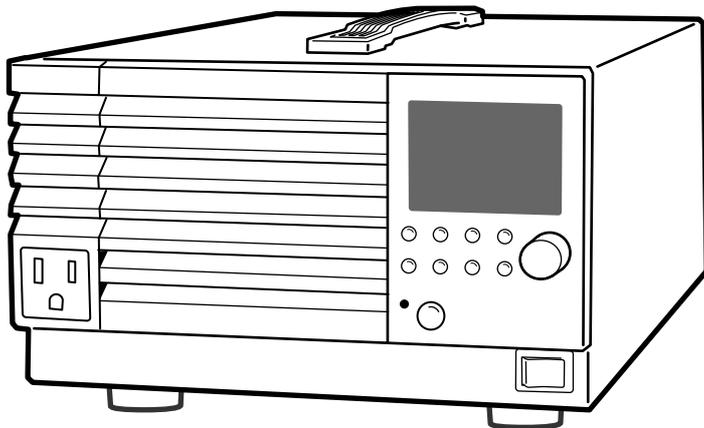


Part No. Z1-004-252, IB016981
Feb. 2008

OPERATION MANUAL

AC POWER SUPPLY
PCR-M series

PCR 500M
PCR1000M
PCR2000M



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.

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

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Safety Symbols

For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Note the meaning of each of the symbols to ensure safe use of the product. (Not all symbols may be used.)

	Indicates that a high voltage (over 1 000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.
DANGER	Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.
 WARNING	Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.
 CAUTION	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
	Shows that the act indicated is prohibited.
	Indicates a general danger, warning, or caution. 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 safety precautions must be observed to avoid fire hazards, electric shock, accidents, and other failures. Keep them in mind and make sure to observe them.

Using the product in a manner that is not specified in this manual may impair the protection functions provided by the product.

Users



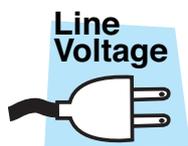
- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If unqualified personnel is to use the product, be sure the product is handled under the supervision of qualified personnel (those who have electrical knowledge). This is to prevent the possibility of personal injury.

Purpose of use



- Never use the product for purposes other than the product's intended use.
- This product is not designed or manufactured for general home or consumer use.

Input power



- Use the product within the rated input power voltage range.
- For applying power, use the power cord provided. For details, see the respective page in the operation manual.
- This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).

Cover



- Some parts inside the product may cause physical hazards. Do not remove the external cover.

Grounding



- This product is an IEC Safety Class I equipment (equipment with a protective conductor terminal). To prevent the possibility of electric shock, be sure to connect the protective conductor terminal of the product to electrical ground (safety ground).

<p>Installation</p> 	<ul style="list-style-type: none"> • This product is designed for safe indoor use. Be sure to use it indoors. • When installing this product, be sure to observe the description in section 2.2, “Precautions Concerning Installation Location” in this manual. • When connecting the power cable to a switchboard, be sure the work is performed by a qualified and licensed electrician or is conducted under the direction of such a person.
<p>Relocation</p> 	<ul style="list-style-type: none"> • Turn off the POWER switch, and disconnect all cables before relocating the product. • When relocating the product, be sure to include the manual.
<p>Operation</p> 	<ul style="list-style-type: none"> • Before using the product, be sure to check the input power voltage and that there is no abnormality in the appearance of the power cord. Be sure to remove the power plug from the outlet before checking it. • If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power plug from the outlet. Make sure the product is not used until it is completely repaired. • Use cables or wires with sufficiently large current capacity for output wires and load cables. • Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.
<p>Maintenance and inspection</p> 	<ul style="list-style-type: none"> • To prevent the possibility of electric shock, make sure to unplug the power plug before carrying out maintenance or inspection. • Do not remove the external cover during maintenance or inspection. • To maintain the performance and safe operation of the product, it is recommended that periodic maintenance, inspection, cleaning, and calibration be performed.
<p>Service</p> 	<ul style="list-style-type: none"> • Kikusui service engineers will perform internal service on the product. If the product needs adjustment or repairs, contact your Kikusui distributor/agent.

How to Read This Manual

Introduction

This manual is intended for first-time users of the PCR-M series. It gives an overview of the PCR-M series and describes various settings, measurement procedures, maintenance, safety precautions, etc.

Read this manual thoroughly to use the functions of the PCR-M series effectively.

You can also review this manual when you are confused about an operation or when a problem occurs.

How to read this manual

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

Related manuals

This manual covers only the basics of remote control. For details, see the Communication Interface Manual. The Communication Interface Manual is provided on the accompanying CD-ROM.

Intended readers of this manual

This manual is intended for users of the PCR-M series AC Power Supply or persons teaching other users on how to operate the PCR-M series.

It assumes that the reader has knowledge about electrical aspects of AC power supplies.

Information on SCPI commands is provided with the premise that the reader has sufficient knowledge about controlling instruments using a personal computer.

Structure of this manual

Below is the structure of the manual. A summary of each chapter is provided.

Chapter1 General Description

This chapter gives a general description and introduces the features of the PCR-M.

Chapter2 Installation and Preparation

This chapter describes the procedures from unpacking to installation.

Chapter3 Operation

This chapter describes the operations of the PCR-M and procedure for controlling the output using external analog signals.

Chapter4 Remote Control

This chapter gives an overview of remote control and describes how to install the instrument driver and software application.

Chapter5 Maintenance

This chapter describes maintenance. Conduct periodic maintenance and calibration to maintain the initial performance as long as possible.

Chapter6 Specifications

This chapter describes the electrical, mechanical, and optional interface board specifications of the PCR-M.

Appendix

Notations used in the manual

- In the interest of brevity, the PCR-M series AC power supply shall be hereafter referred to as the "PCR-M series" or the "power supply".
- The word computer used in the text is a collective term for personal computers and workstations.
- The following markings are used in the explanations in the text.

WARNING

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

CAUTION

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

NOTE

Indicates information that you should know.

DESCRIPTION

Explanation of terminology or operation principle.

See

Indicates reference to detailed information.

>

Indicates menu settings that you select. The menu item to the left of the > symbol is a higher level menu.

SHIFT+switch name (marked in blue)

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

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Would like to rack mount the PCR-M. What do I need to prepare?	section 2.4, "Attachment to the Rack Mount Frame," section 6.2, "Dimensions"	2-6 6-7

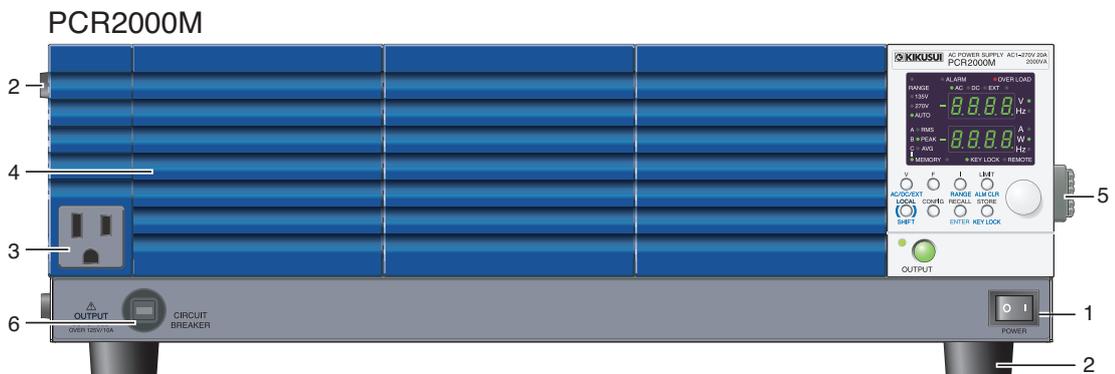
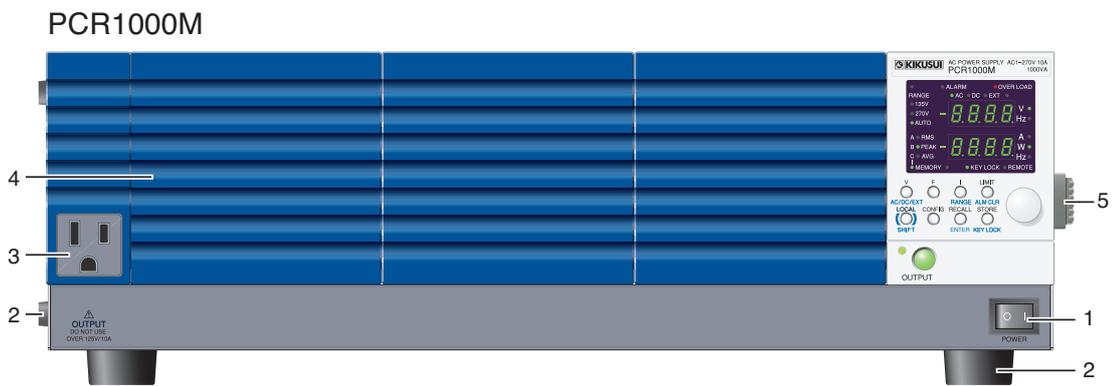
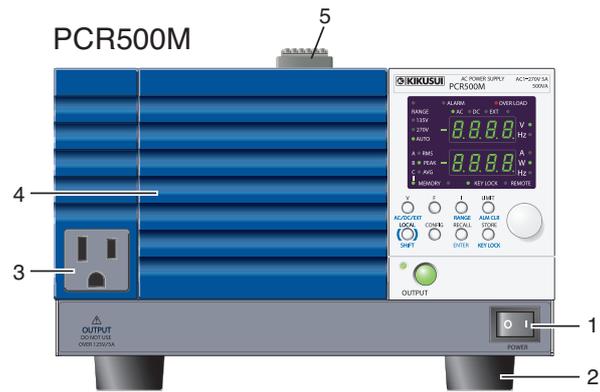
Operation

Situation	Heading	 page
Would like to test drastic changes in voltage or frequency.	section 3.8, "Using Memories"	3-12
Would like to superimpose DC voltage on the AC voltage.	section 1.2, "Options"	1-3
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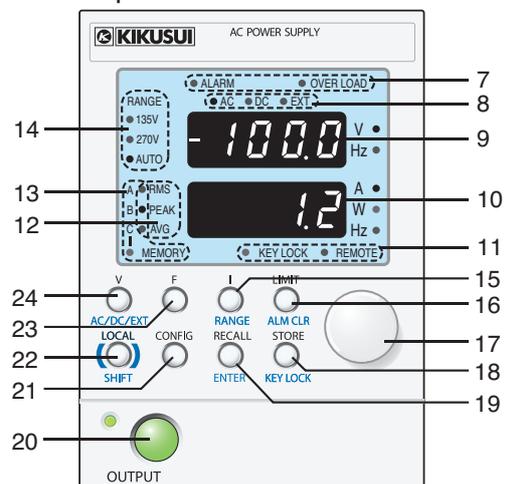
Maintenance

Situation	Heading	 page
Would like to clean the dust filter.	section 5.1.2, "Cleaning the Dust Filter"	5-2

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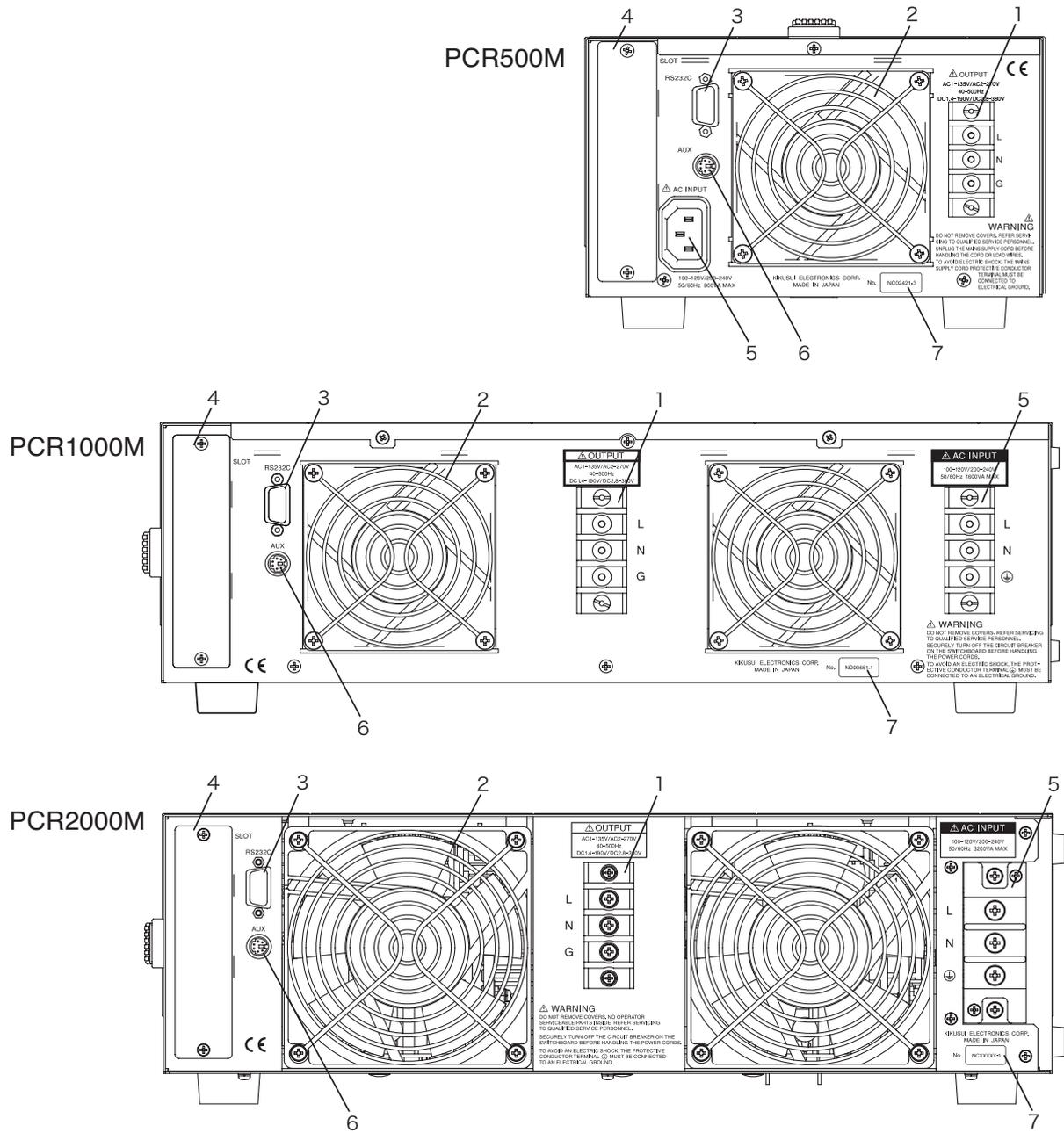


Operation Panel

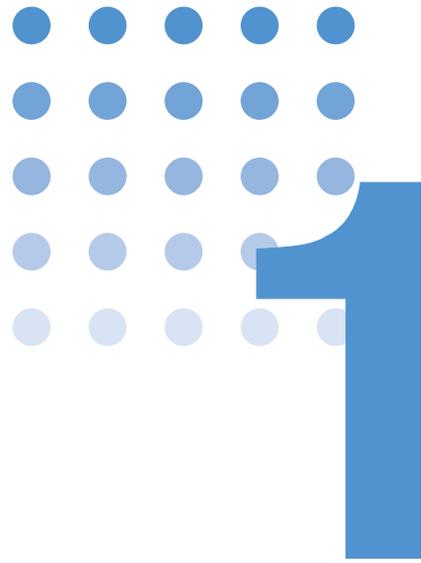


No.	Name		Description	See Page
		+SHIFT		
1	POWER		POWER switch. Push (I) to turn on; push (O) to turn off.	2-10
2	Feet		PCR500M: Four locations on the bottom PCR1000M / PCR2000M: Four locations on the bottom, four locations on the side.	–
3	OUTPUT outlet		Front panel output	2-12
4	Air inlet		Air inlet for internal cooling. A dust filter is built in.	5-2
5	Handle		Handle for transporting	–
6	CIRCUIT BREAKER		Reset button of the circuit breaker.	3-17
7	Alarm/overload		Illuminates when an alarm or overload occurs.	3-15
8	Output mode		The selected mode illuminates (AC, DC, or EXT).	3-2
9	Upper numeric display		Displays voltage or frequency.	–
10	Lower numeric display		Displays current or power. Displays the frequency when the memory is used.	3-8
11	Key lock/remote		Illuminates when the key is locked or when in remote mode.	3-14
12	Rms value, peak value, and average value		RMS, PEAK, or AVG illuminates according to the type of value shown on the numeric display.	3-8
13	Memories A, B, and C		The selected memory (A, B, or C) illuminates. MEMORY illuminates when saving settings and blinks when recalling settings.	3-12
14	Voltage range		The selected voltage range (135 V, 270 V, or AUTO) illuminates.	3-3
15	I		Selects the type of value shown on the lower numeric display (RMS, PEAK, AVG, or W).	3-8
		RANGE	Sets the voltage range.	3-3
16	LIMIT		Sets the limit value. The switch illuminates when active.	3-10
		ALM CLR	Clears alarms.	3-14
17	Rotary knob		Changes the settings.	–
18	STORE		Saves to the memory (memories A, B, or C).	3-12
		KEY LOCK	Locks the keys	3-14
19	RECALL		Recalls from memory.	3-12
		ENTER	Confirms memory recall or storage.	
20	OUTPUT		Turns the output on/off.	3-6
21	CONFIG		Sets the configuration.	3-18
22	LOCAL		Switches to local mode.	3-13
		SHIFT	SHIFT switch	–
23	F		Sets the frequency. The switch illuminates when active.	3-5
24	V		Sets the voltage. The switch illuminates when active.	3-4
		AC/DC/EXT	Selects the output mode.	3-2

Rear panel



No.	Name	Description	See Page
1	OUTPUT terminal block	Output terminal block with a cover	2-12
2	Air outlet	Exhaust port for cooling	—
3	RS232C	A connector for RS232C remote control	6-5
4	Option slot	Installs an option board.	1-3
5	AC INPUT	PCR500M: AC inlet PCR1000M / PCR2000M: AC input terminal block	2-7
6	AUX	A connector for functional expansion	—
7	Serial number	Serial number of PCR-M series	—



General Description

This chapter gives a general description and introduces the features of the PCR-M.

1.1 Overview

The PCR-M is a compact AC power supply that inherits the high quality and high performance features of the PCR-LA/W Series. The PCR-M can be readily used on the desktop or by the desk.

It is equipped with the functionality and performance required of a test instrument for the design, development, and quality assurance of DC/DC converters for devices and onboard power supplies.

Firmware version of the product to which this manual applies

This manual applies to PCR-Ms with firmware version 1.2x

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

 page 2-10

- Model (indicated at the top section on the front panel)
- Firmware version
- Serial number (indicated at the bottom section on the rear panel)

Features

● Wide range of output voltage and frequency

The output voltage and frequency can be set over a wide range. Nominal voltage of various countries (single-phase) can be supported. The PCR-M can be used to test power supplies that are to be placed on airplanes, ships, etc.

● DC output

DC output is possible. The DC voltage can be superimposed on the AC voltage if the optional interface board is used.

● Compact and light

The reduction in size and weight can be enabled by using a PWM inverter method. PCR500M is approximately 1/5th in volume and 1/4th in weight with respect to Kikusui's linear amplifier type AC power supplies.

● Memory function

Up to three presets can be stored. Presets can be recalled in the middle of the output operation to test drastic changes in voltage or frequency.

● Measurement function

Voltage, current, and power of AC and DC output can be monitored. The true rms value and average value (DC) of the output voltage as well as the true rms value, peak value, and average value (DC) of the output current can be displayed.

● Maximum peak current

A maximum peak current that is three times the maximum rated current (rms value) can be output to a capacitor-input rectifying load.

1.2 Options

Interface boards

The functions below are expanded depending on the interface board that is installed in the PCR-M.

- Selection of AC+DC mode in which DC power is superimposed on the AC power
- Increased number of memory sets from 3 to 10.

■ GPIB interface board (IB21)

This is an interface board used to control the PCR-M with the GPIB.

■ USB interface board (US21)

This is an interface board used to control the PCR-M with the USB.

■ Analog interface board (EX04-PCR-M)

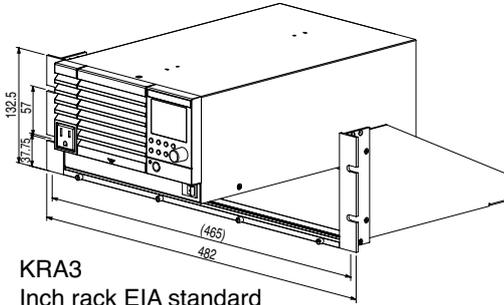
This is an interface board used to control the output with external analog signals. The following functions are expanded.

- The voltage of the output AC waveform (sine wave) is varied according to the input DC signal (EXT-AC mode).
- The input waveform is simply amplified and output (EXT-DC mode).

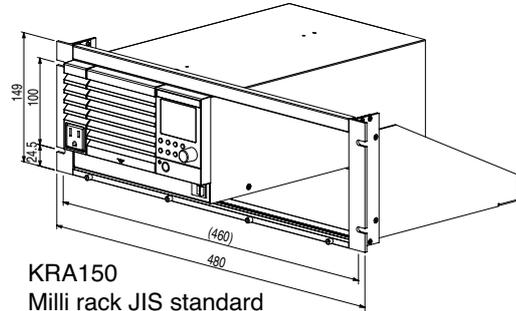
Rack mount option

Rack mounting options shown in Fig.1-1 are available.

PCR500M

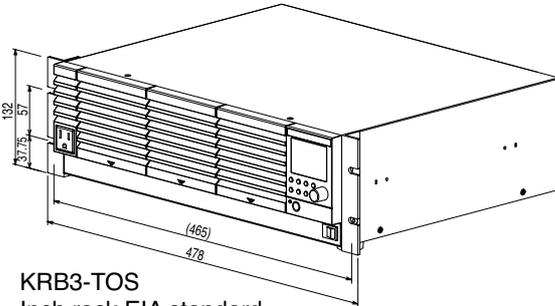


KRA3
Inch rack EIA standard

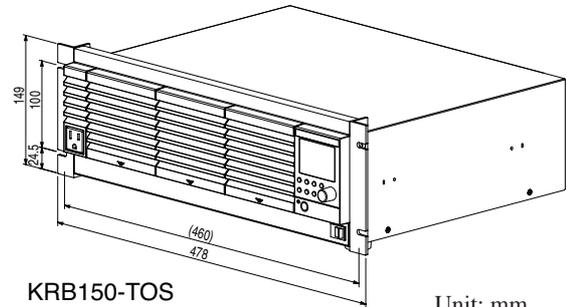


KRA150
Milli rack JIS standard

PCR1000M / PCR2000M (Example : PCR1000M)



KRB3-TOS
Inch rack EIA standard



KRB150-TOS
Milli rack JIS standard

Unit: mm

Fig.1-1 Rack mount option





Installation and Preparation

This chapter describes the procedures from unpacking to installation.

2.1 Checking the Package Contents

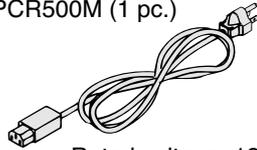
When you receive the product, check that all accessories are included and that the product and accessories have not been damaged during transportation.

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

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

Accessories

For PCR500M (1 pc.)



Rated voltage: 125 Vac
PLUG: NEMA5-15
[85-AA-0004]

or



Rated voltage: 250 Vac
PLUG: CEE7/7
[85-AA-0005]

or



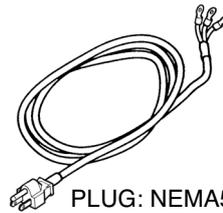
Rated voltage: 250 Vac
PLUG: GB1002
[85-10-0790]

For PCR1000M (1 pc.)



[85-10-0630]

or

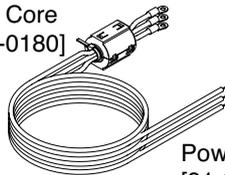


PLUG: NEMA5-15
[91-87-5752]

This power cord with the plug can be used for the input voltage of 114 Vac to 126 Vac. It can not be used except for those specified range.

For PCR2000M (1 set)

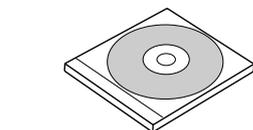
Ferrite Core
[96-01-0180]



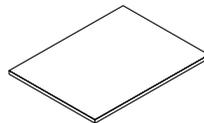
Power cord
[91-87-6140]

Power cord

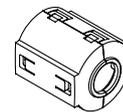
The power cord that is provided varies depending on the destination for the product at the factory-shipment.



CD-ROM (1 pc.)
[SA-6021]



Operation manual
(this manual, 1 pc.)
[Z1-004-252]



Ferrite Core
(Only PCR2000M) (1 pc.)
[96-01-0180]



Cable tie (Only PCR2000M) (1 pc.)
[P4-200-001]

Fig.2-1 Accessories

2.2 Precautions Concerning Installation Location

Be sure to observe the following precautions when installing the PCR-M.

- Do not use the product in a flammable atmosphere.

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

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

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

Operating temperature range: 0 °C to 40 °C

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

- Avoid humid environments.

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

Operating humidity range: 20 %rh to 80 %rh (no condensation)

Storage humidity range: 90 %rh or less (no condensation)

Condensation may occur even within the operating humidity range. In such cases, do not use the PCR-M until the condensation dries up completely.

- Be sure to use it indoors.

This product is designed for safe indoor use.

- Do not install the product in a corrosive atmosphere.

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

- Do not install the product in a dusty location.

Accumulation of dust can lead to electric shock or fire.

- Do not use the product where ventilation is poor.

Secure adequate space around the product so that air can circulate around it.

Allow at least 20 cm of space between the air inlet/outlet and the wall (or obstacles).

- Do not place objects on the PCR-M.

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

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

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

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

The product may malfunction.

2.3 Precautions to Be Taken When Moving the Product

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

- Turn off the POWER switch.

Moving the product while the power is turned on can cause electric shock or damage to it.

- Remove all wiring.

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

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

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

- Be sure to include this manual.

2.4 Attachment to the Rack Mount Frame

Before assemble the unit to the rack mount frame, remove the handle and the feet. As for the instruction of mount assembly, please refer to the instruction manual of KRA series.

Install the suitable support angles applying to the used rack system to support the instrument.

In case the unit is disassembled from the rack mount, it is recommended that all the removed parts are kept in the storage.

Once the unit is disassembled from the rack mount, please attach all of the removed parts to original location of each part.

PCR500M

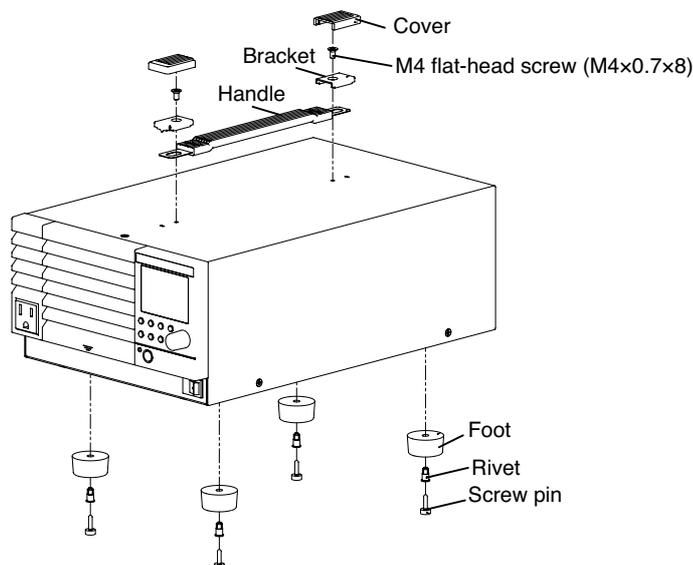


Fig.2-2 Removing the handle and feet (PCR500M)

PCR1000M / PCR2000M

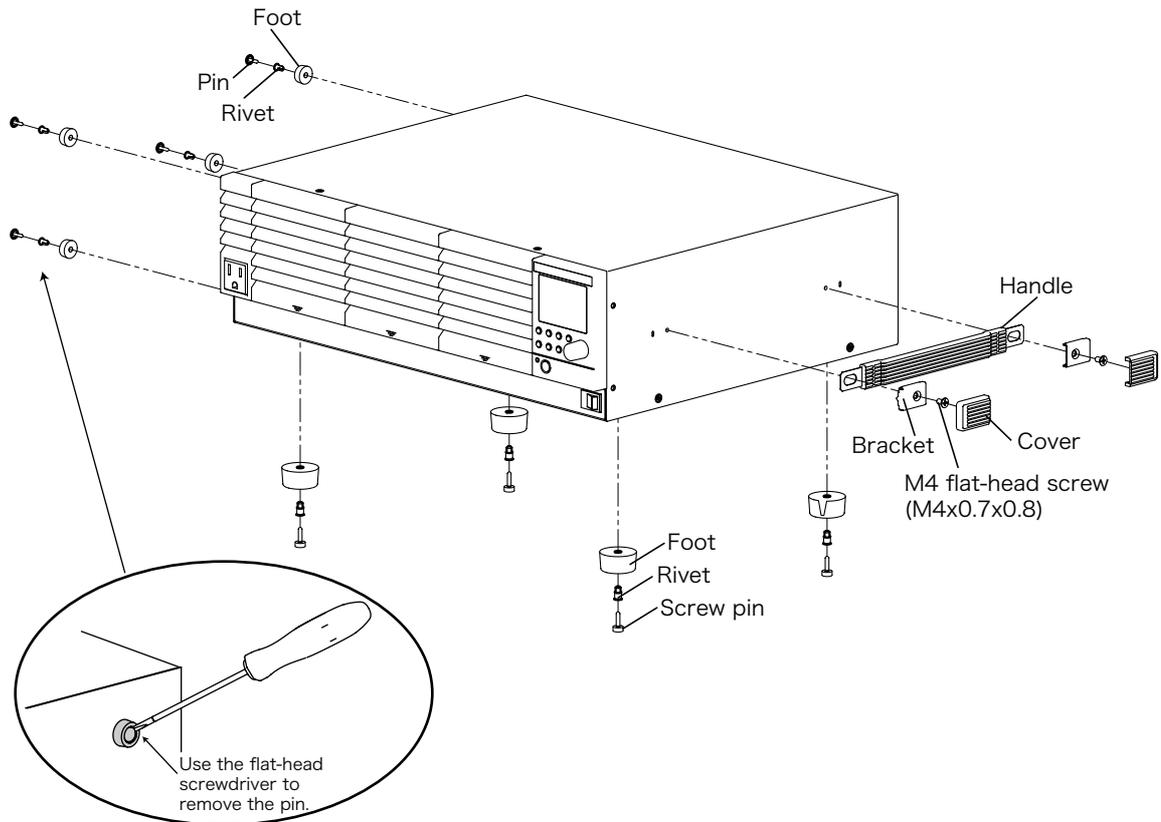


Fig.2-3 Removing the handle and feet (Example : PCR1000M)

Removing the handle and feet

1. Pull up on the handle cover (two locations).
2. Unfasten the M4 flat-head screws (two locations) and remove the entire handle.
3. While pulling down on each foot on the bottom (four locations), turn the screw pin, and remove the foot. Remove all four feet.
4. Unlatch the pin in the foot on the side (four locations) using a flat-head screwdriver, and remove the foot. Remove all four feet. (PCR1000M / PCR2000M only)

2.5 Attachment of the Optional Interface Board

Install an interface board to the option slot on the rear panel if you wish to control the PCR-M externally through an interface other than RS232C or control the output using external analog signals.

1. Check that the POWER switch is turned off.
2. Touch the grounded metal to discharge your physical static electricity
3. Unfasten the screws that are holding the slot cover in place, and remove the cover from the panel.
4. Hold the panel section of the board so that the component side of the printed circuit board is facing right.
5. Slide the board into the slot so that the connector section of the printed circuit board is inserted into the connector at the back of the slot.
6. Push the board all the way in.
7. Use the screws that were holding the slot cover in place to fix the board to the panel.

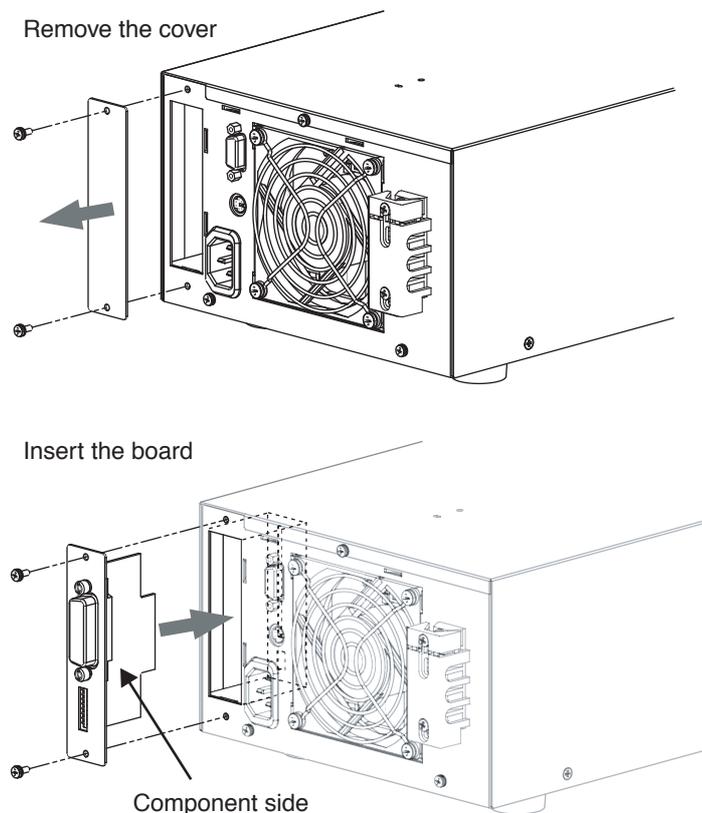


Fig.2-4 Attaching the option board
(GPIB interface board example)

The switch at the back of the slot is set to the high side. Do not change the switch setting.

2.6 Connecting the Power Cord

The power cord provided with the product varies depending on the type. This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).



WARNING Possible electric shock.

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

- PCR500M

Connect the power cord to a properly grounded power outlet.

- PCR1000M / PCR2000M

Make sure to connect the \oplus (GND) terminal of the AC INPUT terminal block to the GND terminal of the switchboard.

PCR500M

The AC power cord that is provided varies depending on the destination for the product at the factory-shipment.

NOTE

- Use the supplied power cord to connect to the AC line.
If the supplied power cord cannot be used due to the rated voltage or the plug shape, have a qualified engineer replace it with an appropriate power cord of length 3 m or less. If obtaining a power cord is difficult, consult your Kikusui agent or distributor.
- The power cord with a plug can be used to disconnect the PCR-M from the AC line in an emergency. Connect the plug to an easily accessible power outlet so that the plug can be removed from the outlet at any time. Be sure to allow enough space around the power outlet.
- Do not use the supplied power cord on other instruments.

page 6-2

1. Check that the AC power line complies with the input rating of the PCR-M.
The voltage that can be applied is any of the nominal power supply voltages in the range of 100 Vac to 120 Vac or 200 Vac to 240 Vac. The frequency is 50 Hz or 60 Hz.



CAUTION

- If the voltage distortion of the AC power line is large, it can lead to malfunction. The PCR-M cannot be connected to a generator or a similar device.

2. Check that the POWER switch is turned off.
3. Connect the power cord to the AC INPUT inlet on the rear panel.
4. Insert the power plug to an outlet.

PCR1000M / PCR2000M

See page 2-7

When the power cord with the plug is attached to the PCR1000M, see the case of model PCR500M.

The power cord attached to the PCR1000M (excluding the cord with plug) and the PCR2000M can be used either at 100Vac to 120 Vac or 200Vac to 240 Vac of the input voltage range.

WARNING

Possible electric shock.

- Turn off the circuit breaker of switchboard before connecting the cord.
- Do not use the terminal block with the terminal cover removed.

Possible Fire.

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

CAUTION

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

NOTE

- Turn off the circuit breaker of switchboard to disconnect the PCR1000M / PCR2000M from the AC line in an emergency.

■ Circuit breaker of switchboard requirement

- Rated current

PCR1000M : 20 A (The circuit breaker of which the rated current is more than 20 A is disabled for safety.)

PCR2000M : 40 A (The circuit breaker of which the rated current is more than 40 A is disabled for safety.)

- Dedicate the circuit breaker for the PCR1000M / PCR2000M.
- Keep the switchboard easily accessible at any time.
- Require labeling to identify that the circuit breaker is dedicated for the PCR1000M / PCR2000M and disconnecting device.

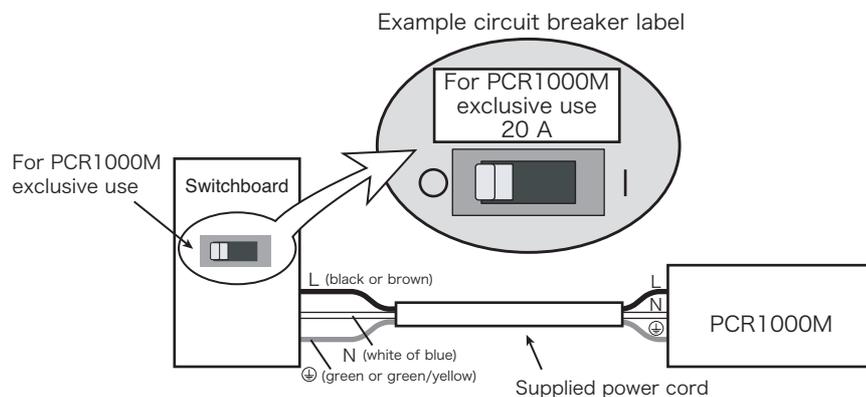


Fig.2-5 Connecting to the switchboard (Example : PCR1000M)

1. Check that the AC power supply meets the nominal input rating of the PCR1000M / PCR2000M.

The voltage that can be applied is any of the nominal power supply voltages in the range of 100 Vac to 120 Vac or 200 Vac to 240 Vac. The frequency is 50 Hz or 60 Hz.

⚠ CAUTION • If the voltage distortion of the AC power line is large, it can lead to malfunction. The PCR-M cannot be connected to a generator or a similar device.

2. Turn off the POWER switch.
3. Remove the terminal cover that is attached to the AC INPUT terminal block.
4. Securely connect the power cord to match the L, N, and \oplus (GND) of the AC INPUT terminal block.
5. Put the terminal cover back to the terminal block that you removed in step3 .

For PCR1000M, use holes on lower side to attach the terminal cover.

6. Attach crimp terminals to the switchboard end of the power cord.
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. Connection must be performed by qualified personnel.
7. Turn off the switchboard.
8. Connect the power cord to match the L, N, and \oplus (GND) of the switchboard.

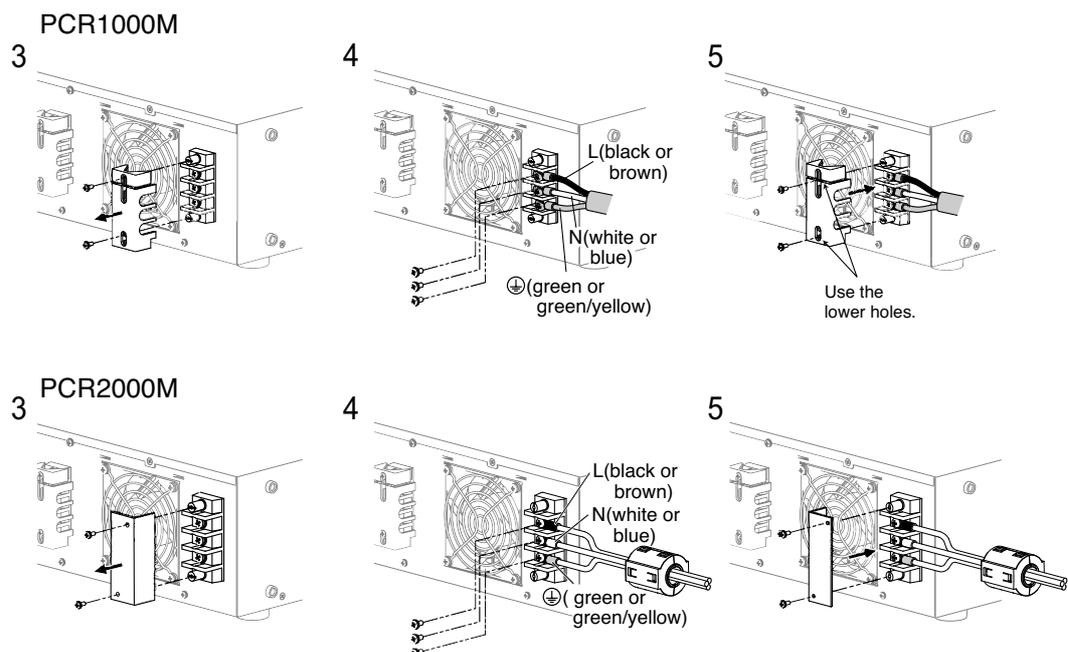


Fig.2-6 Connecting to the AC INPUT terminal block

2.7 Turning the Power On

Turning the POWER switch on

See Fig. 2-7

Turn the power on without the load connected.

1. Check that the POWER switch is turned off (O).
2. Check that nothing is connected to the OUTPUT terminal block on the rear panel and the OUTPUT outlet on the front panel.
3. Check that the power cord is correctly connected.
4. Turn the POWER switch on.

Push the (I) side of the POWER switch to turn the PCR-M on.

If an odd sound, odd odor, fire, or smoke occurs around or in the PCR-M, remove the power plug from the outlet or turn off the switchboard.

5. Check the firmware version on the front panel display.

The firmware version as shown in Fig. 2-7 is displayed for few seconds, and a self-test is carried out. If no error is detected, the measured value display appears.

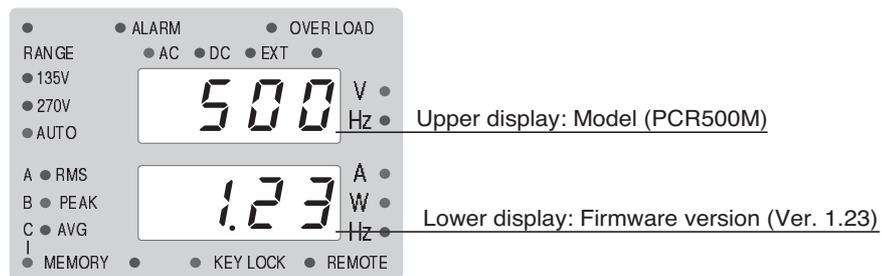


Fig.2-7 Checking the firmware version
(Example: Ver.1.23, PCR500M)

The measured value display appears after displaying the firmware version.

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

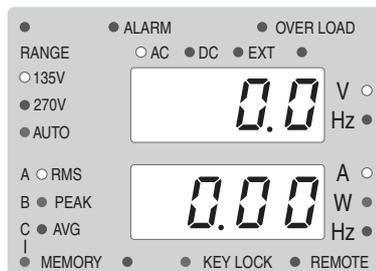


Fig.2-8 Measured value display

If the ALARM LED illuminates or an error number is displayed, see section 3.11, “Protection Functions and Alarm Errors.”

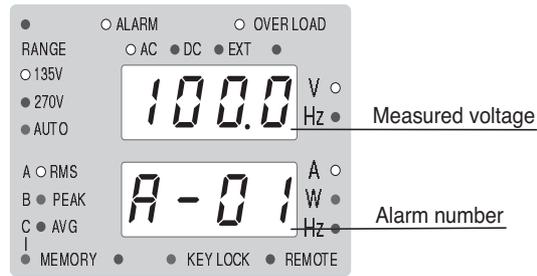


Fig.2-9 ALARM LED illumination and error number display example

Turning the POWER switch off

Push the (O) side of the POWER switch to turn the PCR-M off.

The PCR-M stores the values below at 5-second intervals. When the POWER switch is turned on, these items start up with the values that existed when the POWER switch was turned off the last time.

- Output voltage and frequency settings
- Output voltage range (135 V, 270 V, or AUTO)
- Measured value display (RMS, PEAK, AVG, or W)
- Output mode (AC, DC, or EXT)
- Display conditions of voltage, current, and power
- Locking the Panel Operation
- Configuration

The output on/off state is not stored. The PCR-M always starts up with the output turned off when the power is turned on.

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

2.8 Connecting the Load

Connecting to the OUTPUT terminal block

■ Preparation of Wire

For connecting the load, use the noncombustible type of load wires which must be rated to carry the maximum rated output current.

Table 2-1 Requirements for single-core cables used to connect to the load

Nominal Cross-Sectional Area [mm ²]	AWG	(Reference cross-sectional area) [mm ²]	Allowable Current* ¹ [A] (Ta = 30 °C)
0.9	18	(0.82)	17
1.25	16	(1.31)	19
2	14	(2.08)	27
3.5	12	(3.31)	37
5.5	10	(5.26)	49
8	8	(8.37)	61
14	5	(13.3)	88

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

The values vary depending conditions such as the wire covering (insulator) and material (allowable temperature) and whether they are multi-core cables. For cables other than those specified in Table 2-1, please consult with the qualified personnel.

■ OUTPUT terminal cover

When shipped from the factory, the terminal cover is attached using the upper holes so that the OUTPUT terminals are not exposed.

If you are not using the OUTPUT terminal block, attach the terminal cover as shown in Fig.2-10.

Use the upper holes to attach the terminal cover.

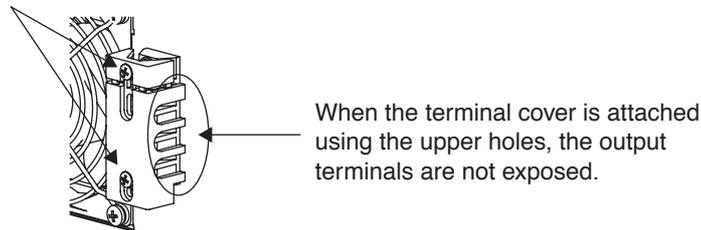


Fig.2-10 OUTPUT terminal cover

Connecting the load cables and attaching the Ferrite Core

Attachment of the ferrite core is only PCR2000M.

⚠ WARNING • There is a danger of electric shock. Do not use the terminal block with the terminal cover removed.

⚠ CAUTION • In DC mode, L is at positive potential and N is at negative potential when setting the positive value. L is at negative potential and N is at positive potential when setting the negative value.

1. Check that the POWER switch is turned off.
2. Remove the terminal cover that is attached to the OUTPUT terminal block.
3. Securely connect the load wires to the OUTPUT terminal block.
If the load has a ground (GND) terminal, be sure to connect it to the G terminal of the PCR-M OUTPUT terminal block. Be sure to use a wire that is greater than or equal to the diameter of the wires used to connect the load.
4. Attach the terminal cover that you removed in step2 using the lower holes.
It is completed of procedure for PCR500M and PCR1000M. As for PCR2000M, it is required to attach the ferrite core to the load wire.
5. Unlock the ferrite core and open it.
6. Close the ferrite core. Avoid catching the wire on the ferrite core.
Attach the ferrite core within 10 cm from the OUTPUT terminal block. Lock it securely in place.
7. To avoid moving the ferrite core, attach the cable tie to fix the position of the ferrite core.

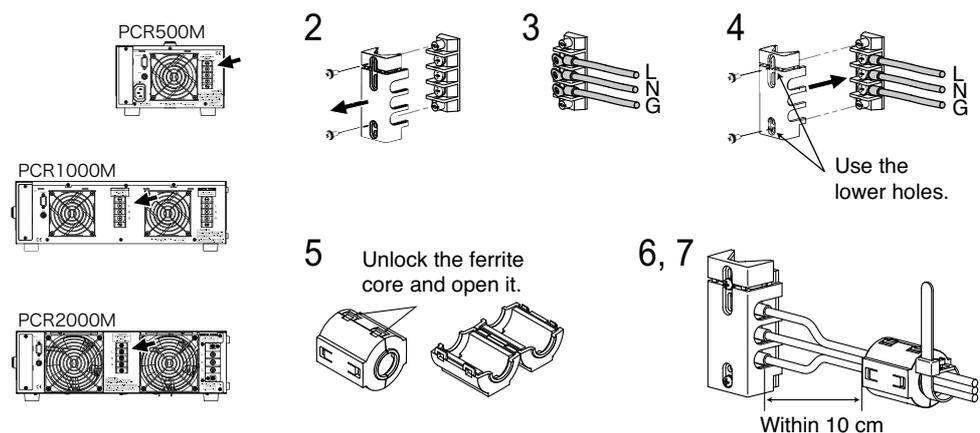


Fig.2-11 Connecting to the OUTPUT terminal block

NOTE

- The L and N terminals of the OUTPUT terminal block are isolated from the AC power line, and the polarity does not constitute a problem in terms of safety. Grounding can be furnished using L or N.

Connecting to the OUTPUT outlet

The PCR-M can output power from the OUTPUT terminal block on the rear panel and the OUTPUT outlet on the front panel. Specifications are not defined for the OUTPUT outlet. A portion of the performance may be degraded.

See page 3-17

As for the PCR2000M, the output is shut down by the circuit breaker when it is over current.

-
- CAUTION** • The maximum rated voltage of the OUTPUT outlet is 125 Vac.
Maximum output voltage: 125 Vac
Maximum output current: PCR500M: 5 Aac
PCR1000M / PCR2000M: 10 Aac
Do not remove the load when the maximum rated voltage of the OUTPUT outlet is exceeded or when in DC mode, as it can lead to malfunction.
-

1. Turn the POWER switch off.
2. Connect the power cord of the load device to the OUTPUT outlet.

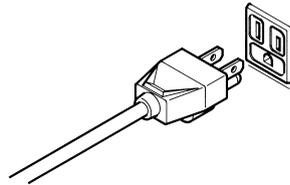


Fig.2-12 Connecting to the OUTPUT outlet

The OUTPUT outlet is dedicated to a type of power plug shown in the figure.

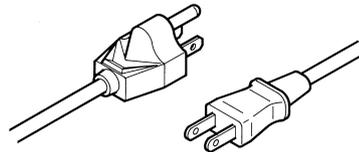


Fig.2-13 Power plug type

When the load is located at a distance from the PCR-M

There may be the case in which the load is located at a distance to remote control the PCR-M.

The remote control enables to turn the output off, but not for the POWER switch off. If the load is used connecting at a distance from the PCR-M, install the switch between the OUTPUT terminal block and the load to prevent electric shock, then turn the switch off.



WARNING Possible electric shock

- When installing the switch between the OUTPUT terminal block and the load, be sure to turn the POWER switch off and removing the power plug from an outlet or turn off the circuit breaker of switchboard.
- The current rating of the switch must be greater than or equal to the maximum current of the PCR-M.
- For the switch circuit, use a two-pole type switch that cuts off L and N wires simultaneously.
- Be sure to turn the switch off before connecting the load to the terminal at the load end of the switch.
- Do not touch the switch terminal when the output is on.

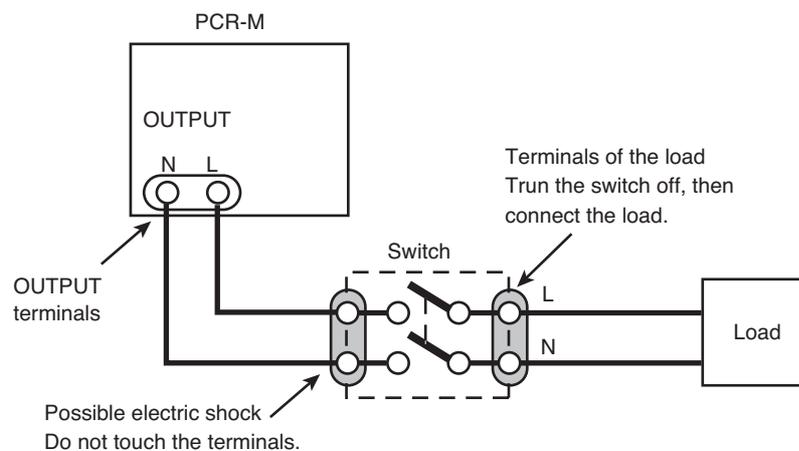
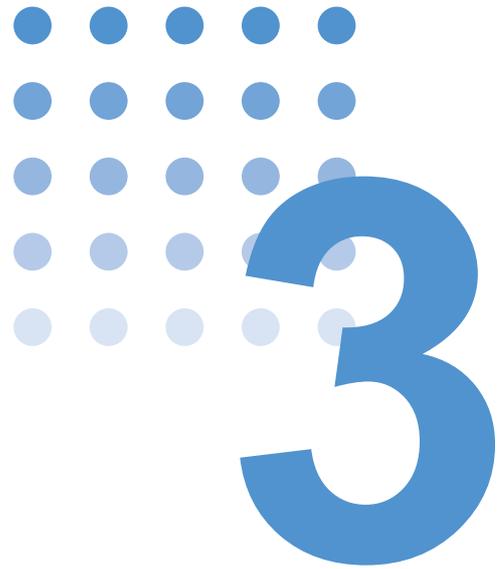


Fig.2-14 The switch between the output terminal and the load.





Operation

This chapter describes the operations of the PCR-M and procedure for controlling the output using external analog signals.

3.1 Switching the Output Mode

See page 3-6, 3-23

The output mode can be switched between AC mode and DC mode when the OUTPUT is turned off. If an optional interface board is installed in the option slot on the PCR-M rear panel, EXT mode (analog interface board only) and AC+DC mode can also be selected.

See page A-6

The AC/DC/EXT switch is disabled when the OUTPUT is turned on.

AC+DC mode can be selected only during remote control. For details, see the Communication Interface Manual.

Table 3-1 Output mode

Output Mode	LEDs That Illuminate	Description
AC mode	AC	AC output
DC mode	DC	DC output
EXT-AC mode	AC and EXT	Output sine waves using external DC signals (only when the analog option board is installed)
EXT-DC mode	DC and EXT	Simply amplify and output the waveform applied externally (only when the analog option board is installed)
AC+DC mode	AC and DC	Superimpose DC voltage on the AC voltage and output. (only when the optional interface board is installed)

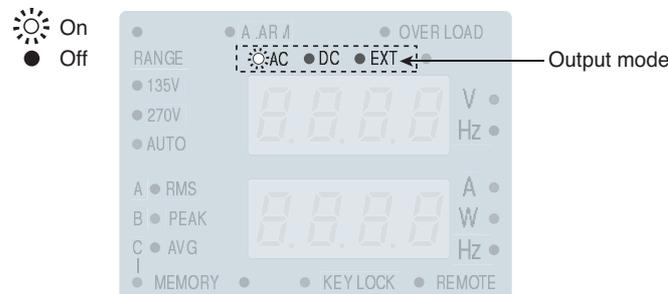


Fig.3-1 Output mode display

1. Press the OUTPUT switch to turn the OUTPUT off.
The LED above on the left of the OUTPUT switch turns off.
2. Press the AC/DC/EXT switch (SHIFT+V) to select the output mode.

The mode switches between AC and DC each time the switch is pressed.

The mode switches among AC, DC, EXT-AC, and EXT-DC when the analog interface board is installed.

The output mode LEDs illuminate according to the mode as shown in Table 3-1.

See page 3-23

3.2 Setting the Voltage Range

The voltage range is switched with the OUTPUT turned off. The selectable voltage ranges are 135 V, 270 V, and AUTO.

The RANGE switch is disabled when the OUTPUT is turned on.

Table 3-2 and Table 3-3 indicate the output voltage setting and maximum output current.

See page 3-4

The AUTO setting automatically switches between 135 V range and 270 V range.

AUTO cannot be selected in AC+DC mode, EXT-AC mode, or EXT-DC mode.

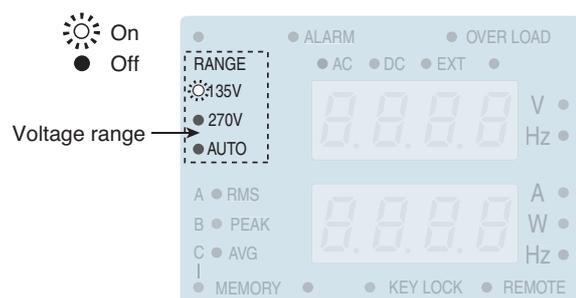


Fig.3-2 Voltage range display

Table 3-2 Voltage range and output voltage setting

Voltage Range	Output Voltage Setting		
	AC mode	DC mode	AC+DC mode
135 V range	0.0 V to 137.5 V	-194.0 V to +194.0 V	
270 V range	0.0 V to 275.0 V	-388.0 V to +388.0 V	

See page A-2, A-4

Table 3-3 Voltage range and maximum output current

	Voltage Range	Maximum Output Current		
		AC mode	DC mode	AC+DC mode
PCR500M	135 V range	5 A	4 A	
	270 V range	2.5 A	2 A	
PCR1000M	135 V range	10 A	8 A	
	270 V range	5 A	4 A	

1. Press the OUTPUT switch to turn the OUTPUT off.
The LED above on the left of the OUTPUT switch turns off.
2. Press the RANGE switch (SHIFT+I) to select the voltage range.
The range switches among 135 V, 270 V, and AUTO each time the switch is pressed. The LED corresponding to the range illuminates.
If the voltage is set above 137.5 V in the 270 V range or AUTO setting and the range is switched to 135 V, the output voltage is set to 0.0 V.

3.3 Setting the Voltage

You can set the voltage regardless of whether the OUTPUT is on or off.

If the voltage range is set to AUTO, the range automatically switches to 135 V or 270 V range according to the specified voltage. When the voltage range switches, the OUTPUT is turned off for approximately 0.5 seconds. After the voltage range switches, the OUTPUT is turned on again.

See page 3-10

The factory default voltage lower limit of DC mode is 0.0 V. You must change the limit to set a negative electric potential.

In AC+DC mode, the voltage can be specified only when the AC and DC voltage settings are within the voltage limit range and the peak value of the AC+DC waveform is within the range of -388 V to 388 V.

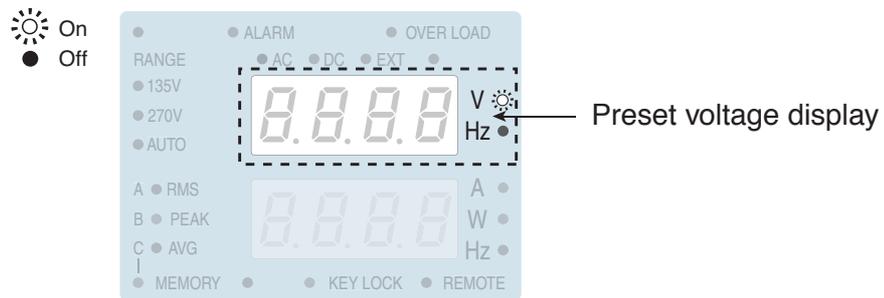


Fig.3-3 Preset voltage display (upper numeric display)

1. Press the V switch.

The V switch illuminates, and the voltage setting display appears.

2. Turn the rotary knob to set the voltage.

The specified voltage is shown on the upper numeric display of Fig.3-3.

If the OUTPUT is on, you can change the set voltage (output voltage) by turning the rotary knob.

If the OUTPUT is off, you can change the preset voltage by turning the rotary knob.

The specified voltage is delivered when the OUTPUT is turned on.

To display the measured value, press the V switch again. The V switch turns off and measured value display appears.

See page 3-3, 3-10

You can also change the output voltage by turning the rotary knob on the measured value display immediately after changing from the voltage setting display if the OUTPUT is on.

If you show the measured value display after displaying another setting display, you cannot change the output voltage. In this case, press the V switch again.

Table 3-4 Switching of the range when the voltage range is set to AUTO

Output Voltage Setting	AC mode		DC mode		
	0 V to 135 V	135.1 V to 275 V	-388 V to -190.1 V	-190 V to 190 V	190.1 V to 388 V
Range	135 V	270 V	270 V	135 V	270 V

3.4 Setting the Frequency

Frequency setting is a function for AC mode and AC+DC mode. You can set the frequency regardless of whether the OUTPUT is on or off.

The F switch is disabled in DC mode.

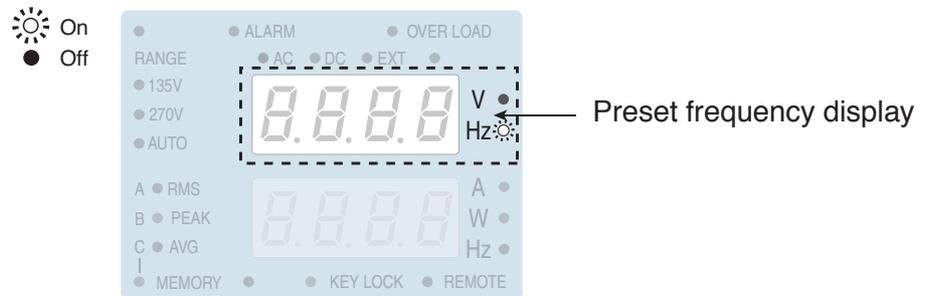


Fig.3-4 Preset frequency display (upper numeric display)

1. Press the F switch.

The F switch illuminates, and the frequency setting display appears.

2. Turn the rotary knob to set the frequency (40.0 Hz to 500.0 Hz).

The specified frequency is shown on the upper numeric display of Fig.3-4.

Press the F switch again, then F switch light off and the measured value display appears to show the value of measured voltage in the upper numeric display.

3.5 Turning the OUTPUT On/Off

The OUTPUT turns on/off each time the OUTPUT switch is pressed.

- **OUTPUT on**
The LED above on the left of the OUTPUT switch illuminates.
The voltage and frequency according to the specified output mode and voltage range are output.
- **OUTPUT off**
The LED above on the left of the OUTPUT switch turns off.

The OUTPUT is always off when the POWER switch is turned on.

If a protection function trips, the OUTPUT is turned off. However, if the current limit operation is set to LIMIT CONTROL and the overload protection function (current limit) trips, the OUTPUT is not turned off.



- WARNING**
- **To prevent the possibility of electric shock, do not touch the OUTPUT terminal block and OUTPUT outlet.**
 - **If a capacitor, battery, or a similar device is connected as a load in DC mode, voltage remains at the section connected to the OUTPUT terminal block or OUTPUT outlet even when the OUTPUT is off until the load energy is discharged. The discharge time of the internal capacitor when no load is connected is approximately 0.1 seconds. To prevent the possibility of electric shock, do not touch the OUTPUT terminal block and OUTPUT outlet.**



- CAUTION**
- When the OUTPUT is turned on, several volts of undershoot or overshoot may appear on the order of ten microseconds.

■ Principle of OUTPUT on/off

The PCR-M 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. Therefore, the output can be turned on/off without chattering. When the OUTPUT is off, the output is in high-impedance condition.

Table 3-5 The resistance in the high-impedance condition

	PCR500M	PCR1000M	PCR2000M
135 V range	approx. 40 kΩ	approx. 20 kΩ	approx. 10 kΩ
270 V range	approx. 80 kΩ	approx. 40 kΩ	approx. 20 kΩ



■ OUTPUT on phase angle

The OUTPUT on phase can be set in AC mode.

See page 3-18

The control of the OUTPUT on phase angle is specified in the configuration. Because the output capacitor inside the PCR-M is discharged when there is no load, OUTPUT turns off at the zero-crossing phase.

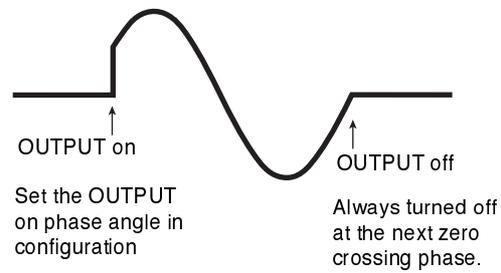


Fig.3-5 OUTPUT on/off phase angle

3.6 Measured value display

The current output value is monitored. The upper numeric display indicates the current measured voltage, and the lower numeric display indicates the current measured current or power. Both displays indicate approximately 0 when the OUTPUT is off.

Display on the lower numeric display

The lower numeric display indicates the measured values below.

You can change the type of displayed value by pressing the I switch.

- AC mode
 - Measured rms current (RMS)
 - Measured peak current (PEAK)
 - Measured power (W)
- DC mode
 - Measured peak current (PEAK)
 - Measured average current (AVG)
 - Measured power (W)

See page 3-18

The measured peak current indicates the absolute value by measuring the maximum instantaneous value of current. The measured peak current is displayed using a positive value even when negative voltage is being output in DC mode. The hold time of peak current is set in the configuration.

The measured current or power is displayed in the lower numeric display even when the voltage setting display or frequency setting display is shown.

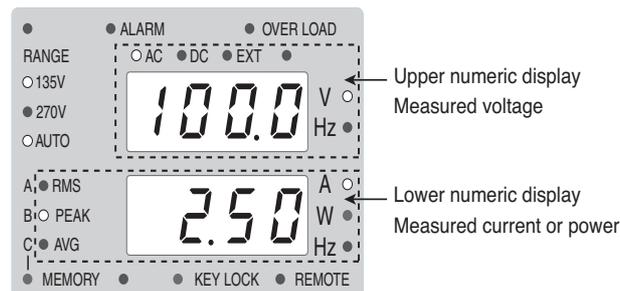


Fig.3-6 Measured value display
(Example for AC mode, voltage range: AUTO, and measured peak current display)

Switching the display

Table 3-6 shows how to switch to the measured value display from other setting displays.

Table 3-6 Switching to measured value display

Other Setting Display	Switching Procedure
Voltage setting display (V switch illuminated)	Press the V switch.
Frequency setting display (F switch illuminated)	Press the F switch.
Limit setting display (LIMIT switch illuminated)	Press the I switch.
Configuration setting display	
Memory storage display (MEMORY LED illuminated)	
Memory recall display (MEMORY LED blinked)	

3.7 Setting the limit value

The limit function prevents damaging the load caused by operation errors by setting a limit on the output setting of the PCR-M. The limit value can be specified to match the load conditions in advance.

The limit can be set regardless of whether the OUTPUT is on or off.

1. Press the LIMIT switch.

The LIMIT switch illuminates, and the limit setting display appears.

The limit settings switch in order each time the LIMIT switch is pressed. Press the LIMIT switch repeatedly until the desired limit setting is displayed. The measured value display is shown after all limit settings are shown.

2. Turn the rotary knob to set the condition.

3. To set other limit values, press the LIMIT switch. To show another setting display or the measured value display, press the V, F, or I switch.

The voltage setting display, frequency setting display, or measured value display is shown, respectively.

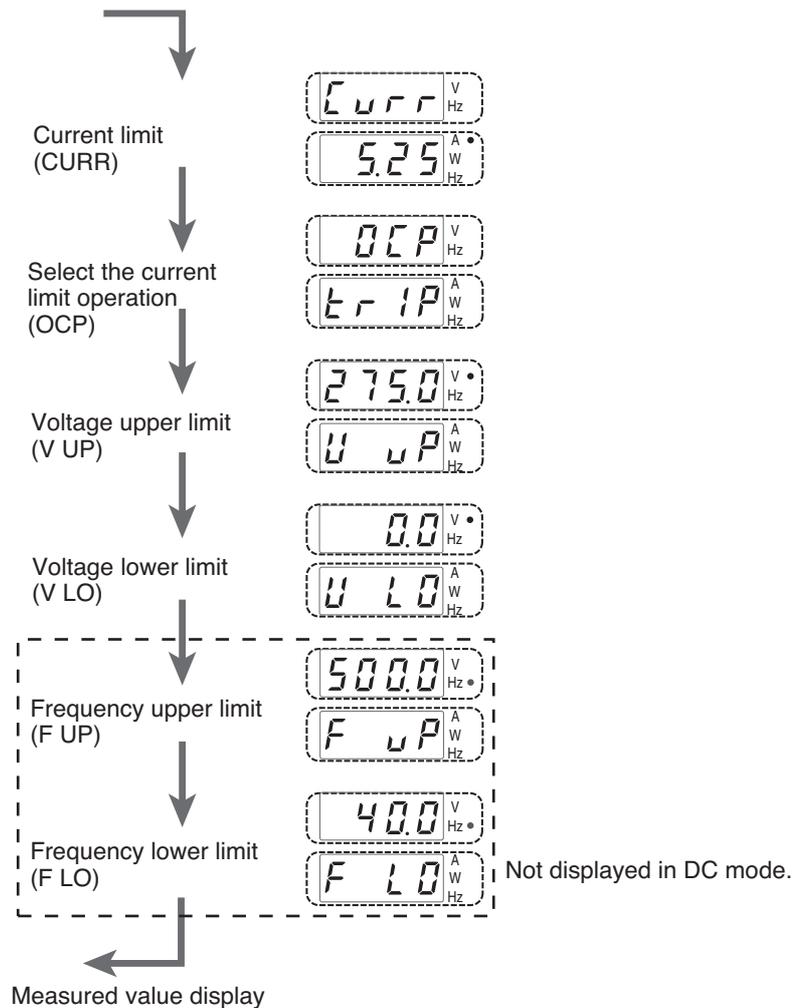


Fig.3-7 Setting the limit value

NOTE

- The limit value takes precedence over the setting value for voltage and frequency. If the current setting value exceeds the limit range when the voltage or frequency limit value is changed, the setting value (voltage or frequency) is set to a limit value that is closest to the current setting value.

■ Current limit value and current limit operation

The current limit value of the output current can be specified.

Table 3-7 Selectable range of current limit values

Output Mode	Limit		
	PCR500M	PCR1000M	PCR2000M
AC mode	0.10 A to 5.25 A	0.20 A to 10.50 A	0.40 A to 21.00 A
DC mode	0.10 A to 4.2 A	0.20 A to 8.40 A	0.40 A to 16.80 A

The operation to be carried out when the current limit is exceeded can be selected.

Table 3-8 Types of current limit operations

Current Limit Operation	Display	Function
TRIP		Turns the OUTPUT off and activates the alarm when an overload condition lasts more than 3 seconds.
LIMIT CONTROL		Decreases the output voltage so that the current does not exceed the limit when an overload occurs (software CC operation ^{*1}).

*1. It is calculated for the RMS value. Due to the relation between the processing time of measurement and the voltage resolution, it may take a few seconds to exceed the value of current limit.



page 3-14, 3-17

■ Setting the voltage upper and lower limits

You cannot set the voltage outside the limit range. Set the limit so that the upper limit is greater than or equal to the lower limit.

Table 3-9 Selectable range of voltage limit values

Output Mode	Voltage Range	Lower Limit	Upper Limit
AC mode	135 V	0.0 V to 137.5 V	0.0 V to 275.0 V
	270 V	0.0 V to 275.0 V	0.0 V to 275.0 V
DC mode	135 V	-388.0 V to 194.0 V	-194.0 V to 388.0 V
	270 V	-388.0 V to 388.0 V	-388.0 V to 388.0 V

■ Frequency upper and lower limits

Cannot be set in DC mode. You cannot set the frequency outside the limit range. Set the limit so that the upper limit is greater than or equal to the lower limit.

Table 3-10 Selectable range of frequency limit values

Output Mode	Lower Limit	Upper Limit
AC mode	40.0 Hz to 500.0 Hz	40.0 Hz to 500.0 Hz

3.8 Using Memories

The settings can be stored to memory. There are three memories, A, B, and C.

Memories are effective when testing drastic changes in voltage or frequency.

In case the optional interface board is installed in the optional slot on the rear panel, the setting condition can be stored up to 10 memories. The memory 4 through 10 can be used only under the remote control operation. For details, see the Communication Interface Manual.

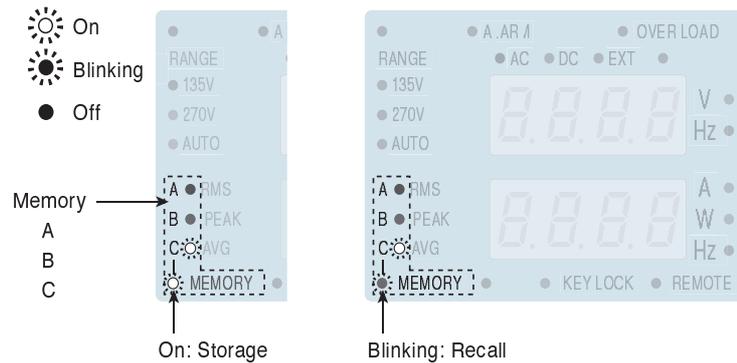


Fig.3-8 Memory display

Saving to the memory

See Table 3-11

1. Configure the PCR-M to the settings you wish to store.
2. Press the STORE switch to select the destination memory (A, B, or C).
The MEMORY LED on the display illuminates. Memories A, B, and C are selected in order each time the STORE switch is pressed, and the corresponding LED illuminates. The upper numeric display indicates the preset voltage. In AC mode, the lower numeric display indicates the preset frequency.
3. Press the ENTER (SHIFT+RECALL) switch to store the settings to the memory.
The settings are stored to the selected memory. The MEMORY LED on the display turns off. To cancel the storage operation, press a switch other than the STORE switch.

Table 3-11 Stored settings

Stored Settings			
Output mode (AC, DC, or EXT)			
Voltage range (135 V, 270 V, or AUTO)			
Voltage	AC		
	DC		
Frequency			
Measured value display (RMS, PEAK, AVG, or W)			
Limit values	AC	Voltage upper limit	
		Voltage lower limit	
		Current limit	
		Frequency upper limit	
		Frequency lower limit	
	DC	Voltage upper limit	
		Voltage lower limit	
		Current limit	
	Current limit operation		

Recalling the memory

If a memory is recalled with the OUTPUT turned on, a short alarm sounds and the recalling is disabled when the output mode or voltage range switches. If this happens, turn the OUTPUT off, recall the memory, and then turn the OUTPUT back on.

1. Press the RECALL switch to select the memory you wish to recall.

The MEMORY LED on the display blinks. Memories A, B, and C are selected in order each time the RECALL switch is pressed, and the corresponding LED illuminates.

The settings stored to memory (preset voltage on the upper numeric display and preset frequency on the lower numeric display) are displayed.

2. Press the ENTER (SHIFT+RECALL) switch to recall the settings from the memory.

The settings of the selected memory are recalled, and new settings are activated. The MEMORY LED on the display turns off. To cancel the recall operation, press a switch other than the RECALL switch.

3.9 Switching from remote control to local control

The RMT LED illuminates when the remote control is activated. Press the LOCAL switch to switch from remote control to local control (Front panel operation).

3.10 Locking (Prohibiting) the Panel Operation

The operation from the panel can be locked to prevent the settings from being changed inadvertently when using the PCR-M with fixed voltage or frequency. When the panel is locked, all switches other than the OUTPUT and KEY LOCK (SHIFT+STORE) switches are disabled.

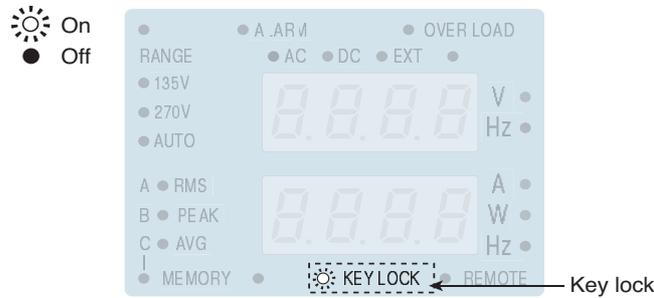


Fig.3-9 KEY LOCK display

Setting and releasing the lock

The panel lock can be set or released each time the KEYLOCK (SHIFT+STORE) switch is pressed.

If the lock is set, the KEY LOCK LED on the display illuminates; if the lock is released, the LED turns off.

3.11 Protection Functions and Alarm Errors

The PCR-M is equipped with the protection functions below. When a protection function is activated, an alarm (A-xx) or an error (E-xx) occurs as shown Table 3-12 in and the OUTPUT is turned off.

- Alarm: Occurs to notify the user that a protection function has been activated.
- Error: Occurs on a major operation error or when there is a possibility of malfunction or damage.

See page 3-17

Table 3-12 Protection function

Protection Function		Alarm or Error Type
Protection against exceeding the input voltage rating range		Error E-10 or E-12
Overheat protection (OHP)		Alarm A-04
Overload protection	Overcurrent (RMS or AVE) protection (OCP)	OVERLOAD illuminates. Alarm A-01.
	Overpower protection (OPP)	OVERLOAD illuminates. Alarm A-03.
	Overcurrent (PEAK) protection (OCP)	OVERLOAD illuminates. Alarm A-02.
Voltage error detection	Overvoltage (OVP)	Alarm A-00
	Low voltage (LVP)	Alarm A-06

3.11.1 Alarm Occurrence

When an alarm or error occurs, an alarm sounds and the ALARM LED on the display illuminates. The upper numeric display shows the output voltage, and the lower numeric display shows the alarm or error number.

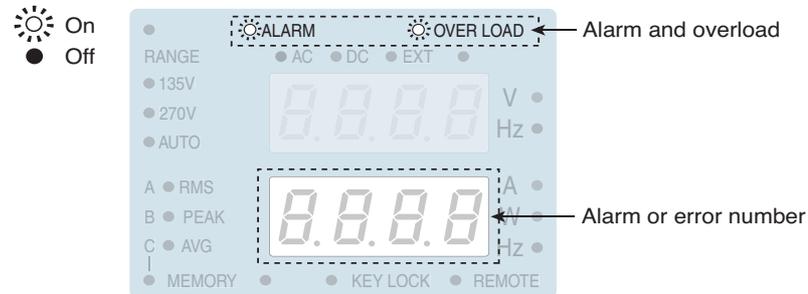


Fig.3-10 Alarm indication

Clearing Alarms

1. Check the alarm number.
2. Press the ALM CLR (SHIFT+LIMIT) switch.

The alarm sound stops, and the alarm indication also clears.

If you press the ALM CLR (SHIFT+LIMIT) switch again, the last alarm number is displayed.

3. Eliminate the cause of the alarm.

Refer to Table 3-13, and eliminate the cause of the alarm that occurred according to the description of the displayed alarm number.

Clearing Errors

1. Check the error number.
2. Turn the POWER switch off.
3. Eliminate the cause of the error.

Refer to Table 3-13, and eliminate the cause of the error that occurred according to the description of the displayed error number.

Turn the POWER switch on again to restore.

Alarm or error number, description, and remedy

Table 3-13 Alarm or error number, description, and remedy

Alarm Number or Error Number		Description and Remedy	See
nOEr		No alarm or error	–
Alarm	A-00	Detected more than 8 V of measured voltage against the setting voltage (OVP, Current limit function : TRIP) or the external signal which exceeds maximum value of the range is applied.	–
	A-01	The overload protection function (overcurrent (RMS or AVE) protection) tripped (OCP).	3-10
	A-02	The overload protection function (overcurrent (PEAK) protection) tripped (OCP).	–
	A-03	Power protection function tripped (OPP).	–
	A-04	The overheat protection function tripped (OHP). The internal temperature may be abnormally high. If the alarm continues to occur after 10 minutes with the POWER switch turned on, it may be caused by an inappropriate installation of the PCR-M or the ambient temperature being outside the operating temperature specifications.	2-3 6-4
	A-06	Detected less than 8 V of measured voltage against the setting voltage (LVP, Current limit function: TRIP).	–
Error	E-09	An error is occurring in the internal communication. Turn the POWER switch off, wait at least 5 seconds, and then turn the POWER switch back on. If E-09 occurs again, contact your Kikusui agent or distributor..	–
	E-10	The input voltage is outside the rated range when the power is turned on. Check the input voltage.	–
	E-11	A voltage error occurred in the internal power unit. Turn the POWER switch off, wait at least 5 seconds, and then turn the POWER switch back on. If E-11 occurs again, contact your Kikusui agent or distributor..	–
	E-12	The input voltage is outside the rated range during operation. Check the input voltage.	–
	E-13	An error occurred inside the PCR-M. Turn the POWER switch off. Wait at least 5 seconds, and then turn the POWER switch on while holding down the RECALL switch. The PCR-M is reset to factory default settings.	–
	E-15	An error occurred in the calibration data. The error cannot be cleared. Contact your Kikusui agent or distributor for repairs.	–

NOTE

- If you cannot clear the alarm even when all of the causes of the alarm are eliminated, the PCR-M may have malfunctioned. Stop using the PCR-M and contact your Kikusui agent or distributor. When making an inquiry, please provide us with the displayed alarm or error number.

3.11.2 Operation when the protection function is activated

 See page 3-10, 3-15, A-5

The OVER LOAD LED on the display illuminates for conditions listed in Table 3-14. The output voltage may vary while the OVER LOAD LED is illuminated.

Table 3-14 Types of OVER LOAD LED illuminating

OVER LOAD LED is illuminated	Description
The measured current (RMS) is greater than or equal to the current limit value or rated current.	Current limit operation:TRIP If this condition lasts for 3 seconds or longer, an alarm (A-01) occurs and the output is shut down. Current limit operation: LIMIT CONTROL (software CC operation) The preset voltage is controlled internally by the PCR-M when an overcurrent condition occurs. An alarm does not occur.
The measured current (PEAK) is greater than or equal to the maximum peak current	If the condition "100 % of the maximum peak current < measured current \leq 115 % of the maximum peak current" lasts for 10 seconds or longer or the condition "115 % of the maximum peak current < measured current" lasts for 1 second or longer, an alarm (A-03) occurs and the output is shut down.
The measured apparent power (VA) is greater than or equal to the rated apparent power.	If this condition lasts for 10 seconds, an alarm (A-03) occurs and the output is shut down.
The measured voltage (RMS) is not within ± 8 V of the preset voltage.	Current limit operation:TRIP If this condition lasts for 3 seconds, an alarm (A-00 or A-06) occurs and the output is shut down.
The external input signal exceeds the maximum of the range.	Current limit operation: LIMIT CONTROL (software CC operation) An overload does not occur.

3.11.3 Steps to be taken if the circuit breaker trips (PCR2000M only)

For the PCR2000M, if more than 10 A of output current flows from the OUTPUT outlet, the circuit breaker may trip to shut down the output from the OUTPUT outlet. Once the breaker is tripped, the red button (Breaker button) on the front panel will be come out.

1. Turn the POWER switch off.
2. Push the breaker button.
3. Adjust the load so that the output current is 10 A or less.
4. Turn the POWER switch on.

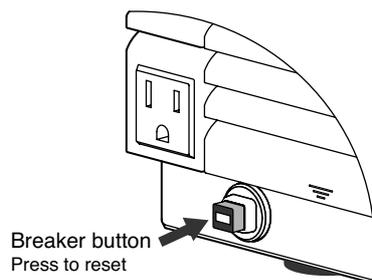


Fig.3-11 Reset the circuit breaker.

3.12 Setting the Configuration

The operating conditions are specified.

1. Press the CONFIG switch.

The configuration setting display appears.

The configuration setting switches in order each time the CONFIG switch is pressed. Press the CONFIG switch repeatedly until the operating condition you wish to set is displayed. The measured value display is shown after all configuration settings are shown.

2. Turn the rotary knob to set the condition.

3. To set other operating conditions, press the CONFIG switch. To show another setting display or the measured value display, press the V, F, or I switch.

The voltage setting display, frequency setting display, or measured value display is shown, respectively.

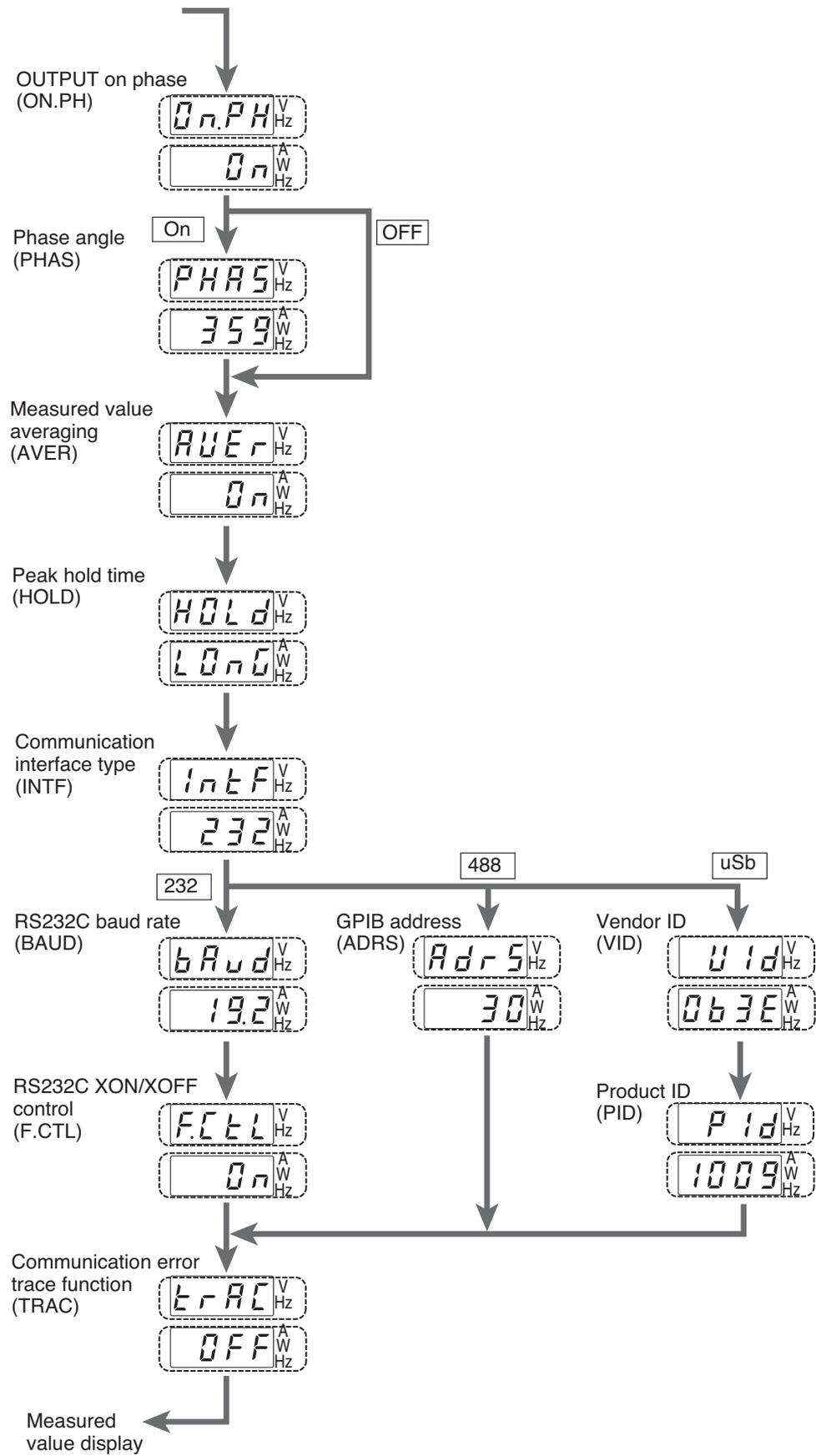


Fig.3-12 Configuration settings

OUTPUT on phase

Set the OUTPUT on phase for AC mode.

When using the OUTPUT on phase control, also set the phase angle.

- OUTPUT on phase
 - ON (ON): OUTPUT on phase control enabled
 - OFF (OFF): FREE operation (no phase control)
- Phase angle
 - 0 deg to 359 deg: Range for phase angle setting

Averaging period

You can select the averaging period of the measured values (excluding the peak current).

- Measured value averaging
 - ON (ON): Displays the moving average over approximately 3 seconds
 - OFF (OFF): Updates and displays approximately every 0.3 s

Hold time of peak current

You can change the hold time of the peak current.

- Peak hold time
 - SHORT (SHORT): Updates approximately every 0.3 s
 - LONG (LONG): Holds the peak value for approximately 5 seconds. If a greater peak value is measured while holding, the new peak value is held for approximately 5 seconds from that point.

Communication interface

The functions of the PCR-M can be expanded by installing an interface board to the option slot. However, the GPIB, RS232C, and USB interfaces cannot be used simultaneously.

- Communication interface type

To activate the settings, the POWER switch must be turned off when at least 5 seconds elapses after changing the settings and then turned back on.

- 232 (232): RS232C (standard equipped)
- 488 (488): GPIB (selectable only when the optional interface board is installed)
- USB (USB): USB (selectable only when the optional interface board is installed)

■ RS232C

If you select RS232C, set the baud rate and the XON/XOFF flow control.

To activate the settings, the POWER switch must be turned off when at least 5 seconds elapses after changing the settings and then turned back on.

- RS232C baud rate
1.2/2.4 ... 19.2: 1 200 bps, 2 400 bps, 4 800 bps, 9 600bps, or 19 200 bps
- RS232C XON/XOFF control
ON (ON): Enable XON/XOFF control
OFF (OFF): Disable XON/XOFF control

■ GPIB

If you select GPIB, select the GPIB address. The dipswitches mounted on the IB21 are not used.

- GPIB address
1 to 30: Address

■ USB

If you select USB, an ID that is required is displayed. You cannot change the settings.

- Vendor ID (0x0B3E: B 3 E) display
- Product ID display
0x1009 (1 0 0 9): PCR500M
0x100A (1 0 0 A): PCR1000M
0x100B (1 0 0 B): PCR2000M

Error display during remote control

Select whether to show or hide the error number on the lower numeric display when there is an error log in the SCPI error queue during remote control.

- Communication error trace function
ON (ON): Show the error number
OFF (OFF): Hide the error number

3.13 Factory Default Settings (Initialization)

If you turn the POWER switch on while holding down the RECALL switch, all items listed in Table 3-15 are set to factory default settings.

Table 3-15 Factory default settings

Item		PCR500M	PCR1000M	PCR2000M	
Output		Off			
Output mode		AC			
Voltage range		135 V			
Voltage	AC	0.0 V			
	DC	0.0 V			
Frequency		60.0 Hz			
Measured value display		RMS			
Limit values	AC	Voltage upper limit	275.0 V		
		Voltage lower limit	0.0 V		
		Current limit	5.25 A	10.50 A	21.00 A
		Frequency upper limit	500.0 Hz		
		Frequency lower limit	40.0 Hz		
	DC	Voltage upper limit	388.0 V		
		Voltage lower limit	0.0 V		
		Current limit	4.20 A	8.40 A	16.80 A
	Current limit operation		TRIP		
	Locking the Panel Operation		Released		
Configuration	OUTPUT on phase		OFF		
	Phase angle		0 deg		
	Measured value averaging		OFF		
	Peak hold time		SHOr (SHORT)		
	Communication interface type		232 (RS232C)		
	RS232C baud rate		19.2 (19200 bps)		
	RS232C XON/XOFF control		On		
	GPIB address		5		
	Communication error trace function		OFF		
Memory A, B, and C	Voltage	AC	0.0 V		
		DC	0.0 V		
	Frequency		60.0 Hz		
	Voltage range		135 V		
	Output mode		AC		
	Limit values AC	Voltage upper limit	275.0 V		
		Voltage lower limit	0.0 V		
		Current limit	5.25 A	10.50 A	21.00 A
		Frequency upper limit	500.0 Hz		
		Frequency lower limit	40.0 Hz		
	Limit values DC	Voltage upper limit	385.0 V		
		Voltage lower limit	0.0 V		
		Current limit	4.20 A	8.40 A	16.80 A
	Current limit operation		TRIP		



3.14 Controlling the Output Using External Analog Signals (Option)

The output can be controlled using external analog signals by installing the analog interface board to the option slot. The analog interface board cannot be used together with the GPIB interface or USB interface.

There are two available modes: EXT-AC mode in which the voltage of the output AC waveform (sine wave) is varied according to the input DC signal and EXT-DC mode in which the input waveform is simply amplified and output.

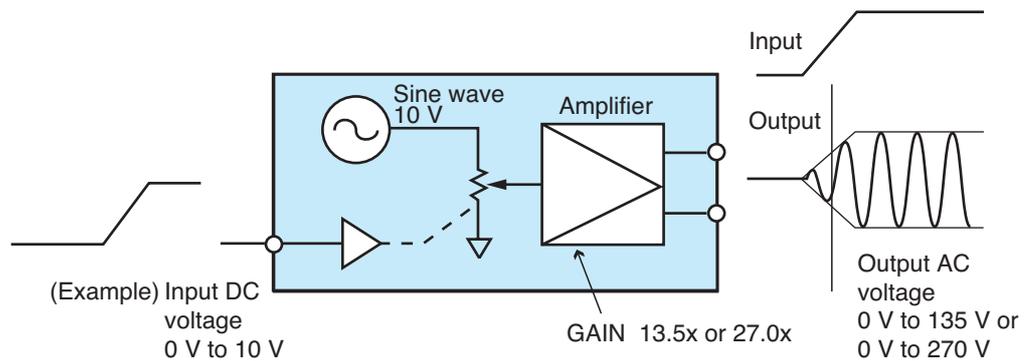


Fig.3-13 EXT-AC mode

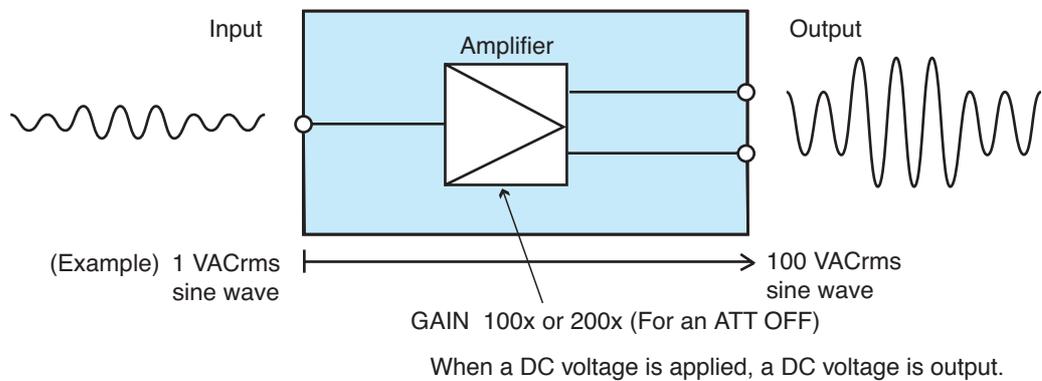


Fig.3-14 EXT-DC mode

⚠ CAUTION • You cannot set the voltage limit when the PCR-M is being controlled using external analog signals. Accidentally applying an excessive external voltage may damage the load.

Names and functions of the parts of the analog interface board

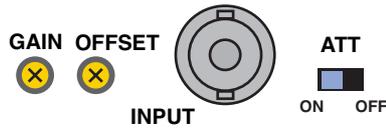


Fig.3-15 Input terminal section

Table 3-16 Names and functions

Name	Description
INPUT	BNC terminal for applying the external signal Input terminals is electrically isolated from the output terminals of the PCR-M.
ATT	Input attenuator switch
GAIN	Variable resistor for fine adjusting the gain (voltage amplification ratio)
OFFSET	Variable resistor for fine adjusting the offset

Varying the voltage of the output AC waveform using DC signals (EXT-AC mode)

The PCR-M outputs AC voltage ranging from 0 V to 135 V (when 135 V range is selected) or 0 V to 270 V (when 270 V range is selected) with respect to a DC signal input ranging from 0 V to ± 10 V.

CAUTION • You have to set the ATT switch to ON. Otherwise the load can be damaged because of PCR500M output an excessive voltage to it.

1. Check that the POWER switch is turned off.
2. Turn the ATT switch on.
The allowable input DC voltage range is -10 V to +10 V.
3. Connect an external signal (generator) to the INPUT terminal.
4. Turn the POWER switch on.
5. Press the AC/DC/EXT switch (SHIFT+V) to set the OUTPUT mode to EXT-AC.
The EXT and AC LEDs illuminate.
6. Press the RANGE switch (SHIFT+I) to set the voltage range (135 V or 270 V).
The LED corresponding to the voltage range illuminates.
AUTO cannot be selected.
7. Press the F switch to set the frequency (40 Hz to 500 Hz).
8. Apply an external signal to the INPUT terminal.
9. Turn the OUTPUT on.

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 page 3-3

 page 3-5

 page 3-10

Setting the limit value

You can set the frequency limit (40 Hz to 500 Hz), the current limit, and the current limit operation (TRIP or LIMIT CONTROL).

Table 3-17 Limit Value of EXT-DC mode

	PCR500M	PCR1000M	PCR2000M
Limit value	0.1 A to 5.25 A	0.2 A to 10.50 A	0.4 A to 21.0 A

Fine adjusting the offset

You can fine adjust the offset by turning the OFFSET variable resistor using the adjustment screwdriver. Adjust the offset so that the output voltage is minimum with the input terminal shorted.

Fine adjusting the gain

You can fine adjust the gain by turning the GAIN variable resistor using the adjustment screwdriver. Adjust the gain so that the output voltage is 135 Vac (135 V range) when 10 Vdc is applied to the input terminal.

Measured value display

 page 3-8

The lower numeric display shows RMS, PEAK, and W in order each time the I switch is pressed.

The upper numeric display shows the measured RMS voltage.

Amplifying the input waveform (EXT-DC mode)

The input waveform is simply amplified and output in this mode.

Turn ATT off

Peak value: The PCR-M outputs a voltage 100 or 200 times the voltage ranging from -1.90 V to +1.90 V.

Turn ATT on

The PCR-M outputs voltage ranging from -190 V to +190 V (when 135 V range is selected) or -380 V to +380 V (when 270 V range is selected) with respect to a signal input ranging from -10 V to +10 V.

1. Check that the POWER switch is turned off.
2. Set the ATT switch.
Off: The input voltage range is -1.90 V to +1.90 V (peak value)
On: The input voltage range is -10 V to +10 V.
3. Connect an external signal (generator) to the INPUT terminal.
4. Turn the POWER switch on.

 page 3-2

5. Press the AC/DC/EXT switch (SHIFT+V) to set the OUTPUT mode to EXT-DC.

The EXT and DC LEDs illuminate.

 page 3-3

6. Press the RANGE switch (SHIFT+I) to set the voltage range (135 V or 270 V).

The LED corresponding to the voltage range illuminates.

AUTO cannot be selected.

 page 3-5

7. If an AC voltage is being applied, press the F switch to set the frequency (40 Hz to 500 Hz).

To display the measured value accurately, set the frequency so that it matches the frequency of the external input signal. If the set frequency is out of synchronization, the measured value will be unstable.

8. Apply an external signal to the INPUT terminal.

9. Turn the OUTPUT on.

Setting limit values

 page 3-10

You can set the frequency limit (40 Hz to 500 Hz), the current limit (0.1 A to 4.2 A), and the current limit operation (TRIP or LIMIT CONTROL).

Table 3-18 Limit Value of EXT-AC mode

	PCR500M	PCR1000M	PCR2000M
Limit value	0.1 A to 4.2 A	0.2 A to 8.4 A	0.4 A to 16.8 A

Fine adjusting the offset

You can fine adjust the offset by turning the OFFSET variable resistor using the adjustment screwdriver. Adjust the offset so that the output voltage is as close to 0 V (DC) as possible with the ATT switch turned off and the input terminal shorted.

Fine adjusting the gain

You can fine adjust the gain by turning the GAIN variable resistor using the adjustment screwdriver. Adjust the gain so that the output voltage is 135 Vac (135 V range) when 1.35 Vac is applied to the input terminal with the ATT switch turned off.

Measured value display

 page 3-8

The lower numeric display shows RMS, PEAK, AVG, and W in order each time the I switch is pressed.

The upper numeric display shows the average measured voltage if AVG is selected on the lower numeric display. Otherwise, the upper numeric display shows the measured RMS voltage.





Remote Control

This chapter gives an overview of remote control and describes how to install the instrument driver and software application.

4.1 Overview

In addition to using the front panel, the PCR-M can be controlled remotely using the following interfaces.

- RS232C interface
- GPIB interface (option: IB21)
- USB interface (option: US21)

The remote interface complies with IEEE Std 488.2 1992 and SCPI Specification 1999.0.

The functionality of the PCR-M is expanded by using the remote control function.

- Peak current (held value) measurement
- Apparent power, reactive power, power factor, and crest factor measurements

The PCR-M conforms to the following standards.

- IEEE Std 488.2-1992 IEEE Standard Codes, Formats, Protocols, and Common Commands For Use With IEEE Std 488.1-1987
- IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation
- Standard Commands for Programmable Instruments (SCPI) version 1999.0
- Universal Serial Bus Specification Rev 2.0
- Universal Serial Bus Test and Measurement Class Specification (USBTMC) Rev 1.0
- Universal Serial Bus Test and Measurement Class, Subclass USB488 Specification (USBTMC-USB488) Rev 1.0

4.2 Installation

The accompanying CD-ROM contains instrument drivers that can be used with Microsoft Visual Basic, Microsoft Office VBA, Microsoft Visual C++, LabVIEW, LabWindows/CVI, and so on.

A VISA library is required to use the PCR-M IVI-COM and the software application. The VISA library (any one of NI-VISA, AgilentVISA, and KI-VISA) must be installed in the controller (Windows).

■ Contents of the accompanying CD-ROM

The driver and the software application run on Windows 98, Windows Me, Windows 2000, or Windows XP.

- Application software
Easy Controller for PCR-M
- Driver
PCR-M IVI-COM driver (includes sample programs)
IVI Shared Components
KI-VISA 3.x.x
- Documents
Communication Interface Manual (English and Japanese)

4.2.1 Installing the VISA Library

VISA (Virtual Instrument Software Architecture) is a specification for a standard software for connecting instruments that was defined by the VXIplug&play Systems Alliance.

One of the VISA libraries (driver software implemented in compliance with the VISA specifications) below is necessary.

Do not install the plural number of VISA library to the PC. It may cause possible malfunction.

Older version of VISA libraries does not support USB.

- NI-VISA by National Instruments (Ver. 3.0 or later, Ver. 3.2 or later for Windows 2000 and Windows XP)
- Agilent VISA by Agilent Technologies (Agilent IO Libraries M01.00 or later)
- KI-VISA Ver. 3.0.x or later

Installing KI-VISA

KI-VISA is Kikusui's original VISA library that supports VXIplug&play VISA Specifications 3.0. The newest version can be downloaded from Download service of Kikusui website (<http://www.kikusui.co.jp/en/download/>).

KI-VISA is not required if NI-VISA or Agilent VISA is already installed.

1. Load the accompanying CD-ROM into the CD-ROM drive.
2. Move to the VISA folder using the menu program of the CD-ROM or Explorer.
3. Double-click Kivisa_3_0_x.exe.
The value for x varies depending on the revision of the VISA library stored on the CD-ROM.
4. Proceed with the installation according to the instructions on the screen.

4.2.2 Installing the Software Application

The following programs are also installed automatically along with the software application.

- PCR-M IVI-COM driver (includes sample programs)
- IVI Shared Components

1. Load the accompanying CD-ROM into the CD-ROM drive.
2. Proceed with the installation according to the instructions on the screen.

4.3 Command Details

For command details, see the Communication Interface Manual on the accompanying CD-ROM.

The communication interface manual is in HTML format that can be viewed with a WWW (World Wide Web) browser. The HTML manual can be viewed using the following browsers.

Operating environment: Windows 98 or later

Browser: Microsoft Internet Explorer 5.5 or later

The list of messages of interface manual is provided in a PDF file. Adobe Reader 6.0 or later is required to view the file.



Maintenance

This chapter describes maintenance. Conduct periodic maintenance and calibration to maintain the initial performance as long as possible.

5.1 Cleaning

-
- ⚠ WARNING** • Possible electric shock. May lead to death or injury. Before carrying out maintenance work, be sure to turn the **POWER** switch and removing the plug of power cord from an outlet or turn off the circuit breaker of switchboard.
-

5.1.1 Cleaning the Panels

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

-
- ⚠ CAUTION** • Do not use volatile chemicals such as benzene or thinner as they may discolor the surface, erase printed characters, cloud the display, and so on.
-

5.1.2 Cleaning the Dust Filter

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

-
- ⚠ CAUTION** • Clogged dust filters hinder the cooling of the inside of the instrument and can cause a malfunction and shortening of the service life.
-

1. Remove the louver A from the panel by placing a finger on the 2nd level of the louver and pulling down the entire louver while pulling the 1st level toward you.

Pressing down the top level of the louver will ease the work.

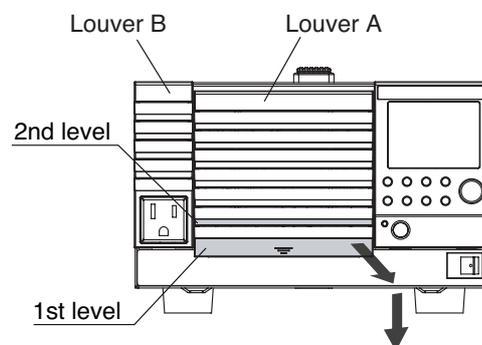


Fig.5-1 Louver A removal (Example: PCR500M)

2. Pull the lower tab of louver B while pressing it upward, slide the entire louver downward, and remove the louver from the panel.

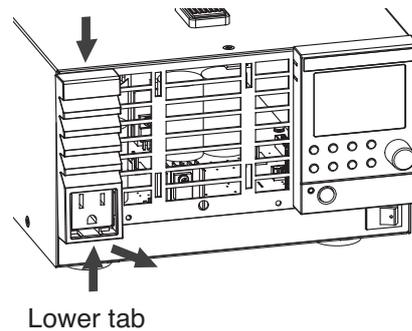


Fig.5-2 Louver B removal

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

CAUTION • When the PCR-M is in operation, air is sucked through the dust filter to cool the inside. If moisture is present in the dust filter, the temperature or humidity inside the PCR-M increases and may cause a malfunction.

4. Attach the dust filters to the louver.
Attach them so that the tab on the louver fits into the cut on the dust filter.

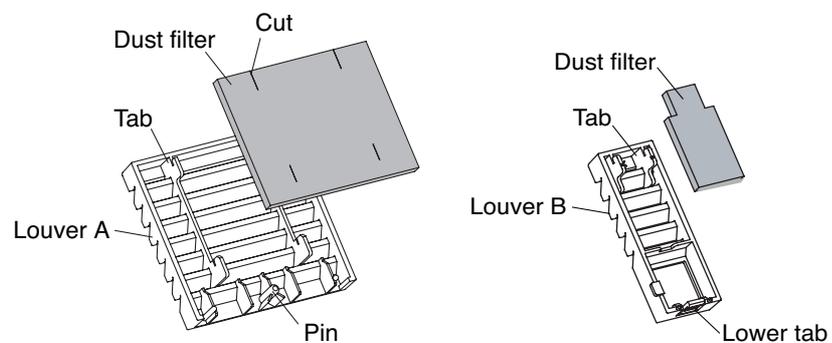


Fig.5-3 Dust filter attachment

5. Attach louver B to the panel first.

Insert the top tab of the louver into the panel, slide the louver up, and press the bottom area in to fix the louver in place.

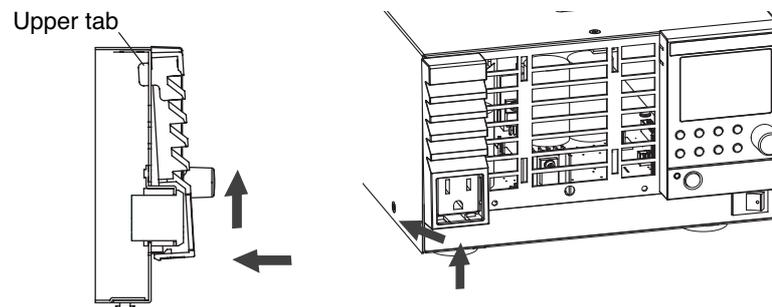


Fig.5-4 Louver B attachment

6. Attach louver A to the panel.

Slide the entire louver up while holding the 2nd level from the bottom of the louver, and fix the pins in place.

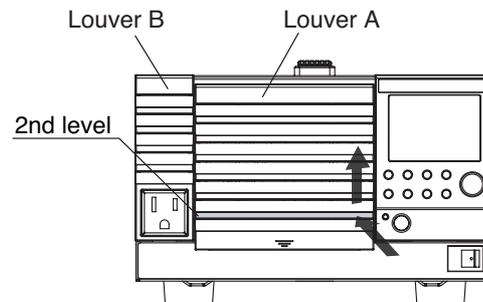


Fig.5-5 Louver A attachment

5.2 Calibration

The PCR-M is shipped after carrying out appropriate calibrations. We recommend periodic calibration to maintain the performance.

For calibration, contact your Kikusui agent or distributor.

5.3 Troubleshooting

If you suspect that the PCR-M has malfunctioned, check whether any of the items below apply to your case. In some cases, the problem can be solved quite easily.

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If you find an item that corresponds to your case, follow the remedy for the item. If you do not, we recommend that you initialize the PCR-M (memory contents are cleared). If the remedy does not correct the problem, contact your Kikusui agent or distributor.

■ The control panel display does not turn on even when the POWER switch is turned on.

Check Item	Check	Possible Cause	Remedy
Is the rated voltage being applied to the AC inlet/ INPUT terminal block?	No	<ul style="list-style-type: none"> Broken power cord Bad contact at the AC inlet of the rear panel (PCR500M) Improper connection of the power cord (PCR1000M / PCR2000M) 	Check that the power cord is not broken and that the AC inlet connection is secure.
	Yes	Malfunction	Remove the power plug from the outlet. (PCR500M) Turn off the circuit breaker of switchboard. (PCR1000M / PCR2000M) Immediately stop the use of the instrument and request repairs.

■ A alarm sounds when the POWER switch is turned on.

Check Item	Check	Possible Cause	Remedy
Is the ALARM LED illuminated or an error number displayed?	Yes	An alarm or error occurs.	Check the alarm or error type.  section 3.11, "Protection Functions and Alarm Errors."
	No	Memory error	The PCR-M has been initialized due to memory error. Memory contents have been cleared. If a alarm sounds many times, request repairs.

■ The ALARM LED illuminates.

Check Item	Check	Possible Cause	Remedy
Is an alarm/error number displayed?	Yes	An internal or external error occurred on the PCR-M.	Check the alarm type.  section 3.11, "Protection Functions and Alarm Errors."
Is the fan stopped?	Yes	The overheat protection (alarm A-04) tripped due to a fan failure.	Immediately stop the use of the instrument and request repairs.
Is the air inlet or outlet obstructed?	Yes	<ul style="list-style-type: none"> The overheat protection (alarm A-04) tripped. Clogged dust filter. 	Allow at least 20 cm between the air outlet and the wall. Do not place objects within 20 cm. Clean the dust filter.
Is the ambient temperature exceeding 40 °C?	Yes	The overheat protection (alarm A-04) tripped.	Use the PCR-M in an ambient temperature of less than or equal to 40 °C. Move equipment that generate heat at high temperatures away from the PCR-M.

If your case does not correspond to any of the items above, see section 3.11, "Protection Functions and Alarm Errors."

■ A portion or all of the control panel do not work.

Check Item	Check	Possible Cause	Remedy
Is the KEYLOCK LED illuminated?	Yes	Key lock is enabled.	Release the panel lock. See section 3.10, "Locking (Prohibiting) the Panel Operation."
Is the input voltage within the rated range?	No	Abnormal input voltage	Set the input voltage so that it is within the rated voltage range.
Is there a device generating strong noise nearby?	Yes	Erroneous operation due to noise	Move the PCR-M away from the noise source.
Is the REMOTE LED illuminated?	Yes	The PCR-M is controlled via the RS232C, GPIB, or USB interface.	This is a normal behavior. To control the PCR-M from the panel, press the LOCAL switch to enable local mode.
Are the voltage limit and frequency limit within the selectable range?	No	The limit values are not set correctly.	Set the limit values correctly. See section 3.7, "Setting the limit value."

■ The output voltage waveform is distorted.

Check Item	Check	Possible Cause	Remedy
Is OVER LOAD illuminated?	Yes	The overload protection tripped.	The PCR-M may be overloaded. Check the load.
	No	Malfunction	Immediately stop the use of the instrument and request repairs.

■ The voltage does not change even when the rotary knob is turned when the PCR-M is showing the measured value display.

Check Item	Check	Possible Cause	Remedy
Did you press the F, LIMIT, or CONFIG switch after pressing the V switch?	Yes	The rotary knob is disabled.	Press the V switch twice again. The voltage changes on the measured value display.

■ The DC output cannot be set to negative voltage.

Check Item	Check	Possible Cause	Remedy
Is the voltage lower limit set to a negative value?	No	The limit value is not set correctly.	Set the voltage lower limit to a negative value. See section 3.7, "Setting the limit value." The factory default voltage lower limit of DC mode is 0.0 V.

■ The PCR-M does not switch to local mode even when the local switch is pressed.

Check Item	Check	Possible Cause	Remedy
Was a local lockout (LLO) command sent via the communication interface?	Yes	Local switch operation disabled by local lockout (LLO).	Use a communication command to clear the local lockout (LLO) command.





Specifications

This chapter describes the electrical, mechanical, and optional interface board specifications of the PCR-M.

6.1 Specifications

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

- The warm-up time is 30 minutes (with current flowing).
- Typical value: Typical values do not guarantee the performance.
- set: Indicates the setting.
- rdng: Indicates the reading.

Electrical specifications

		PCR500M	PCR1000M	PCR2000M
Input rating				
AC input	Nominal input rating	100 V to 120 V/200 V to 240 V, 50 Hz/60 Hz, single phase		
	Input voltage range	90 V to 132 V/180 V to 250 V (auto detected when the power is turned on)		
Input frequency range		47 Hz to 63 Hz		
Apparent power		800 VA or less	1600 VA or less	3200 VA or less
Power factor *1		0.9 (typical value)		
Current (Input AC voltage 90 V to 132 V/180 V to 250 V)		9 A/4.5 A or less	18 A/9 A or less	36 A/18 A or less
Output rating for AC mode				
Voltage range (135 V/270 V range)	Rated voltage range	1 V to 135 V/2 V to 270 V		
	Preset voltage range	0 V to 137.5 V/0 to 275 V		
Voltage setting resolution		0.1 V		
Voltage setting accuracy *2		$\pm(1\% \text{ of set} + 0.6 \text{ V}/1.2 \text{ V})$		
Output phase		Single phase		
Maximum current *3		5 A/2.5 A	10 A/5 A	20 A/10 A
Maximum peak current *4		15 A/7.5 A	30 A/15 A	60 A/30 A
Load power factor		0 to 1 (leading phase or lagging phase)		
Power capacity		500 VA	1000 VA	2000 VA
Frequency setting range		40 Hz to 500 Hz		
Frequency setting resolution		0.1 Hz		
Frequency accuracy		Within $\pm 2 \times 10^{-4}$		
Output rating for DC mode				
Voltage range (135 V/270 V range)	Rated voltage range	1.4 V to 190 V/2.8 V to 380 V		
	Preset voltage range	-194 V to 194 V/-388 V to 388 V		
Voltage setting resolution		0.1 V		
Voltage setting accuracy *5		$\pm(1\% \text{ of set} + 0.6 \text{ V}/1.2 \text{ V})$		
Maximum current *6		4 A/2 A	8 A/4 A	16 A/8 A
Maximum instantaneous current *7		12 A/6 A	24 A/12 A	48 A/24 A
Power capacity		400 W	800 W	1600 W

		PCR500M	PCR1000M	PCR2000M	
Output voltage stability					
Line voltage variation	*8	Within $\pm 0.15\%$			
Output current variation (135 V/270 V range)	*9	For 40 Hz to 100 Hz: Within $\pm 0.15\text{ V}/\pm 0.3\text{ V}$ For other frequencies: Within $\pm 0.5\text{ V}/\pm 1\text{ V}$			
Output frequency variation	*10	Within $\pm 1\%$			
Ripple noise	*11	0.7 V _{rms} /1.4 V _{rms} (typical value)			
Ambient temperature variation	*12	100 ppm/°C (typical value)			
Output voltage waveform distortion ratio	*13	0.5 % or less			
Output voltage response time	*14	150 μs (typical value)			
Efficiency	*15	70 % or greater			
Measured value display *16					
Voltage measurement	Resolution	0.1 V			
	Accuracy (135 V/270 V range)	RMS, AVG *17	For 45 Hz to 65 Hz and DC: $\pm(0.5\%$ of rdng + 0.3 V/0.6 V) For all other frequencies: $\pm(0.7\%$ of rdng + 0.9 V/1.8 V)		
Current measurement	Resolution	0.01 A			
	Accuracy (135 V/270 V range)	RMS, AVG *18	For 45 Hz to 65 Hz and DC: $\pm(0.5\%$ of rdng + 0.02 A/0.01 A) For all other frequencies: $\pm(0.7\%$ of rdng + 0.04 A/0.02 A)	For 45 Hz to 65 Hz and DC: $\pm(0.5\%$ of rdng + 0.04 A/0.02 A) For all other frequencies: $\pm(0.7\%$ of rdng + 0.08 A/0.04 A)	For 45 Hz to 65 Hz and DC: $\pm(0.5\%$ of rdng + 0.08 A/0.04 A) For all other frequencies: $\pm(0.7\%$ of rdng + 0.16 A/0.08 A)
		PEAK *19	$\pm(2\%$ of rdng + 0.1 A/0.05 A) (typical value)	$\pm(2\%$ of rdng + 0.2 A/0.1 A) (typical value)	$\pm(2\%$ of rdng + 0.4 A/0.2 A) (typical value)
Power measurement	Resolution	0.1 W, 1 W (For 1000 W or more)			
	Accuracy	*20	$\pm(2\%$ of rdng + 0.5 W)	$\pm(2\%$ of rdng + 1 W)	$\pm(2\%$ of rdng + 2 W)

- *1. For an output voltage of 100 V/200 V (135 V/270 V range), maximum current, and a load power factor of 1.
- *2. For an output voltage of 13.5 V to 135 V/27 V to 270 V, an output frequency of 45 Hz to 65 Hz, no load, and 23 °C \pm 5 °C.
- *3. For an output voltage of 1 V to 100 V/2 V to 200 V.
Limited by the power capacity when the output voltage is 100 V to 135 V /200 V to 270 V.
- *4. With respect to the capacitor-input rectifying load. Limited by the maximum current.
- *5. for an output voltage of 19 V to 190 V/38 V to 380 V, no load, and 23 °C \pm 5 °C.
- *6. For an output voltage of 1.4 V to 100 V/2.8 V to 200 V.
Limited by the power capacity when the output voltage is 100 V to 190 V/200 V to 380 V.
- *7. Limited by the maximum current.
- *8. For changes in the rated range.
- *9. For an output voltage of 80 V to 135 V/160 V to 270 V, a load power factor of 1, stepwise change from an output current of 0 A to maximum current (or its reverse), using the output terminal on the rear panel.
- *10. For an output voltage of 100 V/200 V and a load power factor of 1. Output voltage variation with 55 Hz as reference.
- *11. For 5 Hz to 1 MHz components in DC mode using the output terminal on the rear panel.
- *12. For an output voltage of 100 V/200 V, an output current of 0 A, and within the operating temperature range.
- *13. At an output voltage of 50 V to 135 V/100 V to 270 V, a load power factor of 1, and in AC mode.
- *14. For an output voltage of 100 V/200 V, a load power factor of 1, with respect to stepwise change from an output current of 0 A to the maximum current (or its reverse).
- *15. For AC mode, at an output voltage of 100 V/200 V, maximum current, load power factor of 1, and an output frequency of 40 Hz to 500 Hz.
- *16. RMS, average (AVG), and power (W) are derived using the following equations.
RMS (true rms computation) = $\sqrt{\sum(\text{square of the instantaneous voltage or instantaneous current})/\text{the number of samples.}}$
AVG = (instantaneous voltage or instantaneous current)/the number of samples
WAC = $\sum(\text{instantaneous voltage} \times \text{instantaneous current})/\text{the number of samples}$
WDC = VAVG \times IAVG
• Sample period: 100 ms to 125 ms for AC output (an integer multiple of the output waveform period, 125 ms for DC output)
• Update interval: Approx. 3 times/s, averaging over 3 s when averaging is turned on
• Peak current value holds the maximum value of the absolute value of the peak current for 0.3 s or approximately 5 s.
• The voltage display is set to RMS in AC mode and AVG in DC mode.
- *17. AC mode: For an output voltage of 13.5 V to 135 V/27 V to 270 V and 23 °C \pm 5 °C.
DC mode: For an output voltage of 19 V to 190 V/38 V to 380 V and 23 °C \pm 5 °C.
- *18. For a waveform of crest factor 3 or less, an output current in the range of 5 % to 100 % of the maximum current, and 23 °C \pm 5 °C.
- *19. For a waveform of crest factor 3 or less, an output current in the range of 5 % to 100 % of the maximum peak current in AC mode, an output current in the range of 5 % to 100 % of the maximum instantaneous current in DC mode, and 23 °C \pm 5 °C.
- *20. For an output voltage of 50 V or greater, an output current in the range of 10 % to 100 % of the maximum current, DC or an output frequency of 45 Hz to 65 Hz, a load power factor of 1, and 23 °C \pm 5 °C.

General Specifications

		PCR500M	PCR1000M	PCR2000M
Insulation resistance	Between input and chassis, output and chassis, input and output	500 Vdc, 30 M Ω or more		
Withstand voltage	Between input and chassis, output and chassis, input and output	1.5 kVac for 1 minute		
Earth continuity		25 Aac, 0.1 Ω or less		
Electromagnetic Compatibility (EMC)	*1	Complies with the requirements of the following directive and standards		Complies with the requirements of the following directive and standards
	*2	EMC Directive 89/336/EEC EN 61326 EN 61000-3-2 EN 61000-3-3		
		Under following conditions The maximum length of all connecting cables and wires to the PCR-M series are less than 3 m.		
Safety	*1	Complies with the requirements of the following directive and standard		Complies with the requirements of the following directive and standard
		Low Voltage Directive 73/23/EEC EN 61010-1 Class I Pollution Degree 2		
Circuit system		PWM inverter system		
Environment	Operating environment	Indoor use, Overvoltage Category II		
	Operating temperature and humidity range	0 °C to 40 °C, 20 %rh to 80 %rh (no condensation)		
	Storage temperature and humidity range	-10 °C to 60 °C, 90 %rh or less (no condensation)		
	Altitude	Up to 2000 m		
External dimensions		See section 6.2, "Dimensions"		
Weight		Approx. 6 kg	Approx. 11 kg	Approx. 15 kg
Input terminal		Inlet	M4 terminal block	M6 terminal block
Output terminal		M4 terminal block		
Accessories	Power cord	1 pc. with plug Length: Approx. 2.5 m	1 pc. without plug, AWG12 Length: Approx. 3 m or with plug, AWG14 Length: Approx. 3 m	1 set with ferrite core without plug, AWG10 Length: Approx. 3 m
	Ferrite core	-	-	1 pc.
	Cable tie	-	-	1 pc.
	Operation manual	1 pc.		
	CD-ROM	*3	1 pc.	

*1. Not applicable to custom order models.

*2. Only on models that have CE marking on the panel. PCR2000M will not be in compliance with EMC limits unless the ferrite core is attached on the load wires.

*3. Contains the Communication Interface Manual, software application, instrument driver, and VISA library (KI-VISA)

RS232C interface specifications

		PCR-M Series
Hardware	Complies with EIA232D	
	D-SUB 9-pin connector (male) *1	
	Baud rate: 1200, 2400, 4800, 9600, or 19200 bps	
	Data length: 8 bits, stop bit: 1 bit, and parity bit: None	
	Flow control: Xon/Xoff	
Program message terminator		LF during reception, CR/LF during transmission

*1. Use a cross cable (null modem cable).

GPIB interface specifications (IB21 option)

		PCR-M Series
Hardware	Complies with IEEE Std 488.1-1978	
	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E1	
Program message terminator		LF or EOI during reception, LF+EOI during transmission
Primary address		1 to 30

USB interface specifications (US21 option)

		PCR-M Series
Hardware		Complies with USB 2.0. Data rate: 12 Mbps (full speed).
Program message terminator		LF or EOM during reception, LF+EOM during transmission
Device class		Complies with the USBTMC-USB488 device class specifications

Common interface specifications

		PCR-M Series
Software protocol		IEEE Std 488.2-1992
Command language		SCPI Specification 1999.0
Operation details	Functions expanded during remote control *1	Apparent power measurement Reactive power measurement Power factor measurement Crest factor Peak hold current measurement
	Functions expanded when an option is installed *2	AC + DC mode (The specifications of output rating such as the voltage range, maximum current, and power capacity are the same as those of the DC mode.) Panel storage memory: 10 memories *3

*1. There are no specifications for the accuracy.

*2. Activated when the GPIB, USB, or analog interface is installed and during remote control.

*3. Includes the three standard memories.

Analog interface specifications (EX04-PCR-M option)

Total performance when the EX04-PCR-M is installed in the PCR-M.

Items not listed below conform to the specifications of the PCR-M.

		PCR-M series	
Input terminal	Maximum allowable input voltage	±15 V	
	Type	BNC	
	Input impedance	10 kΩ ± 5 % (unbalanced)	
	Isolation voltage	±100 Vmax	
EXT-AC mode *1	Input voltage range	0 V to ±10 V (DC)	
	Voltage amplification ratio (135 V/270 V range)	13.5x/27x (Outputs an AC voltage of 0 V to 135 V/0 V to 270 V with respect to a DC voltage input of 0 V to 10 V)	
	Frequency setting range	40 Hz to 500 Hz	
	Other output rating specifications	Same as the specifications of the output rating for AC mode	
EXT-DC mode	Input voltage range	When ATT is OFF	0 V to ±1.90 Vpeak (0 V to 1.35 Vrms sine wave)
		When ATT is ON	0 V to ±10 V (DC)
	Input frequency range	When ATT is OFF	40 Hz to 500 Hz (Sine wave) /40 Hz to 100 Hz (Rectangular wave) /DC
		*2	
	Frequency characteristics	When ATT is OFF	-0.3 dB at 500 Hz with respect to 55 Hz (typical value)
	Voltage amplification ratio (135 V/270 V range)	When ATT is OFF	100x/200x (Outputs an AC voltage of 0 V to 135 V/0 V to 270 V with respect to an AC voltage input of 0 V to 1.35 V)
When ATT is ON		19x/38x (Outputs a DC voltage of 0 V to ±190 V/0 V to ±380 V with respect to a DC voltage input of 0 V to ±10 V)	
Other output rating specifications		Same as the specifications of the output rating for DC mode	
Output voltage distortion ratio		*3	PCR-M specifications + 0.5 % or less
Output voltage temperature coefficient		PCR-M specifications + 200 ppm/°C (typical value)	
Insulation resistance	Between input (BNC) and chassis, input (BNC) and output	500 Vdc, 30 MΩ or more	
Withstand voltage	Between input (BNC) and chassis, input (BNC) and output	500 Vac for 1 minute	

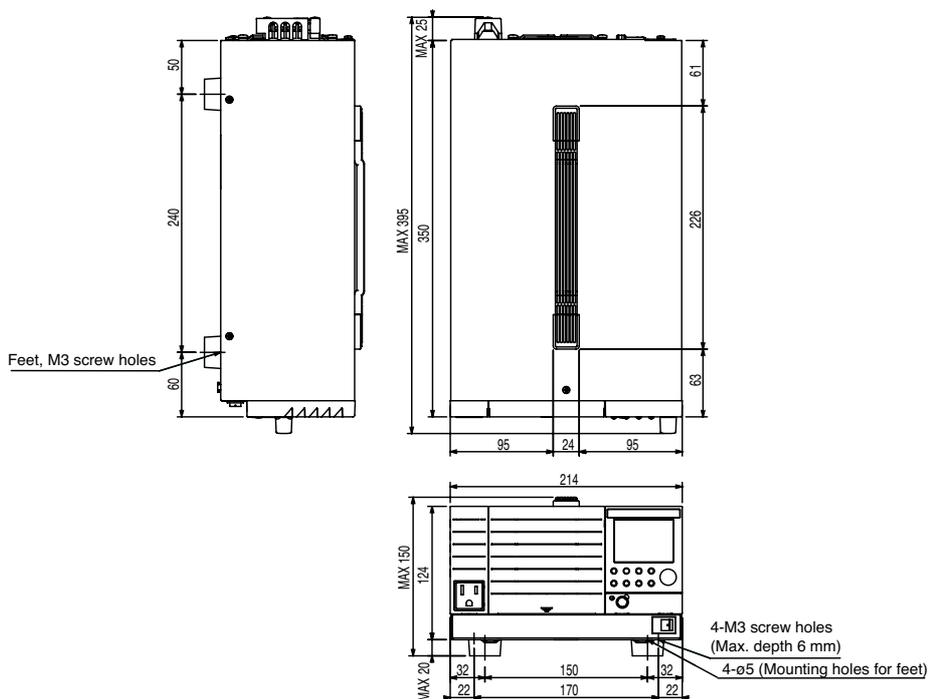
*1. ATT ON at all times

*2. The measurable range of voltage, current, and power is DC and 40 Hz to 500 Hz.
Set the frequency according to the input waveform period.

*3. When DC voltage is applied for EXT-AC mode or when a sine wave with distortion ratio of 0.1 % or less is applied for EXT-DC mode.

6.2 Dimensions

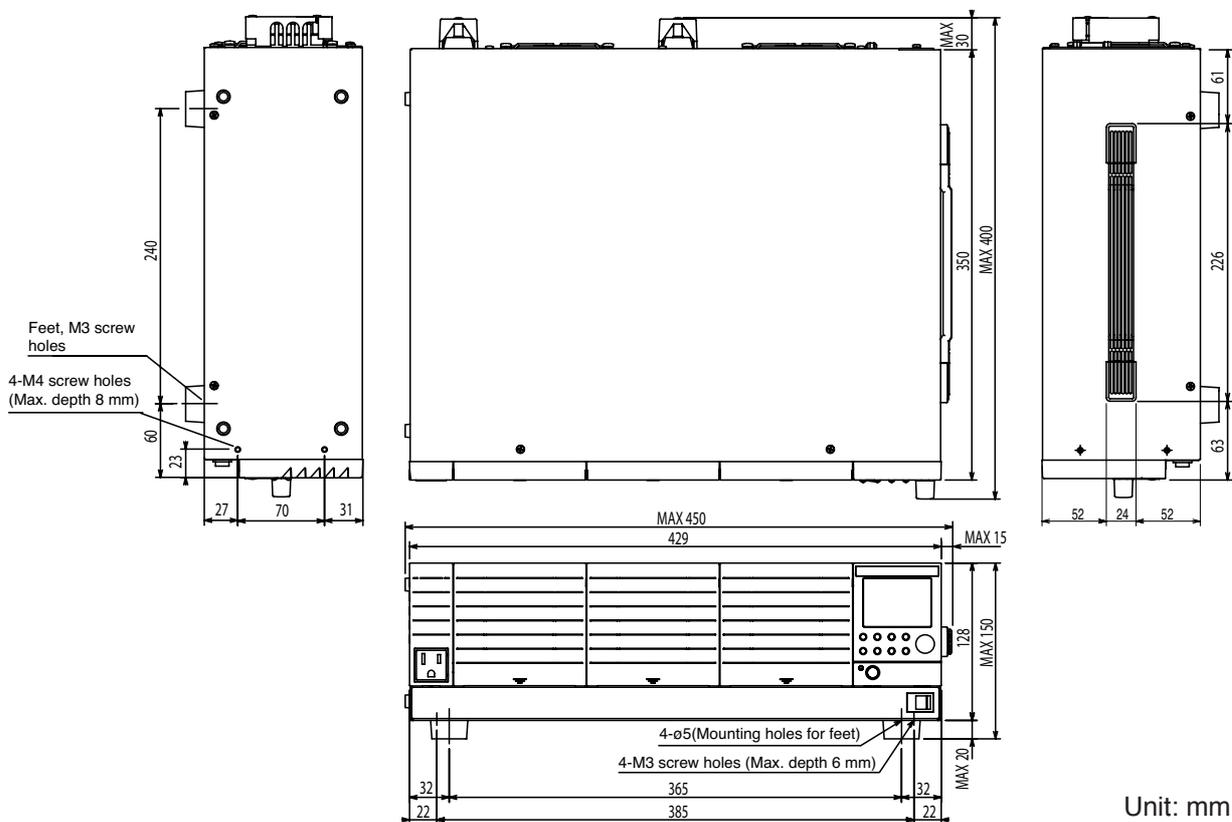
PCR500M



Unit: mm

Fig.6-1 PCR500M outline drawing

PCR1000M



Unit: mm

Fig.6-2 PCR1000M outline drawing

PCR2000M

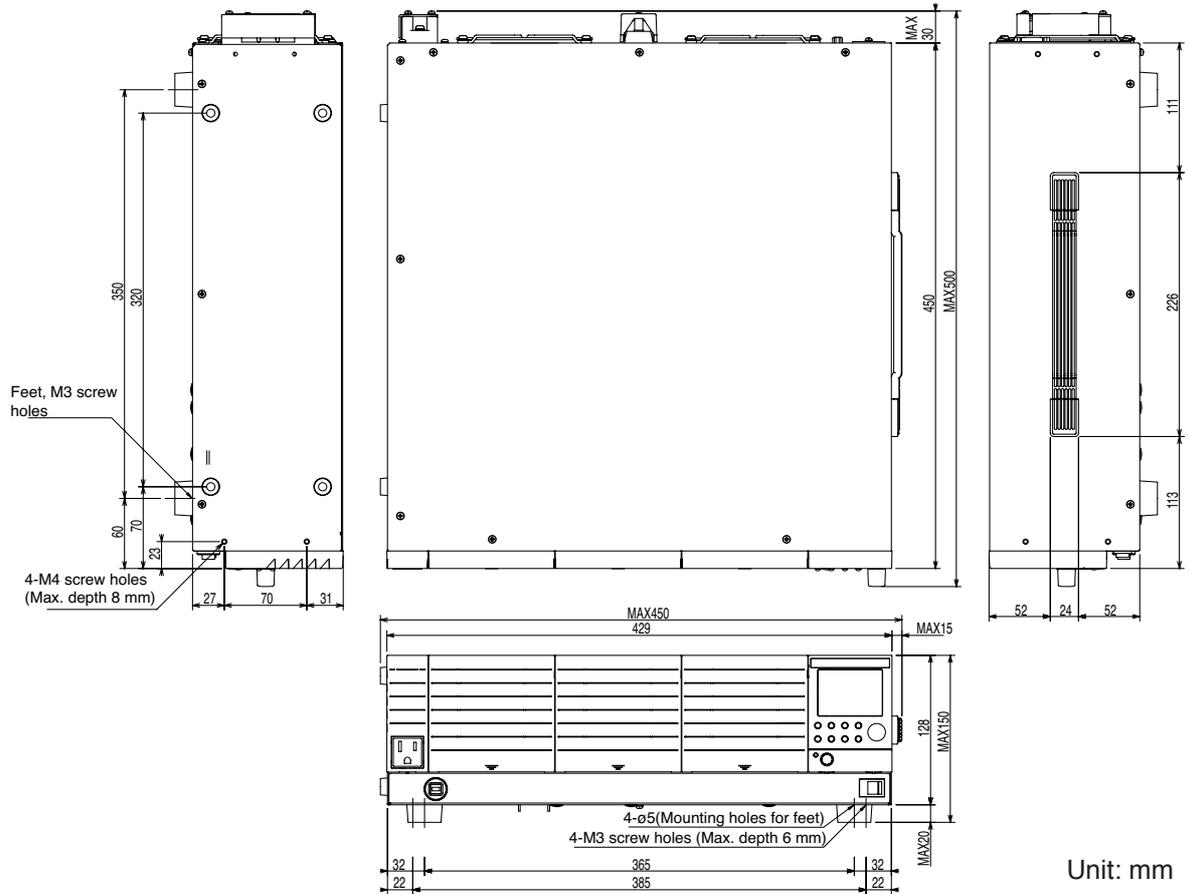
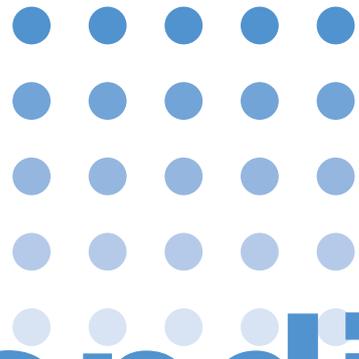


Fig.6-3 PCR2000M outline drawing





Appendix

A.1 Output and Load

Rated output current of AC mode

For linear loads

The rated AC output current of the PCR-M is limited by the PCR-M output capacity as shown in the graph of Fig. A-1.

Table A-1 Output capacity of AC mode

	PCR500M	PCR1000M	PCR2000M
Output capacity	500 VA	1 000 VA	2 000 VA

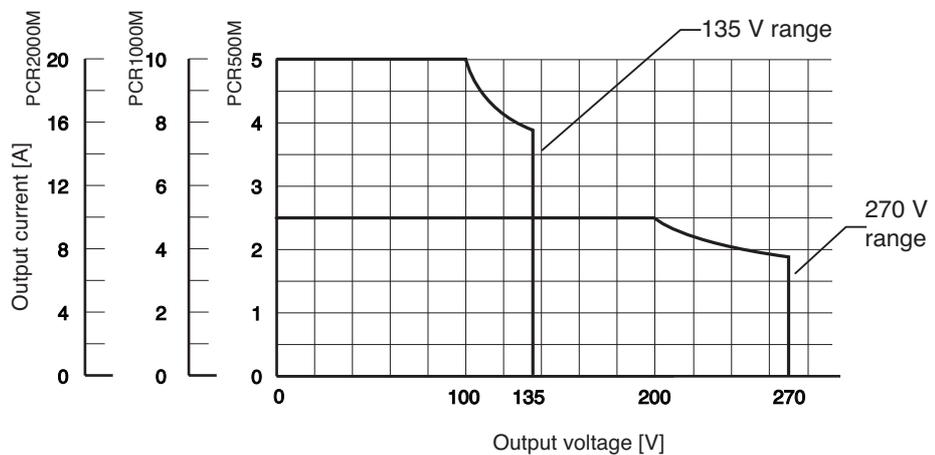


Fig.A-1 Output voltage vs. rated output current (AC mode)

For capacitor-input rectifying loads

In general, a peak current several times the output current rms flows near the peak output voltage as the output current (Fig. A-2).

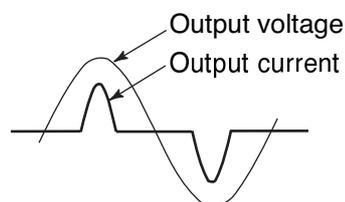


Fig.A-2 Output current waveform

In this case, the maximum output peak current must not exceed three times the rated maximum current.

- 135 V range: Maximum peak current = (Rated output capacity/100 V)×3
- 270 V range: Maximum peak current = (Rated output capacity/200 V)×3

If the PCR-M is used with a current exceeding the maximum rated peak current or the maximum current, the protection function of the PCR-M activates and may extremely distort the output voltage waveform or cut off the output.

To supply the maximum peak current above, hold the output voltage (setting) constant. If you suddenly change (increase) the output voltage setting, the output or current waveform may be distorted.

For loads that draw an inrush current

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

■ Transformers and slide transformers

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

■ Motor and lamp loads

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

■ For capacitor-input rectifying loads

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

The PCR-M is capable of feeding a maximum output peak current up to three times the rated maximum rms current to a capacitor input-type rectifying load.

If an inrush current exceeding the peak current flows, the protection function of the PCR-M activates and distort the output voltage waveform or cut off the output.

For loads that generate surges

Loads (such as a fluorescent lamp) that generate surges when voltage is applied or when the voltage changes suddenly may cause the PCR-M to malfunction. For these types of loads, install a noise filter in the load end.

For special loads

A current of 100 kHz to 150 kHz caused by the OUTPUT ripple voltage of a PWM inverter method flows to a capacitor when the capacitor is directly connected to the INPUT terminal of a load.

Rated output current of DC mode

The rated DC output current that can be drawn from the PCR-M is limited by the PCR-M output capacity as shown in the graph of Fig. A-3.

Table A-2 Output capacity of DC mode

	PCR500M	PCR1000M	PCR2000M
Output capacity	400 W	800 W	1 600 W

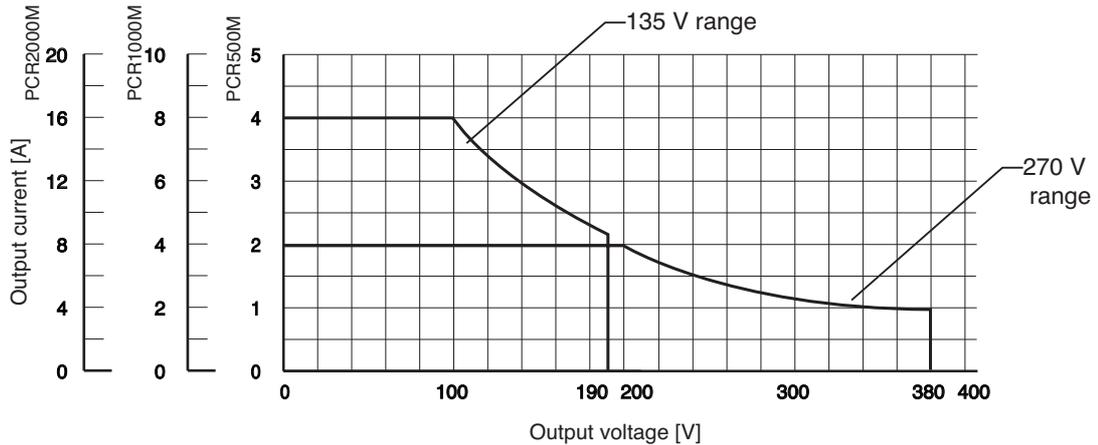


Fig.A-3 Output voltage vs. rated output current (DC mode)

If the PCR-M is used with a current exceeding the rated DC output current, the protection function of the PCR-M activates and may cause the output voltage to drop or to be cut off.

A.2 Overload Protection Functions

Current limiting function

This function is activated if the PCR-M's output current exceeds the current limit value (maximum setting: 1.05 times the rated maximum current). If the current limiting function is activated, OVER LOAD illuminates, and the output voltage gradually drops. If this condition lasts approximately 3 seconds, the output is automatically turned off.

Peak current and power monitor functions

This function is activated if the PCR-M's peak current exceeds three times the rated maximum current. If a current exceeding three times the rated maximum current flows through the load, OVER LOAD illuminates, and the output voltage drops or the waveform is distorted. If this condition lasts approximately 10 seconds, the output is automatically turned off.

Causes of and remedies for overload status

If the overload protection function is activated, take the remedies below. Then, wait at least 1 minute before resuming operations.

When the cause of the overload is eliminated, the protection function is automatically deactivated.

■ For linear loads

Overload Condition		Remedy
Gradual output current increase	<ul style="list-style-type: none"> If the voltage drops as shown in Fig. A-4 (a), the current limiting function is activated. If the output voltage waveform is distorted as shown in Fig. A-4 (b-1) or (b-2), the internal protection function is activated. 	<ul style="list-style-type: none"> If the current limit value is set low, change the setting. If the rated maximum current is exceeded, reduce the load.
Sudden output current increase	<ul style="list-style-type: none"> If the output voltage waveform is distorted as shown in Fig. A-4 (b-1), (b-2), or (c), the internal protection function is activated. 	

■ For capacitor-input rectifying loads

Overload Condition		Remedy
Output current increase	<ul style="list-style-type: none"> If the voltage drops as shown in Fig. A-4 (a), the current limiting function is activated. 	<ul style="list-style-type: none"> If the current limit value is set, change the setting. If the rated maximum current is exceeded, reduce the load.
	<ul style="list-style-type: none"> If the voltage waveform is distorted as shown in Fig. A-4 (c), the internal protection function is activated due to the output peak current. 	<ul style="list-style-type: none"> Reduce the peak current.

■ For loads that draw an inrush current

Overload Condition		Remedy
When voltage is applied to the load or when the voltage suddenly changes	<ul style="list-style-type: none"> If the voltage waveform is distorted as shown in Fig. A-4 (c), the internal protection function is activated due to the inrush current. 	<ul style="list-style-type: none"> Reduce the inrush current.

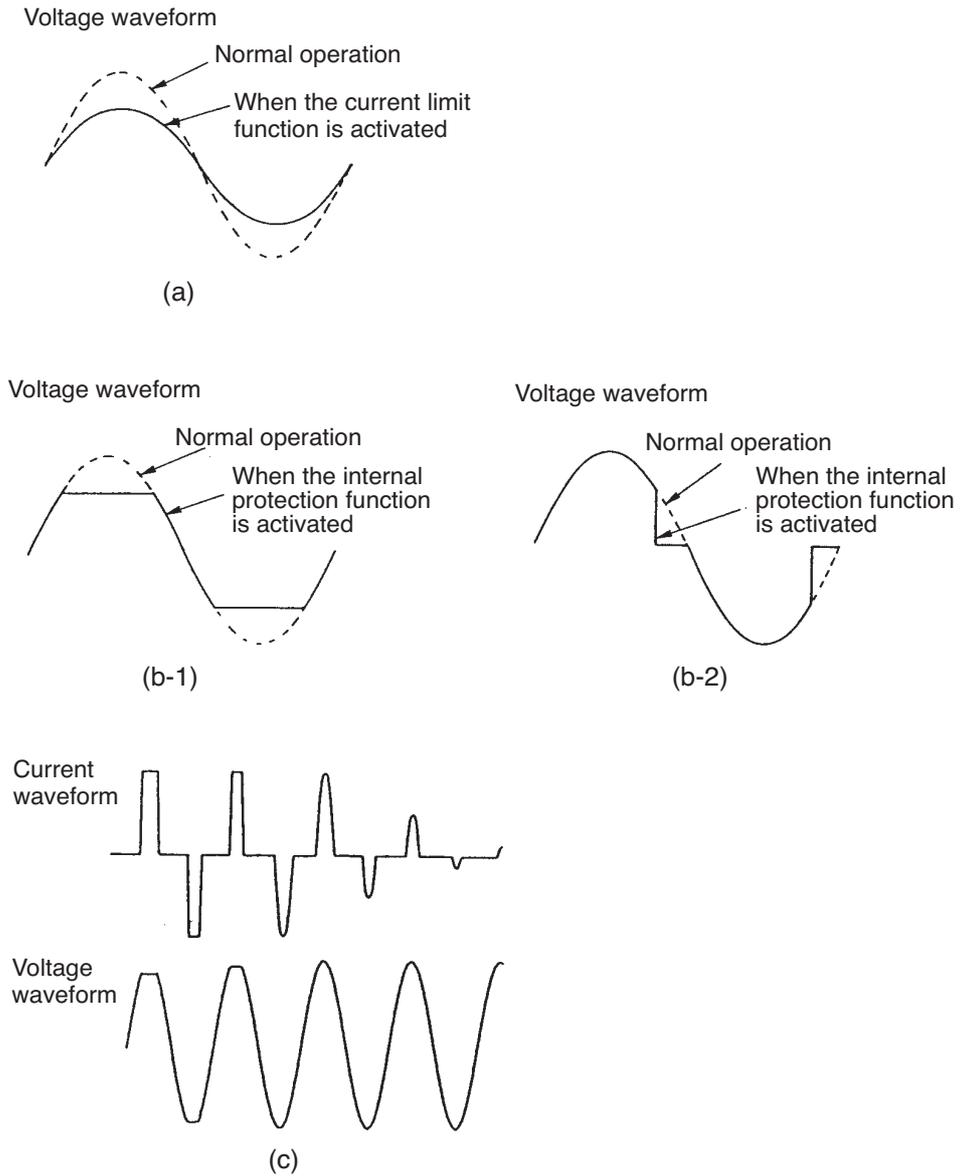


Fig.A-4 Overload condition

A.3 AC+DC mode

AC+DC mode is a function used to superimpose DC voltage on AC voltage or AC voltage on DC voltage. It can be used via the RS232C, GPIB, or USB interface. For details on the commands, see the Communication Interface Manual.

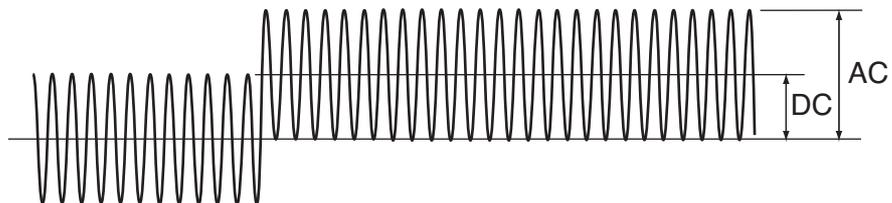


Fig.A-5 Waveform example

A.4 Glossary

Rated output (power) capacity or power capacity

The maximum value (unit: VA) of the output power capacity that can be continuously supplied when the output voltage is 100 V to 135 V (for the 135 V range) or 200 V to 270 V (for the 270 V range) and the output frequency is 40 Hz to 500 Hz in AC mode or when the output voltage is 100 V to 190 V (for the 135 V range) or 200 V to 380 V (for the 270 V range) in DC mode.

Table A-3 Power capacity

	PCR500M	PCR1000M	PCR2000M
Power capacity	500 VA	1000 VA	2000 VA

The power capacity in DC mode is 80 % of that of AC mode.

Rated maximum current

The maximum value (unit: A) of the output current (rms value) that can be continuously supplied when the output voltage is 100 V (for the 135 V range) or 200 V (for the 270 V range) and the output frequency is 40 Hz to 500 Hz in AC mode or when the output voltage is 100 V (for the 135 V range) or 200 V (for the 270 V range) in DC mode.

The maximum current in DC mode is 80 % of that of AC mode.

$$\text{Rated maximum current} = \frac{\text{Rated output (power) capacity [VA, W]}}{\text{Output voltage 100 V or 200 V}}$$

Rated output current

■ For AC mode

The maximum continuous value of the output current (rms value) that has been reduced by the output voltage.

■ For DC mode

The maximum continuous value of the output current (unit: A) that has been reduced by the output voltage.

Maximum peak current (AC mode only)

The maximum continuous value (unit: A_{peak}) of the output current (peak value) that the PCR-M can supply to a capacitor input-type rectifying load when the output voltage is 100 V to 135 V (for the 135 V range) or 200 V to 270 V (for the 270 V range) and the output frequency is 40 Hz to 500 Hz.

$$\text{Maximum peak current} = \text{Rated maximum current (rms value)} \times 3$$

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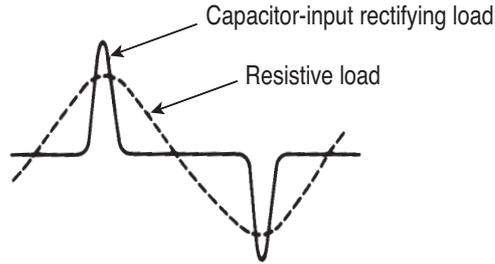


Fig.A-6 Output current waveform example

Output voltage waveform distortion ratio

The total harmonic distortion factor (%) of the output voltage waveform when the output voltage is 50 V to 135 V (for the 135 V range) or 100 V to 270 V (for the 270 V range) and the load power factor is 1.

Output voltage response time

The time (unit: μs) for the output voltage change to exceed 10 % of the overall change and return within 10 % of the overall change, when the output current percentage is changed from 0 % to 100 % given that the output voltage is 100 V (for the 135 V range) or 200 V (for the 270 V range) and the load power factor is 1 (in the AC mode).

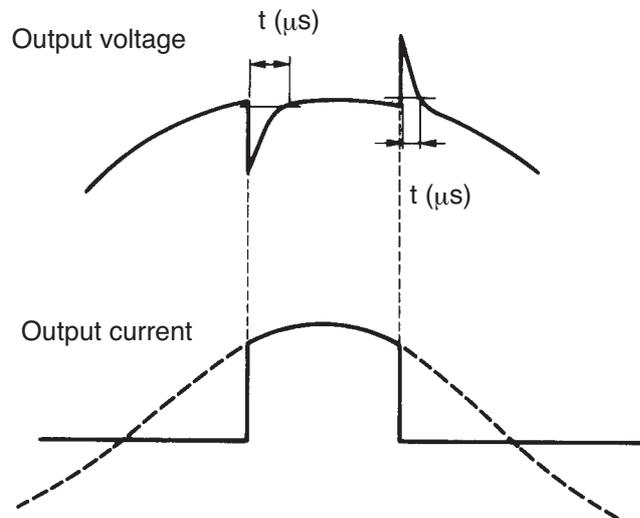


Fig.A-7 Output voltage response time

Power factor (PF)

The power factor is the ratio of the active power with respect to the apparent power. It indicates the level of degradation in the efficiency caused by the phase difference between the AC voltage and AC current.

$$\text{Power factor} = \frac{\text{Active power}}{\text{Apparent power}}$$

Form factor

The form factor is the ratio of the rms value with respect to the average value.

$$\text{Form factor} = \frac{\text{Rms value}}{\text{Average value}}$$

Crest factor (CF)

The crest factor is the ratio of the rms value with respect to the peak value (crest value) of the waveform.

$$\text{Crest factor} = \frac{\text{Peak value}}{\text{Rms value}}$$

The crest factor is 1.41 for sine waves.

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 PCR-M. It is a switching-controlled active filter. The use of the filter improves the power factor (0.9 (typical value)).

Capacitor input-type rectifying (circuit) load

A load that is equipped with a rectifying circuit shown in Fig. A-8 (b). This type of load draws current as shown in Fig. A-8 (a).

The input current peak value is generally approximately two to three 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.).

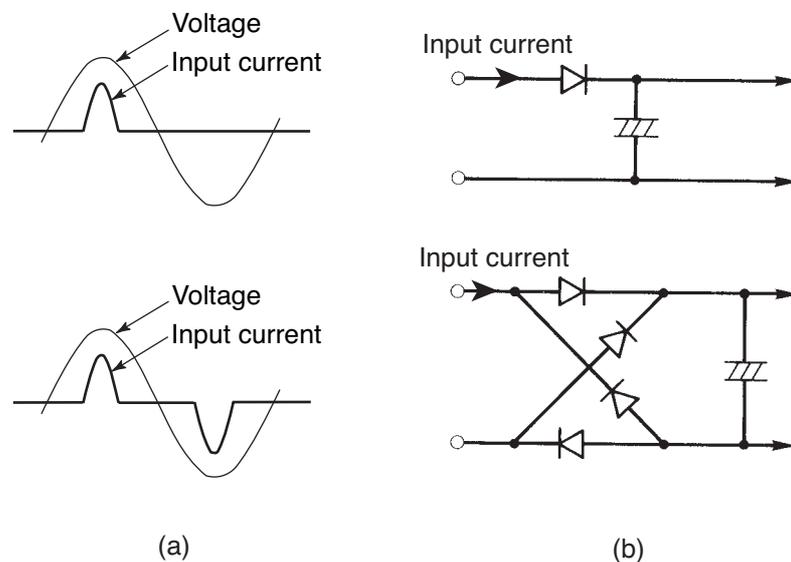


Fig.A-8 Capacitor input-type rectifying (circuit) load

■ Examples of major capacitor input-type rectifying loads

Household electric appliances

TV sets, video equipment such as VCRs, audio equipment, microwave ovens, inverter air conditioners, and inverter lighting equipment

Office automation equipment

PCs, facsimiles, CAD systems, etc.

Others

Mainframe computers, factory automation equipment, communication equipment, and other devices and equipment equipped with a switching power supply

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