*1
87	POL?	R						Returns the voltage variation starting polarity.											
88	RANGE	W	0/100	1/200				Sets a voltage range.						*1	*1	*1	*1	*1	*1
89	RANGE?	R						Returns a voltage range. 100 V range (0) 200 V range (1) In the PCR-L mode, (000) or (001) is returned.											
90	RPT	W	0	9999	1		9999: ∞	Sets the number of repetitions for Power line abnormality simulation.				*1	*1		*1		*1	*1	*1
91	RPT?	R																	
92	RUNNING?	R	0	1				Returns whether a Power line abnormality simulation or sequence is running (1) or stopped (0). In the PCR-L mode, (001) or (000) is returned.											

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
93	SEDIT	W	0	99	1		Address	Sets sequence data.							*1	*1	*1	*1	*1
			0/OFF	1/ON			Fre-quency ramp												
			1.00	999.9	0.01/ 0.1		Fre-quency												
			0/OFF	1/ON			Voltage ramp												
			0	152.5/ 305.0	0.1		AC voltage												
			0	999	1		Hour												
			0	999	1		Minute												
			0.001	999.999	0.001		Second												
			0	14	1		Wave-form bank												
			0	16.000	†		OUT Z	† Differs depending on the model and range.											
			-215.5/-431.0	215.5/ 431.0	0.1		DC voltage												
			0/OFF	1/ON			Status	Status: Whether to output a signal to the “STAT” BNC connector on the rear panel											
			0/OFF	1/ON			Trigger	Trigger: Whether to output a signal to the “TRIG” BNC connector on the rear panel											
			0/OFF	1/ON			Output	Output: ON/OFF											
94	SEDIT xx?	R	0	99	1		Address	Returns the sequence data setting.											
95	SELFTEST?	R						Returns self-test results. `OK / ADRxx,NOx`											
96	SEQEND	W	1	99	1		Address	Sets a sequence end address.							*1	*1	*1	*1	*1
97	SEQEND?	R						Returns a sequence end address.											
98	SEQLOOP	W	0	99999				Sets the number of sequence loops.							*1	*1	*1	*1	*1
99	SEQLOOP?	R						Returns the number of sequence loops.											
100	SEQPAUSE	W	0	1				Pauses a sequence. 1:PAUSE; 0: RESTART								*1	*1	*1	*1

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
101	SEQPAUSE?	R						Returns whether a sequence is being run (0) or paused (1). In the PCR-L mode, (000) or (001) is returned.											
102	SEQRUN	W						Starts a sequence.							*1	*1	*1	*1	*1
103	SEQSTART	W	0	98	1		Address	Sets a sequence start address.							*1	*1	*1	*1	*1
104	SEQSTART?	R						Returns a sequence start address.											
105	SEQSTOP	W						Stops a sequence.								*1	*1	*1	*1
106	SETINI	W						Resets each set value to the factory-shipped setting, with the exception of memory, sequence, alarms, and user-defined waveforms (This command is the same as *RST.)											*1
107	SILENT	W	0/OFF	1/ON				OK/ERROR for RS-232C											
108	SIMMODE	W	0/OFF	1/ON				Sets ON/OFF for Power line abnormality simulation mode.		*1		*1	*1	*1	*1			*1	*1
109	SIMMODE?	R						Returns whether the power supply is in the power line abnormality simulation mode (1) or not (0). In the PCR-L mode, (001) or (000) is returned.											
110	SIMRUN	W						Starts a Power line abnormality simulation. The same as INT 1.						*3	*1			*1	*1
111	SIMSTOP	W						Stops a Power line abnormality simulation. The same as INT 0.							*1	*7		*1	*1
112	STB?	R						Returns a status byte register value.											
113	STS?	R						Returns a status register value.											
114	SYNC	W	0/OFF	1/ON				Sets ON/OFF for the synchronous function.				*1	*1		*1	*1	*1	*1	*1
115	SYNC?	R						Returns whether the synchronous function is ON (1) or OFF (0). In the PCR-L mode, (001) or (000) is returned.											
116	T1	W	0.0	999.9	0.1	ms		T1 (start) time (If the unit is omitted, “s” applies.)				*1	*1		*1		*1	*1	*1
117	T1?	R						Returns the T1 (start) time.											
118	T1DEG	W	0	360	1			T1 (start) phase				*1	*1		*1		*1	*1	*1
119	T1DEG?	R						Returns the T1 (start) phase.											
120	T2	W	0 0.00	9999 99.99	1 0.01	ms s	x1 x10	T2 (slope) time (If the unit is omitted, “s” applies.)				*1	*1		*1		*1	*1	*1

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
121	T2?	R						Returns the T2 (slope) time.											
122	T3	W	0.0 0	999.9 9999	0.1 1	ms ms	x1 x10	T3 (regulation) time (If the unit is omitted, “s” applies.)				*1	*1		*1		*1	*1	*1
123	T3?	R						Returns the T3 (regulation) time.											
124	T3VSET	W	0	152.5/ 305.0	0.1			T3 (regulated) voltage				*1	*1		*1		*1	*1	*1
125	T3VSET?	R						Returns the T3 (regulated) voltage.											
126	T4	W	0 0.00	9999 99.99	1 0.01	ms s	x1 x10	T4 (slope) time (If the unit is omitted, “s” applies.)				*1	*1		*1		*1	*1	*1
127	T4?	R						Returns the T4 (slope) time.											
128	T5	W	0 0.00	9999 99.99	1 0.01	ms s	x1 x10	T5 (recovery) time (If the unit is omitted, “s” applies.)				*1	*1		*1		*1	*1	*1
129	T5?	R						Returns the T5 (recovery) time.											
130	TERM	W	0	3	1			Terminator 0: CRLF + EOI; 1: CR + EOI; 2: LF + EOI; 3: EOI											*8
131	TERM?	R						Returns the terminator setting (0, 1, 2, or 3). In the PCR-L mode,returns (000, 001, 002, or 003) .											
132	UNMASK	W	0	#HFF				Sets the unmask register (service request enable register).											
133	UNMASK?	R						Clears the unmask register.											
134	VA?	R						Returns an apparent power value.											
135	VM?	R						Returns the output voltage measurement mode. VMRMS, VMPK, or VMAVE											
136	VMAVE	W						Sets the output voltage measurement mode to Ave.			*1								*1
137	VMPK	W						Sets the output voltage measurement mode to Peak.											*1
138	VMRMS	W						Sets the output voltage measurement mode to rms.											*1
139	VMSET	W						Sets the voltage display to a set value.											*1
140	VOUT?	R						Returns a measured output voltage value.											
141	VSET	W	0	152.5/ 305.0	0.1			The same as the ACVSET command	*7			*1			*1		*1		*1
142	VSET?	R						The same as the ACVSET? command											
143	VSTO	W	0	99	1		Memory No.	Stores a set AC voltage value in memory.	*4						*1	*1	*1	*1	*1

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
144	VSTO xx?	R	0	99	1			Returns the AC voltage value stored in a specified memory number. In the PCR-L mode, a memory number and AC voltage value are returned.											
145	WATT?	R						Returns an output power value.											
146	WAVE	W	1	14	1		Bank	Sets a waveform bank. X-axis 0:0° position, 512:180° position Y-axis 1: minus peak; 2048: center; 4095: plus peak						*1	*1	*1	*1	*1	*1
			0	1023	1		Address												
			0	4095	1		Data												
147	WAVE xx,xx?	R	1	14	1		Bank	Returns data for a specified bank and address.											
			0	1023	1		Address												
148	WAVEBANK	W	0	14	1			Switches between waveform banks.				*1			*1	*1	*1	*1	*1
149	WAVEBANK?	R						Returns a waveform bank.											
150	WAVEPC	W	1	14	1		Bank	Sets the peak clip value of a specified bank. 1.41 is a sinusoidal wave.						*1	*1	*1	*1	*1	*1
			1.10	1.41	0.01		Crest factor												
151	WAVEPC xx?	R	1	14	1		Bank	Returns the peak clip value of a specified bank.											
152	PHASEV	W	0	360	1			U-V phase difference (3P)	*3			*1	*1		*1			*1	*1
153	PHASEW	W	0	360	1			U-W phase difference (3P)	*3			*1	*1		*1			*1	*1
154	VLINE	W						Line voltage display (3P)	*9										*1
155	VPHASE	W						Phase voltage display (3P)	*3										*1
156	LINEVSET	W						Sets the line voltage (3P).	*4						*1	*1	*1		*1
157	UCURHARMA N?	R	1	40	1			Returns the U-phase's n-th order harmonic data (3P).	*3									*3	
158	VCURHARMA N?	R	1	40	1			Returns the V-phase's n-th order harmonic data (3P).	*3									*3	
159	WCURHARMA N?	R	1	40	1			Returns the W-phase's n-th order harmonic data (3P).	*3									*3	
160	UCURHARMP N?	R	1	40	1			Returns the U-phase's n-th order harmonic data as a percentage (3P).	*3									*3	
161	VCURHARMP N?	R	1	40	1			Returns the V-phase's n-th order harmonic data as a percentage (3P).	*3									*3	
162	WCURHARMP N?	R	1	40	1			Returns the W-phase's n-th order harmonic data as a percentage (3P).	*3									*3	
163	UCURHARMA ODD?	R						Returns the odd-numbered order harmonics data of phase U by separating it with "," (3P).	*3									*3	

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
164	VCURHARMA ODD?	R						Returns the odd-numbered order harmonics data of phase V by separating it with “,” (3P).	*3									*3	
165	WCURHARMA ODD?	R						Returns the odd-numbered order harmonics data of phase W by separating it with “,” (3P).	*3									*3	
166	UCURHARMP ODD?	R						Returns the odd-numbered order harmonics data of phase U (as a percentage) by separating it with “,” (3P).	*3									*3	
167	VCURHARMP ODD?	R						Returns the odd-numbered order harmonics data of phase V (as a percentage) by separating it with “,” (3P).	*3									*3	
168	WCURHARMP ODD?	R						Returns the odd-numbered order harmonics data of phase W (as a percentage) by separating it with “,” (3P).	*3									*3	
169	UCURHARMA EVEN?	R						Returns the even-numbered order harmonics data of phase U by separating it with “,” (3P).	*3									*3	
170	VCURHARMA EVEN?	R						Returns the even-numbered order harmonics data of phase V by separating it with “,” (3P).	*3									*3	
171	WCURHARMA EVEN?	R						Returns the even-numbered order harmonics data of phase W by separating it with “,” (3P).	*3									*3	
172	UCURHARMP EVEN?	R						Returns the even-numbered order harmonics data of phase U (as a percentage) by separating it with “,” (3P).	*3									*3	
173	VCURHARMP EVEN?	R						Returns the even-numbered order harmonics data of phase V (as a percentage) by separating it with “,” (3P).	*3									*3	
174	WCURHARMP EVEN?	R						Returns the even-numbered order harmonics data of phase W (as a percentage) by separating it with “,” (3P).	*3									*3	
175	UCURHARMA LOW?	R						Returns 1st- to 20th-order harmonics data of phase U by separating it with “,” (3P).	*3									*3	
176	VCURHARMA LOW?	R						Returns 1st- to 20th-order harmonics data of phase V by separating it with “,” (3P).	*3									*3	
177	WCURHARMA LOW?	R						Returns 1st- to 20th-order harmonics data of phase W by separating it with “,” (3P).	*3									*3	
178	UCURHARMP LOW?	R						Returns 1st- to 20th-order harmonics data of phase U (as a percentage) by separating it with “,” (3P).	*3									*3	
179	VCURHARMP LOW?	R						Returns 1st- to 20th-order harmonics data of phase V (as a percentage) by separating it with “,” (3P).	*3									*3	

	Header	Program data						Description	2P/3P	Sync	AC/AC-S	DC	ACDC	Out On	Seq Run	SimMode	Sim Run	FFT On	Alarm
		W/R	Min	Max	Reso-lution	Unit	Remarks												
180	WCURHARMP LOW?	R						Returns 1st- to 20th-order harmonics data of phase W (as a percentage) by separating it with "," (3P).	*3									*3	
181	UCURHARMA HIGH?	R						Returns 21st- to 40th-order harmonics data of phase U by separating it with "," (3P).	*3									*3	
182	VCURHARMA HIGH?	R						Returns 21st- to 40th-order harmonics data of phase V by separating it with "," (3P).	*3									*3	
183	WCURHARMA HIGH?	R						Returns 21st- to 40th-order harmonics data of phase W by separating it with "," (3P).	*3									*3	
184	UCURHARMP HIGH?	R						Returns 21st- to 40th-order harmonics data of phase U (as a percentage) by separating it with "," (3P).	*3									*3	
185	VCURHARMP HIGH?	R						Returns 21st- to 40th-order harmonics data of phase V (as a percentage) by separating it with "," (3P).	*3									*3	
186	WCURHARMP HIGH?	R						Returns 21st- to 40th-order harmonics data of phase W (as a percentage) by separating it with "," (3P).	*3									*3	
187	UVSET	W	0	152.5/ 305.0	0.1			Sets a U-phase voltage value (3P).	*7						*1		*1		*1
188	UVSET?	R						Returns a U-phase voltage value (3P).	*3										*1
189	VVSET	W	0	152.5/ 305.0	0.1			Sets a V-phase voltage value (3P).	*7						*1		*1		*1
190	VVSET?	R						Returns a V-phase voltage value (3P).	*3										*1
191	WVSET	W	0	152.5/ 305.0	0.1			Sets a W-phase voltage value (3P).	*7						*1		*1		*1
192	WVSET?	R						Returns a W-phase voltage value (3P).	*3										*1

*1. Invalid command
*2. Invalid when "Not"
*3. Invalid in the line voltage display mode or when (U-phase voltage) ≠ (V-phase voltage) ≠ (W-phase voltage)
*4. See the SIMSTOP/SIMRUN commands.
*5. Invalid if an alarm other than that indicating an overload occurs
*6. Invalid in the line voltage display mode
*7. Invalid when OUTPUT is OFF in Sim Mode
*8. Invalid for RS-232C
*9. Invalid when (U-phase voltage) ≠ (V-phase voltage) ≠ (W-phase voltage)

Definitions of the terms in the function columns

2P/3P: When 2P03-PCR-LA (single-phase three-wire output driver) or 3P03-PCR-LA (three-phase output driver) is used

Sync: When the synchronous function is activated

AC/AC-S: When the AC power supply is operating in AC or AC-S mode

DC: When the AC power supply is operating in DC mode

ACDC: When the AC power supply is operating in AC+DC mode

Out On: When power is supplied to a load with the output turned ON

Seq Run: When a sequence action is being run using the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller

SimMode: When the power line abnormality simulation function has been activated using the RS-232C Control, GPIB Interface, RC03-PCR-LA Remote Controller, or RC04-PCR-LA Remote Controller (This includes setting prior to the start of simulation.)

Sim Run: When a power line abnormality simulation is being run using the RS-232C Control, GPIB Interface, RC03-PCR-LA Remote Controller, or RC04-PCR-LA Remote Controller

FFT On: When the harmonics current analysis function has been activated using the RS-232C Control, GPIB Interface, or RC04-PCR-LA Remote Controller

Alarm: In the event of an alarm

10

Chapter 10 Optional Equipment

Describes the options of the PCR-LA-series AC power supplies.

10.1 Option Types and Option Combinations

The following optional products are available for the PCR-LA-series AC power supplies. An option is connected to an interface connector on the front panel or inserted into a slot on the rear of the power supply for use (this does not include the Line Impedance Network, Harmonics Analyzer, or Immunity Tester).

Product name	Model name	Connection
Remote Controller	RC03-PCR-LA	Connector on the front panel
Remote Controller	RC04-PCR-LA	Connector on the front panel
GPIB Interface	IB03-PCR-LA	Slot No. 2 on the rear panel
Single-phase Three-wire Driver	2P03-PCR-LA	Slot No. 3 or 4 on the rear panel
Three-phase Driver	3P03-PCR-LA	Slot No. 3 or 4 on the rear panel
Parallel-operation Driver	PD03M-PCR-LA PD03S-PCR-LA	Slot No. 3 or 4 on the rear panel
Output Terminal Kits	OT01-PCR-LA/2,/3	See “10.15 Output Terminal Kits”.
Line Impedance Network (selectable impedance type)	LIN40MA-PCR-L	Slot No. 1, 3, or 4 on the rear panel
Harmonics Analyzer	HA01F-PCR-L	Slot No. 1, 3, or 4 on the rear panel
Immunity Tester	IT01-PCR-L	Slot No. 1, 3, or 4 on the rear panel

When more than one applicable slot is available on the rear of the AC power supply, the relevant optional board can be inserted into any of the slots to accomplish the operation.

IB03-PCR-LA requires a computer with a GPIB Interface and a GPIB cable.

The standard connection of Line Impedance Network LIN40MA-PCR-L is for connection with the PCR1000LA, PCR2000LA, or PCR4000LA.

For the LIN40MA-PCR-L, insert the control card that automatically selects impedances according to the voltage or frequency into Slot 1 (Slots 3 and 4 are also available). The control card is supplied with the LIN40MA-PCR-L.

Also for HA01F-PCR-L and IT01-PCR-L, insert the control card (provided for each option) into Slot 1 (Slots 3 and 4 are also available).

When using an option, see the operation manual for that product.

Combined Use of Optional Products

	RC03	RC04	IB03	*RS-232C	3P03	2P03	PD03M	PD03S
RC03	—	×	△	△	×	×	△	×
RC04	×	—	△	△	○ (U)	○ (U)	○	×
IB03	△	△	—	△	○ (U)	○ (U)	○	×
*RS-232C	△	△	△	—	○ (U)	○ (U)	○	△
3P03	×	○ (U)	○ (U)	○ (U)	—	×	○	×
2P03	×	○ (U)	○ (U)	○ (U)	×	—	○	×
PD03M	△	○	○	○	○	○	—	—
PD03S	×	×	×	△	×	×	—	—

○: Can be used simultaneously. However, an option with ○ (U) can be installed only on the U-phase unit.

△: Allows simultaneous installation in the power supply. However, optional products cannot be operated simultaneously.

×: Allows no simultaneous installation in the power supply

—: The same option cannot be used simultaneously.

* RS-232C: Provided as standard

The Line Impedance Network can be used in conjunction with another optional product.

⚠WARNING • Never attempt to use a combination of equipment designated with the — and × marks. Otherwise, the products will not operate normally. Using equipment marked with — and equipment marked with × together will cause damage to both the optional equipment and the AC power supply.

■ RS-232C is provided as standard.

RS-232C Control allows the following functions:

“10.2 Power Line Abnormality Simulation”

“10.3 Sequence Operation”

“10.4 Harmonic Current Analysis Function”

“10.5 Special Waveform Output”

“10.6 Output Impedance Setting”

“10.7 Measurements of Power Factor, VA, and Peak Holding Current”

“10.8 Output ON/OFF Phase Setting”

“10.9 AC + DC Mode”

“10.10 Expansion of the Memory Function”

10.2 Power Line Abnormality Simulation

The AC power supply allows simulation of a interruption, rapid voltage dip (dips), or rapid voltage swell (pops). This function is used to test switching power supplies or electronics devices.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC03-PCR-LA
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

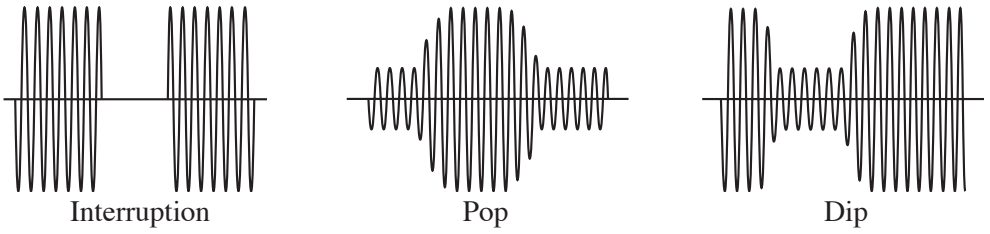


Fig.10-1 Examples of Waveforms

10.3 Sequence Operation

Specifying the sequence operation by combining the output voltage and frequency or other factors with the time setting allows automatic operation.

Product names and models having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

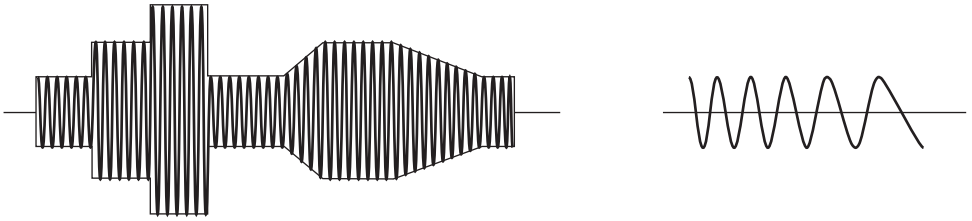


Fig. 10-2 Examples of Waveforms

10.4 Harmonic Current Analysis Function

Harmonic current analysis is available for output current from the AC power supply. Because the measurement method employed is simplified, it does not meet IEC or other standards. To conduct standard-compliant measurements, use our HA01F-PCR-L Harmonics Analyzer.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

10.5 Special Waveform Output

This function allows the AC power supply to output any waveforms other than sine waves. “Peak-clipped waveform,” in which the peak of a sine wave is suppressed, is provided as standard. In addition, if arbitrary waveform data is transferred to the power supply, that waveform can be output.

Product name and model name having the peak-clipped-waveform and arbitrary-waveform functions:

Product name	Model name
GPIB Interface	IB03-PCR-LA

Product name and model name having the peak-clipped-waveform function only:

Product name	Model name
Remote Controller	RC04-PCR-LA

Fig. 10-3 Example of Waveform

10.6 Output Impedance Setting

The AC power supply has output impedance (output resistance) of nearly 0 Ω; the actual commercial power line has impedance (resistance) of several mΩ to several Ω. When an option is connected, the power supply allows the output impedance to vary. This enables simulation of an environment similar to that of an actual commercial power line. This function is backed up inside the power supply. Therefore, once setting is made using an optional device, the power supply can operate in the same condition continuously even if the option is removed, as long as the setting conditions remain the same.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

10.7 Measurements of Power Factor, VA, and Peak Holding Current

The AC power supply can conduct measurements of the power factor, VA, and peak holding current. With peak holding current measurement, the peak current is measured until the AC power supply receives a peak clear signal or message. Thus, this function is useful in measuring an inrush current of load observed at power-on, among others. The power supply's peak value measurement uses an analog peak holding circuit to measure the peak current value in order to obtain the maximum absolute value of that data. Thus, the peak current display indicates an absolute value with no polarity sign.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

10.8 Output ON/OFF Phase Setting

Output ON/OFF phase setting is available separately. This function is backed up inside the AC power supply. Therefore, once setting has been performed using an optional device, the power supply can operate in the same condition continuously with the option removed, as long as the setting conditions remain the same.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

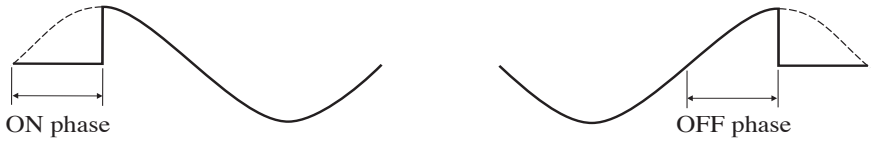


Fig. 10-4 Examples of Waveforms

10.9 AC + DC Mode

This function allows the AC power supply to output voltage waveforms in which the AC voltage is superimposed on the DC voltage.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

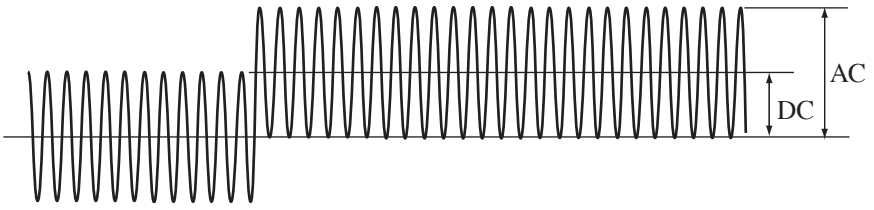


Fig. 10-5 Example of Waveform

10.10 Expansion of the Memory Function

The AC power supply allows nine sets of voltage and frequency settings to be stored as standard in the memory (memory addresses 1 to 9), enabling the data to be read for output as necessary. When an optional product is attached, the power supply can accommodate a maximum of 99 sets of voltage and frequency set values for storage.

In the AC + DC mode, both AC and DC memory values can be output, allowing all memory operations to be performed in the AC + DC mode.

Product names and model names having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA
GPIB Interface	IB03-PCR-LA

10.11 Regulation Adjustment

With regulation adjustment, the output voltage is adjusted automatically to compensate for the voltage drop caused by the output current. This function is used for the same purpose as the sensing function. The sensing function measures the sensing-point voltage in order to maintain a constant sensing-point voltage; with regulation adjustment, the voltage drop caused by the output current is calculated in order to raise the output voltage in an amount equivalent to the drop. This function is used for stabilization of the voltage at the load end if there is a considerable distance between the load and the power supply.

When regulation adjustment is performed, the voltage stability accuracy, distortion factor, and response speed decrease. Therefore, this function may not be suitable, depending on the application. Check the specifications prior to use.

Product name and model name having this optional function:

Product name	Model name
Remote Controller	RC04-PCR-LA

10.12 Single-phase Three-wire Output

Provide two PCR-LA power supplies, and connect their outputs in series. This allows single-phase three-wire output to be performed.

Product name and model name having this optional function:

Product name	Model name
Single-phase Three-wire Driver	2P03-PCR-LA

10.13 Three-phase AC Output

Provide three PCR-LA power supplies, and connect their outputs in a star connection. This will allow you the line-to-line voltages to be set and measured, different phase voltages to be set, and phase angles to be changed.

Product name and model name having this optional function:

Product name	Model name
Three-phase Driver	3P03-PCR-LA

10.14 Parallel Operation (Master-Slave Control)

If larger output power is required, connect up to five power-supply units of the same model (PCR2000LA, PCR4000LA, or PCR6000LA) in parallel, and operate them in a master-slave control mode. In this way, single-phase AC output of up to 30 kVA can be obtained.

The output power is calculated as follows:

Pt = Ps x n

Where, Pt: Total output power

Ps: Output power of each power supply

n: Number of units operated in parallel

Names, models, and quantity of the products having this optional function:

Product name	Model name	Number of units operated in parallel			
		2	3	4	5
Parallel-operation Driver (For master unit)	PD03M-PCR-LA	1	1	1	1
Parallel-operation Driver (For slave unit)	PD03S-PCR-LA	1	2	3	4

The PD03M-PCR-LA is to be installed on the master unit and the PD03S-PCR-LA is to be installed on each slave unit. Up to three units may be operated in parallel if AC power supplies are used in combination with the 2P03-PCR-LA (single-phase three-wire driver) or 3P03-PCR-LA (three-phase driver).

10.15 Output Terminal Kits

Use of the PCR-LA-series power supplies allow configuration of an output switching system. Switching the outputs of the power supplies allows switching between single-phase and single-phase three-wire outputs, and switching between single-phase and three-phase outputs.

Single-phase/single-phase three-wire switching system

Model name	Number of PCR-LA power supplies	Rated output capacity
OT01-PCR4000LA/2	Two PCR2000LAs	4 kVA
OT01-PCR8000LA/2	Two PCR4000LAs	8 kVA
OT01-PCR12000LA/2	Two PCR6000LAs	12 kVA

Single-phase/three-phase switching system

Model name	Number of PCR-LA power supplies	Rated output capacity
OT01-PCR6000LA/3	Three PCR2000LAs	6 kVA
OT01-PCR12000LA/3	Three PCR4000LAs	12 kVA
OT01-PCR18000LA/3	Three PCR6000LAs	18 kVA

10.16 Approximating Output Impedance to that of a Commercial Power Line

A commercial power line can be simulated by connecting a standardized Line Impedance Network between the AC power supply and a load. This function is used to measure harmonic components and/or flicker noise in a load current.

The impedance value has been defined in the following standards:

- Japanese Guideline for Reduction of Harmonic Emission (Guidelines to reduce harmonic emissions caused by electrical and electronic equipment for household and general use)
- IEC61000-3-3 Standard (voltage regulation and flicker measurements)

Product name and model name having this optional function:

Product name	Model name
Line Impedance Network	LIN40MA-PCR-L

Impedance

0.4 Ω + 0.37 mH: For single phase, 100 V

0.38 Ω + 0.46 mH: For single phase, 200 V

0.4 Ω + jn0.25 Ω: For single phase, 230 V

0.19 Ω + 0.23 mH: For a 3-phase 3-wire system or a 3-phase 4-wire system, with two units

0.24 Ω + jn0.15 Ω: For a 3-phase 3-wire system or a 3-phase 4-wire system, with two units

The symbol “n” denotes the order of harmonic frequency.

If the LIN40MA-PCR-L is used in conjunction with the AC power supply, the corresponding impedance automatically selected as the voltage is set at the power supply. (It is also possible to manually select an impedance.) In addition, the function in which the impedance is bypassed can be selected (by switching from the panel).

For a three-phase load and single-phase three-wire load, two units of LIN40MA-PCR-L are required. (Three-phase three-wire system, nominal 200 V: maximum load power of 6.9 kVA. Three-phase three-wire or 4-wire system, 400 V (phase voltage 230 V): maximum load power of 2 kVA. Single-phase three-wire system, nominal 200 V: maximum load power of 4 kVA)

10.17 Harmonics Analyzer

This optional product is used to measure harmonic current, voltage fluctuation, or flicker. Use of the dedicated control software in combination allows harmonic current measurements to be conducted in compliance with the IEC 61000-3-2 Standard and Guidelines for Harmonic Suppression of Household Electrical Appliances or General-Purpose Devices. In voltage fluctuation and flicker measurements, it can conduct measurements in compliance with the IEC61000-3-3 Standard.

Product name and model name having this optional function:

Product name	Model name
Harmonics Analyzer	HA01F-PCR-L

10.18 Immunity Tester

The immunity tester is used to test for immunity against voltage dips, short interruption, and voltage variation. Use of the dedicated control software in conjunction allows testing to be conducted in compliance with the IEC 61000-4-11 Standard.

Product name and model name having this optional function:

Product name	Model name
Immunity Tester	IT01-PCR-L

10.19 Rack Mounting

Using a rack-mounting bracket below allows the AC power supply to be installed in Kikusui standard rack KRO1600, KRO1250, KRO900, or RC322. For details on the racks, see the product catalogs.

PCR-LA-series model for rack mounting	Option model required	
	JIS standard (in units of mm)	EIA standard (in units of inches)
PCR500LA	KRB250	KRB5
PCR1000LA	KRB400	KRB8
PCR2000LA	KRB500	KRB11
PCR4000LA	KRB850	KRB19
PCR6000LA	*KRB1150	*KRB25

* KRB1150 and KRB25 are manufactured to order.

11

Chapter 11 Specifications

This chapter provides the electrical and mechanical specifications of the unit, along with its operating characteristics.

11.1 Specifications of the Unit

Input rating (AC rms values)

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Voltage (input voltage range of 100 V/200 V) (*1))	85 to 132 V/170 to 250 V				170 to 250 V
Number of phases, frequency	Single phase, 47 Hz to 63 Hz				
Apparent power	Approx. 1 kVA	Approx. 2 kVA	Approx 4 kVA	Approx. 8 kVA	Approx. 12 kVA
Power factor (*2)	0.95 (typical value)				
Current (line voltage range: 100 V/200 V)	12 A/6 A or less	24 A/12 A or less	48 A/24 A or less	96 A/48 A or less	72 A or less

Output rating, AC mode (AC rms values)

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Voltage (output voltage range of 100 V/200 V) (*3)	1 to 150 V/2 to 300 V				
Voltage setting accuracy (output voltage range of 100 V/200 V) (*17)	±(0.3 % of set value + 0.6 V)				
Maximum current (*4)	5 A/2.5 A	10 A/5 A	20 A/10 A	40 A/20 A	60 A/30 A
Number of phases	Single phase				
Power capacity	500 VA	1 kVA	2 kVA	4 kVA	6 kVA
Maximum peak current (*5)	Four times the maximum current (rms value)				
Power factor of load	0 to 1 (leading phase or lagging phase) (*4)				
Frequency	1 Hz to 999.9 Hz (*4, *6)				

Output rating DC mode

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Voltage (output voltage range of 100 V/200 V) (*3)	1.4 to 212 V/2.8 to 424 V				
Voltage setting accuracy (output voltage range of 100 V/200 V) (*18)	±(0.05 % of set value + 0.05 V/0.1 V)				
Maximum current (*4)	2.5 A/1.25 A	5 A/2.5 A	10 A/5 A	20 A/10 A	30 A/15 A
Maximum instantaneous current (*19)	Four times the maximum current (rms value)				
Power capacity	250 W	500 W	1 kW	2 kW	3 kW

Output voltage stability

Model name		PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Line voltage variation (with respect to changes in the rated range)		Within ±0.1 %				
Output current variation (with respect to 0 % to 100 % changes in rating)		Within ±0.1 V/±0.2 V (output voltage range of 100 V/200 V) (*7)				
Output frequency variation	AC mode (in the range of 40 Hz to 999.9 Hz)	Within ±1 % (*8)				
	AC-S mode (in the range of 40 Hz to 999.9 Hz)	Within ±1 % (*8)				
Ripple noise: DC mode (5-Hz to 1-MHz components)		0.1 V rms or less	0.15 V rms or less	0.2 V rms or less	0.3 V rms or less	0.4 V rms or less
Ambient-temperature variation (with respect to changes in the rated range)		100 ppm/°C (typical value) (*9)				

Output frequency setting accuracy and stability, waveform distortion, response time, and efficiency

Model name		PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Frequency setting accuracy	With respect to changes in all rated ranges	Within ±1 x 10^{-4}				
Output frequency stability		Within ±5 x 10^{-5}				
Output voltage waveform distortion ratio (*10)		0.3 % or less				
Output voltage response time (*11)		30 μs (typical value)				
Efficiency (*2)		50 % or more				

Indicators (vacuum fluorescent display (VFD) indication)

Model name			PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Voltmeter (*12, *14)	Resolution	RMS display mode	±0.1V				
		PEAK and AVE display mode	0.2 V (0 to ±212 V) / 0.3 V (±212 to ±424 V)				
	Accuracy	RMS and AVE display mode	Within ±(1 % of rdg + 2 digits) (in the range of 10 V to 424 V at room temperature)				
		PEAK display mode	Within ±(2 % of rdg + 2 digits) (in the range of 10 V to 424 V at room temperature)				
Ammeter (*12, *14)	Resolution	RMS display mode	0.01 A	0.01 A	0.01 A	0.1 A	0.1 A
		PEAK and AVE display mode	0.02 A	0.02 A	0.02 A	0.2 A	0.2 A
	Accuracy	RMS and AVE display mode	Within ±(1 % of rdg + 2 digits) (in the range of 5 % of the rated maximum current to the rated maximum current at room temperature) (*20)				
		PEAK display mode	Within ±(2 % of rdg + 4 digits) (in the range of 5 % of the rated maximum current to the rated maximum peak current at room temperature) (*20)				
Wattmeter (*15)	Resolution		0.1 W/1 W				
	Accuracy		Within ±(1 % of rdg + 3 digits) (in the range of 10 % of the rated power capacity to the rated power capacity, load power factor of 1, and at room temperature)				
Frequency meter (*13)	Resolution		0.01 Hz/0.1 Hz				

Insulation resistance, withstand voltage, circuit method, operating ambient temperature/humidity

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Insulation resistance (input to cubicle, output to cubicle, and input to output)	500 V DC at 300 MΩ or more		500 V DC at 10 MΩ or more		
Withstand voltage (input to cubicle, output to cubicle, and input to output)	1.5 kV AC for 1 minute				
Circuit method	Linear amplifier system				
Operating temperature/humidity	0 to +50°C/20 % to 80 % R.H. (no condensation allowed)				
Storage temperature/humidity	-10 to +60°C/90 % R.H. or less (no condensation allowed)				

External dimensions and weight

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
External dimensions (cubicle)	430 x 217 x 550	430 x 351 x 550	430 x 484 x 550	430 x 839 x 550	430 x 1 105 x 550
Weight	Approx. 25 kg	Approx. 49 kg	Approx. 69 kg	Approx. 120 kg	Approx. 160 kg

Input/output terminal board connecting screws and accessories

Model name			PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Input terminal board connecting screws			(Inlet)	M6			
Output terminal board connecting screws			M4	M6			
Accessories	Input power cable (sectional conductor area/length)	Shape	Three-core heavy PVC jacketed cable		Single core cable, 3		
		Wire diameter	2 mm^2/3 m with a three-pronged plug	5.5 mm^2/3 m	8 mm^2/3 m	22 mm^2/3 m	22 mm^2/3 m
	Cable clamper		—	1 set			
	Cable-clamper fixing screws		—	M3, 1 pc. M4, 2 pcs.	M3, 2 pcs. M4, 2 pcs.	M3, 4 pcs. M4, 2 pcs.	
	Operation Manual		1 copy				
	Weight seal		1 sheet				

Applicable standards, etc.

Model name	PCR500LA	PCR1000LA	PCR2000LA	PCR4000LA	PCR6000LA
Electromagnetic compatibility (EMC) (*16)	Conforms to the requirements of the following directive and standard. EMC Directive 89/336/EEC EN61326:1997/A2:2001 Emissions: Class A Immunity: Minimum immunity test requirements				—
	Conforms to the following standards. EN61000-3-2:2000 EN61000-3-3:1995/A1:2001		—	—	
Safety (*16)	Conforms to the requirements of the following directive and standard. Low Voltage Directive 73/23/EEC EN61010-1:2001 Class I Pollution degree 2				—

*1 An input voltage range of 100 V/200 V can be selected using a switch.

*2 For the output voltage range of 100 V/200 V, the output current rating, a load power factor of 1, and an output frequency of 40 Hz to 999.9 Hz

*3 An output voltage range of 100 V/200 V can be selected using a switch on the front panel. Resolution: 0.1 V.

*4 For output voltage of 1 V to 100 V/2 V to 200 V and a load power factor of 0.8 to 1 (AC/AC-S mode)
When the output voltage is 100 V to 150 V/200 V to 300 V (AC/AC-S mode) or 100 V to 212 V/200 V to 424 V (DC mode), the output current is reduced based on the output voltage.
When the load power factor is 0 to 0.8, the output current is reduced based on the load power factor (AC/AS-S mode).
When the output frequency is 1 Hz to 40 Hz, the output current is reduced based on the output frequency (AC/AC-S mode).

*5 With respect to a capacitor input-type rectifying load (Note that the peak current is limited based on the rms value of the rated output current.)

*6 Resolution: 1) 0.01 Hz (1.00 Hz to 100.0 Hz); 2) 0.1 Hz (100.0 Hz to 999.9 Hz)

*7 For output voltage of 80 V to 150 V/160 V to 300 V and a load power factor of 1. The specified value is obtained at the output terminal board.

*8 For output voltage of 80 V to 150 V/160 V to 300 V and a load power factor of 1. The specified range is output voltage variations measured with 200 Hz as a reference.
*9 For output voltage range of 100 V/200 V and an output current of 0 A
*10 For output voltage of 80 V to 150 V/160 V to 300 V and a load power factor of 1
*11 With respect to changes from an output current of 0 A to the rating and vice versa when the output voltage range is 100 V/200 V and the load power factor is 1
*12 With the display of a true rms value and waveform having a crest factor of 3 or less
*13 Displays the output frequency set value (frequency of the internal reference voltage)
*14 At an output frequency of 40 Hz to 999.9 Hz
*15 At an output frequency of 45 Hz to 65 Hz
*16 Only on models that have CE marking on the panel.
Not applicable to custom order models.
*17 At an output frequency of 45 Hz to 65 Hz, with no load, and at room temperature
*18 With no load and at room temperature
*19 Limited by the rms value of the rated output current
*20 Rated maximum current in an output voltage range of 100 V

■ Output Voltage Ratio — Rated Output Current Characteristics

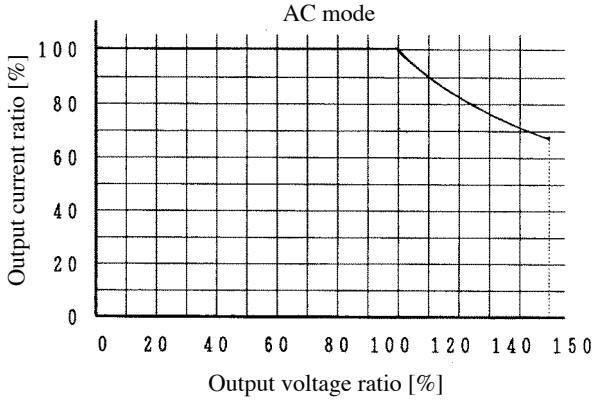


Fig.11-1 Output Voltage Ratio — Rated Output Current Characteristics (AC mode)

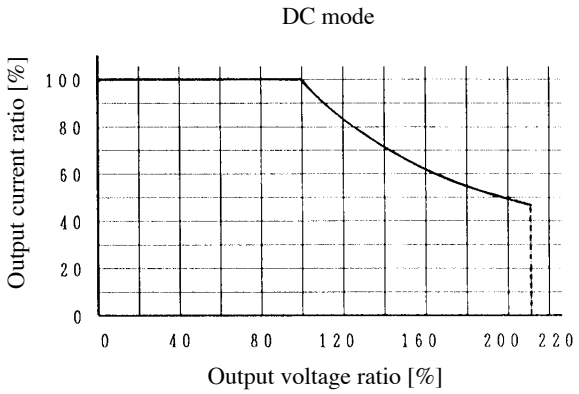


Fig. 11-2 Output Voltage Ratio — Rated Output Current Characteristics (DC mode)

■ Load Power Factor — Rated Output Current Characteristics

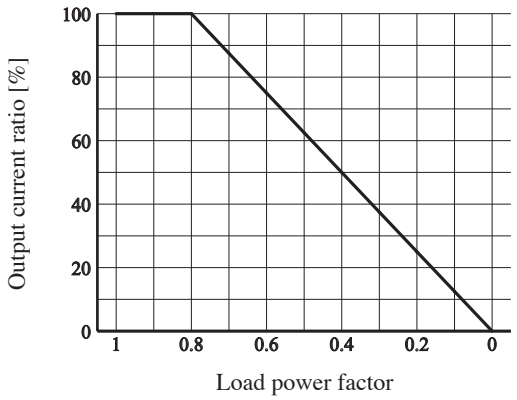


Fig. 11-3 Load Power Factor — Rated Output Current Characteristics

■ Output Frequency — Rated Output Current Characteristics

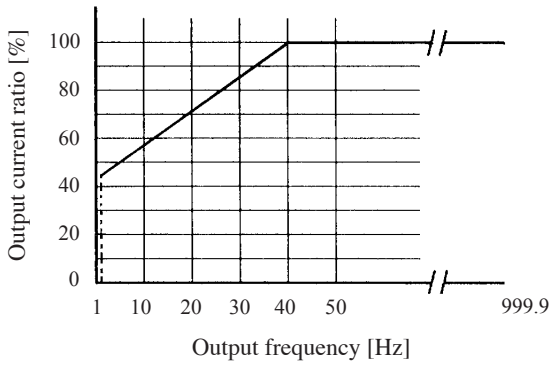


Fig. 11-4 Output Frequency — Rated Output Current Characteristics

The output voltage ratio is displayed as a percentage when the 100 V/200 V output voltage (in the 100 V/200 V output range) is regarded as 100 %. The output current ratio is displayed as a percentage when the maximum rated output current is regarded as 100 %. From Fig. 11-1 and Fig. 11-3, the rated output current is the product of both output current ratios. Moreover, the output current ratio in Fig. 11-4 has precedence over the others when it is smaller than the product of the noted output current ratios (this applies only in AC mode).

11.2 Operating Specifications of RS-232C and GPIB

Power line abnormality simulation

Item		Setting Range	Resolution	Setting Accuracy
T1	x 1deg	0 deg to 360 deg	1 deg	1 deg: When T2 = T4 = 0 1 ms: When T2 > 0 or T4 > 0
	x 1ms	0 ms to 999.9 ms	0.1 ms	$\pm(1 \times 10^{-3} + 0.1$ ms): When T2 = T4 = 0 $\pm(1 \times 10^{-3} + 1$ ms): When T2 > 0 or T4 > 0
T2	x 1	0 ms to 9999 ms	1 ms	$\pm(1 \times 10^{-3} + 1$ ms)
	x 10	0.00 s to 99.99 s		
T3	x 1	0.0 ms to 999.9 ms	0.1 ms	$\pm(1 \times 10^{-3} + 0.1$ ms): When T2 = T4 = 0 $\pm(1 \times 10^{-3} + 1$ ms): When T2 > 0 or T4 > 0
	x 10	0 ms to 9999 ms	1 ms	
T4	x 1	0 ms to 9999 ms	1 ms	$\pm(1 \times 10^{-3} + 1$ ms)
	x 10	0.00 s to 99.99 s		
T5	x 1	0 ms to 9999 ms	1 ms	1 cycle
	x 10	0.00 s to 99.99 s	10 ms	
N	x 1	0 to 9999 cycles	1 cycle	1 cycle
	x 10	0 to 99990 cycles	10 cycle	
	x 100	0 to 999900 cycles	100 cycle	
V(T3)		Same as the setting range of the output voltage	0.1 V	—
RPT		0 to 9998 times or ∞	Once	Once

Sequence operation

Item		Setting Range	Resolution	Setting Accuracy
ADR		0 to 99	1	—
FRQ		Same as the setting range of the output frequency	Same as at the left	Same as at the left
Vac		Same as the setting range of the output voltage	Same as at the left	Same as at the left
TIME	HOUR	0 hr to 999 hr 59 min	1 min	$\pm(1 \times 10^{-3}$+0.5 min)
	MIN	0 min to 999 min 59 sec	1 s	$\pm(1 \times 10^{-3}$+0.5 s)
	SEC	0 sec to 999.999 sec	1 ms	$\pm(1 \times 10^{-3}$+0.5 ms)
WAVE		Same as the special waveform output	Same as at the left	—
IMP		Same as the output impedance	Same as at the left	Same as at the left
Vdc		Same as the setting range of the output voltage	Same as at the left	Same as at the left

AC + DC mode

Item	Setting Range	Resolution	Setting Accuracy
Voltage setting	The AC voltage setting range is the same as that of AC mode. The DC voltage setting range is the same as that of DC mode. Note that the peak value of the AC + DC voltage is within the setting range of the DC voltage.	Same as those of AC and DC modes	—
Maximum current	Same as that of DC mode	—	—
Power capacity	Same as that of DC mode	—	—
Frequency	Same as that of AC mode	Same as at the left	—

Special waveform output

Item	Setting Range	Resolution	Setting Accuracy
Waveform bank	0 to 14 (“0” is for read only)	0	—
Crest factor	1.10 to 1.40	0.01	0.01

Output impedance setting

Item		Setting Range	Resolution	Setting Accuracy
PCR500LA	100 V range	0 Ω to 4.0 Ω	40 mΩ	±(20 %+80 mΩ)
	200 V range	0 Ω to 16.0 Ω	160 mΩ	±(20 %+320 mΩ)
PCR1000LA	100 V range	0 Ω to 2.0 Ω	20 mΩ	±(20 %+40 mΩ)
	200 V range	0 Ω to 8.0 Ω	80 mΩ	±(20 %+160 mΩ)
PCR2000LA	100 V range	0 Ω to 1.0 Ω	10 mΩ	±(20 %+20 mΩ)
	200 V range	0 Ω to 4.0 Ω	40 mΩ	±(20 %+80 mΩ)
PCR4000LA	100 V range	0 Ω to 0.5 Ω	5 mΩ	±(20 %+10 mΩ)
	200 V range	0 Ω to 2.0 Ω	20 mΩ	±(20 %+40 mΩ)
PCR6000LA	100 V range	0 Ω to 0.333 Ω	3.33 mΩ	±(20 %+6.67 mΩ)
	200 V range	0 Ω to 1.333 Ω	13.33 mΩ	±(20 %+26.67 mΩ)

Output ONOFF phase setting

Item	Setting Range	Resolution	Setting Accuracy
Phase setting	0 deg to 360 deg	1 deg	1 deg

Indicator

Item	Setting Range	Resolution	Setting Accuracy
Apparent-power measurement	—	Minimum (varies with the value)	Same as that of the wattmeter
Power-factor measurement	—	0.01	Same as that of the wattmeter
Peak hold current measurement	—	Same as that of the peak ammeter	Within ±(2 % of rdg + 16 digits) (in the range of 5 % of the rated maximum current to the rated maximum peak current at room temperature)

11.3 Operating Characteristics

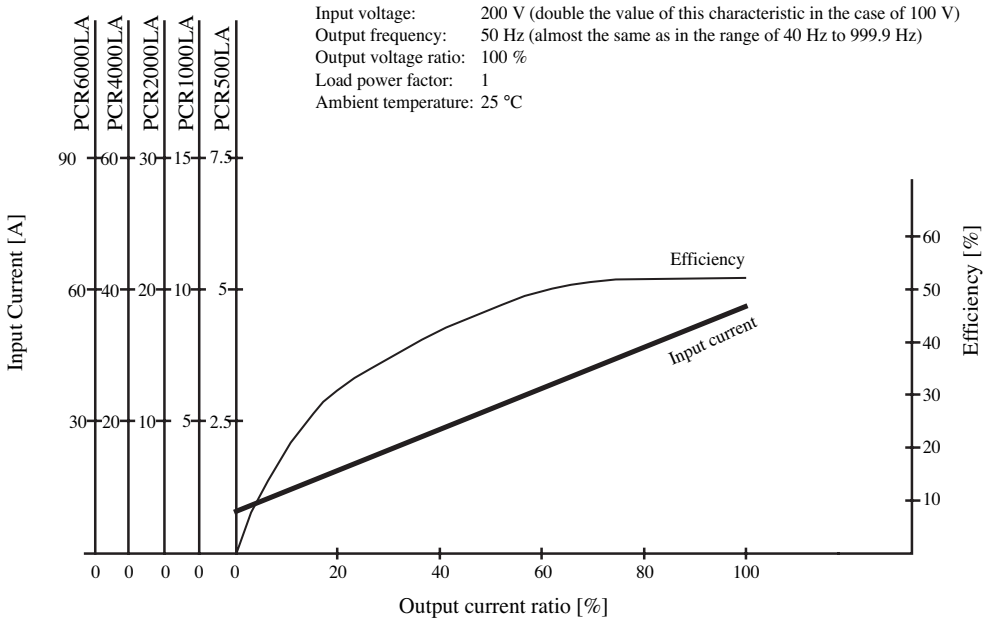


Fig. 11-5 Output Current — Input Current, Efficiency Characteristics (Typical Value in AC Mode)

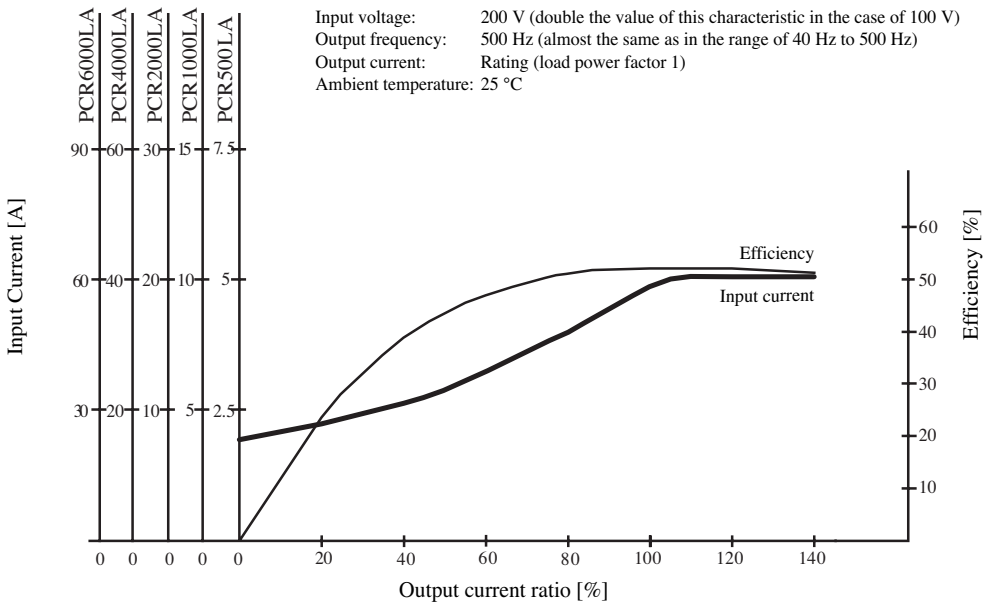
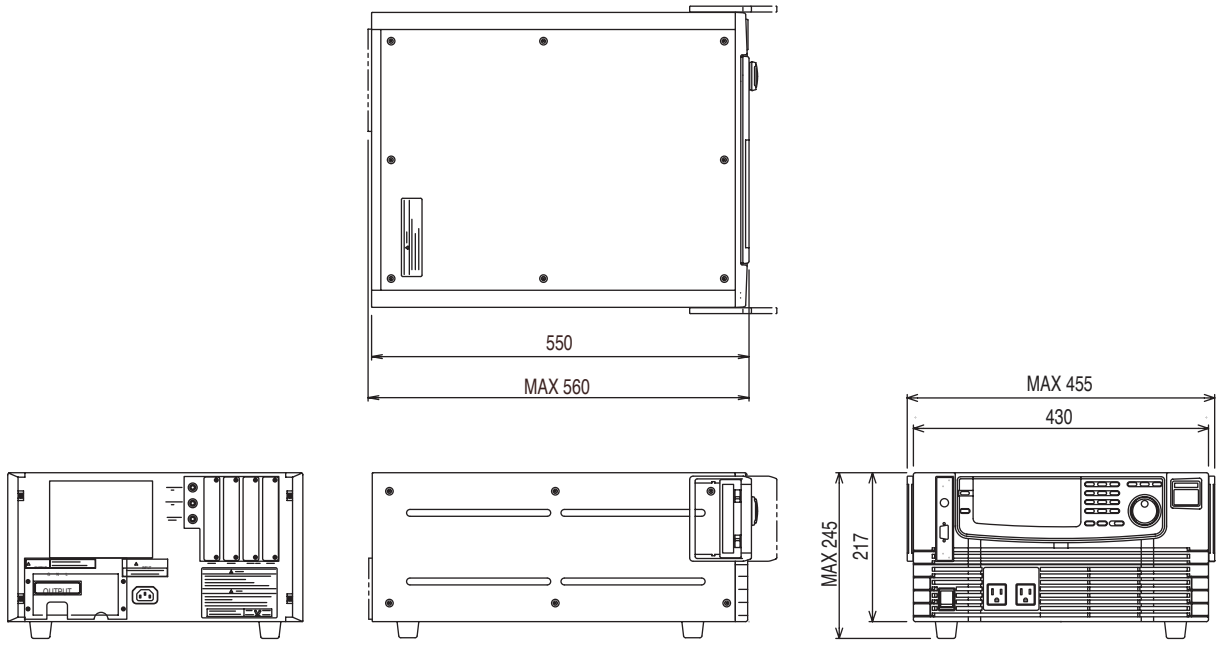


Fig. 11-6 Output Voltage — Input Current, Efficiency Characteristics (Typical Value in AC Mode)

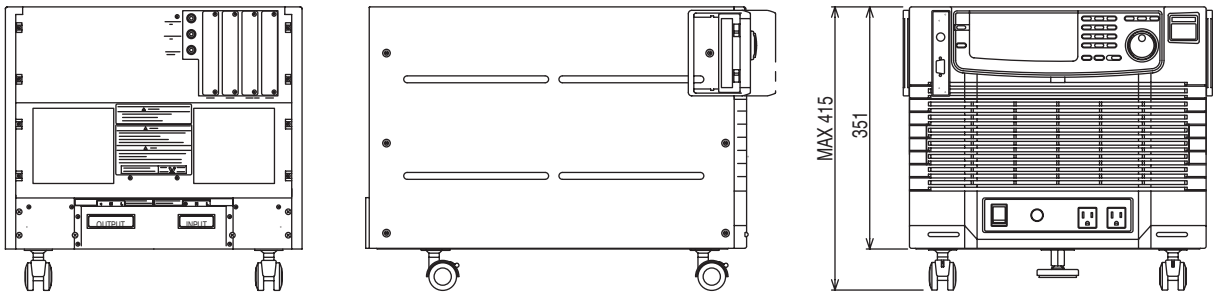
Output current ratio: Displayed as a percentage when the maximum rated output current is regarded as 100 %

Output voltage ratio: Displayed as a percentage when the 100 V/200 V output voltage (in the 100 V/200 V output range) is regarded as 100 %

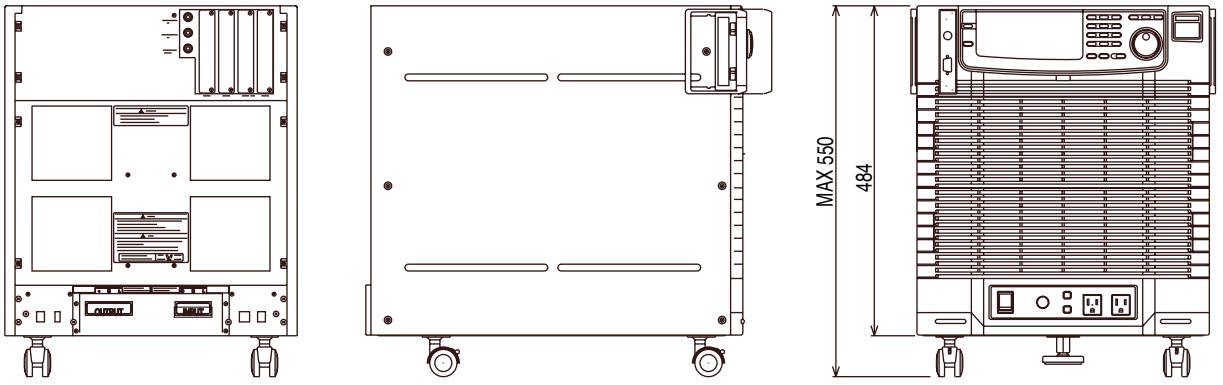
11.4 Dimensions



PCR500LA



PCR1000LA



PCR2000LA

Fig. 11-7 PCR500LA, PCR1000LA, PCR2000LA

Unit: mm

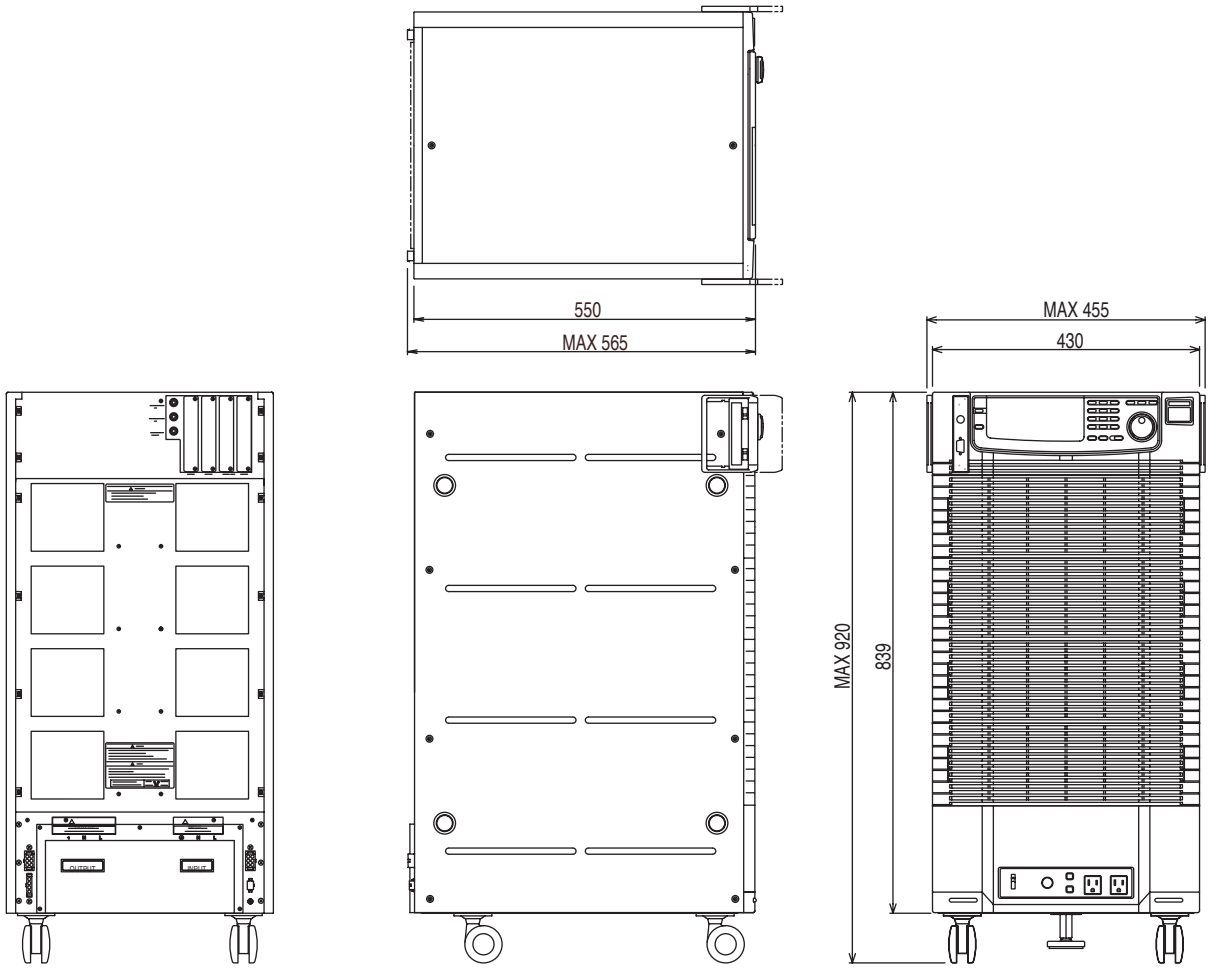


Fig. 11-8 PCR4000LA

Unit: mm

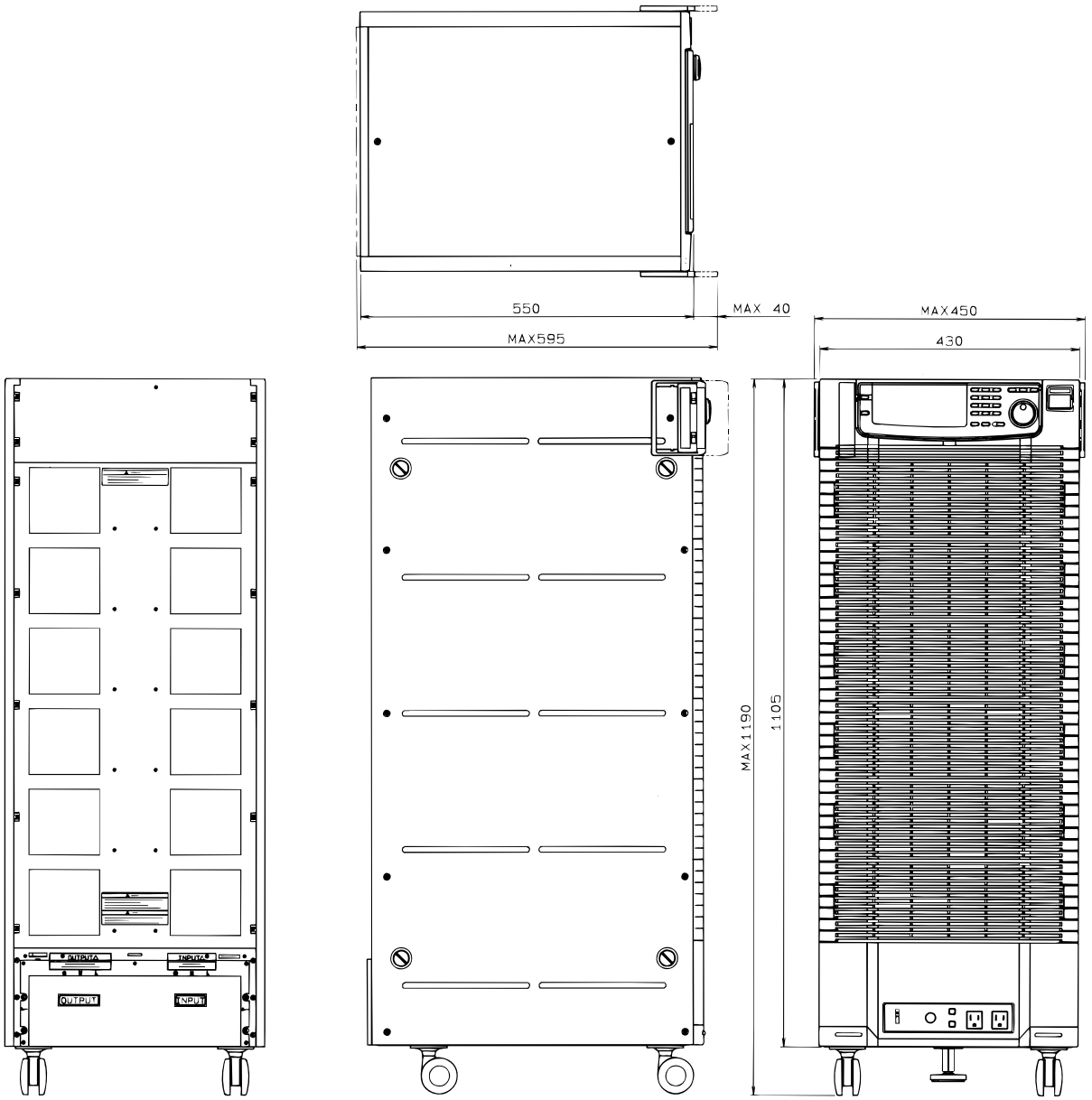


Fig. 11-9 PCR6000LA

Unit: mm

Appendix

This appendix contains Glossary, Power Line Abnormality Simulation Operation Setting Sheet, Sequence Operation Setting Sheet, and Sample Programs.

A.1 Glossary

1. Rated Output (Power) Capacity or Power Capacity

Maximum value (unit: VA) of the output power capacity that can be continuously supplied in the following range

		AC mode or AC-S mode	DC mode
Output voltage	For the 100 V output range	100 V to 150 V	100 V to 212 V
	For the 200 V output range	200 V to 300 V	200 V to 424 V
Load power factor		0.8 to 1.0	—
Output frequency		40 Hz to 999.9 Hz	—

• For example, the PCR1000LA has a rated output capacity of 1 [kVA].

• In the DC mode, the value becomes half that in the AC mode.

2. Maximum Rated Output Current

Maximum value (unit: A) of the output current (rms value) that can be continuously supplied in the following range

		AC mode or AC-S mode	DC mode
Output voltage	For the 100 V output range	100 V	100 V
	For the 200 V output range	200 V	200 V
Load power factor		0.8 to 1.0	—
Output frequency		40 Hz to 999.9 Hz	—

• In the DC mode, the value becomes half that of the AC or AC-S mode.

$$\text{Maximum rated output current} = \frac{\text{rated output (power) capacity [VA]}}{\text{voltage at which the output voltage percentage is 100 \% [V]**}}$$

**: 100 V or 200 V

3. Rated Output Current

■ For the AC and AC-S modes

Maximum continuous value of the output current (rms value) reduced by a combination of the output voltage, load power factor, and output frequency

■ For the DC mode

Maximum continuous value (unit: A) of the output current reduced by the output voltage

• For more information, see the description of “8.4 Outputs and Loads”.

4. Maximum Output Peak Current (Maximum Peak Current) (AC or AC-S mode only)

Maximum continuous value (unit: A peak) of the output current (peak value) that the AC power supply can supply to a capacitor input-type rectifying load

Maximum output peak current = maximum rated output current (rms value) x 4

$$\text{Only when the crest factor} = \frac{\text{peak value}}{\text{rms value}} \quad 4$$

Output voltage: 100 V to 150 V (for the 100 V output range)
200 V to 300 V (for the 200 V output range)

Output frequency: 40 Hz to 999.9 Hz

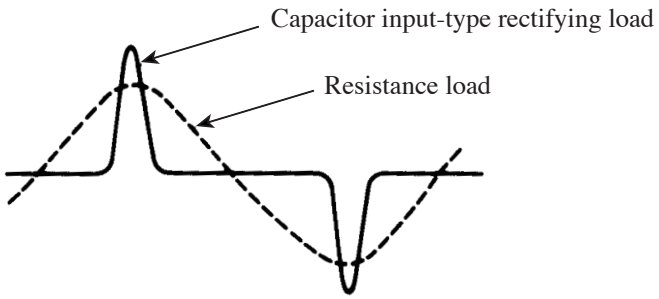


Fig.A-1 Sample output current waveform

5. Instantaneous Peak Current

Maximum instantaneous (for approx. 1 sec) value (unit: A peak) of the output current (peak value) that the AC power supply can supply to a load. The instantaneous peak current differs depending on the current waveform, output voltage, output frequency, and load power factor.

(Example) When the sine-wave output voltage is 100 V, the output frequency is 50 Hz, and load power factor is 1

Instantaneous peak current (peak value) = maximum rated output current (rms value) x 2

• For more information, see the description of “8.4 Outputs and Loads”.

6. Instantaneous Peak Current Ratio

Percentage (unit: %) of an instantaneous peak current when the maximum rated output current is regarded as 100 %

• For more information, see the description of “8.4 Outputs and Loads”.

7. Output Current Ratio

Percentage (unit: %) of the output current when the maximum rated output current is regarded as 100 %

8. Output Voltage Ratio

Percentage (unit: %) of the output voltage when an output voltage of 100 V/200 V is regarded as 100 % in the 100 V/200 V output range

9. Output Voltage Waveform Distortion Factor

Total harmonic distortion factor (unit: %) of the output voltage waveform when the output voltage is 80 V to 150 V (for the 100 V output range) or 160 V to 300 V (for the 200 V output range) and the load power factor is 1.

10. Output Voltage Response Time

Time (unit: μs) from the instant the output voltage change exceeds 10 % of the overall change to the instant the output voltage change returns to within 10 % of the overall change, while the output current percentage changes from 0 % to 100 % when the output voltage is 100 V (for the 100 V output range) or 200 V (for the 200 V output range) and the load power factor is 1 (in the AC mode)

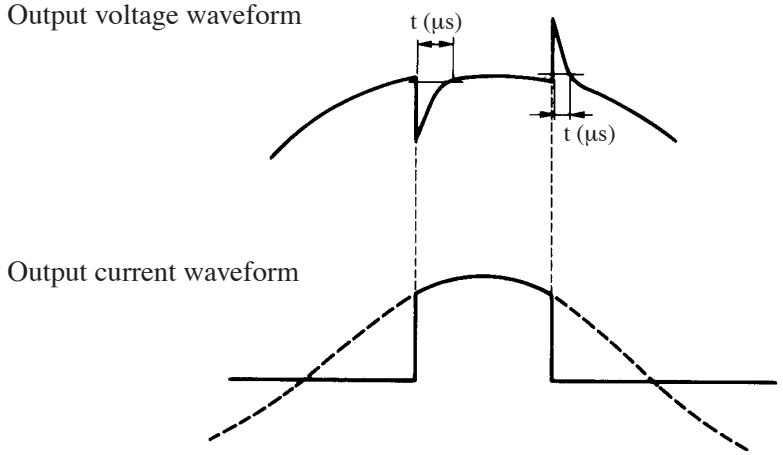


Fig. A-2 Output Voltage Response Time

11. Active Filter

A circuit used to reduce the input current distortion factor (harmonic current). This filter is used in the input power-supply block of the AC power supply. It is a switching-controlled active filter. Use of an active filter improves the power factor (0.95 or more; the current waveform is virtually sinusoidal), and the input voltage is less distorted.

12. Capacitor input-type Rectifying (Circuit) Load

The “capacitor input-type rectifying load” has a filter capacitor connected directly across the rectifier output, as shown in Fig. A-3(a). This type of load draws a current as shown in Fig. A-3(b).

The input current peak value is generally approximately two to four times the rms value, and the flow angle (current flow period) is 20 deg. to 90 deg., centering on the output voltage peak (phase angle: 90 deg. or 270 deg.).

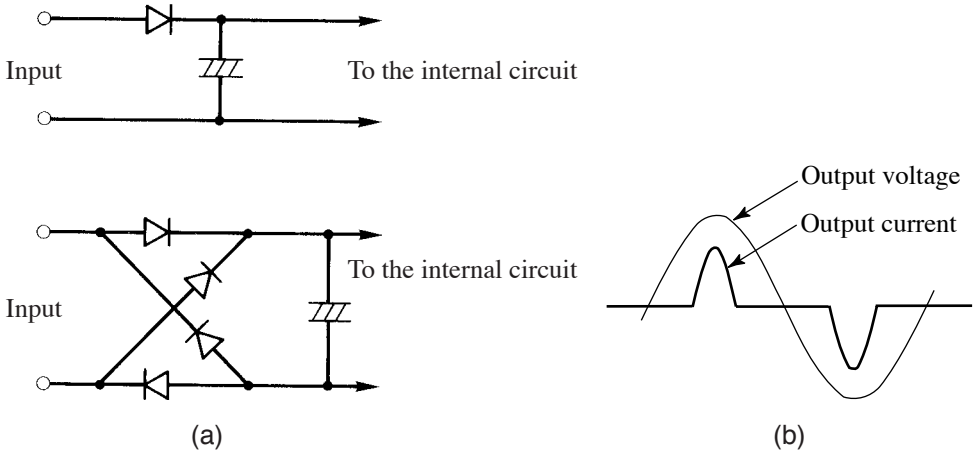


Fig. A-3 Capacitor Input-type Rectifying (Circuit) Load

Examples of main capacitor input-type rectifying loads

Consumer electronics appliances:

TV sets, video equipment such as VCRs, audio equipment, microwave ovens, inverter air conditioners, and inverter lighting equipment

Office automation equipment:

Personal computers, office computers, fax machines, and CAD systems

Others:

Mainframe computers, factory automation equipment, communication equipment, and other switching-power-supply-equipped devices and equipment

13. Derating

This generally means reducing the claimed maximum performance ratings (such as voltage and current) of the relevant equipment or devices with respect to the ambient conditions (such as temperature and load).

14. Short Interruption

This is the status in which the voltage in a commercial power line instantaneously dips due to the effects of lightning or the like.

Generally, in such cases, the voltage dip time is several dozen msec to hundreds of msec, and the voltage drop level is 20 % to 80 %.

A.2 Power Line Abnormality Simulation Operation Setting Sheet

PCR-LA series

TITLE _____ DATE _____ No. _____

NO.	T1	T2	T3	T4	T5/N	V(T3)	RPT	POL	MEMO

A.3 Sequence Operation Setting Sheet

PCR-LA series

TITLE _____ DATE _____ No. _____

START _____ END _____ LOOP _____

ADR	R	F	R	Vac	Th	Tm	Ts	WAVE	IMP	Vdc	STRT	TRG	OUT

Appx

A.4 Sample Programs

This section contains examples of remote programs using the RS-232C Control or GPIB Interface. Sample programs 1 to 3 use the Visual Basic driver (PCR-L driver) available from the Download Service on our website at http://www.kikusui.co.jp. Sample programs 4 to 6 do not use the PCR-L driver, but use the VISA library only. To use the PCR-L driver, download the Visual Basic driver Ver. 2.81 or later of the PCR-L/W series from the Download Service page. Basically, the PCR-LA series inherits the message system of the PCR-L-series messages, and thus the PCR-L/W-series driver can be used for PCR-LA AC power supplies.

To use the GPIB Interface, the GPIB card (National Instruments NI-488.2M-compatible card) must be installed in compliance with the VISA (Virtual Instrument Software Architecture) library.

To use the RS-232C Control, set the baud rate to 19,200 bps, the stop bit to 1, the data length to 8, and the parity to None (0812).

Regardless of which interface is used, RS-232C or GPIB, the VISA library must be installed. The NI-VISA library can be downloaded from http://www.ni.com.

The PCR-L driver can be run on Microsoft Visual C++, Borland Delphi, or other applications in addition to Microsoft Visual Basic. Sample programs 1 to 3 take Microsoft Visual Basic as an example. Sample programs 4 to 6 take Microsoft Excel 97 VBA as an example.

To run the VISA library and the PCR-L driver on Visual Basic, perform the following preparatory procedure:

1. Install the VISA library. (If only the VISA library is to be used, step 2 and thereafter can be omitted.)
2. Install the PCR-L driver (pcrdriverx.exe).
3. Select “Set Reference” from the Visual Basic menu item “Project” to display the Set Reference dialog.
4. Click on [Reference] to select C:\Program Files\Common Files\Kikusui Shared\PcrlDrv.dll.
5. Check the Kikusui PCR-L/W-series driver in the list on the Set Reference dialog.

PCR-L driver Help can be referenced as follows: Select the object browser (F2) to set <All Libraries> to PcrlDrv. Place the cursor on each class or member, click it, and then press the F1 key.

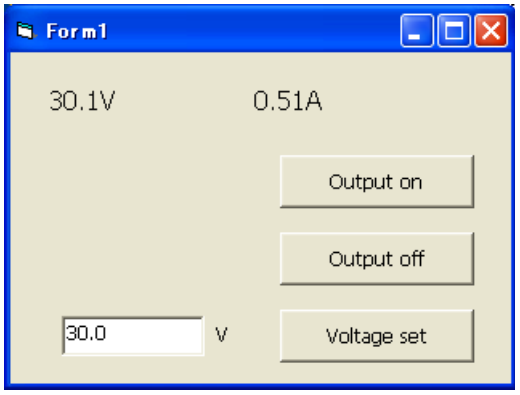
It is not safe to send a query message to a PCR-LA power supply with no waiting time. Because query messages are handled by a GPIB/RS-232C interrupt, they have precedence over other processes.

```
For i = 1 To n
 Call ibwrt(PcrLa, "VOUT?")
 Call ibrd(PcrLa, sBuf)
Next i
```

If VOUT? continues to be sent with no waiting time as specified above, the PCR-LA power supply could overrun in a worst-case scenario. It is recommended that the status be monitored at intervals of approx. 1 second, using a timer. In addition, when multiple command messages are sent, waiting time should occasionally be provided.

Sample Program 1

This program sets the output voltage (in AC mode) to turn the output ON/OFF and monitor and display the output voltage and output current values.

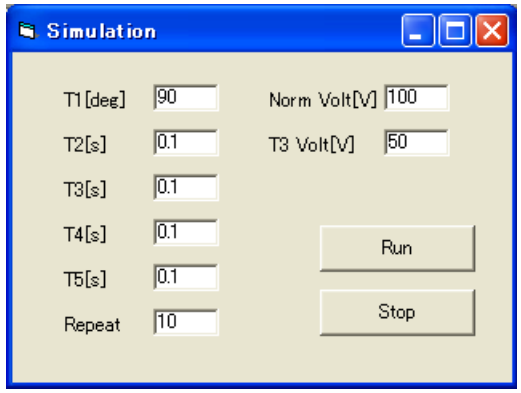



```
Dim LA As New IPcrl                    ' Create the instance (entity) of object IPcrl.

Private Sub Form_Load()                ' Make a connection when Form is created.
'    LA.Connect "GPIB::1"              ' For GPIB address 1
     LA.Connect "ASRL1"                ' For RS-232C COM1 ("ASRL2" for COM2)
```

```
End Sub

Private Sub Form_Unload(Cancel As Integer)    ' Cancel the connection when Form disappears.
    LA.SetString "LOC"                        ' Return control to Local.
    LA.Disconnect                             ' Cancel connection to the GPIB or RS-232C.
End Sub

Private Sub VoltSetButton_Click()             ' Voltage Set button
    LA.Voltage = Val(VoltText.Text)           ' Set the voltage value set in the text box to the PCR-LA power supply.
End Sub

Private Sub OutputOnButton_Click()            ' Output On button
    LA.Output = True                          ' Output on
End Sub

Private Sub OutputOffButton_Click()           ' Output Off button
    LA.Output = False                         ' Output off
End Sub

Private Sub Timer1_Timer()                    ' 1000-ms-interval timer
    Dim dVolt As Double                       '
    Dim dCurr As Double

    LA.SetString "VOUT?"                      ' Send a VOUT? command message.
    dVolt = Val(LA.GetString)                 ' Convert the voltage to a value.
    Label1.Caption = Format(dVolt, "0.0 V")   ' Display the output voltage value in Label1.

    LA.SetString "IOUT?"                      ' Send an IOUT? command message.
    dCurr = Val(LA.GetString)                 ' Convert the current to a value..
    Label2.Caption = Format(dCurr, "0.0A")    ' Display the output current value in Label2.
End Sub
```

Sample Program 2

This program performs a power line abnormality simulation. It allows the setting of parameters such as T1 and T2.

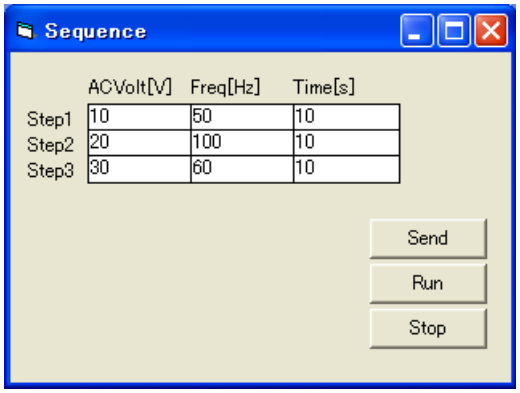



```
Dim LA As New IPcrl                          ' Create the instance (entity) of object IPcrl.
Dim Sim As IPcrlSimulation                   ' Create the sub-object of simulation.

Private Sub Form_Load()                      ' Make a connection when Form is created.
'    LA.Connect "GPIB::1"                    ' For GPIB address 1
     LA.Connect "ASRL1"                      ' For RS-232C COM1 ("ASRL2" for COM2)
     Set Sim = LA.Simulation                 ' Substitute Sim for LA.Simulation.
End Sub

Private Sub Form_Unload(Cancel As Integer)   ' Cancel the connection when Form disappears.
     LA.SetString "LOC"                      ' Return control to Local.
     LA.Disconnect                           ' Cancel connection to the GPIB or RS-232C.
End Sub

Private Sub RunButton_Click()                ' Run button

     LA.Output = False                       ' Output off
     Sim.Active = True                       ' Select the simulation mode.
                                             ' Same as LA.Simulation.Active = True
```

```
    Sim.T1(pcrlUnitDegree) = Val(T1.Text)     ' Set T1 to the phase angle.
    Sim.T2 = Val(T2.Text)                     ' Set T2 to a value in the text box.
    Sim.T3 = Val(T3.Text)                     ' Set T3 to a value in the text box.
    Sim.T4 = Val(T4.Text)                     ' Set T4 to a value in the text box.
    Sim.T5 = Val(T5.Text)                     ' Set T5 to a value in the text box.
    Sim.Repeat = Val(Repeat.Text)             ' Set the number of repetitions to a value in the text box.
    Sim.VT3 = Val(T3Volt.Text)                ' Set the T3 voltage value to a value in the text box.

    LA.Voltage = Val(NormVolt.Text)           ' Set the normal voltage value to a value in the text box.
    LA.Output = True                          ' Output on
    Sim.Run                                   ' Start the simulation.
End Sub

Private Sub StopButton_Click()                ' Stop button
    Sim.Stop                                  ' Stop the simulation.
    LA.Output = False                         ' Output off
End Sub
```

Sample Program 3

This program runs a sequence. It allows setting of the output voltage (in the AC mode), frequency, and time in steps 1 to 3.

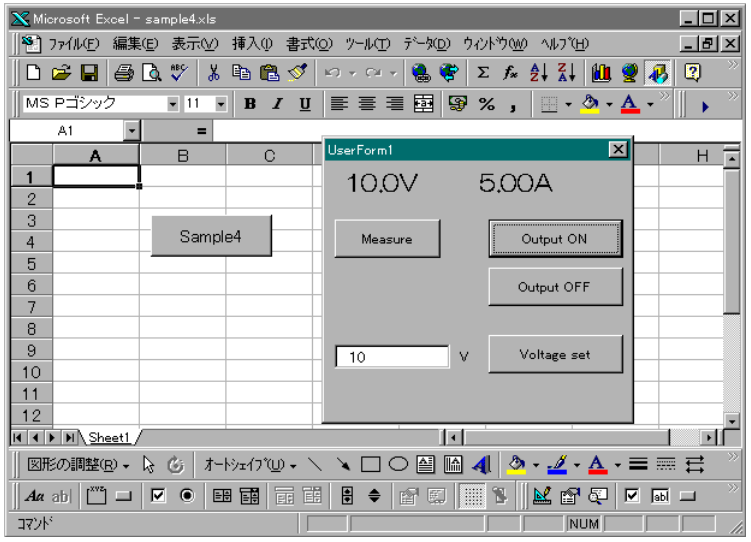



```
Dim LA As New IPcrl                              ' Create the instance (entity) of object IPcrl.
Dim Seqs As IPcrlSeqItems                        ' Create the sub-object of sequence collection.
Dim Seq As IPcrlSeqItem                          ' Create the sub-object of sequence.

Private Sub Form_Load()                          ' Make a connection when Form is created.
'   LA.Connect "GPIB::1"                         ' For GPIB address 1
    LA.Connect "ASRL1"                           ' For RS-232C COM1 ("ASRL2" for COM2)
    Set Seqs = LA.SeqItems                       '
End Sub

Private Sub Form_Unload(Cancel As Integer)       ' Cancel the connection when Form disappears.
    LA.SetString "LOC"                           ' Return control to Local.
    LA.Disconnect                                ' Cancel connection to the GPIB or RS-232C.
End Sub

Private Sub SendButton_Click()                   ' Send button
    Seqs.RemoveAll                               ' Clear the collection.
```

```
    Set Seq = Seqs.Add                      ' Add sequence step 1 to the collection.
    Seq.Voltage = Val(ACVolt1.Text)         ' Set the voltage in step 1 to a value in the text box.
    Seq.Frequency = Val(Freq1.Text)         ' Set the frequency in step 1 to a value in the text box.
    Seq.Second = Val(Time1.Text)            ' Set the time [s] in step 1 to a value in the text box.

    Set Seq = Seqs.Add                      ' Add sequence step 2 to the collection.
    Seq.Voltage = Val(ACVolt2.Text)         ' Set the voltage in step 2 to a value in the text box.
    Seq.Frequency = Val(Freq2.Text)         ' Set the frequency in step 2 to a value in the text box.
    Seq.Second = Val(Time2.Text)            ' Set the time [s] in step 2 to a value in the text box.

    Set Seq = Seqs.Add                        Add sequence step 3 to the collection.
    Seq.Voltage = Val(ACVolt3.Text)         ' Set the voltage in step 3 to a value in the text box.
    Seq.Frequency = Val(Freq3.Text)         ' Set the frequency in step 3 to a value in the text box.
    Seq.Second = Val(Time3.Text)            ' Set the time [s] in step 3 to a value in the text box.

    For Each Seq In Seqs                    ' Send the data
        Seq.Send                            ' in steps 1 to 3.
    Next Seq
End Sub

Private Sub RunButton_Click()               ' Run button
    Seqs.Run 1, 3, 10                       ' Start: 1; End: 3; Loop: 10
End Sub

Private Sub StopButton_Click()              ' Stop button
    Seqs.Stop                               ' Stop the sequence.
    LA.Output = False                       ' Output off
End Sub
```

Sample Program 4

This program sets an AC output voltage value, turns the output ON/OFF, sets the output voltage, and displays the current.



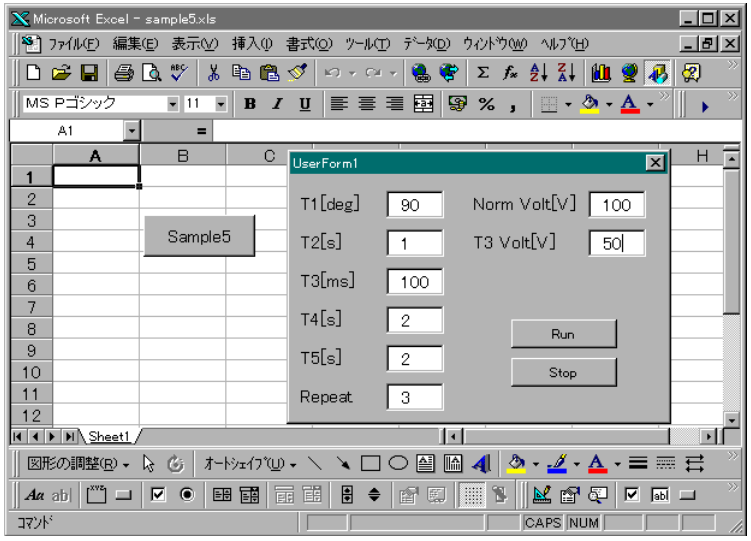

```
    Dim vi As Long
    Dim la As Long
    Dim vs As Long

    Dim r As Long
    Dim c As Long
    Dim strCommand As String
    Dim strRdBack As String
    Dim dsr As Integer
    Dim Result As String

Private Sub UserForm_Initialize()                    ' Processing to be performed when Form is read
    vs = viOpenDefaultRM(vi)                         ' Initialize the VISA library.
    vs = viOpen(vi, "ASRL1", vbNull, 10, la)         ' For RS-232C
    ' vs=viopen(vi,"GPIB::1",vbnull,10,la)           ' For GPIB (address 1)
```

```
    ' RS-232C initial settings (matched to the initial settings of a PCR-LA power supply)
    Dim lIntfType As Long
    vs = viGetAttribute(la, VI_ATTR_INTF_TYPE, lIntfType)
    If lIntfType = VI_INTF_ASRL Then
        vs = viSetAttribute(la, VI_ATTR_ASRL_BAUD, 19200)
        vs = viSetAttribute(la, VI_ATTR_ASRL_PARITY, VI_ASRL_PAR_NONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_DATA_BITS, 8)
        vs = viSetAttribute(la, VI_ATTR_ASRL_STOP_BITS, VI_ASRL_STOP_ONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_FLOW_CNTRL, VI_ASRL_FLOW_XON_XOFF)
    End If

    vs = viClear&(la)

End Sub

Private Sub UserForm_Terminate()                        ' Return control to Local when Form is closed.
   strCommand = "loc" + vbCrLf
   vs = viWrite(la, strCommand, Len(strCommand), r)     ' Return control to Local.
   vs = viClose(la)
   vs = viClose(vi)
End Sub

Private Sub CommandButton1_Click()                      ' Output On button
    strCommand = "out on" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Turn the output ON.
End Sub

Private Sub CommandButton2_Click()                      ' Output Off button
    strCommand = "out off" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Turn the output OFF.
End Sub
```

```
Private Sub CommandButton3_Click()                      ' Set Voltage button
    strCommand = "vset " + TextBox1.Value + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Set the voltage.
End Sub

Private Sub CommandButton4_Click()                      ' Measure button
    Dim dVolt As Double
    Dim dCurr As Double

    strRdBack = Space(255)

    strCommand = "VOUT?" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Inquire about the output voltage.
    vs = viRead(la, strRdBack, 255, c)                  ' Acquire the measured value.
    dVolt = Val(strRdBack)                              ' Convert the voltage to a value.
    Label1.Caption = Format(dVolt, "0.0 V")             ' Display the voltage value.

    strCommand = "IOUT?" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Inquire about the output current.
    vs = viRead(la, strRdBack, 255, c)                  ' Acquire the measured value.
    dCurr = Val(strRdBack)                              ' Convert the voltage to a value.
    Label2.Caption = Format(dCurr, "0.0A")              ' Display the current value.

End Sub
```

Sample Program 5

This program performs a power line abnormality simulation. It enables setting of a variety of parameters, and allows a simulation to be run and stopped.




```
    Dim vi As Long
    Dim la As Long
    Dim vs As Long

    Dim r As Long

    Dim strCommand As String

Private Sub UserForm_Initialize()                    ' Processing to be performed when Form is read

    vs = viOpenDefaultRM(vi)                         ' Initialize the VISA library.
    vs = viOpen(vi, "ASRL1", vbNull, 10, la)         ' For RS-232C
    ' vs=viopen(vi,"GPIB::1",vbnull,10,la)           ' For GPIB (address 1)
```

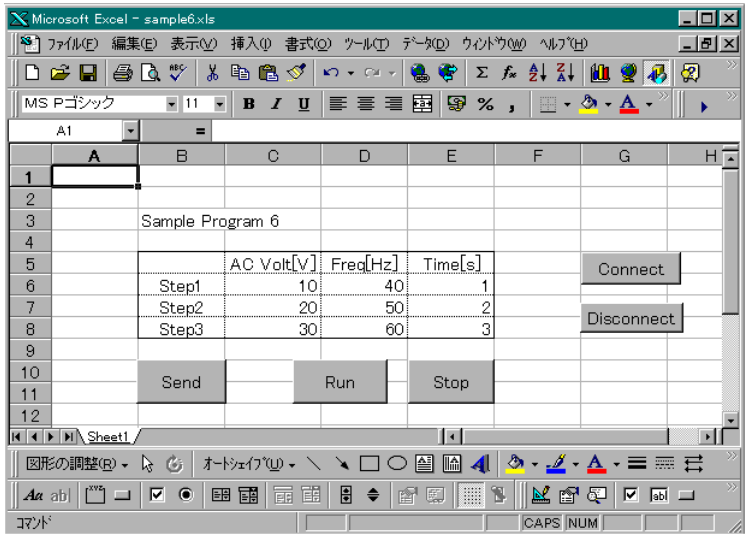
```
    ' RS-232C initial settings (matched to the initial settings of a PCR-LA power supply)
    Dim lIntfType As Long
    vs = viGetAttribute(la, VI_ATTR_INTF_TYPE, lIntfType)
    If lIntfType = VI_INTF_ASRL Then
        vs = viSetAttribute(la, VI_ATTR_ASRL_BAUD, 19200)
        vs = viSetAttribute(la, VI_ATTR_ASRL_PARITY, VI_ASRL_PAR_NONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_DATA_BITS, 8)
        vs = viSetAttribute(la, VI_ATTR_ASRL_STOP_BITS, VI_ASRL_STOP_ONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_FLOW_CNTRL, VI_ASRL_FLOW_XON_XOFF)
    End If

    vs = viClear&(la)

End Sub

Private Sub UserForm_Terminate()                    ' Return control to Local when Form is closed.
    strCommand = "loc" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Return control to Local.
    vs = viClose(la)
    vs = viClose(vi)
End Sub

Private Sub CommandButton1_Click()                  ' RUN button
    strCommand = "out off" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Turn the output OFF.

    strCommand = "SIMMODE ON" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Select the power line abnormality simulation mode.

    strCommand = "T1DEG_" + TextBox1.Value + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)    ' Set T1 [deg].
```

```
    strCommand = "T2_" + TextBox2.Value + "s" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set T2 [s].

    strCommand = "T3_" + TextBox3.Value + "ms" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set T3 [ms].

    strCommand = "T4_" + TextBox4.Value + "s" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set T4 [s].

    strCommand = "T5_" + TextBox5.Value + "s" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set T5 [s].

    strCommand = "RPT_" + TextBox6.Value + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set the number of repetitions.

    strCommand = "T3VSET" + TextBox8.Value + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set regulated voltage V (T3).

    strCommand = "VSET" + TextBox7.Value + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set the voltage prior to regulation.

    strCommand = "OUT ON" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Turn the output ON.

    strCommand = "SIMRUN" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Start power line abnormality simulation.

End Sub

Private Sub CommandButton2_Click()                        ' STOP button
    strCommand = "SIMSTOP" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' End power line abnormality simulation.
```

```
    strCommand = "OUT OFF" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)       ' Turn the output OFF.

End Sub
```

Sample Program 6

This program runs a sequence. It allows the output voltage (in the AC mode), frequency, and time to be set in steps 1 to 3.




```
    Dim vi As Long
    Dim la As Long
    Dim vs As Long

    Dim r As Long
    Dim strCommand As String


Sub Button1_Click()                                    ' Send button
```

```
    Dim strVolt As String
    Dim strFreq As String
    Dim strTime As String
    Dim intCtr As Integer
    Dim strStep As String

    For intCtr = 6 To 8                                    ' Read cell values in turn.
        strStep = Str(intCtr - 5)                          ' Sequence address

        strVolt = Range("c" + Format(intCtr))      ' Voltage set values of the intCtr (6th to 8th)
                                                           rows in column C on sheet 1
        strFreq = Range("d" + Format(intCtr))      ' Frequency set values of the intCtr (6th to 8th)
                                                           rows in column D on sheet 1
        strTime = Range("e" + Format(intCtr))      ' Time set values of the intCtr (6th to 8th)
                                                           rows in column E on sheet 1

        strCommand = "SEDIT " + strStep            ' SEDIT command message + sequence address
        strCommand = strCommand + ",OFF,"          ' Frequency ramp
        strCommand = strCommand + strFreq          ' Frequency
        strCommand = strCommand + ",OFF,"          ' Voltage ramp
        strCommand = strCommand + strVolt          ' Voltage
        strCommand = strCommand + ",0,0," + strTime        ' Hour, minute, second
        strCommand = strCommand + ",0,0,0"                 ' Waveform bank, impedance, DC voltage
        strCommand = strCommand + ",OFF,OFF,1"             ' Status, trigger, output
        strCommand = strCommand + vbCrLf                   ' CR LF

        vs = viWrite(la, strCommand, Len(strCommand), r) ' Set sequence data.

    Next intCtr
End Sub

Sub Button2_Click()                                    ' Run button
    strCommand = "SEQSTART 1" + vbCrLf
```

```
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set a start address.
    strCommand = "SEQEND 3" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set an end address.
    strCommand = "SEQLOOP 3" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Set the number of repetitions.

    strCommand = "SEQRUN" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Start sequence
End Sub

Sub Button3_Click()                                       ' Stop button
    strCommand = "SEQSTOP" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)      ' Stop the sequence.
End Sub

Sub Button4_Click()                                       ' Connect button
    vs = viOpenDefaultRM(vi)                              ' Initialize the VISA library.
    vs = viOpen(vi, "ASRL1", vbNull, 10, la)              ' For RS-232C
    ' vs=viopen(vi,"GPIB::1",vbnull,10,la)                ' For GPIB (address 1)

    ' RS-232C initial settings (matched to the initial settings of a PCR-LA power supply)
    Dim lIntfType As Long
    vs = viGetAttribute(la, VI_ATTR_INTF_TYPE, lIntfType)
    If lIntfType = VI_INTF_ASRL Then
        vs = viSetAttribute(la, VI_ATTR_ASRL_BAUD, 19200)
        vs = viSetAttribute(la, VI_ATTR_ASRL_PARITY, VI_ASRL_PAR_NONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_DATA_BITS, 8)
        vs = viSetAttribute(la, VI_ATTR_ASRL_STOP_BITS, VI_ASRL_STOP_ONE)
        vs = viSetAttribute(la, VI_ATTR_ASRL_FLOW_CNTRL, VI_ASRL_FLOW_XON_XOFF)
    End If

    vs = viClear&(la)
```

```
End Sub

Sub Button5_click()                                    ' Disconnect button

    strCommand = "OUT OFF" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)   ' Turn the output OFF.
    strCommand = "loc" + vbCrLf
    vs = viWrite(la, strCommand, Len(strCommand), r)   ' Return control to Local.
    vs = viClose(la)
    vs = viClose(vi)

End Sub
```

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