OPERATION MANUAL

PARALLEL
OPERATION DRIVER

PD02M-PCR-L

PD02S-PCR-L

KIKUSUI

Part No. Z1-000-422, IA002172

The specifications of this product and the contents of this Operation Manual are subject to change without prior notice.

Printed in Japan

This manual applies to the PD02M-PCR-L or PD02S-PCR-L Parallel Operation Driver connected to a PCR-L AC Power Supply with ROM version 2.00 or higher. When you inquire about the product, be prepared to provide us with the following information:

- PCR-L AC Power Supply model number
- PCR-L AC Power Supply ROM version
- PCR-L AC Power Supply serial number and revision number (indicated on the lower rear part of the equipment)
- Parallel Operation Driver model number
- Parallel Operation Driver serial number and revision number

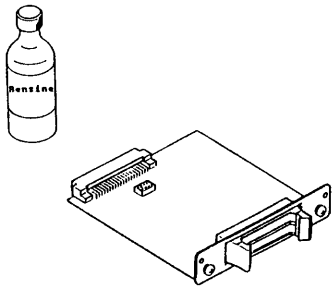
* Before using this Parallel Operation Driver, be sure to read the PCR-L AC Power Supply Operation Manual.

  This device is a dedicated option for the PCR-L Series. It cannot be used for any other equipment.

  A PCR-L AC Power Supply with ROM version below 2.00 requires partial modification.

FOR SAFETY USE

Always observe the following warnings and precautions when handling or using the Parallel Operation Driver.



○ Take proper precautions against explosion or fire.

- **Do not use the device in an explosive atmosphere or near flammable substances.**

○ Do not use substitute components or otherwise modify the device.

- **The device uses no parts that can be replaced by the customer.**

○ Ensure safety first in the events of a problem.

- **If the device is damaged or becomes defective, immediately disconnect the PCR-L AC Power Supply input plug from the electrical outlet or cut off power from the power distribution board.**
- **Take appropriate measures to ensure that the device will not be used by mistake until repair has been completed.**

Warning and Precaution Symbols Indicated on the Parallel Operation Driver and in the Operation Manual

The following symbols are indicated where special caution is required in handling the device.

Parallel Operation Driver	Operation manual	Description
	WARNING	Indicates the existence of a personnel hazard. • Never fail to follow the applicable operating procedure. Incorrect operating procedures may result in personal (bodily) injury. • Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.
	Caution	Indicates the existence of a hazard. • Always follow the applicable operating procedure. Incorrect operating procedures may damage the device or other equipment. • Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.
		Operation manual reference symbol • If this mark is indicated on the device, see the relevant section of this Operation Manual.

CONFIGURATION OF THE OPERATION MANUAL

This operation manual is structured as follows:

Chapter 1 GENERAL	Describe the basics of the Parallel Operation Driver use. Be sure to read this information.
Chapter 2 PREPARATION	
Chapter 3 CABLE CONNECTION	
Chapter 4 OPERATION CHECK	
Chapter 5 OPERATION METHOD	Describes the basic operating procedures.
Chapter 6 PART NAMES	Shows the part names and describes their functions in detail.
Chapter 7 MAINTENANCE	Describes how to handle the Parallel Operation Driver in the event of a problem. Always read this chapter before requesting a repair.
Chapter 8 SPECIFICATIONS	
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Chapter 1

GENERAL

Describes the Parallel Operation Driver overview and features.

Contents

1.1 Outline

This device (PD02M-PCR-L and PD02S-PCR-L) is an option for one-control parallel operation for the PCR-L Series AC Power Supplies. Connecting outputs of two to three PCR-L Series AC Power Supplies in parallel and installing the Parallel Operation Driver in these power supplies allows the equipment to be used as single-phase large-capacity power supplies. The number of Parallel Operation Drivers (models) required changes as listed below depending on the number of PCR-L Series AC Power Supplies connected and operated in parallel.

The PD02M-PCR-L is used in the master equipment and the PD02S-PCR-L in slave equipment.

Number of PCR-L AC Power Supplies in parallel operation	Number of PD02M-PCR-Ls	Number of PD02S-PCR-Ls
2	1	1
3	1	2

1.2 Features

a) Provision of large-capacity AC power supplies with multiple functions and high-quality output

- AC power supplies of single-phase 18 kVA maximum output is available.
- Output capacity = Output capacity of a single PCR-L AC Power Supply × number of PCR-L AC Power Supplies
- A maximum of three same models of PCR2000Ls, PCR4000Ls, or PCR6000Ls can be connected and operated in parallel.

b) Future or temporary output capacity expansion

Extension of the output capacity is available in which a PCR-L AC Power Supply is used as a small-capacity unit and is later enhanced to large-capacity equipment. If large capacity is temporarily required for tests or other purposes when PCR-L AC Power Supplies are generally used as individual small-capacity units, use of the Parallel Operation Drivers allows integration of such PCR-L AC Power Supplies for extension of output capacity. This offers economical equipment investment.

Chapter 2

PREPARATION

Describes the preparation required for using the Parallel Operation Driver.

Contents

2.1 Check at Unpacking

The PD02M-PCR-L and PD02S-PCR-L Parallel Operation Driver was carefully tested and inspected, both mechanically and electrically, before shipment to ensure its normal operation. Check the Parallel Operation Driver upon receipt for damage that might have occurred during transportation. Also, check if all items listed in the tables below have been provided. If the device appears to be damaged or if any accessory missing, notify your Kikusui agent.

Items to be checked at unpacking

■ PD02M-PCR-L

Items	Q'ty	Check
Master card	1	
Mounting screws (M3)	2	
Operation Manual	1	

■ PD02S-PCR-L

Items	Q'ty	Check
Slave card	1	
Drive signal cable	1	
Power signal cable (for PCR2000L)	1	
Power signal cable (for PCR4000L or PCR6000L)	1	
Mounting screws (M3)	2	
Operation Manual	1	

2.2 Parallel Operation Driver Handling Precautions

The PD02M-PCR-L consists of the master card to be installed in a mater PCR-L AC Power Supply and the PD02S-PCR-L is composed of the slave card to be installed in a slave PCR-L AC Power Supply, and drive signal and power signal cables used to connect the master and slave equipment. Observe the following handling precautions for these items.

(1) Handling of the master and slave cards

Always observe the following cautions when handling each card since its PCB is exposed.

Caution

- *Never touch any of electronics parts installed on the PCB.*
- *Never handle a card under the conditions where static electricity might accumulate.*
- *After unpacking the Parallel Operation Driver carton, install each card in a PCR-L AC Power Supply promptly.*
- *When storing these cards, always take measures to prevent static electricity such as storing them in the bags used for the packing.*
- *Do not drop a card or subject it to other impact.*
- *Do not place a card where it could be exposed to water and other liquid.*

(2) Handling of drive signal and power signal cables

Caution

- *Do not damage the cables.*
- *Do not pull, bend, or apply any other stress on the cables.*

2.3 Combination with Other Options

The PCR-L Series has various options in addition to the Parallel Operation Driver. Note that the following options can be used only in the PCR-L Series AC Power Supply where the master card has been installed.

Option name	Model number
Remote Controller	RC02-PCR-L
GP-IB Interface	IB11-PCR-L
RS-232C Interface	RS11-PCR-L
3-Phase Driver	3P02-PCR-L

Chapter 3

CABLE CONNECTION

Describes the installation of the Parallel Operation Driver in PCR-L Series AC Power Supplies and the connection of the AC power supplies.

Contents

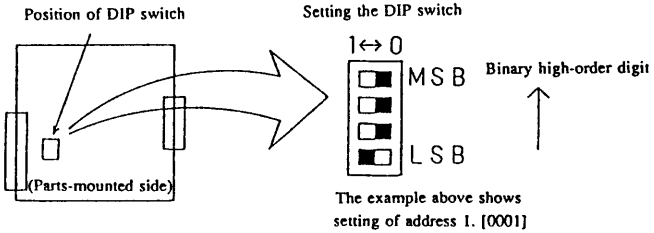
3.1 Parallel Operation Driver Installation Method

The Parallel Operation Driver can be installed by inserting each card into SLOT4 or SLOT5 of PCR-L AC Power Supplies.

The PCR-L AC Power Supply with the master card plays a role of the master equipment that controls one-control parallel operation. It is recommended that the PCR-L AC Power Supply with the master card be installed where it can be easily accessible for operation.

3.1.1 Setting Parallel Operation Addresses

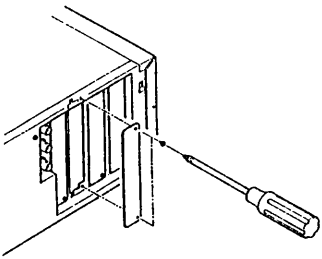
The Parallel Operation Driver cards have a DIP switch (on PCB) used to set parallel operation addresses. Set the addresses as specified below in accordance with the number of PCR-L AC Power Supplies operated in parallel.



Number of equipment in parallel operation	PD02M-PCR-L address	PD02S-PCR-L address	
	Master	Slave 1	Slave 2
2	0 [0000]	0 [0000]	-
3	1 [0001]	0 [0000]	1 [0001]

Slaves 1 to 2 are not related to the arrangement of slave AC power supplies. It is acceptable as long as a different address has been set to each slave AC power supply (with PD02S-PCR-L). Figures in a square blanket show DIP switch setting (binary).

3.1.2 Installing Cards into a Slot

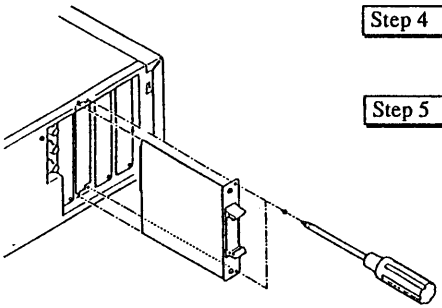


Caution *Before installing the master or slave card into a slot, always turn OFF the PCR-L AC Power Supply POWER switch.*

Step 1 Unscrew the screws that fasten the SLOT4 or SLOT5 cover to remove the slot cover. (Keep the removed cover so that it is not lost.)

Step 2 Hold the panel part of a card.

Step 3 Orient the card so that the parts-mounted side of the PCB is at the right, and place the PCB into the slot grooves.



Step 4 Carefully insert the card into the slot so that the PCB does not come out of the grooves.

Step 5 Insert the card all the way, then fix the card to the PCR-L AC Power Supply using the screws provided. This completes installation of a card. Install the other card (or cards) in the same way.

3.1.3 Connecting Drive Signal Cable(s)

(Caution) *Before connecting a drive signal cable, always turn OFF the PCR-L AC Power Supply POWER switches.*

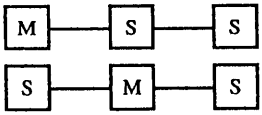
Step 1 Arrange PCR-L AC Power Supplies as near as possible. A PCR-L Power Supply with the master card operates as the master equipment that controls one-control parallel operation. It is recommended that the PCR-L AC Power Supply with the master card be installed where it can be easily accessible for operation.

Step 2 Using drive signal cables, connect the master card to a slave card and the slave card to a slave card in accordance with steps 3 and onward.

This requires no connection order between the cards.

Equipment arrangement example (M stands for the master equipment and S slave equipment.):

Three PCR-L AC power supplies in parallel operation



(M may be on the right side.)

Step 3 Open the clicks of the J1 connector of each card, orient a connector of a drive signal cable, and insert it to the J1 connector. The J1 connector has two connection ports and either connection operates the same. Two drive signal cables are connected to the J1 connector of a card in any PCR-L AC Power Supply located at a place other than both ends. Thus, both connection ports of the J1 connector are used.

Step 4 Close the J1 connector clicks to lock the connectors. This completes the connection of the drive signal cables.

3.1.4 Moving Precautions

(Caution) *Moving a PCR-L AC Power Supply with a drive signal cable connected to the Parallel Operation Driver may place unreasonable stress on the drive signal cable and connectors. This may damage the Parallel Operation Driver. Before moving a PCR-L AC Power Supply, always disconnect the drive signal cables.*

3.2 PCR-L AC Power Supply Connection Method

This section describes how to connect PCR-L AC Power Supplies mutually. For the input and output connection method, always read Chapter 3, CONNECTING THE INPUT POWER, and Chapter 5, CONNECTING A LOAD, of the PCR-L Series AC Power Supply Operation Manual.

(WARNING) *Always cut off power feed from the power distribution board before carrying out this connection.*

3.2.1 Connecting Power Signal Cable(s) and Cables between OUTPUT Terminal Boards

One-control parallel operation of PCR-L Series AC Power Supplies requires connection of power signal cable(s) and OUTPUT terminal-to-OUTPUT terminal connection. The following describes their connections.

Step 1 Using a power signal cable provided, connect the J1 or J2 terminal in the terminal box at the lower part of an PCR-L AC Power Supply to that of another PCR-L AC Power Supply firmly.

(Caution) *Never attempt to use any cable other than those provided for the Parallel Operation Driver since such step may cause problems. Also, connect a power signal cable firmly. Otherwise, output may become abnormal, which possibly damages a load or causes problems in a PCR-L AC Power Supply.*

For connection between PCR2000Ls, use the power signal cable with a connector at both ends. Insert a connector into the J1 or J2 connectors securely until the lock applies. For PCR4000L-to-PCR4000L or PCR6000L-to-PCR6000L connection, use the power cable with a crimp terminal at both ends. Connect a crimp terminal to the J1 or J2 terminals of PCR-L AC Power Supplies firmly. (PCR4000L and PCR6000L use the same cable.) Either the J1 or J2 connector can be used, but it is recommended that the one that allows a nearer distance for PCR-L AC Power Supply arrangement be used.

Step 2 Taking care of polarity, connect the L and N terminals of the OUTPUT terminal board of a PCR-L AC Power Supply to those of another PCR-L AC Power Supply.

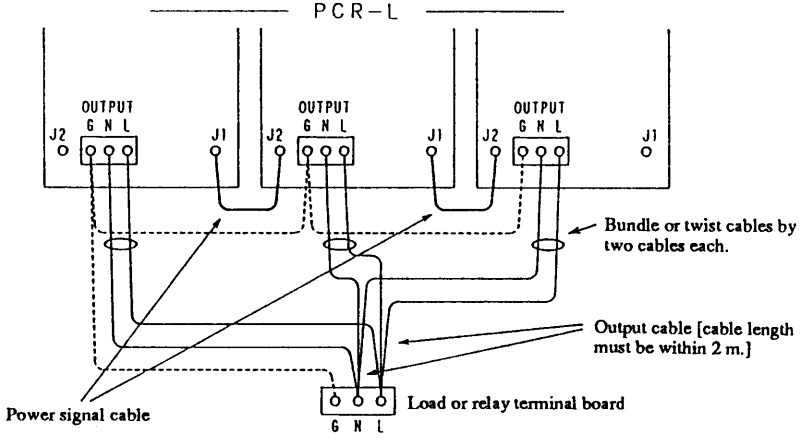
Caution *Note that incorrect L and N polarity (connecting L to N or vice versa) causes problems. Furthermore, improper terminal connection causes abnormal output, which may damage a load or cause problems in a PCR-L AC Power Supply.*

The thickness (sectional conductor area) of cables to be used in this connection must be the same as that of the output cables per PCR-L AC Power Supply.

For cable selection, follow the table of the correspondence between the wire size and allowable current in Step 3, Chapter 3, and Section 5.1, Connection to the OUTPUT Terminal Board, of the PCR-L Series AC Power Supply Operation Manual.

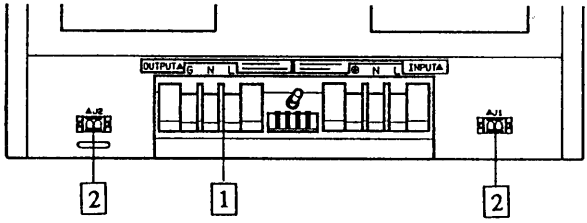
A specific connection example is given below.

The below illustration is only to show the electrical connections.
Actual layout of the terminals may differ from that shown here.
For the actual layout of the terminals, refer to the Terminal Layout Drawing of PCR-L Main Unit on the next page.

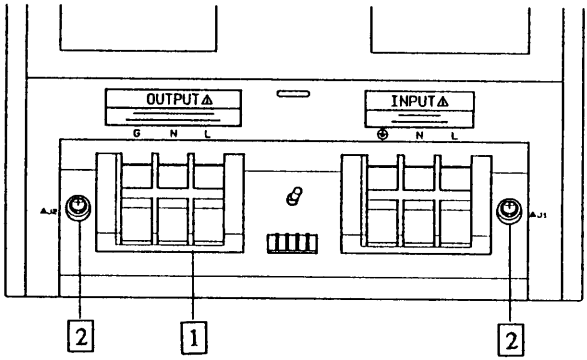


If connection of output cables to a load is difficult, provide a relay terminal between a load and PCR-L AC power supplies or contact Kikusui agent.

Terminal Layout Drawing of PCR-L Main Unit



PCR2000L



PCR4000L, PCR6000L

[1] OUTPUT terminal board

To connect the output cable.

[2] J1, J2

To connect the power signal cable (supplied).
For the PCR2000L, use a cable with connector; for the PCR4000L or PCR6000L, use a cable with crimping terminals.

Chapter 4

OPERATION CHECK

Describes the operation check to be conducted before operating the Parallel Operation Driver.

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After completing connection of the input power, drive signal, and power signal cables and OUTPUT terminal-to-OUTPUT terminal connection by making preparation through chapter 3, conduct operation check as described in this chapter.

Basically, operation check needs to be conducted in the same way as Chapter 4, OPERATION CHECK, in the PCR-L Series AC Power Supply Operation Manual. In doing so, also check the following.

(1) The PCR-L Series AC Power Supply Operation Manual notes that nothing should be connected to the OUTPUT terminal board. However, for one-control parallel operation, connect cables other than the output (load) cables as shown in the connection diagram in 3.2.

(Caution) *Improper connection of any of the cables noted above may cause failure in an PCR-L AC Power Supply. Ensure that these cables have been securely connected before turning ON the POWER switches.*

(2) When turning ON the PCR-L AC Power Supply POWER switches, turn ON the POWER switch of the PCR-L AC Power Supply with the master card first or turn ON the POWER switches of all PCR-L AC Power Supplies (master and slave equipment) simultaneously. Furthermore, the POWER switches of all AC power supplies must be turned ON/OFF in an interval of 3 second or less.

(3) For control panel display, see the Description given below.

(4) Use only the PCR-L AC power supply with the master card to operate the control panel.

Description **Difference in Display between Individual PCR-L AC Power Supply Operation and One-Control Parallel Operation**

Use of one-control parallel operation with the Parallel Operation Driver installed causes control panel display to differ from that accomplished in individual PCR-L AC Power Supply operation.

(1) Display of the master PCR-L AC Power Supply display panel

- Same as that accomplished in individual PCR-L AC Power Supply operation. However, current indication shows the total output current of the master and slave AC power supplies.

(2) Display of slave PCR-L AC Power Supplies

- The frequency display area displays parallel operation address. (one digit figure)

Chapter 5

OPERATION METHOD

Describes the operation and functions of the Parallel Operation Driver.

Contents

This operation manual describes how to use the functions which differ from those available when a single PCR-L Series AC Power Supply is used. For the contents not described in this manual, see the PCR-L Series AC Power Supply Operation Manual. Furthermore, before reading the PD02M-PCR-L/PD02S-PCR-L Parallel Operation Driver Operation Manual, always read the PCR-L Series AC Power Supply Operation Manual.

Description Basic Operation Required for One-Control Parallel Operation

Use of one-control parallel operation with the Parallel Operation Driver in PCR-L AC Power Supplies requires the basic operation as follows:

(1) When turning ON the PCR-L AC Power Supply POWER switches, turn the POWER switch of the master AC power supply first or turn the POWER switches of the master and slave AC power supplies (all equipment) simultaneously.

(2) Turn ON/OFF each PCR-L AC Power Supply POWER switch within three seconds. Be sure that all the power supplies are always turned ON or OFF.

(3) Operate the POWER switches of all the power supplies in the same way. For example, do not turn only one POWER switch OFF and then ON again.

• Incorrect use of a POWER switch may disable start of PCR-L AC Power Supply. Should such a case happen, once turn OFF all the POWER switches and re-turn them ON correctly.

(4) In one-control parallel operation, the master AC power supply controls all AC power supplies; use the control panel of the master AC power supply.

• Use of one-control parallel operation causes all AC power supplies to operate in the status (voltage, frequency, and other factors) that has been set to the master AC power supply.

(5) If an alarm occurs in one of the PCR-L AC power supplies operating in one-control parallel operation, outputs from all the equipment are set to OFF.

(6) For output current, the total value of the master and slave AC power supplies is indicated on the control panel of the master AC power supply.

5.1 Limit Value Setting

- When one-control parallel operation is used for the first time, a current limit that has been set to the master AC power supply applies to all AC power supplies in parallel operation. Set the required value in accordance with the steps given in 6.5.3 of the PCR-L Series AC Power Supply Operation Manual.
- For voltage and frequency limits, those that have been set to the master AC power supply also apply.
- Disconnecting the Parallel Operation Driver to release one-control parallel operation causes all PCR-L AC Power Supply current limits to enter initial setup status. (maximum set values)

5.2 Self-Test Function

During one-control parallel operation, self-test can be integrally performed through the master AC power supply control panel.

- Self-test operation procedure is the same as that described in the Alarm-Type Checking Procedure (SELF TEST) in Chapter 9, PROTECTIVE FUNCTIONS AND THEIR OPERATIONS, of the PCR-L Series AC Power Supply Operation Manual.
- Turning JOG causes AD. and NO. numbers to change. AD. indicates a number as listed in the table below.

PCR-L AC Power Supply model	Master	Slave 1	Slave 2
PCR2000L	1 to 2	11 to 12	21 to 22
PCR4000L	1 to 4	11 to 14	21 to 24
PCR6000L	1 to 6	11 to 16	21 to 26

5.3 Measured Current Value Zero Calibration

Use of one-control parallel operation for the first time may causes an offset (short indication of value even though AC power supplies are in no-load condition) to occur in measured current value relations (current, power, power-factor, and VA display and harmonic current analyzed value).

In this case, zero calibration is available using one of the following options.

- RC02-PCR-L (Remote Controller)
- IB11-PCR-L (GP-IB Interface)
- RS11-PCR-L (RS-232C Interface)

For accurate measurement, turn ON the POWER switches of the PCR-L AC Power Supplies and idle them for more than 30 minutes. Then, conduct zero calibration immediately before starting measurement.

Make setting as follows first when any of the options is used. (Incorrect setting disables the zero calibration function.)

- AC/DC mode: DC mode
- Current display mode: AVE
- Voltage setting: 0 V
- OUTPUT switch: ON

In addition, set output range (100V or 200V) to the required range. Changing output range requires zero calibration in that range. When one-control parallel operation is performed for the first time, conduct zero calibration in both output ranges. Once zero calibration is made, the calibrated values are stored in the PCR-L AC Power Supply even when the POWER switch is turned OFF or another option card is disconnected from the AC power supply during one-control operation (as long as cable connection is not changed). Zero calibration is possible even when a load is connected; however, disconnect a load for accurate calibration.

5.3.1 Operation Procedure for Using RC02-PCR-L

Always read the RC02-PCR-L Remote Controller Operation Manual, too.

Step 1 Press [ESC] to call the Home Position.

Step 2 Press [SHIFT] + [MODE] . This causes the following to appear.

```
I0CAL
```

[F1] [F2] [F3] [F4] [F5]

Step 3 Press [F1]. This starts zero calibration and the display changes to the following.

```
NOW RUNNING
I0CAL
```

[F1] [F2] [F3] [F4] [F5]

In tens seconds, zero calibration completes. Then the following appears.

```
FINISHED
I0CAL
```

[F1] [F2] [F3] [F4] [F5]

Step 4 Press [ESC] to exit the zero calibration mode.

The calibrated values are stored in the PCR-L AC Power Supply memory; however, conduct re-calibration depending on changes in ambient temperature.

5.3.2 Command during Use of IB11-PCR-L or RS11-PCR-L

Always read the IB11-PCR-L GP-IB Interface or RS11-PCR-L Remote Controller Operation Manual, too.

Use the [CALPARA] command to conduct zero calibration.

Other commands are not accepted until zero calibration completes, which takes tens seconds.

The calibrated values are stored in the PCR-L AC Power Supply memory; however, conduct re-calibration depending on changes in ambient temperature.

5.4 Optional Functions

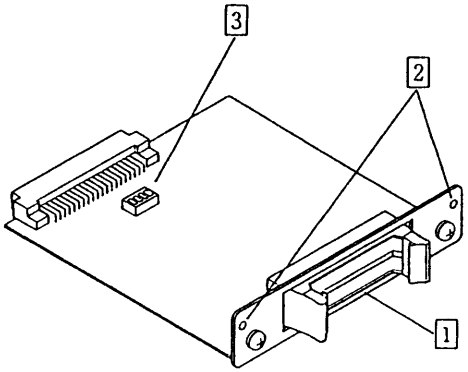
All options to be inserted into a PCR-L AC Power Supply must be installed in a slot of the master AC power supply. Otherwise, any optional function is not available.

The extent of optional functions and their operation methods are the same as those available during individual PCR-L AC Power Supply operation.

Chapter 6

PART NAMES

Indicates the names of the parts of the Parallel Operation Driver and describes the functions of these parts.



1 Drive signal connector

Used to connect a drive signal cable.

2 Mounting holes

Used to mount a card.

3 Parallel operation address setting switch

A DIP switch used to set a master or slave AC power supply address.

Chapter 7
MAINTENANCE

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7.1 Before Requesting a Repair

If a problem occurs in the Parallel Operation Driver, check that problem in accordance with the following table. Also, disconnect the Parallel Operation Driver from a PCR-L AC Power Supply and check if the power supply alone operates normally. If it is not possible to recover a normal status, contact your Kikusui agent to request repairs.

Problem	Check item	Results	Possible causes
PCR-L AC Power Supply display panel displays "Err2" or nothing, or keeps the version number indication.	Check if the master and slave cards are correctly inserted into a slot.	NO	Improper card installation (see 3.1.2)
	Check if the drive signal cables are correctly connected.	NO	Improper drive cable connection (see 3.1.3)
	Check if the all PCR-L AC Power Supply POWER switches are ON.	NO	One-control parallel operation is not available unless the all PCR-L AC Power Supply POWER switches are correctly turned ON.
	Check if the DIP switch (parallel operation address) of each card has been correctly set.	NO	Incorrect parallel operation address setting (see 3.1.1)
ALARM indication appears or output voltage is not generated as set.	Check if the power signal cables and cables between the OUTPUT terminal boards have been correctly connected.	NO	Improper cable connection. Unless all cables are correctly connected, one-control parallel operation does not function correctly. Also, improper cable connection may cause problems. (See 3.2.1)
Rated output cannot be obtained.	Check if the DIP switch (parallel operation address) of each card has been correctly set.	NO	Incorrect parallel operation address setting (see 3.1.1)

Chapter 8

SPECIFICATIONS

List the specifications.

Contents

8.1 Specifications

The specifications given in this section cover the overall performance where the Parallel Operation Driver is installed in the PCR-L AC Power Supplies to perform one-control parallel operation. Other specifications comply with those of the PCR-L Series AC Power Supply.

Input/Output power (current) capacity		[Power capacity of one PCR-L AC Power Supply] × N N: Number of PCR-L AC Power Supplies in parallel operation (A maximum of three same models of PCR-L AC Power Supplies are available.)
Output voltage stability		
Output current variations	To changes of 0 to 100% of rating	± 0.5 V (*1) (*2)
Output frequency variations	To changes in rated range	Within ± 1.2% (*1) (*3)
Output voltage waveform distortion		0.5% or less (*1) (*2)
Output voltage response rate		60 μS typical (*4)
Ammeter and power meter		Total value of parallel operation is displayed (*5).
Insulation resistance	Between input and enclosure, output and enclosure, and input and output	500 V DC [Insulation resistance of one PCR-L AC Power Supply] / N N: Number of PCR-L AC Power Supplies in parallel operation

(*1) Value obtained at the OUTPUT terminal board of the master AC power supply.

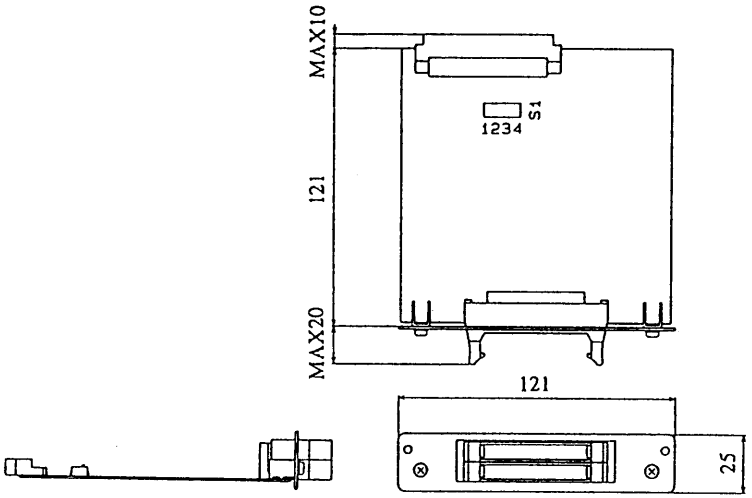
(*2) When output voltage is 80 through 150 V/160 through 300 V at a load power factor of 1.

(*3) Output voltage variation when 200 Hz is regarded as reference at an output voltage of 80 through 150 V/160 through 300 V and a load power factor of 1.

(*4) With respect to changes of 0 A output current to rated value when output voltage is 100 V/200 V and load power factor is 1.

(*5) Resolution changes with output capacity during parallel operation, and accuracy is the same as that of individual PCR-L AC Power Supply operation when zero calibration has been conducted.

8.2 Dimensions



Unit: mm

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PARALLEL OPERATION DRIVER PD02M/PD02S-PCR-L OPERATION MANUAL

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