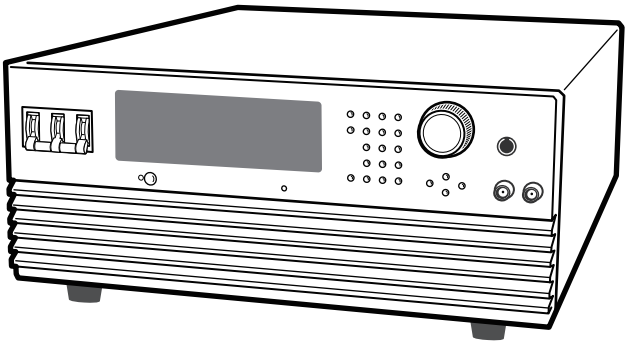
Part No. Z1-003-532, IB019621
Dec. 2009

OPERATION MANUAL

Regenerative Electronic Load

PLZ6000R



KIKUSUI

Use of Operation Manual

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

If you find any misplaced 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. If the product needs adjustment or repairs, contact your Kikusui distributor/agent. In either case, please contact Kikusui distributor/agent, and provide the “Kikusui Part No.” given on the cover.

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

⚠ Safety Symbols

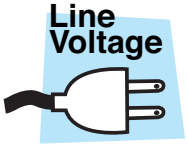
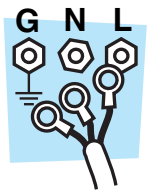
For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Note the meaning of each of the symbols to ensure safe use of the product. (Not all symbols may be used.)

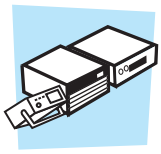
	Indicates that a high voltage (over 1000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.
DANGER	Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.
 WARNING	Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.
 CAUTION	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
	Shows that the act indicated is prohibited.
	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 cable specified. 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).

Installation 	• This product is designed for safe indoor use. Be sure to use it indoors. • When installing this product, be sure to observe the description in “2.2 Precautions Concerning Installation in this manual. • When connecting the power cable to a switchboard, be sure work is performed by a qualified and licensed electrician or is conducted under the direction of such a person.
Relocation 	• Turn off the POWER switch, and disconnect all cables before relocating the product. • The product weighs over 20 kg. When moving the product, have more than one person to carry it. The weight of the product is indicated on the rear panel of the product and in the specification table in this manual. • When relocating the product, be sure to include the manual.
Operation 	• Before using the product, be sure to check the input power voltage and that there is no abnormality in the appearance of the power cable. Be sure to turn off the switchboard breaker before checking. • If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power cable from the switchboard. Make sure the product is not used until it is completely repaired. • Use cables or wires with sufficiently large current capacity for output wires and load cables. • Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.
Maintenance and inspection 	• To prevent the possibility of electric shock, be sure to turn off the switchboard breaker before performing maintenance or inspection. • Do not remove the external cover when performing 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.
Service 	• 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

Thank you for purchasing the PLZ6000R regenerative electronic load.

This manual is intended for the first-time user of the PLZ6000R regenerative electronic load. It gives an overview of the PLZ6000R and describes various settings, operations, SCPI commands, maintenance, safety precautions, etc.

Read this manual thoroughly to use the functions of the PLZ6000R 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 the beginning to the end. We recommend that you read the manual thoroughly from the beginning before using the PLZ6000R for the first time.

Intended readers of this manual

This manual is intended for those using the PLZ6000R or teaching other users on how to operate the PLZ6000R.

It is assumed that the reader has knowledge about electrical aspect of a regenatated electronic load.

Information for the SCPI commands are provided with the premise that the readers has sufficient knowledge about controlling electronic loads using a personal computer.

Notations used in this manual

- "PLZ6000R" refers to the regenerative electronic load.
- "PC" in this manual is a generic term for personal computers and workstations.
- The following marks are used with the corresponding explanations in this manual.

⚠WARNING	Indicates an imminently 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.

SHIFT+ named key (printed in blue)

Indicates an operation involving pressing the named key (printed in blue) while the SHIFT key is held down.

Structure of this manual

This Operation Manual consists of the following chapters. The following outlines each chapter.

Chapter 1 General Description

This chapter gives an overview and introducing the features of the PLZ6000R.

Chapter 2 Installation and Preparation

This chapter explains how to prepare the product for use, from unpacking to installation.

Chapter 3 Operations

This chapter describes the operating procedure of each operation mode and other basic functions.

Chapter 4 Applied Operation

This chapter describes the functions such as ABC preset memories, sequence function and external control that are used in actual applications.

Chapter 5 Remote Control

This chapter gives an overview of the remote control functions and explains the SCPI command structure, syntax, details of each command, registers, and so on used in the remote control.

Chapter 6 Maintenance

This chapter describes maintenance of the PLZ6000R.

Chapter 7 Specifications

This chapter gives description on the electrical and mechanical specifications of the PLZ6000R and its options.

Appendix

The appendix contains explanations of basic operation modes, operation regions, the regenerative power function, the new sequence program table, examples of sequence programs, lists of messages, and lists of command errors.

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Chapter 5 Remote Control

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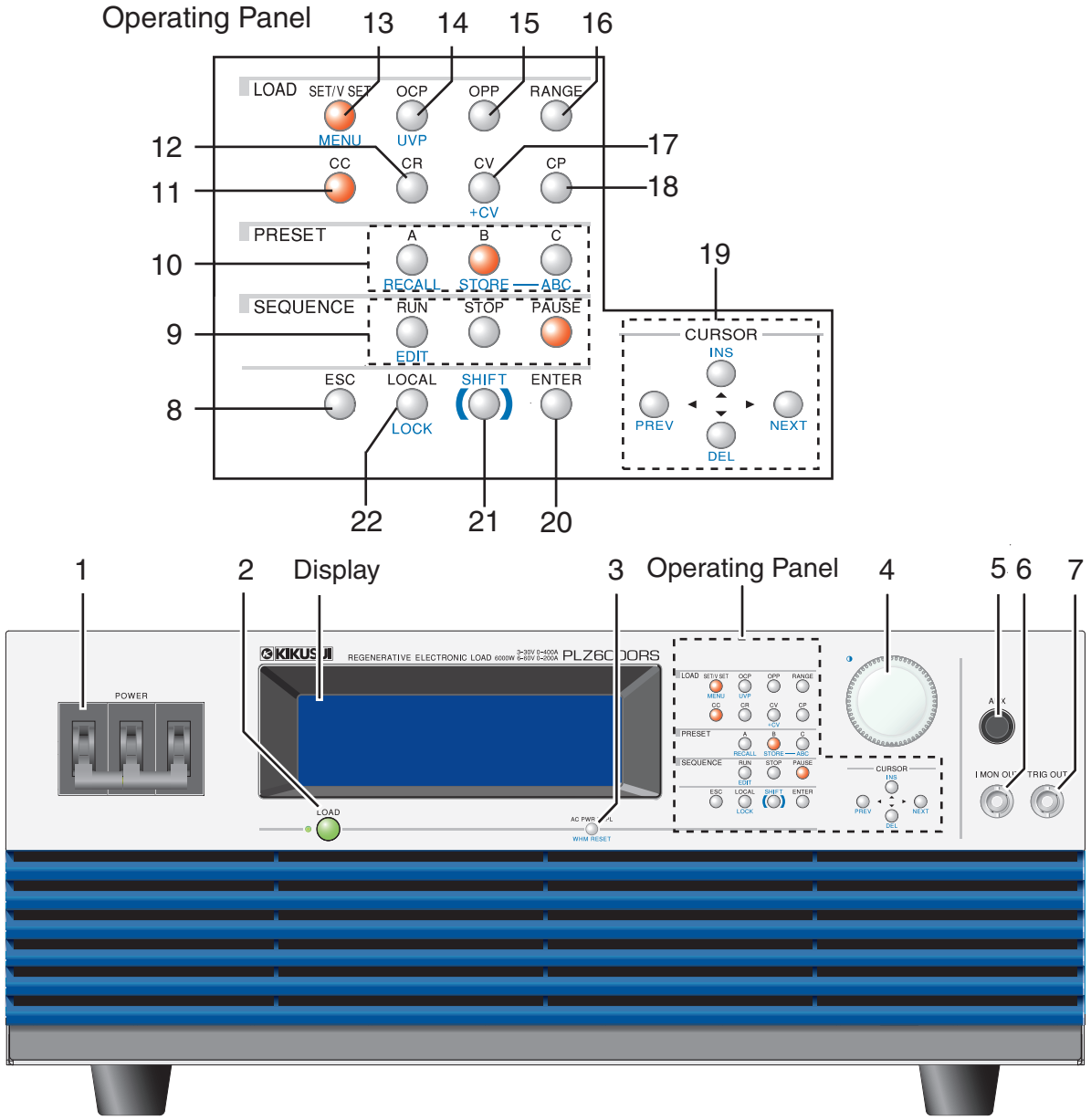
Front Panel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SET/V SET
OCP
OPP
RANGE
MENU
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12
17
CC
CR
CV
CP
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+CV
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C
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SEQUENCE
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STOP
PAUSE
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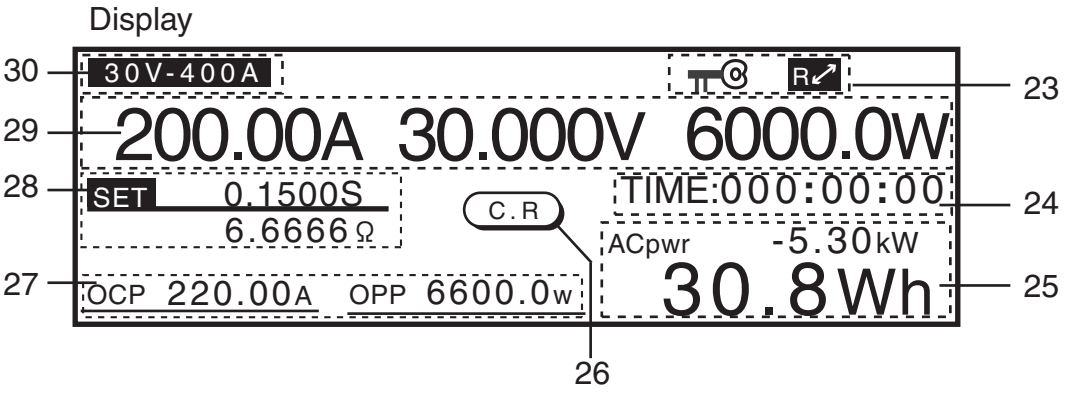
1
2
Display
3
Operating Panel
4
5
6
7
POWER
KIKUSUI
REGENERATIVE ELECTRONIC LOAD
PLZ6000R
LOAD
I MON OUT
TRIG OUT


Display
30
30V-400A
23
29
200.00A 30.000V 6000.0W
28
SET 0.1500S
6.6666Ω
C.R
TIME:000:00:00
24
ACpwr -5.30kW
27
OCP 220.00A OPP 6600.0W
30.8Wh
25
26

No.	Name	+SHIFT	Description	See Page
1	POWER		Power on/off switch (raise the lever to turn the power on (|) / lower to turn the power off (○))	3-3
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28	Setup display		Displays the basic settings in the specified value	Table 3-1, Table 3-2
29	DC input value		Displays DC input current, voltage and power at load input side	–
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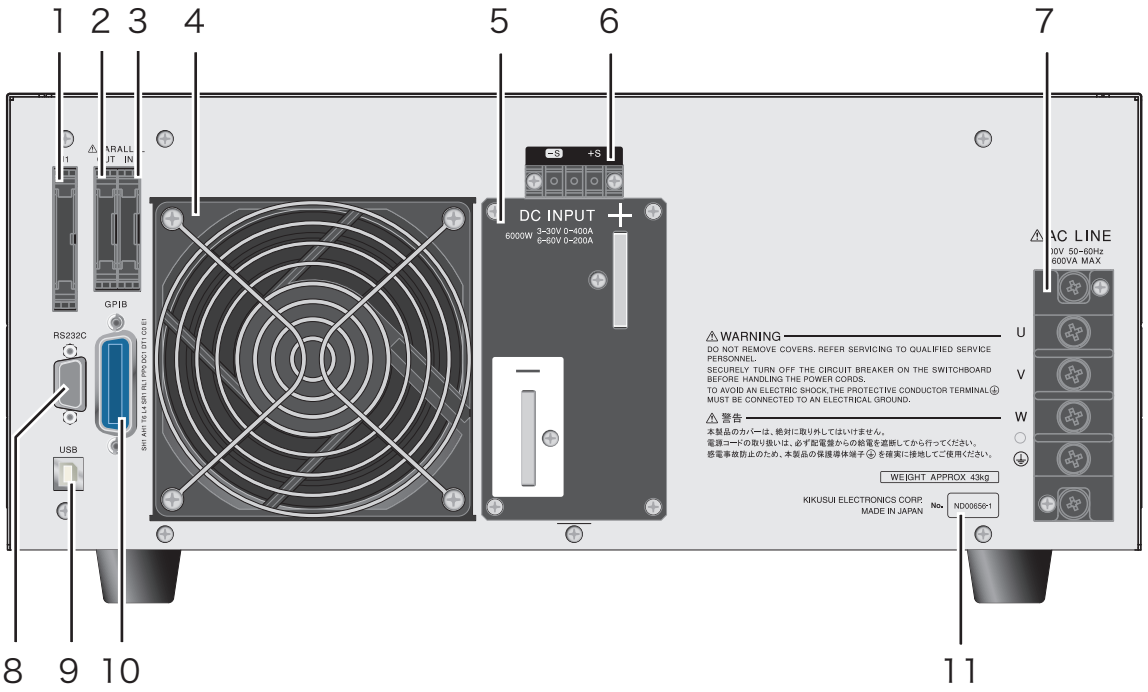
Rear Panel



No.	Name	Description	See page
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11	Manufacturing number	Manufacturing number of the PLZ6000R	–

General Description

This chapter gives an overview and introducing the features of the PLZ6000R.

1.1 About This Manual

This manual describes the PLZ6000R Regenerative Electronic Load.

Applicable firmware version of the PLZ6000R

This manual applies to the PLZ6000R with the following firmware version.

IFC version 1.1x

IOC version 1.xx

DSP version 1.xx

See p. 3-3

The firmware version can be verified on the display when the power switch is turned on.

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

- Model name (indicated at the top section of the front panel)
- Firmware version (indicated on the screen when the power switch is turned on)
- Serial number (indicated at the bottom section of the rear panel)

1.2 Product Overview

The PLZ6000R is the electronic load that has a function of regenerating the load power back to the AC line.

The PLZ6000R operates as an electronic load with the constant current (CC), the constant resistance (CR) and the constant voltage (CV) mode operations. In the CC and CR mode operations, it is possible to combine the CV mode operation to them.

What is the Regenerative Electronic Load?

With normal electronic load equipment, the load power is converted to heat and consumed by a semiconductor. In the regenerative electronic load, heat converted from power is converted back into reusable power that is regenerated in the AC line. In so doing it suppresses exhaust heat and save energy.

1.3 Features

The PLZ6000R realizes high regeneration efficiency, energy saving, compact size, and low amount of exhaust heat.

- High regenerative efficiency: more than 85 %, 90 % max at the rated power.
- Equipped with 4 operating modes (Constant Current, Constant Resistance, Constant Voltage, Constant Power)
- Sequence function

  Sequence patterns set arbitrarily can be saved to built-in memory.

  Up to 10 normal sequence programs can be saved. Up to 256 total steps can be saved regardless of the number of programs.

  The sequence pattern can be edited easily using the large LCD.
- Capable to expand the system up to 5 sets in parallel operation (6 kW/set, MAX 30 kW)
- Standard GPIB, RS232C, USB communication functions

  The PLZ6000R equips with GPIB, RS232C, and USB communication functions as standard, it can easily be incorporated into wide-ranging test and inspection systems.

  Wide variety of systems can be configured when combined with the sequence function.
- Soft Start function

  This function enables raising the input current gradually on the load side in CC mode.
- ABC preset memory

  Allows you to save the current operation mode at the current range to ABC preset memories.

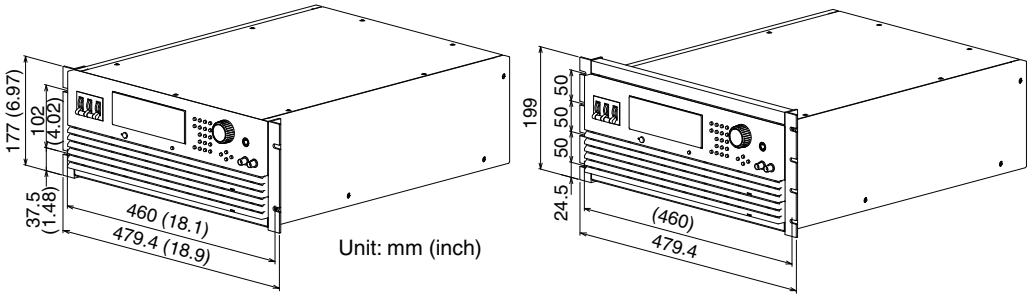
1.4 Options

The options listed below are available for the PLZ6000R.

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

■ Rack mounting option

Product	Model	Note
Rack mount bracket	KRB4	Inch rack EIA standard
	KRB200	Milli rack JIS standard

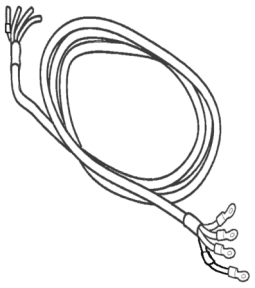


KRB4 KRB200

■ Power cable

A power cable to connect to the input terminal block on the rear panel.

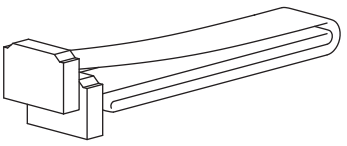
Product	Model	Note
Power cable	AC8-4P4M-M6C	4 m 4 cores



■ Cable for parallel operation

A cable used when performing parallel operation.

Product	Model	Note
Cable for parallel operation	PC01-PLZ-4W	300 mm 20 pins



Installation and Preparation

This chapter explains how to prepare the product for use, from unpacking to installation.

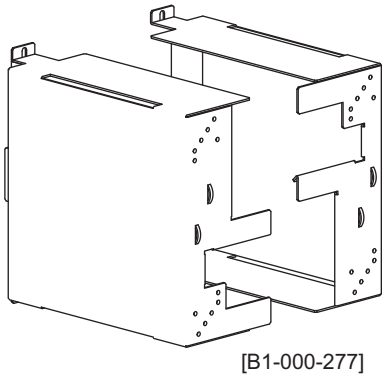
2.1 Checking the Contents of the Package

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

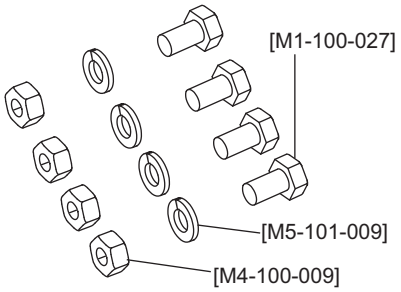
If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

We recommend that all packing materials be saved, in case the product needs to be relocated in the future.

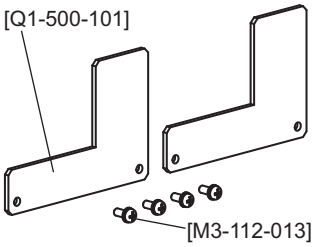
Accessories



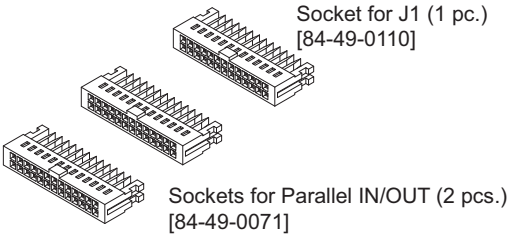
☐DC input terminal cover (1 set)



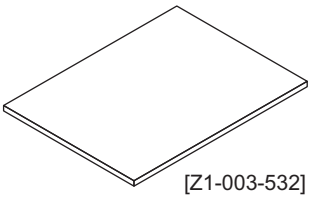
☐DC input terminal bolt (M12) (4 sets)



☐ Lock plate (2 sets)
Lock plate setscrew (M3) (4 pcs.)



☐J1/Parallel IN/OUT protection socket (3 pcs.)
(attach to the connector)



☐Operation manual (1 pc.)

Fig. 2-1 Accessories

2.2 Precautions Concerning Installation

Be sure to observe the following conditions when installing the product.

- The PLZ6000R is designed for the regenerative flow of in-house power lines. Each PLZ6000R requires at least 5.4 kW of the power constantly consumed by devices in the same power line (otherwise it can not be used).
- 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 (32 °F to 104 °F)

  Storage temperature: -25 °C to 70 °C (-13 °F to 158 °F)
- Avoid humid environments.

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

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

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

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

  Placing heavy objects on top of the product may cause failures.
- 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 nere strong magnetic or electric fields, or in 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 the product or transporting the product to the installation location.

- Lower the lever and turn the “POWER” switch off.

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

- Remove all wiring.

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

- The unit should always be moved by more than one person.

  The product should be relocated by no less than two persons. Take extra care when placing the unit on a tilted or uneven surface. Never lay the unit on its side or turn it up-side down.

- 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.

- Make sure this manual is included.

2.4 Rack-Mount Frame Installation

Before installing the rack-mount frame, remove the installation screw and the rubber feet. The following Fig. 2-2. shows how to remove the rubber feet.

Concerning installation, refer to the instruction manual of KRB4 or the KRB200.

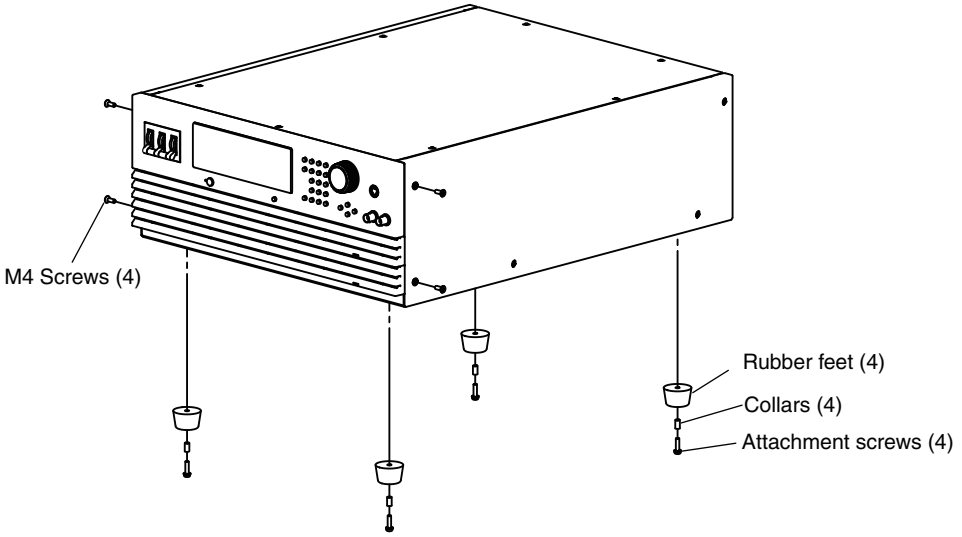


Fig. 2-2 Removing rubber feet

Removing rubber feet

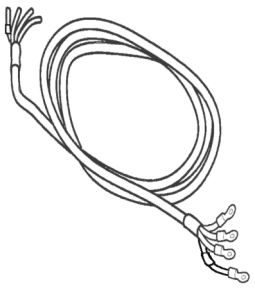
Unfasten the screws and remove the rubber feet (4 places).

2.5 Connecting the Power Cable

See p. 1-4

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

This product does not come with a power cable. If the optional power cable (AC8-4P4M-M6C) comes with your package, you can use it immediately as it is already assembled.



Three phase power cable
(AC8-4P4M-M6C)

Fig. 2-3 Optional power cable

Exercise the following precautions when preparing the power cable.

⚠WARNING **Possible electric shock.**

- **Before connecting the power cable, be sure to turn off the breaker switch on the power switch board (to shut down the power supply from the switchboard).**
- **This product is an IEC Safety Class I (equipment with a protective conductor terminal) device. Be sure to ground the product to prevent electric shock.**
- **Connect the ground terminal to earth ground.**

⚠CAUTION

- Inside the product, an appropriate circuit is connected to the input terminal. Be sure to connect the wires correctly by matching the U, V, W, and ⏚(GND) between the electrical cable and the product.
- Be sure to have a qualified engineer connect the power cable to the switchboard.
- The “POWER” switch of the product can be used to disconnect the product from the AC line in an emergency. Provide adequate space around the “POWER” switch so that the “POWER” switch can be turned off at any time.

Use a four-core PVC insulated cable with a nominal cross-sectional area of at least 8 mm^2 for 600 Vac.

Attach crimping terminals that comply with the terminal screws on the switchboard and connect the power cable firmly so that it does not come loose.

Connection procedure (option required)

1. Check that the AC power supply meets the nominal input rating of the product.
   The nominal input rating : 200 Vac, 50 Hz or 60 Hz, Three phase three wires.
2. Check that the “POWER” switch is turned off.
3. Connect the power cable to the AC LINE terminal block as shown in Fig. 2-4.

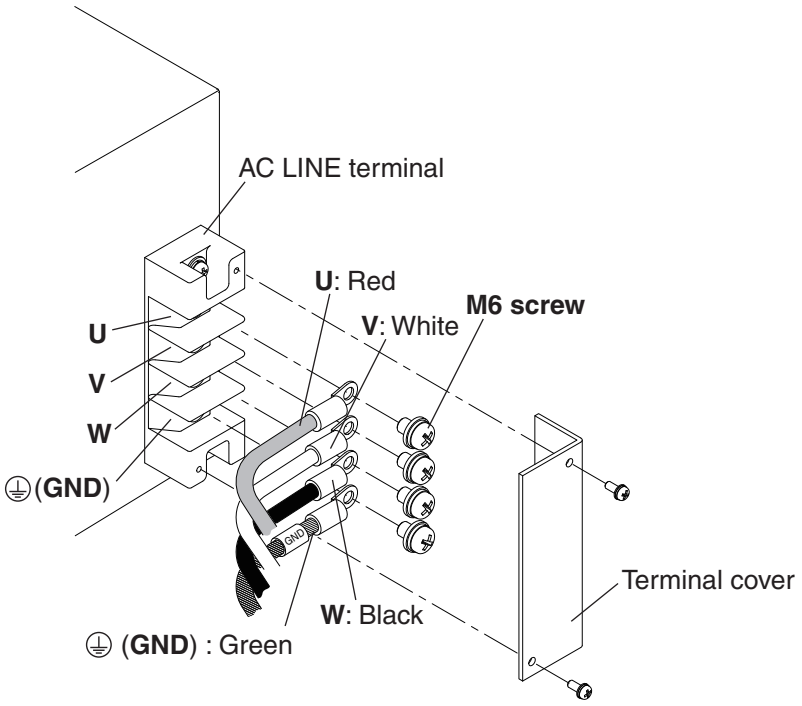


Fig. 2-4 Connecting the power cables

4. Attach crimping terminals to the switchboard end of the power cable.
5. Turn off the switchboard.
6. Connect the power cable by matching the U, V, W, and ⏚ (GND) of the switchboard.

Precautions concerning grounding (Earth)

⚠CAUTION • If you do not ground the product, malfunction may occur due to external noise, or the noise generated by the product may become large.

Make sure to ground the unit for your safety. Please securely connect the GND terminal of the AC LINE terminal board and the GND terminal of the switch board.

2.6 Load Wiring

To ensure that the functions of the PLZ6000R work accurately and reliably, all wires must be connected correctly.

2.6.1 Precautions Concerning Wiring

Electric wire used

⚠WARNING

- **To prevent the possibility of fire, use a load cable with sufficient current capacity with respect to the rated output current of the PLZ6000R.**
- **To prevent the possibility of electric shock, use a load cable with a higher voltage rating than the isolation voltage of the PLZ6000R. The isolation voltage of the PLZ6000R is ±500 V.**

Use the wires connected to the load input terminal as referred to Table 2-1, and use wires having a cross-sectional area that can accomodate a Kikusui-recommended current that is higher than the actual current used. Also, use wires having coating with a heat resistant temperture of 75 °C or more.

Table 2-1 Nominal cross-sectional area of wires and allowable currents

Nominal Cross-Sectional Area [mm^2]	AWG	(Reference Cross-Sectional Area) [mm^2]	Allowable Current*1 [A] (Ta = 30 °C)	Kikusui Recommended Current[A]
2	14	(2.08)	27	10
3.5	12	(3.31)	37	-
5.5	10	(5.26)	49	20
8	8	(8.37)	61	30
14	5	(13.3)	88	50
22	3	(21.15)	115	80
30	2	(33.62)	139	-
38	1	(42.41)	162	100
50	1/0	(53.49)	190	-
60	2/0	(67.43)	217	-
80	3/0	(85.01)	257	200
100	4/0	(107.2)	298	-
125	-	-	344	-
150	-	-	395	300
200	-	-	469	400

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

■ Load wire inductance

If the load cable is long or has a large loop, the wire inductance is increased.

In such a condition, the input voltage may fall below the minimum operating voltage of the PLZ6000R causing the current waveform to be distorted. In some cases, the input voltage may exceed the maximum input voltage and cause damage to the PLZ6000R. The phase lag of the current may cause instability in the PLZ6000R control inducing oscillation.

Connect the PLZ6000R and the equipment under test using the shortest twisted wire possible to adjust the voltage generated by the inductance so that it falls in the range from the minimum operating voltage to the maximum input voltage of the PLZ6000R.

A capacitor and a resistor may be connected to the load input terminal as shown in Fig. 2-5 to alleviate oscillation. In this case, use the capacitor within its allowable ripple current.

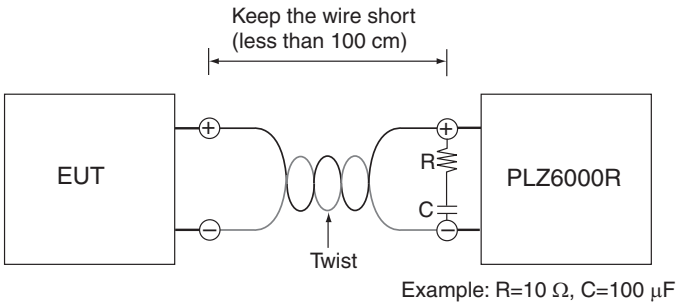


Fig. 2-5 Length of wiring

■ Operation when the response speed is changed

You can change the response speed in CC mode (CC+CV mode) and CR mode (CR+CV mode).

In some cases, the wire inductance increases and the condition of input current or voltage may cause instability in the PLZ6000R control inducing oscillation.

See p. 3-15

In such cases, you can decrease the response speed to assure stable operation.

Overvoltage

⚠CAUTION • Do not apply voltage exceeding the maximum voltage (33 Vdc with the 30 V range, 66 Vdc with 60 V range) to the load input terminal, as it may cause damage.

The maximum voltage that can be applied to the load input terminal is 33 Vdc with the 30 V range and 66 Vdc with 60 V range. Voltage exceeding the maximum cannot be used.

If overvoltage is applied, an alarm message appears along with an alarm buzzer, and the load is turned off. In this case, immediately lower the voltage of the equipment under test.

Polarity

⚠CAUTION • If the polarity is reversed, overcurrent may damage the EUT and PLZ6000R.

Be sure to match the polarities between the load input terminal and the equipment under test.

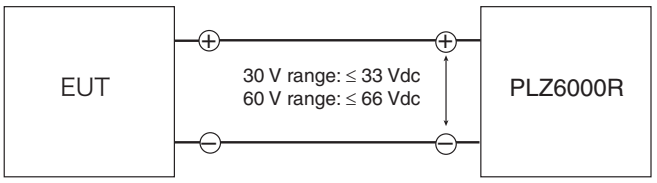


Fig. 2-6 Connection by paying attention to the polarity

If the polarity is reversed and reverse voltage of 0.6 V or greater is applied, the activated reverse connection protection (REV) appears on the display along with a beeping alarm sound. In this case, immediately turn off the power of the equipment under test.

2.6.2 Connection to the Load Input Terminal

⚠WARNING • **Do not touch the load input terminal while the PLZ6000R is turned on, as it may lead to electric shock. In addition, be sure to use the load input terminal cover.**

⚠CAUTION • There is a danger of breakdown. Do not connect the equipment under test to the load input terminal when the load is turned on.

• There is a danger of overheat. Attach a crimping terminal to the wire and use the set of screws that came with the package for connection.

1 Turn off the “POWER” switch.

2 Attach the crimp terminal to the wire for the load input.

3 Be sure to match the polarity between the load input terminal and the equipment under test, then connect the load input wire to the load input terminal on the rear panel.

Secure the wires using a bolt, nut and washer. Insert the bolts from the outsides of the terminals facing toward the space in between the terminals. – (negative) terminal is on the left side, and + (positive) terminal is on the right side.

⚠CAUTION • If the polarity is reversed, overcurrent may damage the EUT and PLZ6000R.

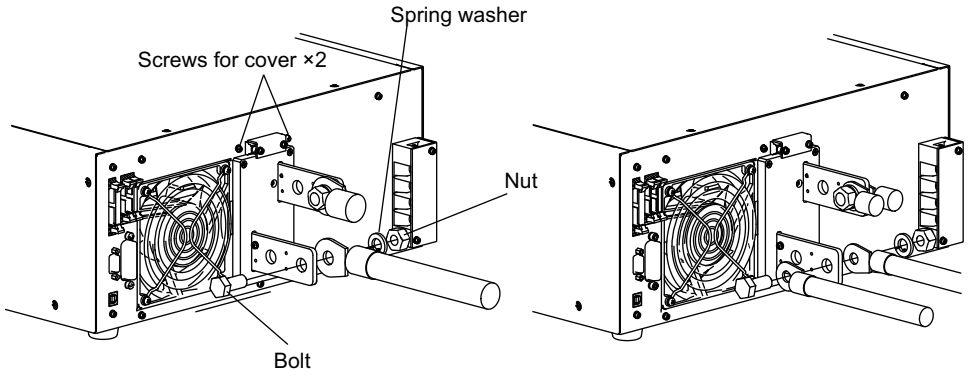


Fig. 2-7 Connection to the load input terminal on the rear panel

4 Remove the two terminal cover screws from the unit.

5 Insert the tab on the terminal cover into the mounting holes on the instrument, then slide down to attach.

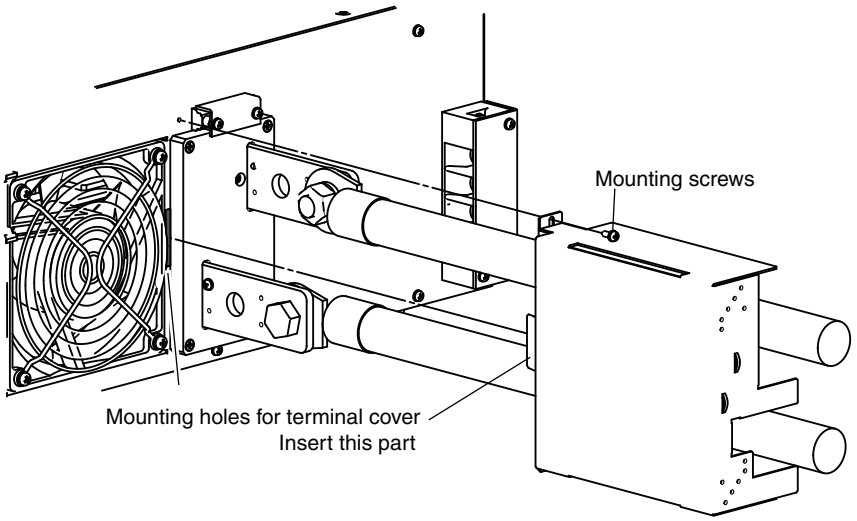


Fig. 2-8 Installing the terminal cover

6 Secure the terminal cover with mounting screws at the top.

7 Install other side of the cover as well.

8 Determine the position of the lock plate in accordance with the number and the thickness of wires.

In case of a single wire, adjust the position of the lock plate according to the thickness of wire as shown in the following figure.

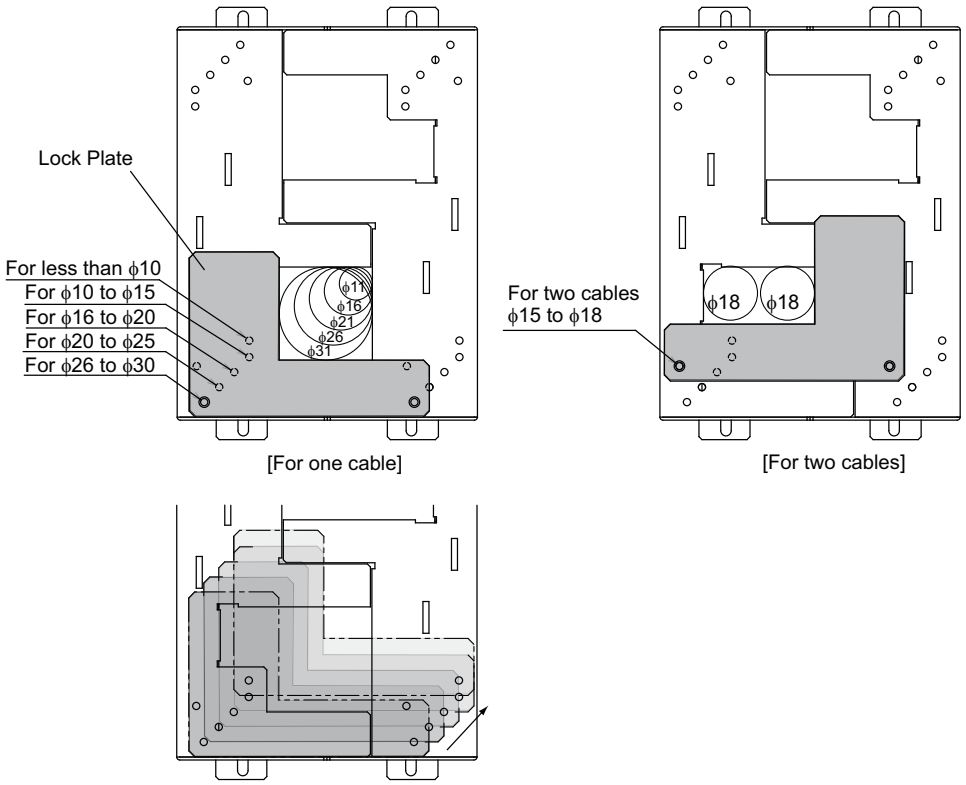


Fig. 2-9 Attaching the lock plate

9 Secure the lock plate with mounting the screws.

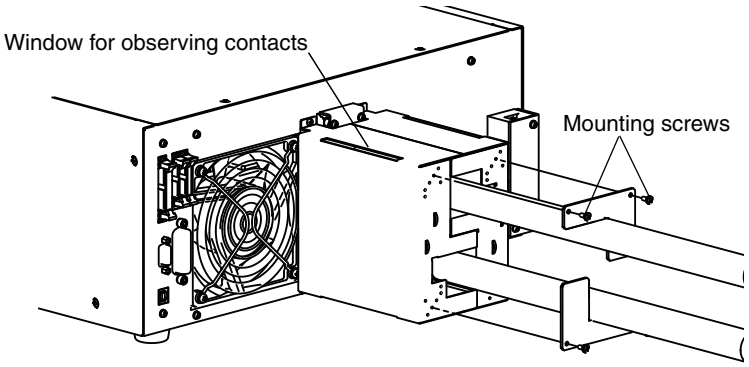


Fig. 2-10 Confirming the connection of wires

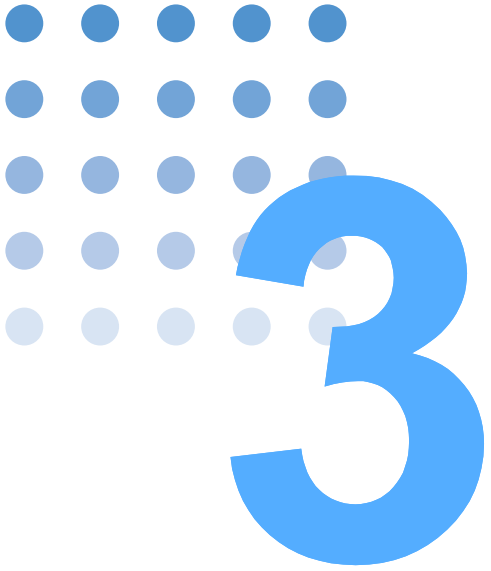
10 Look through the window of the terminal cover and confirm that the load input terminal and the bolt are not touching the terminal cover.

If any contact is found, re-arrange the wires so that they no longer touch the terminal cover.

⚠WARNING • **It may cause danger of electric shock. Do not touch the load input terminal or and the bolt to the terminal cover.**

Removing the load input terminal cover

Remove the lock plates and the load input terminal cover by reversing the steps described above.



Operations

This chapter describes the operating procedure of each operation mode and other basic functions.

3.1 Basic Front Panel Operation

Various basic front operations are described below.

■ How to use the "Rotary knob"

The "Rotary knob" is used when setting values such as the current and resistance. Turning the "Rotary knob" to the right increases the value and turning it to the left decreases the value. The amount of change varies according to the rotating speed of the "Rotary knob". Rotate at high speed to increase or at low speed to decrease the amount of change.

■ How to use the CURSOR key

In each setting screen, the cursor is used to select the value of the blinking item. Moves the cursor up and down or right and left to select the value. The “CURSOR ▲, ▼, ▶, ◀” keys are used to move the cursor.

When “PREV / NEXT” appear on the front panel display, press the “ENTER” key or the “NEXT (SHIFT + ▶)” key and proceed to the following screen. Press the “PREV (SHIFT + ◀)” to go back to the previous screen.

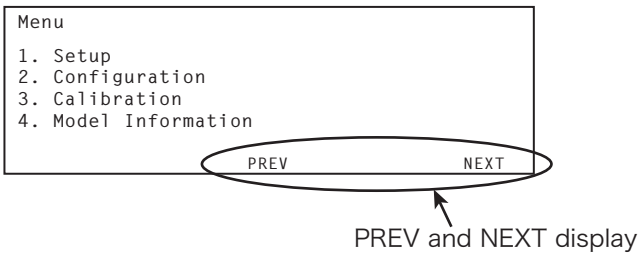


Fig.3-1 PREV and NEXT display

■ Selecting items

To select one of several choices, turn the "Rotary knob" to display the desired setting.

■ Entering values

For numerical settings, you can increase or decrease the value by turning the "Rotary knob". If the value consists of many digits, you can press the or “CURSOR” key to move the cursor directly to the desired digit and increase ◀ or ▶ decrease of the value only for that digit.

■ Invalid key operation

The PLZ6000R is controlled from the operation panel on the front panel. If you make an invalid selection or perform an invalid key operation, a beep is sounded to notify the error.

3.2 Turning the Power On

See p. 3-4

The procedure to turn the “POWER” switch on is given below. When turning the “POWER” on with the default setting, the load current does not flow. To supply the load current, turn on the load.

⚠CAUTION

- Allow an interval of 20 seconds or more between power cycles. Any shorter interval poses the risk of malfunction of the inrush current limit circuit, or the “POWER” switch may no longer turn on.
- Note that if “Load on” is set, the load will turn on affer turning the power on (Menu setting: 2. Configuration > 2. Pow On > Load On). Refer to Table 3-4 for the panel operation.

Turning the POWER switch On

See p. 2-6, p. 2-10

1. Check that the “POWER” switch is turned off (○).
2. Check that all wiring is correctly connected.
3. Raise the lever and turn the “POWER” switch to on (|).
4. Check the firmware version on the front panel display.

   Model and firmware version are displayed.

```
MODEL   : PLZ6000R
VERSION : IFC  1.00
          IOC  1.00
          DSP  1.00
```

Fig. 3-2 Version display example
(Ver. IFC 1.00, IOC 1.00, DSP 1.00)

See p. 3-18

The PLZ6000R powers up using the factory default settings when the “POWER” switch is turned on for the first time after purchase.

See p. 3-7

When the “POWER” switch is turnd on while the AC line voltage is in abnormal condition, the protevtion function activates to turn off the “POWER” switch, however, the alarm status may not be indicated on the panel display.

Turning the POWER Off

Lower the lever and turn the “POWER” switch to off (○).

The PLZ6000R saves the last setup conditions, menu setup, memory settings (ABC preset memory, setup memory) through the backup function when the “POWER” switch is turned off.

See p. 3-8

The AC_UVP alarm occurring at power-on time does not indicate a fault.

3.3 Turning On or Off the Load

"Turning on the load" refers to the operation of supplying current to the PLZ6000R. "Turning off the load" refers to the operation of cutting off the current to the PLZ6000R.

Each time the "LOAD" switch is pressed, it turns on or off the load. When the protection function trips except "OCP", "OPP" and "LIMIT (current or voltage value restriction)" are activated, it automatically turns off the load.

- Load on: The load current flows.
  The left LED of the "LOAD" switch illuminates.
  The operating mode is displayed.
- Load off: The load current does not flow
  The left LED of "LOAD" switch turns off.

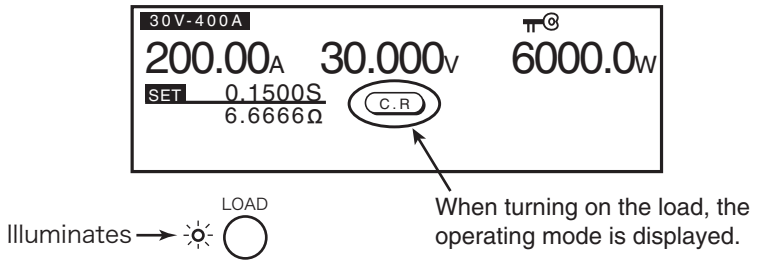


Fig. 3-3 Load on status display (example of C.R operation)

⚠CAUTION

- There is a danger of breakdown. Turn off the load when applying the output of the equipment under test to the PLZ6000R. Then, turn the load on. If you are making the connection with the load turned on, be sure to turn off the output of the equipment under test. If a relay or electromagnetic switch is inserted between the load input terminal and the output terminal of the equipment under test, turn on the relay or electromagnetic switch when the load is turned off. Then, turn the load on.

Starting with the load turned on

See Table 3-4

If you select 2. Configuration > 2. Power On from the menu and set the "Load On" setting to on, the load is turned on when you turn on the "POWER" switch. The new setting is confirmed by power cycling the PLZ6000R. However, if the load is turned off with an external contact, the unit does not start with the load on status when the "POWER" switch is turned on, when the load on/off switch of the external control is the load off.

3.4 Protection Functions and Alarms

The PLZ6000R is equipped with the following protection functions.

- Overcurrent protection (OCP)
- Overpower protection (OPP)
- Reverse connection protection (REV)
- AC input overvoltage protection (AC_OVP)
- AC input overcurrent protection (AC_OCP)
- AC input undervoltage protection (AC_UVP)
- Frequency protection (UFP/OFP)
- Alarm input protection (EXTERNAL)
- Parallel operation slave alarm (PARA ALM)
- Internal overcurrent protection (UNIT OCP 0 to UNIT OCP 3)
- Internal circuit protection (SNB 0 to SNB 1, DC OVP, IGBT)
- Overvoltage protection (OVP)
- Undervoltage protection (UVP)
- Overheat protection (OHP)

Occrrance and releasing alarms

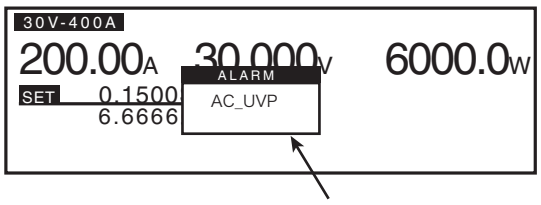
Occurance of an alarm

See p. 4-30

An alarm is generated when the protection trips.

When the alarm is occured, the alarm sounds and the protection function appears on the display. In such cases, the PLZ6000R turns off automatically for the load or the power. As for the overcurrent protection (OCP) and the overvoltage protection (OVP), you can select the voltage or current limit as well as the load off.

In the event of any alarm occurrence, the ALARM STATUS (pin #10) of J1 connector on the rear panel is turned on (Output by the relay contact).



When the alarm occurs, the protection function appears on the display.

Releasing an alarm

When an alarm is activated, you can press the “ENTER” key to clear the alarm and the display, then it makes the key operation possible. If the alarm will not be released even though all causes for alarm are cleared, the product may be malfunction. Contact your Kikusui distributor or agent.

Protection function

Overcurrent protection (OCP)

The protection trips when a current flows that is equal to greater than the specified overcurrent value, 440 A with the 30 V range, 220 A with the 60 V range. At this point, the load is turned off (LOAD OFF) or to limit the trip point of overcurrent protection. The OCP trip point can be set when in a mode other than CC mode.

See p. 3-13

To set the protect action when the OCV is activated, select 1. Setup > 2. Protect Action > OCP from the menu settings.

When “LIMIT” is specified, the “OCP” is automatically cleared when the alarm condition is corrected.

■ Setting the overcurrent trip point

1. Press the “LOAD” switch to turn it off.
2. Press the “OCP” key.

   The “OCP” key illuminates.
3. Turn the "Rotary knob" to set the overcurrent trip point (2.00 A to 440.00 A).

Overvoltage protection (OVP)

The protection trips when a current that is equal to or greater than the specified overcurrent value, 33 V is applied with 30 V range or 66 V is applied with 60 V range. At this point, the load is turned off (LOAD OFF).

Overpower protection (OPP)

The protection trips when a power, that is equal to or greater than the specified overpower value, or 6600 W or more is applied. At this point, the load is turned off (LOAD OFF) or to limit the trip point of overpower protection.

To change the protect action, select 1. Setup - 2. Protect Action - OPP and specify “LIMIT” or “LOAD OFF”. When “LIMIT” is specified, the limit is cleared when the alarm condition is corrected.

The “OPP” trip point can be set in a mode other than CP mode.

See Table 3-4

To change the protect action, select 1. Setup > 2. Protect Action > OPP of the menu setting and specify LIMIT or LOAD OFF.

When “LIMIT” is specified, the “OPP” is automatically cleared when the alarm condition is corrected.

■ Overpower protection trip point setting

1. Press the “LOAD” switch to turn it off.
2. Press the “OPP” key.
   The “OPP” key illuminates.
3. Turn the "Rotary knob" to set the overpower trip point (1.0 W to 6600.0 W).

Undervoltage protection (UVP)

The protection trips when the voltage equals or falls below the specified voltage (Trip point of undervoltage protection). At this point, the load is turned off. The undervoltage protection can be disabled (OFF).

See p. 4-6

When the elapsed time display (Count Time) is set to ON, the elapsed time from the last load on to load off is displayed on the display.

■ Undervoltage protection trip point setting

1. Press the “LOAD” switch to turn it off.
2. Press “UVP (SHIFT + OCP)”.
   The “UVP” setting value is displayed.
3. Turn the "Rotary knob" to set the undervoltage trip point (OFF, 0.000 V to 60.000 V).
   If the UVP is not needed, select “OFF”.

Reverse connection protection (REV)

The protection trips when a reverse voltage is applied to the load input terminal. At this point, the load turns off.

Immediately turn off the power to the equipment under test.

Overheat protection (OHP)

The protection trips when the temperature inside the power unit exceeds 80 ˚C. At this point, the load is turned off.

Check whether the air intake on the front panel and the air outlet on the rear panel are being obstructed.

AC line terminal overvoltage protection (AC_OVP)

The protection trips when the voltage equal to 240 V or higher is applied to the AC line terminal. At this point, the load turns off and the “POWER” switch turns off automatically.

AC line terminal overcurrent protection (AC_OCP)

The protection trips when the current equal to 32 A or higher is drawn to the power cable connected to the AC line terminal. At this point, the load turns off and the "POWER" switch turns off automatically.

AC line terminal undervoltage protection (AC_UVP)

The protection trips when the voltage equal to 170 V or lower is applied to the AC line terminal. At this point, the load turns off and the "POWER" switch is turned off automatically. This alarm also occurrs when the "POWER" switch is turned off. Because the AC input power is cut off, the equipment does not malfunction.

Underfrequency/Overfrequency protection (UFP/OFP)

The protection trips when a frequency of 45 Hz or lower, or 65 Hz or higher is applied to the AC line terminal. At this point, the alarm is displayed, the load turns off and the "POWER" switch turns off automatically.

External alarm input detection (EXTERNAL)

The external alarm input detection trips when the emergency stop signal is input from the external equipment and not when the alarm is detected on the PLZ6000R.

The protection trips when a low level (TTL) signal is applied to the ALARM INPUT (pin #14) of the J1 connector on the rear panel. At this point, the load is turned off.

Release the alarm on the equipment connected to external control, and then release the alarm on the PLZ6000R.

Parallel operation alarm protection (PARA ALM)

The protection trips when the slave unit alarm occurs during parallel operation and the alarm is input to the master unit. At this point, the load of all units in the system will be turned off.

Internal OCP (UNIT OCP 0 to UNIT OCP 3)

The protection trips when the overcurrent flows through the internal DC load circuit. At this point, the load is turned off. If the alarm often occurs, the PLZ6000R may have failed to operate properly. Contact your Kikusui agent.

Internal circuit protection (SNB 0 to SNB 1, DC OVP, IGBT)

The protection trips when the overcurrent flows through or the overvoltage is applied to the internal power convertor circuit. At this point, the load is turned off. Also, the protection trips when the DC OVP or the IGBT alarm occurs. At this point, the load is turned off and the "POWER" switch is turned off automatically. If the alarm often occurs, the PLZ6000R may have failed to operate properly. Contact your Kikusui agent.

3.5 Operation Modes

The following four operation modes are available on the PLZ6000R. Furthermore, constant voltage mode (+CV) can be added to CC and CR modes.

- Constant current mode (CC mode and CC+CV mode)
- Constant resistance mode (CR mode and CR+CV mode)
- Constant voltage mode (CV mode)
- Constant power mode (CP mode)

Switching operation modes

You can switch the operation mode by pressing the CC, CR, CV or CP key. The pressed key illuminates. By pressing +CV (SHIFT+ CV) in CC mode or CR mode, you can add CV mode. The operation modes can be switched even when the load is turned on. If the operation mode is switched with the load turned on, once the current is cut off, the operation mode is switched to the specified mode.

3.5.1 CC Mode

In CC mode, you set the current [A].

Table 3-1 CC/CC + CV mode setting value

	30 V range	60 V range
Current setting value	0.00 A to 408.00 A	0.00 A to 204.00 A
Voltage setting value	3.000 V to 31.500 V	6.000 V to 63.000 V

1. Press the “LOAD” switch to turn it off.
2. Press the “CC” key to select the CC mode.
   The “CC” key illuminates.
3. Press the “RANGE” key to select the range (30 V/60 V).
4. Press the “SET/VSET” key.
5. Turn the "Rotary knob" to set the current value.
6. Press the “LOAD” switch to turn it on.
   The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.
   Turn the "Rotary knob" to change the current setting.
7. Press the “LOAD” switch to turn it off.
   The left LED of the “LOAD” switch turns off.

CC + CV mode

You can add CV mode in CC mode.

1 Press the “LOAD” switch to turn it off.

2 Press the “CC” key to select the CC mode.

The “CC” key illuminates.

3 Press the “RANGE” key to select the range (30 V / 60 V).

4 Press the “+ CV (SHIFT+ CV)” key to set the CC + CV mode.

The “CC” and “CV / + CV” key illuminate.

See Table 3-1

5 Turn the "Rotary knob" to set the current value and voltage value.

Press the SET/VSET key to switch to the current/voltage setting.

6 Press the “LOAD” switch to turn it on.

The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.

Turn the "Rotary knob" to change the current or voltage setting.

7 Press the “LOAD” switch to turn it off.

The left LED of the “LOAD” switch is turned off.

The CC+CV mode operation is indicated by “CV” displayed on a colored background C.V on the front panel.

3.5.2 CR Mode

In CR mode, you set the conductance [S], an inverse of the resistance. The resistance calculated from the conductance is also displayed.

Conductance [S] = 1/resistance [Ω]

Table 3-2 CR / CR + CV mode setting value

	30 V range	60 V range
Conductance setting value	136.0000 S to 0.0000 S	34.0000 S to 0.0000 S
Voltage setting value	3.000 V to 31.500 V	6.000 V to 63.000 V

1 Press the “LOAD” switch to turn it off.

2 Press the “CC” key to select the CC mode.

The “CR” key illuminates.

3 Press the “RANGE” key to select the range (30 V / 60 V).

4 Press the “SET/VSET” key.

5 Turn the "Rotary knob" to set the conductance value [S].

6 Press the “LOAD” switch to turn it on.

The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.

Turn the "Rotary knob" to change the conductance setting.

7 Press the “LOAD” switch to turn it off.

The left LED of the “LOAD” switch is turned off.

CR + CV mode

You can add CV mode in CR mode. The conductance value is displayed in the CR + CV mode.

1 Press the “LOAD” switch to turn it off.

2 Press the “CR” key to set the CR mode.

The “CR” key illuminates.

3 Press the “RANGE” key to set the range (30 V / 60 V).

4 Press the “+ CV (SHIFT + CV)” to set the CR + CV mode.

The ”CR” and “CV / + CV” key illuminate.

5 Turn the "Rotary knob" to set the conductance value and voltage value.

Press the “SET/VSET” key to switch to the conductance/voltage setting.

6 Press the “LOAD” switch to turn it on.

The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.

Turn the "Rotary knob" to change the conductance or voltage setting.

7 Press the “LOAD” switch to turn it off.

The left LED of the “LOAD” switch is turned off.

The CR+CV mode operation is indicated by “CV” displayed on a colored background C.V on the front panel.

3.5.3 CV Mode

In CV mode, you set the Voltage [V].

1 Press the “LOAD” switch to turn it off.

2 Press the “CV” key to set the CV mode.

The “CV” key illuminates.

3 Press the “RANGE” key to set the range (30 V / 60 V).

4 Press the “SET/VSET” key.

See Table 3-1

5 Turn the "Rotary knob" to set the voltage value.

6 Press the “LOAD” switch to turn it on.

The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.

Turn the "Rotary knob" to change the voltage setting.

7 Press the “LOAD” switch to turn it off.

The left LED of the “LOAD” switch is turned off.

3.5.4 CP Mode

In CP mode, you set the wattage (W).

1 Press the “LOAD” switch to turn it off.

2 Press the “CP” key to set the CP mode.

The “CP” key illuminates.

3 Press the “RANGE” key to set the range (30 V / 60 V).

4 Press the “SET/VSET” key.

5 Turn the “Rotary knob” to set the wattage (0 W to 6300 W).

6 Press the “LOAD” switch to turn it on.

The left LED of the “LOAD” switch illuminates, and the current flows. The display shows the operation mode and the measured values (voltage, current, and wattage) at the load input terminal.

Turn the "Rotary knob" to change the wattage setting. The maximum value or higher can be set to the power value.

7 Press the “LOAD” switch to turn it off.

3.5.5 Range Switching

You can set the range with the load turn to off. The selectable ranges are the 30 V and 60 V.

Table 3-3 Voltage range

Range	Maximum current	Maximum voltage	Maximum power
30 V	400 A	30 V	6000 W
60 V	200 A	60 V	

The range (30 V/60 V) is alternated each time you press the RANGE key. The setting values vary according to the range.

3.6 Menu Setup

The menu is used to change the operating conditions or measurement function of the PLZ6000R.

Fig. 3-4 Menu display (in case of item #1)

1 Press the “LOAD” switch to turn it off.

2 Press the “MENU (SHIFT + SET / V SET)” key to proceed to the menu screen (Fig. 3-4).

3 Press the “▲” and “▼” or “NEXT(SHIFT + ▶)” CURSOR key several times until the desired menu item is highlighted on the menu.

Press the “NEXT (SHIFT + ▶)” key to display the sub categories of the highlighted item.

Press the “PREV (SHIFT + ◀)” key to go back to the previous screen.

4 Turn the "Rotary knob" to select the value of the item.

To continue the menu setting, repeat the step 3 and step 4 .

5 Press the “MENU (SHIFT + SET / V SET)” key to end the menu setting. Exit from the menu.

NOTE

- In 2. Configuration setting, power cycle the PLZ6000R 20 seconds or more after finishing the menu setup. The new setting is confirmed by power cycling the PLZ6000R.

Table 3-4 shows the menu setting items. The underlined items are the default settings.

Table 3-4 Menu Items

Menu name1	Menu name 2	Menu name 3	Value	Description	See Page
1. Setup	1.Function	Soft Start	20 ms, / 50 ms / 100 ms /200 ms	Soft start time	3-15
		Count Time	OFF / ON	Load on elapsed time display	4-6
	2.Protect Action	OCP	LOAD OFF / LIMIT	OCP setting	3-5
		OPP	LOAD OFF / LIMIT	OPP setting	3-6
	3.Memory	Recall	DIRECT / SAFETY	Preset memory recall method	4-3
	4.Cut Off	Time	OFF,/0:00:01 - 999:59:59 (hour : min. : s..., ms)	Automatic load off timer	4-6
	5.Response	Response CC,CR	1/1 / 1/2 / 1/5 / 1/10	CC and CR modes response speed	3-15
		Response CV	1/1 / 1/2 / 1/5 / 1/10	CV mode response speed	3-15
2. Configuration*1	1.Master/ Slave	Operation	Master / Slave	Master or slave setting	4-37
		Parallel*2	– / 2 - 5	Total unit number of the parallel operation	4-37
	2.Pow On	Load On	OFF / ON	Load on at power-on	3-4
		Key Lock	OFF / ON	Panel operation lock at power-on	3-17
	3.Interface	Control	GPIB / RS232C / USB	Remote control source	5-2
		Adress*3	1 - 32	GPIB adress	5-4
		Baudrate*4	2400 bps / 4800 bps / 9600 bps / 19200 bps	Baud rate setting	5-6
		Data, Stop*4	8,1 / 8,2	Data length (8 bit fixed), Stop bit	5-6
		Parity*4	NONE	Parity (fixed)	5-6
		VID*5	0x0B3E	Vendor ID (display only)	–
		PID*5	0x100C	Product ID (display only)	–
		S/N*5	xxxx	Serial No. (display only)	–
	4.External	Control CC/CR/ CP	OFF / V / R / Rinv	External control: CC/CR/CP mode	4-20
		Control CV	OFF / V / R / Rinv	External control: CV mode	4-20
		LoadOn IN	LOW / HIGH	External control: Load on/off logic	4-20
	5.Remote Sensing	Sensing	OFF / ON	Remote sensing	4-19
3. Calibration	1.CC (200A)		Refer to 6.2, “Replacing the Backup Battery” on p. 6-4.	CC mode 200 A range calibration	–
	2.CC (400A)			CC mode 400 A range calibration	–
	3.CV (60V)			CV mode calibration	–
4. Model Info*6		MODEL	PLZ6000R	Model name	3-3
		VERSION	FC IOC DSP	Version NO.	3-3

*1. The new setting of configuration is confirmed by power cycling the PLZ6000R.
*2. The item is displayed only when selecting 2.Configuration > 1.Master/Slave > Operation and set Master.
*3. The item is displayed only when selecting 2.Configuration > 3.Interface > Control and set GPIB.
*4. The item is displayed only when selecting 2.Configuration > 3.Interface > Control and set RS232C.
*5. The item is displayed only when selecting 2.Configuration > 3.Interface > Control and set USB.
*6. Item value is not changed.

3.7 Soft Start Time Setting

The soft start function is used in CC mode when the voltage is applied from a no-input state (0 V) with the load already on, so that the input current from the load side rises gradually when turned on, or the load is turned on.

When the currnt rise time of the load is faster than the EUT (equipment under test), the distortion may be generated on the output voltage. By setting the soft start time appropriately, the distortion of the output voltage of the EUT is suppressed.

Set the soft start time in advance according to the rise tome of the EUT.

See Table 3-4

Select 1.Setup > 1.Function > Soft Start on the menu. Set the soft start time (20 ms / 50 ms / 100 ms / 200 ms).

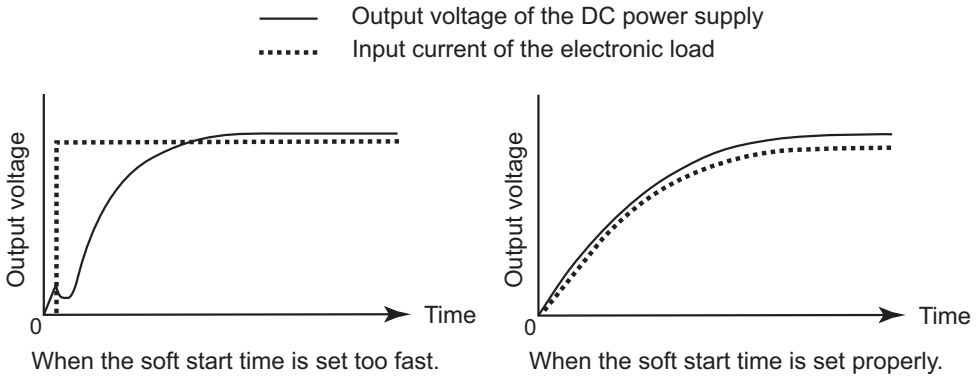


Fig. 3-5 Operation of the soft start time setting

3.8 Response Speed

The PLZ6000R operates by detecting the input current or voltage and feeding back those values. You can set the response speed of the negative feedback control. The response speed can be specified in CC mode (CC + CV mode) and CR mode (CR + CV mode). You can decrease the response speed to assure stable operation. If the load cable is long or has a large loop, the wire inductance is increased. In such conditions, the input voltage may fall below the minimum operating voltage of the PLZ6000R causing the current waveform to be distorted. In some cases, the input voltage may exceed the maximum input voltage and cause damage to the PLZ6000R.

In such cases, it is important that you use the shortest twisted wire possible for the connection. Then, decrease the slew rate setting or lower the response speed so that the voltage induced by the inductance is within the minimum operating voltage and the maximum input voltage range of the PLZ6000R.

Also, in the case of DC operation also, the phase lag of the current may cause instability in the PLZ6000R control inducing oscillation. If this occurs, use the shortest twisted wire possible for the connection, and achieve stable operation by lowering the response speed.

■ Setting the response speed

The menu setting allows you to set the response speed. For the CC and CR modes, the response speed time is the same speed. For the CV mode, the response speed time is set separately from the CC and CR modes.

See Table 3-4

Table 3-5 Response speed time

Mode	Setting method (menu settings)	Setting value
CC	1.Setup > 5.Response > Response CC,CR	1 / 1, 1 / 2, 1 / 5, 1 / 10
CR		
CV	1.Setup > 5.Response > Response CV	

Value:

1 / 1	Normal response speed (default setting)
1 / 2	1/2 the normal response speed, (Slows down by a factor of 2.)
1 / 5	1/5 the normal response speed, (Slows down by a factor of 5.)
1 / 10	1/10 the normal response speed, (Slows down by a factor of 10.)

Settings other than 1/1 slow down the speed and otherwise affect the performance of soft start and the slew rate, as well as the rise and fall times of load on/off.

During parallel operation, the response speed of the master unit is used.

3.9 Other Settings

Lock function

The PLZ6000R can be locked to prevent erroneous operation such as inadvertently changing the settings or overwriting the memory or sequence. The functions that can be used when the lock function is enabled are indicated below.

- Load on/off: “LOAD” switch
- Sequence execution: “RUN” key
- Lock clear: “LOCK (SHIFT + LOCAL)” key
- ABC preset memory recall: “A, B, C” key
- Setup memory recall: “RECALL” key

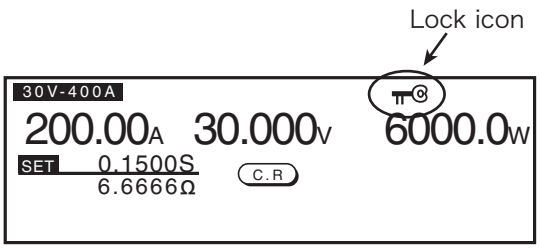


Fig. 3-6 Example of locking operation panel

■ Setting the lock

Press the “LOCK (SHIFT + LOCAL)” key to lock the operation panel. A key icon is indicated in the upper-right of the display.

■ Releasing the lock

Hold down “LOCK (SHIFT + LOCAL)” for a few seconds until a beep is heard. The lock is released and the key icon clears.

Locking the PLZ6000R at power on

By default, the PLZ6000R is not locked at power on. You can change the setting from the menu so that the PLZ6000R is locked at power on.

See Table 3-4

Select 2.Configration > 2.Pow On > Key Lock on the menu and select ON.

Display contrast

You can change the display contract by turning the "Rotary knob" while holding down the “SHIFT” key.

Turn the "Rotary knob" clockwise to increase the contrast, and counterclockwise to decrease the contrast.

Switching from remote to local control

The R↗ is displayed when the PLZ6000R is being controlled remotely. You can switch to panel control (local control) by pressing the “LOCAL” key.

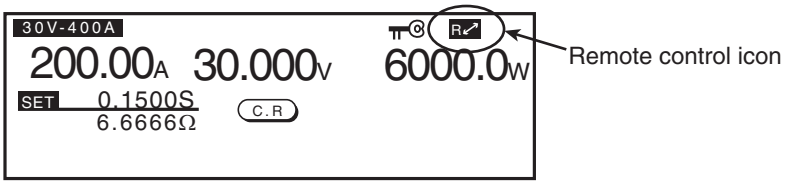


Fig. 3-7 Remote control panel display example

Displaying the AC power

The electric power of the main power supply is displayed in the lower right screen.

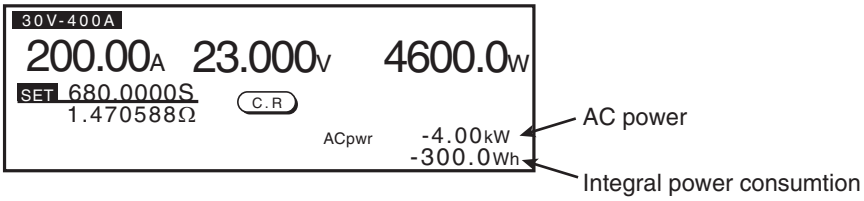


Fig. 3-8 Regenerative power display example

The AC power display or non display is alternated each time the “AC PWR DSPL” switch is pressed. When the regenerative function is activated, “-” (subtraction sign) is attached to the power value number.

Integral power consumption

The maximum display value of the integral power consumption is 4999.9 kWh. When the value exceeds 4999.9 kWh, it returns to 0. it can not be reset even when the POWER switch is turned off.

■ Resetting the integral power consumption

Press the “WHM RESET (SHIFT + AC PWR DSPL)” switch to reset the integral power consumption.

Factory default setting

While holding down the “ENTER” key, turning on the “POWER” switch initializes all settings shown in Table 3-6 to factory default. Also, the ABC preset and the setup memories are cleared.

Table 3-6 Factory default settings

Item	Settings (Panel settings)*1
OCP value	Maximum value
OPP value	Maximum value
UVP value	OFF
Current	0 A
Conductance	0 S
Voltage	3 V
Wattage	0 W
Voltage range	30 V
Load on/off	Load off
Operation mode	CC
ABC preset memories	Settings above in each mode
Menu setup	Refer to Table 3-4 (p. 3-14)

*1. Setup memory settings (all 100 sets) are same settings as the settings (Panel settings).

Applied Operation

This chapter describes the functions such as ABC preset memories, sequence function and external control that are used in actual applications.

4.1 ABC Preset Memories

The PLZ6000R has a feature which feature enabling storage of up to three different settings for the combination of each operation mode, range and setting value. Any desired setting can be stored by selecting the preset key of “A, B or C”. Also each of the stored setting can be recalled by selecting those keys. This ABC Preset Memory can be saved or recalled even when the load is turned on.

4.1.1 Storing the ABC Preset Memories

Three different settings for each combination of operation mode can be stored to preset memories A, B and C. These settings can be stored even when the load is turned on. Stored setting values are specified in Table 4-1

Table 4-1 Stored setting values

Operating Mode & Range		Stored Setting values
CC Mode	30 V	Current value in 30 V range
	60 V	Current value in 60 V range
CC + CV Mode	30 V	Current & voltage value in 30 V range
	60 V	Current & voltage value in 60 V range
CR Mode	30 V	Conductance value in 30 V range
	60 V	Conductance value in 60 V range
CR + CV Mode	30 V	Conductance & voltage value in 30 V range
	60 V	Conductance & voltage value in 60 V range
CV Mode	30 V	Voltage value in 30 V range
	60 V	Voltage value in 60 V range
CP Mode		Power value

1 Switch to the desired operation mode and set the range and value.

Set the stored condition.

2 Then, press the key of “ABC (SHIFT + C)”

The “A, B or C” key will be flashing on and off. To cancel the process, press any other keys on the control panel.

3 Press the “A, B or C” key to confirm the preset memory setting. The pressed key will be illuminated on by this time. The illuminated key will be turned off when the setting value is changed.

4.1.2 Recalling the ABC Preset Memories

Stored setting values cannot be recalled when in a different operation mode and range than the ones that were active when stored.

There are two methods for recalling memories: SAFETY and DIRECT. At the factory default setting, the SAFETY method is selected.

See Table 3-4

From the Menu, select 1.Setup > 3.Memory > Recall to select the DIRECT or SAFETY

Table 4-2 To recall the preset memories

Mode	Description
DIRECT	To recall the stored setting value in the preset memory without confirmation.
SAFETY	To Recall the stored setting value in the preset memory with confirmation.

DIRECT RECALL

Press A, B or C to recall the stored setting value of the preset memory.

SAFETY RECALL

1 Press either the A, B or C key to recall the stored setting value of the preset memory.

Pressed key will be flashing on and off and the stored setting value will be displayed. To cancel, press any other key besides A,B or C.

2 Confirm the setting values, then press the “ENTER” key.

The preset memory key will be illuminated on. The lighted key will be turned off when the setting value is changed.

4.2 Setup Memory

Up to 100 setting conditions can be stored. (in memory numbers 00 to 99), and up to 15 characters can be added for each memory.

Following contents can be saved.

- Operation mode (CC / CC + CV / CR / CR + CV / CV / CP)
- Setting value (Current/Resistance/Voltage/Power)
- Range setting (30 V / 60 V)
- Protection setting (OCP / OPP / UVP)
- Contents of preset memory for ABC (setting value applied to the Operation Mode, Range)

4.2.1 Saving to the Setup Memory

Set the desired setting value

1 Press the “STORE (SHIFT + B)” Key.

The “STORE” screen will appear on the display.

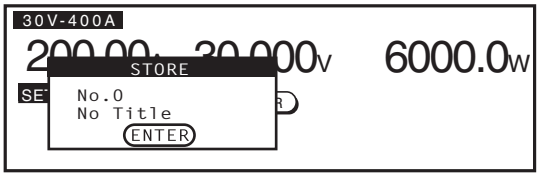


Fig.4-1 STORE Display

2 Turn the “Rotary knob” to select the memory number 0 to 99.

3 Press the “▼” key to move the cursor.

4 Enter up to 15 characters with the “Rotary knob” and the “▶ , ◀” keys, it can be registered up to 15 characters.

Turn the ""Rotary knob"" to select the characters, press the “▶” key to move to the right, press the “◀” key to return to the left.

Press the “SHIFT + ▲” key to insert the characters (INSR), press the “SHIFT + ▼” key to delete (DEL).

To cancel the transaction, press the “ESC” key or the “STORE (SHIFT + B)” key once again.

5 Press the “ENTER” key to store the setup memory.

The settings described above are saved to the selected memory number. If settings are already stored at the selected memory number, the settings will be overwritten.

4.2.2 Recalling the Setup Memory

The setup memory can not be recalled when the load is turned on.

Note that if the stored settings differ from the current operation mode or range settings, they will be switched to the memory settings.

1 Press the “LOAD” switch to turn off the load.

2 Press the “RECALL (SHIFT + A)” key.

The “RECALL” screen will appear on the display.

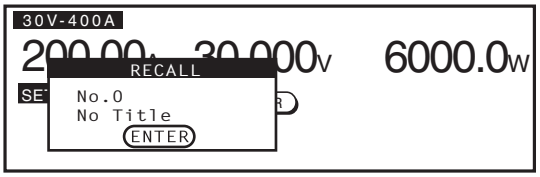


Fig.4-2 RECALL Display

3 Turn the "Rotary knob" to select the desired memory number (00 to 99).

To cancel the transaction, press the “ESC” key or the “STORE (SHIFT + B)” key once again.

4 Press the “ENTER” key to recall the setup memory.

The applied memory number will be recalled.

4.3 The Elapsed Time Display and the Auto Load Off Timer

Two convenient functions are available for the discharge tests of batteries.

- Measure the time from discharge start until the cutoff voltage is reached (the elapsed time display)
- Measure the closed circuit voltage after a specified time elapses from discharge start (automatic load off timer)

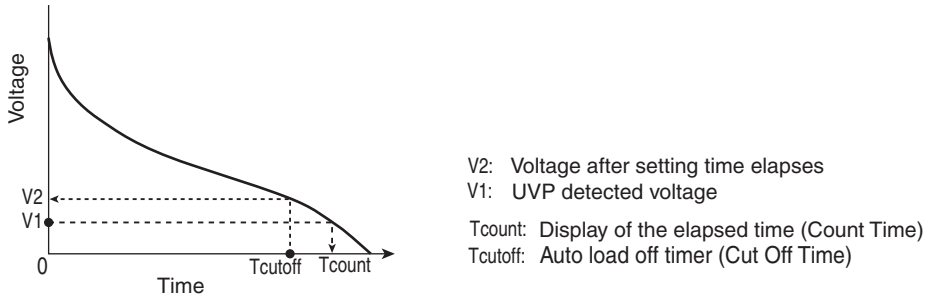


Fig.4-3 Count Time and Cut Off Time

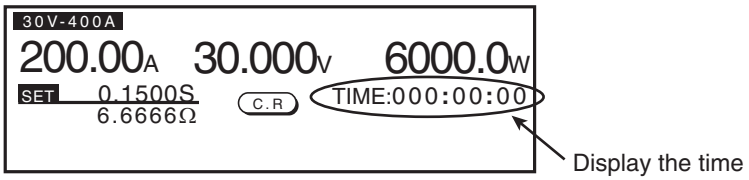


Fig.4-4 Elapsed time display

Elapsed Time Display (Count Time)

The elapsed time from load on and off will be appeared on the display.

See Table 3-4

1 From the setting menu, select 1.Setup > 1.Function > Count Time and select ON.

If the elapsed time display function is not required, select OFF to disable it.

Auto Load Off Timer (Cut Off Time)

If the load is turned off after the set load on time has elapsed, the voltage that is displayed is the input voltage measured just before the load is turned off.

See Table 3-4

By menu setting, go to 1.Setup > 4.Cut Off > Time and set the load on time (1sec. to 999 hours 59 minutes 59 seconds). If the Auto load off timer function is not required, select OFF for not to be used.

4.4 Sequence Function

The sequencer is a function that automatically executes a series of specified instructions, all at once. By specifying a sequence of operations (steps), various waveform simulations can be executed. The sequence that you create is saved by the backup function even when the power is turned off.

The sequence can be set and executed from either the operation panel or an external control via communication functions.

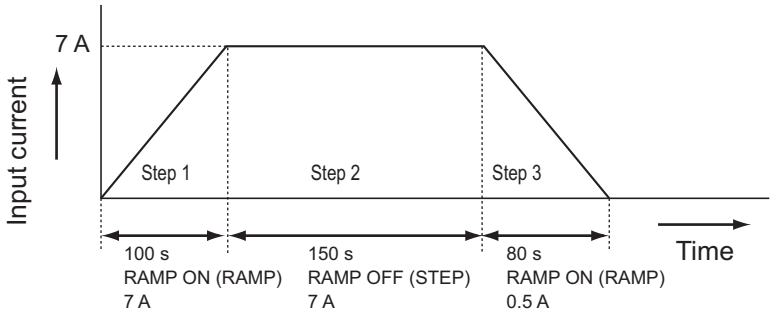


Fig.4-5 Sequence execution example

To create a sequence, you first need to understand the concept of a " Program" and a "Step"

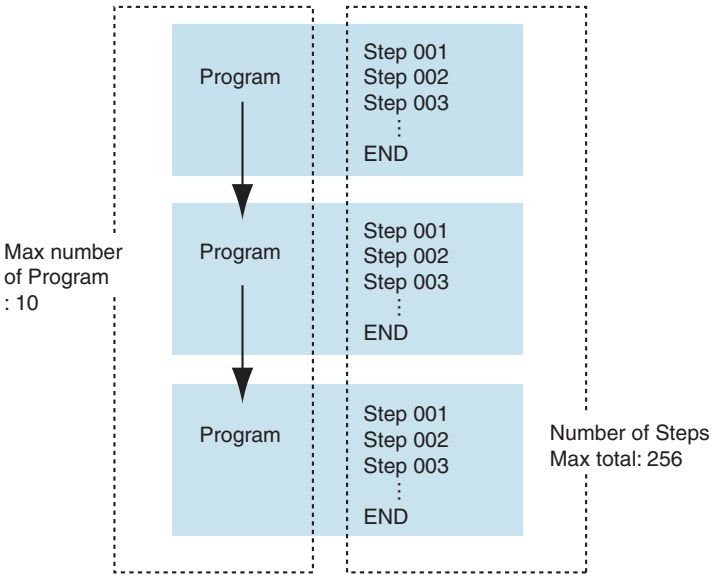


Fig.4-6 Conceptual diagram of programs and steps

A program is a collection of steps. When the specified program is executed (RUN), steps are executed one by one in ascending order from step number 001. The completion of the last step signifies the end of one program execution. It is also possible to execute the same program repeatedly or continue to execute the other program repeatedly (chain).

Program

The “Program” is a collection of steps, it indicates the mode, range.

Setting items are described in Table 4-3.

Table 4-3 Setup items on program

Item	Setup conditions	Description
No.	1 to 10	Program number
Memo	–	Memo (up to 11 characters)
Mode	CC/CR/CV/CP	Operation Mode
Range	30 V, 60 V	Range setting
Loop	1 to 9 999 times	Number of repeated cycle 9999 is infinite loop
Last Load	ON/OFF	Load condition when chain is off
Last Set	0 to 100 % of the range setting	Current value when chain is off
Chain	OFF, 1 to 10	The number of the next program to be executed after the end of the program

■ No.

Set the Program number. Up to 10 programs can be stored.

Value: 1 to 10

■ Memo

A memo of up to 11 characters can be added to each program.

The “Memo” can be used as an easy reference of program’s contents. Memos do not affect execution of sequence. It is suggested to include the test date, time, description of the test, name of program, and setting conditions in the memo to allow users to recall that information at a later time.

Turn the "Rotary knob" and the “▶ , ◀ ” key to enter the characters.

■ Mode

Set the operation mode of the program

Value:	NCC	CC Mode
	NCR	CR Mode
	NCV	CV Mode
	NCP	CP Mode

■ Range

Set the range of the program.

Value:	30 V to 400 A	30 V Range
	60 V to 200 A	60 V Range

■ Loop

Set the number of program loops. Select the number 9999 for an infinite loop. Press the STOP key to terminate the sequence operation when it is set for an infinite loop.

Value: 1 to 9 999 times (9999 is infinite loop)

■ Last load

Set the load ON/OFF at the end of the program when chain is off.

Value: ON Load ON after the end of program

OFF Load OFF after the end of program

■ Last set

Set the current value at the end of the program when chain is off.

Value: 0 to 408 30 V Range

0 to 204 60 V Range

Unit A

■ Chain

If the mode and range settings are of the same program, it can be executed continuously. Set the number of the program to be executed continuously. If the program selected is different range or mode the program is terminated.

Value: OFF Terminate the program

1 to 10 Number of the program to be executed continuously

Step

One execution condition can be specified per step. In other words, one operation of the executed waveform corresponds to one step. The setting of steps is described in Table 4-4.

Table 4-4 Setting of steps

item	Setup condition		description
No.	1 to 256*1		Number of steps
CC/CR/CV/ CP SET	CC Mode	30 V Range: 0 A to 408 A 60 V Range: 0 A to 204 A	Setting for the current value
	CR Mode	30 V Range: 136 S to 0 S 60 V Range: 34 S to 0 S	Setting for the conductance value
	CV Mode	30 V Range: 3 V to 31.5 V 60 V Range: 6 V to 63 V	Setting for the voltage value
	CP Mode	0 W to 6 300 W	Setting for the power value
h:min:s.ms	0:00:00.01 to 999:59:--.---		Execution time for the step
LOAD	ON / OFF		Load On or Off
RAMP	ON / OFF		Current transition ON: slope, OFF: step
TRIG	ON / OFF		Output or do not output the trigger signal during the step execution
PAUSE	ON / OFF		Pause or not pause during step execution

*1. Up to 256 steps can be shared among all programs (10 programs)

■ No.

Regardless of the number of programs. Up to 256 steps can be stoned, and each step can be shared among all programs (10 programs)

■ CC/CR/CV/CP SET

Set the values of current, conductance, voltage and wattage according to the operation mode and range.

Value:	CC Mode	30 V Range: 0 A to 408 A
		60 V Range: 0 A to 204 A
Value:	CR Mode	30 V Range: 136 S to 0 S (7.35 mΩ to OPEN)
		60 V Range: 34 S to 0 S (29.41 mΩ to OPEN)
Value:	CV Mode	30 V Range: 3 V to 31.5 V
		60 V Range: 6 V to 63 V
Value:	CP Mode	0 W to 6 300 W

■ h:min:s.ms

Set the step execution time.

Value: 00:00:00.01 to 999:59:--.--- (hours : minutes : seconds)

■ LOAD

Set the execution pattern of load “ON”/”OFF”.

Value:	ON	Load “ON”
	OFF	Load “OFF”

NOTE

- If the next step after a load ON/OFF is set to load ON/OFF, execution of the step will take at least 100 ms. Therefore, set the execution in this case to 100 ms or more.

■ RAMP (current transition)

Set the “RAMP”.

Value:	ON	slope form
	OFF	step form

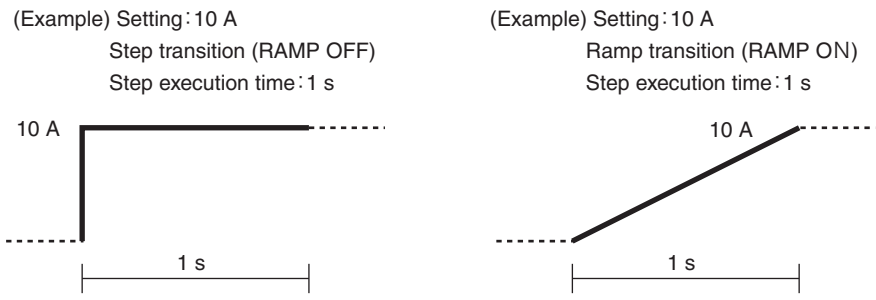


Fig.4-7 RAMP Sequence Example

■ TRIG (trigger output)

Set the presence or absence of trigger output.

Value: ON — A trigger signal is output from the TRIG OUT terminal on the front panel at the same time as the step is executed.

OFF — No trigger signal

(Example) Set the trigger output at step number n (TRIG ON)

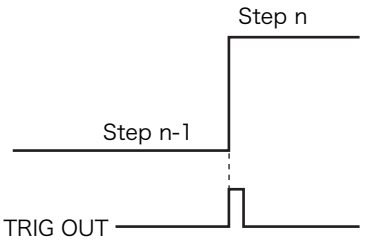


Fig.4-8 TRIG sequence example

■ PAUSE

Pauses the program.

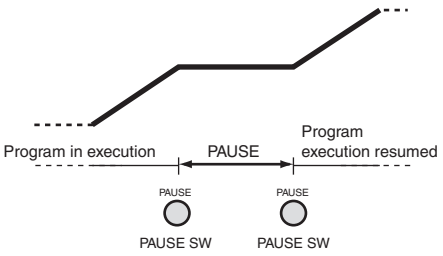
See p. 4-33

To resume, press the "RUN" key or apply the signal to the "TRIG INPUT (pin #11)"

Value: ON — The sequence operation is paused after executing the step.

OFF — The sequence operation is not paused.

(Example) Pause and resume using the PAUSE switch



(Example) Pause by executing PAUSE in a program and resume using trigger input (TRIG IN)

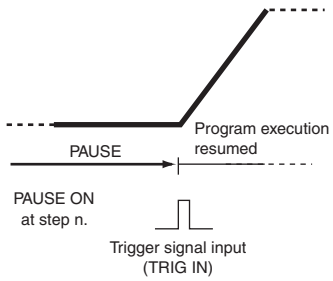


Fig.4-9 PAUSE sequence example

4.4.1 Sequence Setting

The contents of written programs can be stored by backup function even when the power is off.

Press the "ENTER" key or the "NEXT (SHIFT +▶)" key to move to the next screen, or press the "PREV (SHIFT +◀)" to go back to the previous screen.

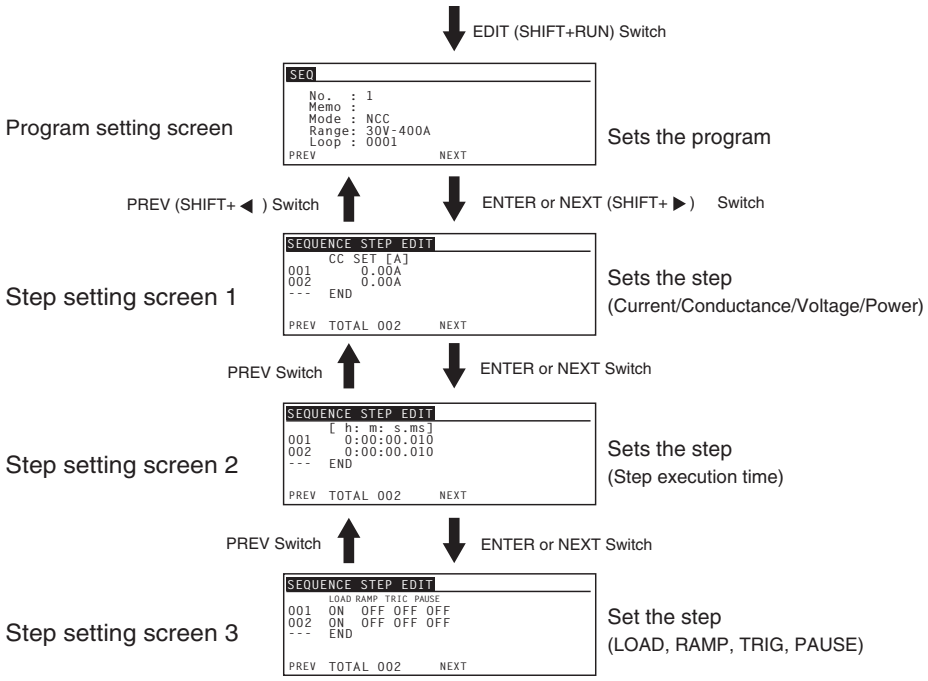


Fig.4-10 Sequence setting screen

1 Press the "LOAD" switch to turn off the load.

2 Press the "EDIT (SHIFT + RUN)" key to display the program setting screen.

3 Use the "Rotary knob" and the cursor keys, "▲, ▼, ▶, ◀" to set the condition of each parameter.
Refer to Table 4-3 for the program setting condition.

4 Press the "ENTER" key or "NEXT (SHIFT +▶)" key to display the step setting screen.
Refer to Table 4-4 for the step setting condition.

5 Press the "INS (SHIFT + ▲)" key to insert step 1.

6 Use the "Rotary knob" to set the value of the current, conductance, voltage and wattage.

7 Press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the screen from the step setting screen.

8 Use the "Rotary knob" and the cursor key "▲, ▼" to set the step execution time.

9 Press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the screen from the step setting screen.

10 Use the "Rotary knob" and the cursor keys "▶, ◀" to set "LOAD", "RAMP", "TRIG" and "PAUSE".

11 To add the steps, move the cursor to the "END" by the cursor key, then press the "INS (SHIFT + ▲)" key.

Additional steps will be added to the front of the highlighted step number.

Use the "Rotary knob", "◀, ▶" key, "PREV (SHIFT +◀)" key, and "NEXT (SHIFT +▶)" key to set each condition of the step.

Repeat this procedure to add as many steps as desired.

12 Press the "PREV (SHIFT +◀)" key for few times to complete the program editing.

Confirming the program and re-editing

To confirm or re-editing the program, press the "EDIT (SHIFT + RUN)" key again.

■ Inserting steps

1 Press the "LOAD" switch to turn off the load.

2 Press the "EDIT (SHIFT + RUN)" key to display the program setting screen.

3 Use the "Rotary knob" to select the desired program number.

4 Press the "ENTER" key or "NEXT (SHIFT +▶)" key to display the step setting screen.

5 Use the "▲, ▼" key to move the cursor and highlight the step line above which you wish to insert a new step.

6 Press the "INS (SHIFT + ▲)" key.

The new step line is inserted above the line where the cursor was.

7 Press the "PREV (SHIFT + ◀)" key a few times to finish editing the program.

■ Deleting steps

1. Press the “LOAD” switch to turn off the load.
2. Press the “EDIT (SHIFT + RUN)” key to display the program setting screen.
3. Use the "Rotary knob" to select the desired program number.
4. Press the “ENTER” key or “NEXT (SHIFT +▶)” key to display the step setting screen.
5. Use the “ ▲, ▼” key to move the cursor and highlight the step line to be deleted.
6. Press the “DEL (SHIFT + ▼)” key.
   The highlighted step line is deleted.
7. Press the “PREV (SHIFT +◀)” key a few times to finish editing the program.

4.4.2 Sequence Example

This section describes the procedure of entering the example sequence programs from the operation panel.

Flow of the example sequence

In this example, two programs (Program 1 and Program 2) are executed to simulate the waveform as described in Fig.4-11.

Program 1 and Program 2 each consist of 3 steps. Once the 3rd step of Program 1 ends, Program 2 repeats 2 times. After 2 executions of Program 2, the sequence program is completed.

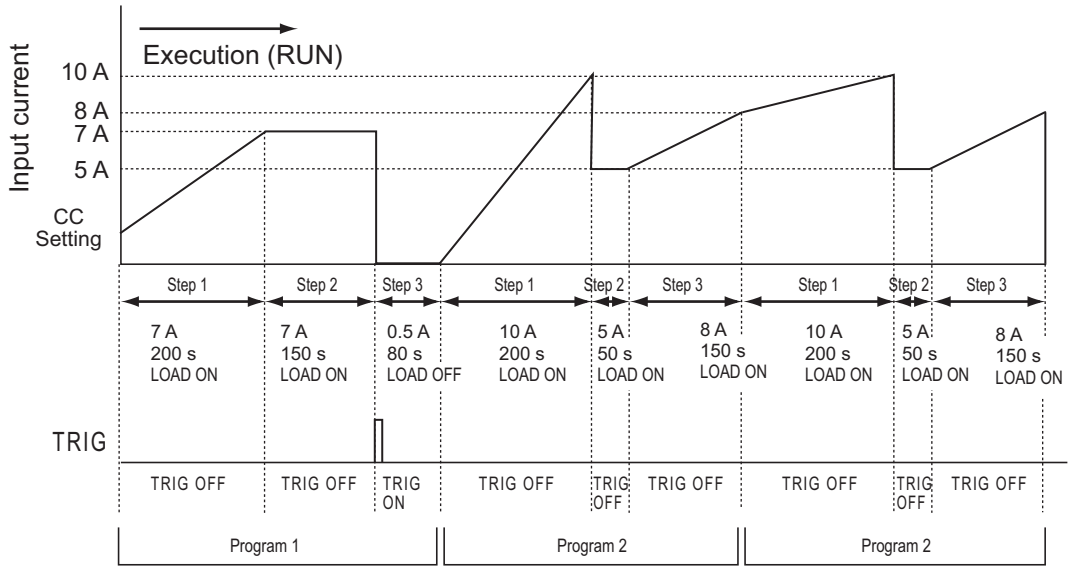


Fig.4-11 Sequence pattern example

Table 4-5 Sequence example, setting values

Program	Step No.	Current	Time	LOAD	RAMP	TRIG	PAUSE
Program 1 CC Mode One time only	Step 1	7 A	200 sec.	ON	ON	OFF	OFF
	Step 2	7 A	150 sec.	ON	OFF	OFF	OFF
	Step 3	0.5 A	80 sec.	OFF	OFF	ON	OFF
Program 2 CC Mode Repeat 2 times	Step 1	10 A	200 sec.	ON	ON	OFF	OFF
	Step 2	5 A	50 sec.	ON	OFF	OFF	OFF
	Step 3	8 A	150 sec.	ON	ON	OFF	OFF

Creating the sequence program

In this example, Program 2 was written after Program 1, but programs can be written in any order.

The steps shall be set in order from the “Current setting value” → ”Execution time” → Execution pattern”

1 Press the “LOAD” switch to turn off the load.

2 Press the “EDIT (SHIFT + RUN)” key to display the program setting screen.

3 Use the "Rotary knob" and the cursor key, “▲, ▼, ▶, ◀” to set each condition of the Program 1.

No.: 1
Memo: Program1
Mode: NCC
Range: 30 V to 400 A
Loop: 1
Last Load: OFF
Last Set: 0 A
Chain: 2

This example will continue to execute Program 2, so the setting status of “Last Load” and “Last Set” will be disregarded.

4 Press the “ENTER” key or the “NEXT (SHIFT +▶)” key to change the step editing screen.

At this stage, there is no setting entry for the step, so the last line of “END” is highlighted.

5 There are 3 steps in the Program 1, so press the “INS (SHIFT +▲)” key 3 times to insert the step lines.

The step lines of “001”, “002” and “003” are inserted.

6 Use the "Rotary knob" and the cursor key “▲, ▼” to set the current value of each step, and press the “ENTER” key or the “NEXT (SHIFT + ▶)” key to change the screen from the step setting screen.

Step 1: 7 A
Step 2: 7 A
Step 3: 0.5 A

7 Use the "Rotary knob" and the cursor key, "▲, ▼, ▶, ◀" to set the execution time of each step, and press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the screen from the step setting screen.

Step 1: 0:03:20.0 (200 s)
Step 2: 0:02:30.0 (150 s)
Step 3: 0:01:20.0 (80 s)

8 Use the "Rotary knob" and the cursor key, "▲, ▼, ▶, ◀" to set the execution pattern of each step.

Step 1: LOAD: ON, RAMP: ON, TRIG: OFF, PAUSE: OFF
Step 2: LOAD: ON, RAMP: OFF, TRIG: OFF, PAUSE: OFF
Step 3: LOAD: OFF, RAMP: OFF, TRIG: ON, PAUSE: OFF

All of the settings in Program 1 are now entered.

9 Next, set Program 2. Press the "PREV (SHIFT + ◀)" key for 3 times to display the program setting screen.

10 Use the "Rotary knob" and the cursor key, "▲, ▼, ▶, ◀" to set each condition of the Program 2.

No.: 2
Memo: Program2
Mode: NCC
Range: 30 V - 400 A
Loop: 2
Last Load: OFF
Last Set: 0 A
Chain: OFF

11 Press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the step editing screen.

At this stage, there is no setting entry for the step, so the last line of "END" is highlighted.

12 There are 3 steps in Program 2, so press the "INS (SHIFT +▲)" key for 3 times to insert the step lines.

The step lines of "001", "002" and "003" are inserted.

13 Use the "Rotary knob" and the cursor key "▲, ▼" to set the current value of each step, and press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the screen from the step setting screen.

Step 1: 10 A
Step 2: 5 A
Step 3: 8 A

14 Use the "Rotary knob" and the cursor key, "▲, ▼, ▶, ◀" to set the execution time of each step, and press the "ENTER" key or "NEXT (SHIFT +▶)" key to change the screen from the step setting screen.

Step 1: 0:03:20.0 (200 s)

Step 2: 0:00:50.0 (50 s)

Step 3: 0:02:30.0 (150 s)

15 Use the "Rotary knob" and the cursor key, "▲, ▼, ▶, ◀" to set the execution pattern of each steps.

Step 1: LOAD: ON, RAMP: ON, TRIG: OFF, PAUSE: OFF

Step 2: LOAD: ON, RAMP: OFF, TRIG: OFF, PAUSE: OFF

Step 3: LOAD: ON, RAMP: ON, TRIG: OFF, PAUSE: OFF

All of the settings in Program 2 are now entered.

16 Press the the "PREV (SHIFT + ◀)" key for 4 times to complete the program editing

This is the end of the setting procedure of the sequence example.

See p. A-18

For a profile of sequence program, see Appendix A.4, "Sequence Program Creation Table". For the result of example program, see Appendix A.5, "Sample Program".

4.4.3 Executing, Pausing and Stopping the Sequence

Executing the sequence

1 Press the "RUN" key to display the sequence execution screen.

The sequence execution screen is displayed. Press the "ESC" key to cancel the execution of the sequence.

2 Use the "Rotary knob" to select the execution program number (1 to 10).

3 Press the "RUN" key to execute the sequence.

The selected program is executed. The measured value during execution will appear on the display.

Pausing the sequence

If the "PAUSE" key is pressed while the sequence is executing, the PAUSE screen appears on the display, and the sequence operation pauses. To resume the operation, press the "PAUSE" key again. If the "STOP" key is pressed while the sequence is pausing, the sequence operations will be stopped.

If a "PAUSE ON" status is entered in a program step, the sequence automatically stops after executing the step. In this case, you can press the "PAUSE" key to resume.

Stopping the sequence

If the "STOP" key is pressed, the executing sequence will be stopped.

4.4.4 When the Sequence Can Not Be Executed

Sequences can not be executed in the following cases.

- If the mode or range of the chained program is different.
- If the load is turned on and the current mode and range settings do not match the settings of the attempted sequence which are attempted to execute.

When the load is turned off and the current mode and range settings do not match the setting of the sequence, the setting condition will be forced to change to the sequence settings and the sequence will be executed.

Table 4-6 Sequence: Operating modes and ranges

	Attempted sequence operating mode and range	Execution	After the execution of operating mode and range
Load on	Matches the current settings	Possible	Same as the current settings
	Does not match the current settings	Not possible	–
Load off	Matches the current settings	Possible	Same as the current settings
	Does not match the current settings	Possible	Forced to change to the current settings

4.5 Remote Sensing Function

The remote sensing function is for reducing the effect of voltage drop caused by the resistance of the wiring to the load. This function also stabilizes the input voltage of the load terminal. Please wire the remote sensing to accurately set the resistance, voltage and power.

Remote sensing improves the transient characteristics in the CR, CV and CP modes for stable operation.

WARNING • **The PLZ6000R may cause electric shock. Never wire to the sensing terminal when the "Power" switch is turned ON.**

CAUTION • If the load cable is disconnected when the remote sensing is being executed, the sensing wire may be damaged. Accidents can be prevented by connecting a protection fuse as shown in Fig.4-12. Use a fuse with a rated current of 0.5 A. and a rated voltage greater than the output voltage of the equipment under test.

Remote sensing wiring

Connect the remote sensing on the rear panel (+S) to the positive terminal of the equipment under test. Likewise, connect the remote sensing (-S) to the negative terminal.

Electric wire used

For mechanical strength, use a wire with a nominal cross sectional area of 0.5 mm^2 or more. Use the crimp terminal for M3 screws for the connection of the PLZ6000R.

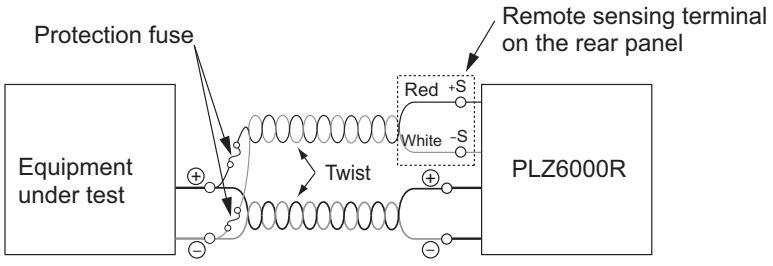


Fig.4-12 Remote sensing wiring

Remote sensing setting

See Table 3-4

By menu setting, go to 2.Configulation > 5.Remote Sensing > Sensing and select "ON". After the power is turned off, turn on the power, then the setting will be confirmed.

In case the remote sensing is not required, follow the same procedure as described in this section and select "OFF".

4.6 External Control

4.6.1 Overview of External Control

The settings in each operation mode use the internal reference signal. In external control, this reference signal is supplied by the external source. The external signal is either voltage (voltage control) or resistance (resistance control).

The external control can be controlled for the range between 0% to 100% of the setting in CC, CR, CP and CV mode.

See Table 4-10

The controls specified below can be controlled externally by the “J1 connector” on the rear panel of the PLZ6000R.

Table 4-7 External control using voltage or resistance

Control Method	Operation mode	Description
Voltage	CC, CP, CV	Change of 0 V to 10 V produces a change of 0 % to 100 % of the range
	CR	Change of 0 V to 10 V produces a change of maximum value to minimum value of the range
Resistance (Proportional)	CC, CP, CV	Change of 0 Ω to 10 kΩ produces a change of 0 % to 100 % of the range
	CR	Change of 0 Ω to 10 kΩ produces a change of maximum value to minimum value of the range
Resistance (Inverse proportional)	CC, CP, CV	Change of 10 kΩ to 0 Ω produces a change of 0 % to 100 % of the range
	CR	Change of 10 kΩ to 0 Ω produces a change of maximum value to minimum value of the range

There are other external controls as indicated below

Table 4-8 Other external controls

Function	Description
Load on/off	Turns on/off the load and monitor the load
Current range switching	Controls the range of each operation mode or monitor the range
Trigger input	Clear the pause in sequence operation
Alarm input	Forced activation of the Alarm
Current monitor	Monitors the input current
Short signal	Relay contact output

4.6.2 J1 Connector

⚠WARNING The PLZ6000R may cause an electric shock.

- **In case the J1 connector is not used, be sure to attach the dummy plug attached to the connector.**
- **Be sure to turn off the unit when attaching or removing the connector.**

To disconnect the connector, remove the lock levers located on either side of the unit and pull the connector itself.

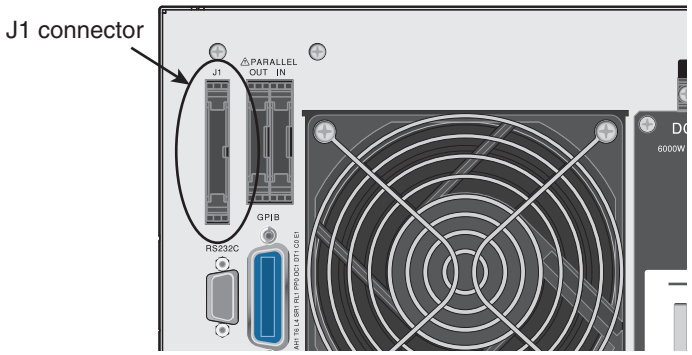


Fig.4-13 Rear panel

Connecting to the connector

Use a standard MIL 20 pin connector for connecting to the J1 connector. Table 4-9 shows the recommended connectors.

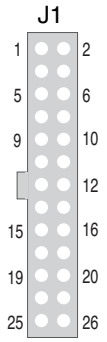
When using a flat cable, be sure to use a connector with a strain relief.

To press-fit discrete wires or flat cables, be sure to use a special tool. For a description of applicable cables and tools, see the relevant catalogues of connector manufacturers.

Table 4-9 Connectors supported, by manufacturer

Manufacturer	Product model/type	Notes
OMRON	XG5M-2632 or XG5M-2635 XG5S-1301 (2 pcs.)	For discrete wires
OMRON	XG4M-2630 XG4T-2604	For flat cables
KEL	6200-026-601	For flat cables

Table 4-10 J1 connector pin arrangement



Pin No.	Signal name	Description
1	EXT R/V CONT CC/CR/CP	Can be used in CC, CR, CV and CP modes
		0 V to 10 V correspond to 0 % to 100 % of 400 A, 6 kW (CC, CP Mode) 0 V to 10 V correspond to Maximum resistance to Minimum resistance (CR Mode)
		0 Ω to 10 kΩ correspond to 0 % to 100 % or 100 % to 0 % of 400 A or 6 kW (CC, CP Model) 0Ω to 10 kΩ correspond to Maximum resistance to Minimum resistance or Minimum resistance to Maximum resistance (CR Mode)
2	EXT R/V CONT CV	Can be used in CV, CC + CV, CR + CV modes
		0 V to 10 V correspond to 0 % to 100 % of 60 V.
		0 Ω to 10 kΩ correspond to 0 % to 100 % or 100 % to 0 % of 60 V.
3	IMON	Current monitor output 10 V f.s (30 V Range), 5 V f.s (60 V Range)
4	V MON	Voltage monitor output 5 V f.s (30 V Range), 10 V f.s (60 V Range)
5	A COM	R/V Control, Monitor Output Common
6	A COM	R/V Control, Monitor Output Common
7	N.C.	(N.A.)
8	N.C.	(N.A.)
9	LOAD ON STATUS	Turns On when the LOAD switch is pressed Output by the Relay contact. When it is ON, the Contact status will be “Make”
10	ALARM STATUS	Alarm (OVP, OCP, OPP, OHP, REV, UVP, AC OVP, AC OCP) Turns On when under operation or an external alarm is applied. The contact status will be “Make”
11	RANGE STATUS	Turns On when 30 V range is selected. Output by the Relay contact. When it is ON, the Contact status will be “Make”
12	STATUS COM	Status signal common for pins 9 to 11
13	STATUS COM	Status signal common for pins 9 to 11
14	ALM INPUT	Activates alarm with L of TTL level signal
15	LOAD ON/OFF CONT	Activate LOAD ON with L (or H) of TTL level signal
16	RANGE CONT	External range key input 60 V range with L of TTL level signal
17 18 19	MODE CONT 0 MODE CONT 1 MODE CONT 2	External mode key input

Mode	MODE CONT 0	MODE CONT 1	MODE CONT2
CC MODE	HI	HI	LOW
CR MODE	HI	LOW	HI
CP MODE	HI	LOW	LOW
CV MODE	LOW	HI	HI
CC + CV	LOW	HI	LOW
CR + CV	LOW	LOW	HI

20	PRESET A CONT	Recall of Preset Memory A with L of TTL level signal
21	PRESET B CONT	Recall of Preset Memory B with L of TTL level signal
22	PRESET C CONT	Recall of Preset Memory C with L of TTL level signal
23	TRIG INPUT	When paused, clear the pause with L of TTL level signal is applied for 100 ms or longer.
24	ALM CLR INPUT	When the alarm is detected, clear the alarm with a L of TTL level signal when any factor of alarm is solved.
25	E COM	External contact control input common
26	E COM	External contact control input common

4.6.3 External Control of Each Mode

The external control of each mode can be carried out using an external voltage or external resistance.

External voltage control

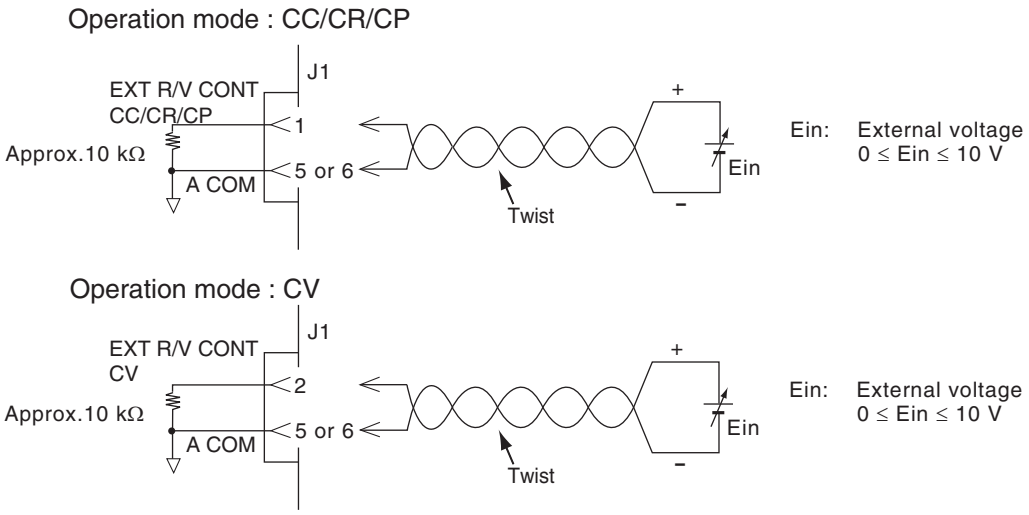
Table 4-11 External voltage control

Operation mode	Description	External voltage 0 V	External voltage 10 V
CC mode	It produces an input current as a proportional change when applying an external voltage in the range of 0 V to 10 V to the PLZ6000R	Input current: 0 A	Input current: 400 A*1
CR mode	It produces a resistance value as a proportional change when applying an external voltage in the range of 0 V to 10 V to the PLZ6000R	Maximum resistance	Minimum resistance
CP mode	It produces an input current as a proportional change when applying an external voltage in the range of 0 V to 10 V to the PLZ6000R	Wattage: 0 W	Wattage: 6 kW
CV mode	It produces an input current as a proportional change when applying an external voltage in the range of 0 V to 10 V to the PLZ6000R	Input voltage: 0 V	Input voltage: 60 V*2

*1. Input current will be 200 A when the external voltage applies 5 V in 60 V, 200 A range.
*2. Voltage value will be 30 V when the external voltage applies 5 V in 30 V, 200 A range.

⚠CAUTION

- The maximum voltage that can be applied across pins #1 and #5 or #6 of the J1 connector is ±11V. Applying a voltage exceeding this value can damage the PLZ6000R.
- The pin #5 and #6 (A COM) of the J1 connector is connected to the negative load input terminal. To prevent damaging the unit, be sure not to let the wire of pins #5 and #6 (A COM) touch any other pins.



CC mode	$Io \approx \frac{Im \times Ein}{10}$	Io: Input current Im: 400 A
CR mode	$\frac{1}{R0} \approx \frac{Gm \times Ein}{10}$	Ro: Operating resistance Gm: 134 S
CP mode	$Po \approx \frac{Pm \times Ein}{10}$	Po: Input power Pm: 6000 W
CV mode	$Vo \approx \frac{Vm \times Ein}{10}$	Vo: Input voltage Vm: 60 V

Fig.4-14 Equivalent circuit (by external voltage)

Setup procedure for the external voltage control

Use external voltage of low noise and high stability. As for the signal wire, use twisted wires. This can prevent disturbance from noise.

1 Pull down the “POWER” switch to turn off the power.

2 Connect the external voltage.

When the operation mode is in CC/CR/CP, connect the external voltage between pin #1 and #5 or #6 of the J1 connector. When the operation mode is in CV, connect the external voltage between pin #2 and #5 or #6 of the J1 connector.

3 Turn on the “POWER” switch.

4 Check that the load is turned off.

Check that the LED located to the left side of the LOAD switch is turned Off. If the LED is illuminated, press the “LOAD” switch to turn the load off.

5 Select the operation mode by pressing either “CC/CR/CV/CP” key.

See Table 3-4

6 Set the condition of external control from the setting menu.

Table 4-12 Setting condition of the external voltage control

Operation mode	Menu setting: conditions	External input setting
CC mode	2.Configuraion > 4.External > Control CC/CR/CP	V
CR mode	2.Configuraion > 4.External > Control CC/CR/CP	V
CP mode	2.Configuraion > 4.External > Control CC/CR/CP	V
CV mode	2.Configuraion > 4.External > Control CV	V

External voltage control is selected.

7 Turn on the “POWER” switch after turning off the “POWER” switch.

The menu settings are confirmed.

See p. 3-14

You can prevent the setting from being changed inadvertently during measurement by pressing the “LOCK (SHIFT + LOCAL)” key to enable the lock.

See Table 3-4

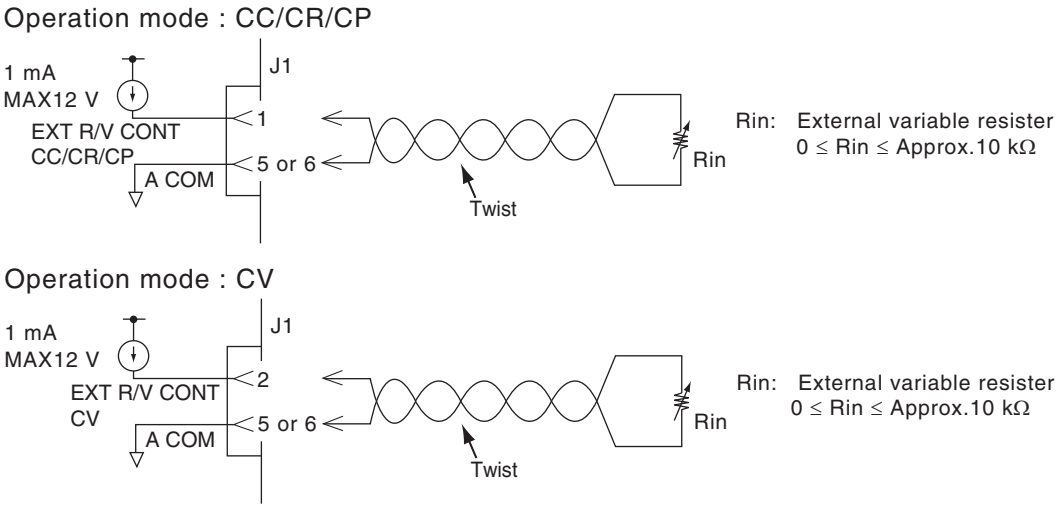
If the external control is not used, go to the menu setting 2.Configuration > 4.External > Control CC/CR/CP or turn Off the “Control CV”.

External resistance control

Table 4-13 External resistance control

Operation mode	Description	Proportional control		Inverse proportional control	
		Against external resistance of 0 Ω	Against external resistance of 10 Ω	Against external resistance of 10 Ω	Against external resistance of 0 Ω
CC Mode	Connecting an external resistance in the range of 0 Ω to 10 kΩ to the PLZ6000R produces an input current that is proportional or inversely proportional to the change.	Input current: 0 A	Input current: 400 A*1	Input current: 0 A	Input current: 400 A*1
CR Mode	Connecting an external resistance in the range of 0 Ω to 10 kΩ to the PLZ6000R produces an input current that is proportional or inversely proportional to the change.	Maximum resistance	Minimum resistance	Maximum resistance	Minimum resistance
CP Mode	Connecting an external resistance in the range of 0 Ω to 10 kΩ to the PLZ6000R produces an input current that is proportional or inversely proportional to the change.	Wattage: 0 W	Wattage: 6 kW	Wattage: 0 W	Wattage: 6 kW
CV Mode	Connecting an external resistance in the range of 0 Ω to 10 kΩ to the PLZ6000R produces an input current that is proportional or inversely proportional to the change.	Voltage: 0 V	Voltage: 60 V*2	Voltage: 0 V	Voltage: 60 V*2

*1. Input current will be 200 A when the external resistance applies 5 kΩ in the 60 V. 200 A range.
*2. Voltage value will be 30 V when the external resistance applies 5 kΩ in the 30 V, 400 A range.



CC mode	Proportional control $Io \approx Im\left(\frac{Rin(k\Omega)}{10}\right)$	Inverse proportional control $Io \approx Im\left(1-\frac{Rin(k\Omega)}{10}\right)$	Io: Input current Im: 400 A
CR mode	Proportional control $\frac{1}{Ro} \approx Gm\left(\frac{Rin(k\Omega)}{10}\right)$	Inverse proportional control $\frac{1}{Ro} \approx Gm\left(1-\frac{Rin(k\Omega)}{10}\right)$	Ro: Operation resistance Gm: 134 S
CP mode	Proportional control $Po \approx Pm\left(\frac{Rin(k\Omega)}{10}\right)$	Inverse proportional control $Po \approx Pm\left(1-\frac{Rin(k\Omega)}{10}\right)$	Po: Input power Pm: 6000 W
CV mode	Proportional control $Vo \approx Vm\left(\frac{Rin(k\Omega)}{10}\right)$	Inverse proportional control $Vo \approx Vm\left(1-\frac{Rin(k\Omega)}{10}\right)$	Vo: Input voltage Vm: 60 V

Fig.4-15 Equivalent Circuit (External resistance control)

Setup procedure for external resistance control

It is recommended that the external variable resistor should be used as a type of wire wound resistor, metal film resistor, or multi rotational potentiometer for those are not affected by the temperature and aging.

Set the resistance to the minimum when using proportional control; set the resistance to the maximum when using inverse proportional control.

Use twisted wires for the signal wires. This can prevent disturbance from noise.

1 Pull down the “POWER” switch to turn off the power.

2 Connect the external resistance.

When the operation mode is in CC/CR/CP, connect the external variable resistor between the pin #1 and #5 or #6 of the J1 connector. When the operation mode is in CV, connect the external variable resistor between the pin #2 and #5 or #6 of the J1 connector.

3 Turn on the “POWER” switch.

4 Check that the load is turned off.

Check that the LED located to the left side of the “LOAD” switch is turned off. If the LED is illuminated, press the “LOAD” switch to turn the Load off.

5 Select the operation mode by pressing either “CC/CR/CV/CP” key.

See Table 3-4

6 Set the condition of external control from the setting menu.

Table 4-14 Setting condition of the external resistance control

Operation Mode	Menu setting: Conditions	External Input setting	
		Proportional control	Inverse proportional control
CC Mode	2.Configuraion > 4.External > Control CC/CR/CP	R	Rinv
CR Mode	2.Configuraion > 4.External > Control CC/CR/CP		
CP Mode	2.Configuraion > 4.External > Control CC/CR/CP		
CV Mode	2.Configuraion > 4.External > Control CV		

External resistance control is selected.

7 Turn on the “POWER” switch after turn off the “POWER” switch.

The menu settings are confirmed.

See p. 3-16

You can prevent the setting from being changed inadvertently during measurement by pressing the “LOCK (SHIFT + LOCAL)” key to enable the lock.

See Table 3-4

If the external control is not used, go to the menu setting 2.Configuration > 4.External > Control CC/CR/CP or turn Off the “Control CV”.

4.6.4 External Control of Load On and Load Off

The external control connector can be used to control the on/off of the load and monitor the status of on/off condition.

External contact control

To control the Load On/Off using an external contact, an external signal is applied between the pin #15 and #25 or #26 of the J1 connector.

When the load is on by the external contact, the “LOAD” switch of the front panel is enabled. When the load is off by the external contact, the “LOAD” switch of the front panel is disabled.

Set the logic of Load On/Off for the external control.

See Table 3-4

Go to the menu setting to 2.Configuration > 4.External> LoadOn IN and select LOW / HIGH. The setting descriptions can be confirmed when turning on the power again after turn off the power switch.

The input terminal is connected to +5 V of the J1 connector through approximately 10 kΩ of resistance. The maximum allowable voltage is 5 V, and the operation threshold level is TTL.

Table 4-15 Load On/Off logic setting

Load On	External contact (SW)	
	ON (close)	OFF (open)
LOW	Load On	Load Off
HIGH	Load Off	Load On

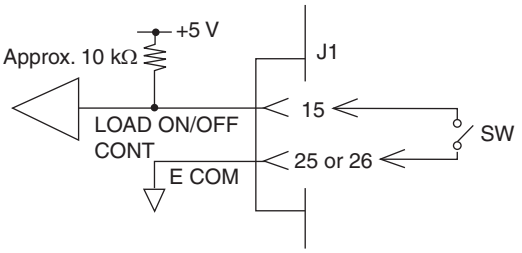
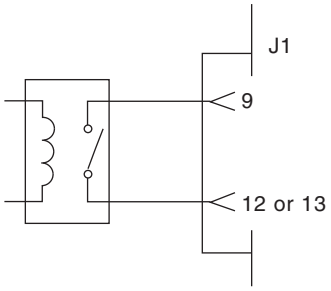


Fig.4-16 Equivalent input circuit
(control by the external contact)

Status signal output

To externally monitor the Load On/Off condition, the output signal across the pins #9 and #12 or #13 of the J1 connector is monitored.



Maximum applied voltage 30 V
Maximum current 500 mA

	Load On	Load Off
Relay Output	Make	Break

Fig.4-17 Equivalent output circuit (Status signal output)

4.6.5 Trigger Signal Control

See p. 4-17

The trigger signal input clears the pause during the sequence execution. This is used to synchronize with other external equipment.

Trigger signal input

Apply a signal voltage across the pins #23 and #25 or #26 of the J1 connector with a maximum voltage of 5 V and minimum pulse width of 100ms.

The input terminal is connected to the E-COM of the J1 connector +5 V of the J1 connector through approximately 10 kΩ of resistance. The maximum allowable voltage is 5 V, and the operation threshold level is TTL.

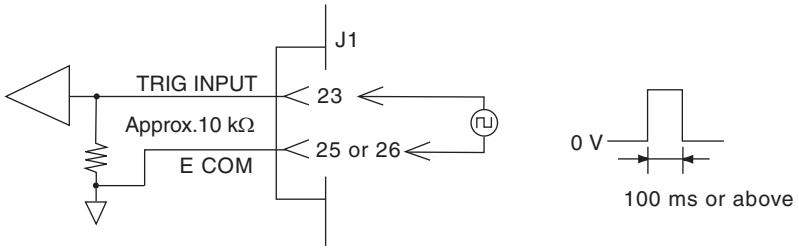


Fig.4-18 Equivalent input circuit (Trigger signal input)

4.6.6 Alarm Signal Control

An alarm can be activated using an external control signal. In addition, the status signal output can be used to monitor the alarm condition.

Alarm signal input

Apply the external signal between the pin #14 and #25 or #26 of the J1 connector. An alarm is activated on a LOW level signal.

The Alarm input terminal is connected to +5 V of the J1 connector through approximately 10 kΩ of resistance. The maximum allowable voltage is 5 V, and the operation threshold level is TTL.

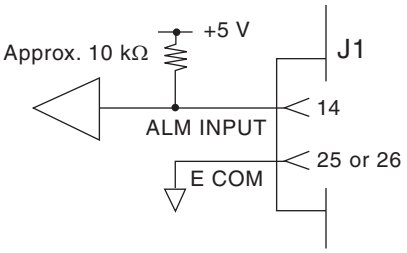
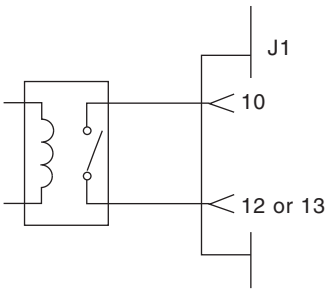


Fig.4-19 Equivalent input circuit (Alarm signal input)

Status signal output

To externally monitor the alarm condition, the output signal between the pin #10 and #12 or #13 of the J1 connector is used.

The output is turned On when OVP, OCP, OPP, OHP, REV or UVP trips or when an external signal is applied.



Maximum applied voltage 30 V
Maximum current 500 mA

	Alarm detected	Normal
Relay output	Make	Break

Fig.4-20 Equivalent output circuit (Status signal output)

4.6.7 External Control of Switching the Range

Operating voltage of 30 V or 60 V can be changed by the external control signal. And the status of range condition can be monitored by the status signal output.

External contact control

Apply the external signal between the pin #16 and #25 or #26 of the J1 connector. The Low level range is selected at 60 V.

The input terminal of the range key is connected to +5 V of the J1 connector through the approximately 10 kΩ of resistance. The maximum allowable voltage is 5 V, and the operation threshold level is TTL.

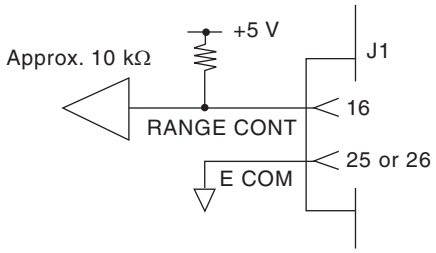


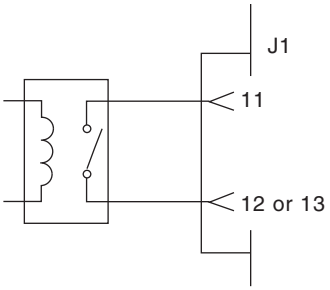
Fig.4-21 Equivalent input circuit
(Switching the range signal input)

When the pin #16 is opened or in the HI level position, switching the range by the panel operation is enabled.

Status signal output

To externally monitor the alarm condition, the output signal across the pins #10 and #12 or #13 of the J1 connector is used.

The status of signal output is the “make” position for the 30 V range, and “break” for the 60 V range.



Maximum applied voltage 30 V
Maximum current 500 mA

	30 V range	60 V range
Relay output	Make	Break

Fig.4-22 Equivalent output circuit (switching the range signal input)

4.6.8 External Control of the Operation Mode

The operation mode can be changed by the external control signal.

External contact control

Apply the external signal to between the pin #17, #18, #19 and #25 or #26 of the J1 connector. The input terminal for changing the mode is connected to +5 V of the J1 connector through approximately 10 kΩ of resistance. The maximum allowable voltage is 5 V, and the operation threshold level is TTL.

Table 4-16 Changing the mode

Mode	MODE CONT 0 (pin 17)	MODE CONT 1 (pin 18)	MODE CONT 2 (pin 19)
CC MODE	HI	HI	LOW
CR MODE	HI	LOW	HI
CP MODE	HI	LOW	LOW
CV MODE	LOW	HI	HI
CC + CV	LOW	HI	LOW
CR + CV	LOW	LOW	HI

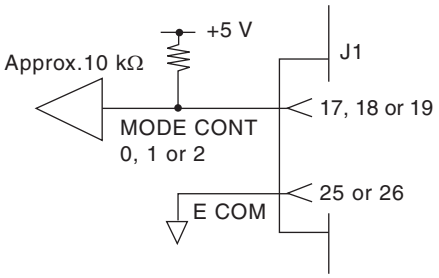


Fig.4-23 Equivalent input circuit
(changing mode signal input)

When MODE from 0 to 2 are opened or all in the HI level position, changing the mode by the panel operation is enabled.

4.7 Monitor Signal Output

Trigger signal output

The trigger signal is used to synchronize with the external equipment during the sequence execution.

The trigger signal is output from the “TRIG OUT” terminal on the front panel of unit.

The trigger signal output voltage is 4.5 V, the pulse width is 1 ms or more, and the output impedance is approximately 500 Ω.

The common terminal is connected to the chassis electric potential. It is isolated from the internal common.

The trigger signal output is generated under the following conditions.

- When a step that has trigger output specified is executed during the sequence operation.

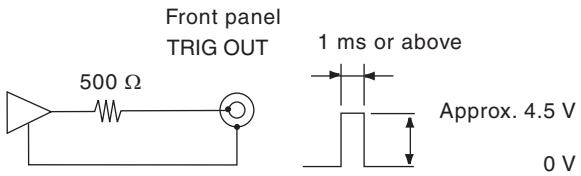


Fig.4-24 Equivalent circuit (The trigger signal output)

Current monitor output

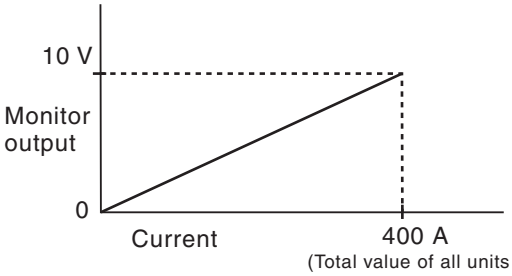
The current monitor output is generated from the “IMON OUT” terminal located on the front panel and across the pin #3 and #5 or #6 (pin #5 and #6 are common) of the J1 connector.

I MON OUT terminal of the front panel (BNC terminal)

The common terminal is connected to the chassis’s electric potential. It is isolated from the internal common. The output of 10 V is generated against 400 A.

Across pins #3 and #5 (or #6) of the J1 connector

The common terminal is connected to the internal common. The output of 10 V is generated against 400 A.



(Total value of all units connected in parallel during parallel operation)

	V
I MON OUT terminal (BNC terminal)	10 V
J1 connector between pins #3 and #5 (or #6)	10 V

Fig.4-25 Current monitor output

For parallel operation, the full scale of the current range is the number of connecting units times 400 A and which output is generated for 10 V.

4.8 Parallel Operation

More than 1 unit of PLZ6000R can be connected in parallel to increase the capacity of current or power. In this parallel operation, one unit becomes a master and the other units become slaves. Up to 4 units can be connected. The master is in charge of control of all slaves.

During parallel operation, the specifications may not be satisfied on the individual unit. The setting and measurement accuracy can be improved by carrying out calibration in parallel operation.

The current ripple during parallel operation is approximately equal to the number of units connected in parallel times the current ripple of an individual unit.

The setting resolutions during parallel operation varies depending on the number of units connected in parallel.

To carry out parallel operation, signal wires for connecting between electronic loads and the load cable for connecting to the equipment under test are required to be connected respectively.

See Fig.4-27

To prevent unstable operation, keep the load cable as far away from the flat cable as possible.

4.8.1 Features of Parallel Operation

■ Current display and voltage display

The master unit displays the total value of current and the wattage of the connected units in parallel parallel operation. The slave unit does not display the value.

■ Remote sensing

Only the master unit can be applied.

■ External control

Only the master unit can be applied.

4.8.2 Wiring Connection (Parallel Operation)

Up to four slaves can be connected. Fig.4-26 shows an example in which the master unit and two slave units are connected. After the third slave connected in parallel operation, wire the cable between “PARALLEL OUT” and “PARALLEL IN” in the same configuration as shown in the drawing.

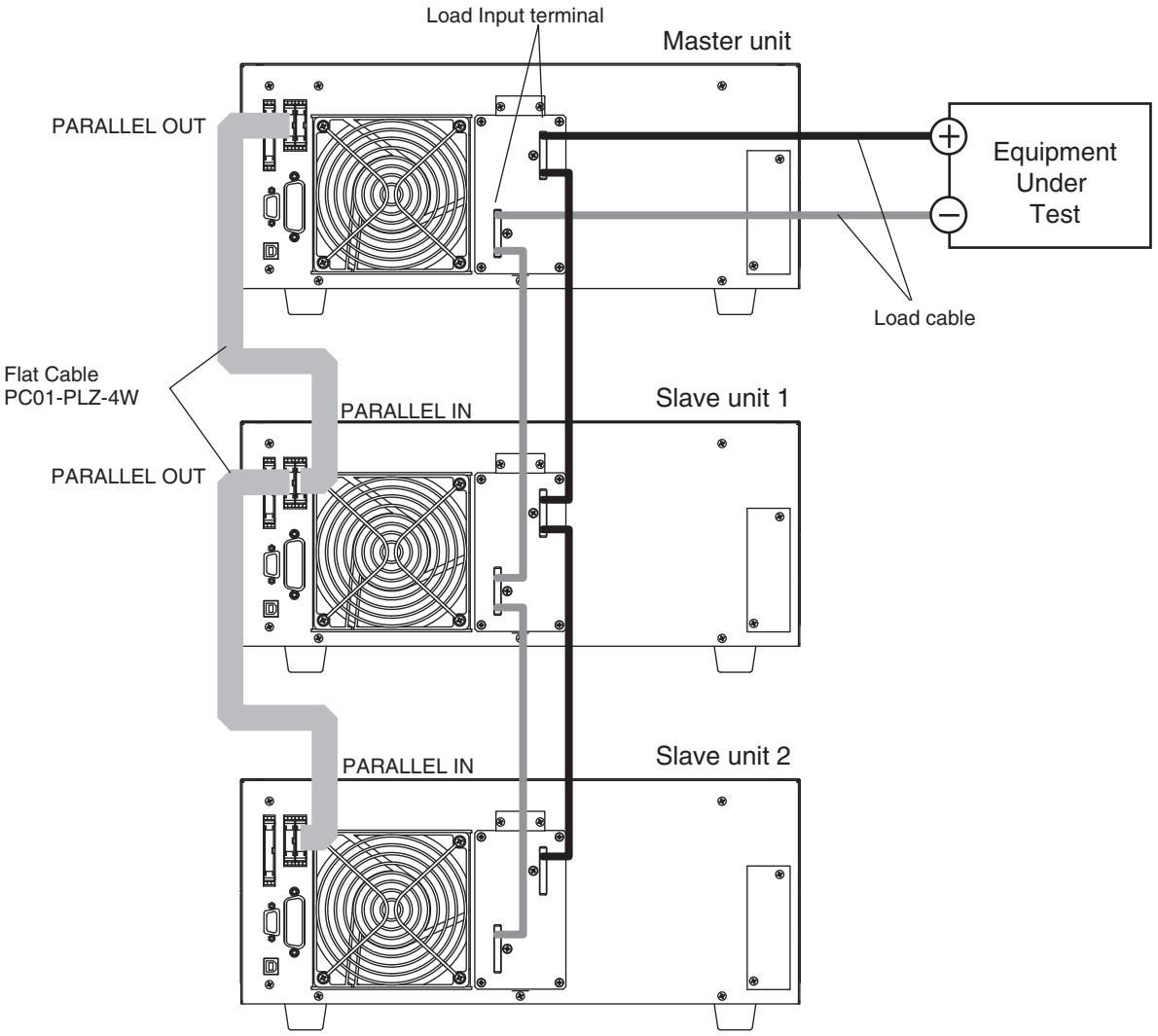


Fig.4-26 Parallel connection of two slave units

Table 4-17 shows the number of connected units and capacity of the system.

Table 4-17 The number of units connected in parallel and the capacity

Connected units	Maximum current/Maximum power
1 unit	400 A / 6 000 W
2 units	800 A / 12 000 W
3 units	1 200 A / 18 000 W
4 units	1 600 A / 24 000 W
5 units	2 000 A / 30 000 W

Parallel connection procedure

See p. 1-4

The optional flat cable (PC01-PLZ4W) is pre-assembled, and can be connected to the unit as-is. The load cable is used for the connection of the unit and the equipment under test.

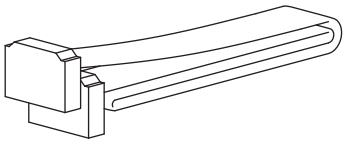


Fig.4-27 Optional flat cable for the parallel operation

⚠WARNING It may cause electric shock.

- **Be sure that the Power switch is off, whenever the Load input terminal, "PARALLEL IN" connector or "PARALLEL OUT" connector are touched. Make sure to attach the cover to the Load input terminal after the wiring connection of the load cable.**
- **In case that the J1 connector, "PARALLEL IN" connector or "PARALLEL OUT" connector are not used, make sure to attach the protective socket to the unused connector.**

⚠CAUTION It may result in damage to the PLZ6000R

- Do not wire the "PARALLEL IN" connector and the "PARRALLEL OUT" connector incorrectly.
- It is recommended to consider the amount of current being used, and use a short load cable with sufficient thickness or the bus bar if necccessary.

NOTE

- Use a load cable with sufficient diameter for the current as well as a non-flammable or flame-resistant cover.
- Use a load cable with the same length as possible to connect the Load input to each unit.

1 Pull down the "POWER" switch to turn off the power.

2 Connect the Load input terminal.

Refer to the connection diagram of Fig.4-26 and to properly connect the Load input terminals of each unit of the same model, in parallel.

3 Connect the external control connector.

Connect the "PARALLEL OUT" connector and "PARALLEL IN" connector of each unit in parallel by using the optional flat cable (PC01-PLZ-4W).

Setting the Master/Slave Units

See Table 3-4

From the menu setting, go to 2.Configuration > 1.Master / Slave > Operation, and select the “Master/Slave”. Turn on the power again after turn off the Power switch, then check the settings.

Value: Operation

Master Master unit

Slave Slave unit

Value: Parallel (Only when “Master” is selected for the operation)

--,2 to 5 Enter the total number of master and slaves

Select “--” for standalone operation

4.8.3 Alarms during Parallel Operation

When an alarm occurs during parallel operation, an error message is displayed, and all connected loads of the PLZ6000R will be turned off.

If the alarm occurs on a slave unit, the “PARA ALM” is displayed on the master unit.

See p. 3-5

Clear the alarm on the master unit.

4.8.4 Response speed during Parallel Operation

See p. 3-15

You can change the response speed in CC mode (CC + CV mode) and CR mode (CR + CV mode).

In some cases, the wire inductance increases and a large voltage drop occurs due to changes in the current or the phase lag of current, and may cause instability in the PLZ6000R control inducing oscillation.

In such cases, you can decrease the response speed to assure stable operation.

As for the response speed in the parallel operation, the setting of the Master unit is applied.

4.8.5 Canceling the Parallel Operation

To switch from parallel operation back to standalone operation, turn off the power of each unit and remove the flat cables.

See Table 3-4

To set as a standalone unit, go to the setting menu 2.Configuration > 1.Master / Slave > Operation, then select the “Master” from the “Master / Slave”, then select “--” from the “Parallel”. Turn On the power again after turn off the Power switch, then setting conditions can be confirmed.

Remote Control

This chapter gives an overview of the remote control functions and explains the SCPI command structure, syntax, details of each command, registers, and so on used in the remote control.

5.1 Overview

In addition to using the front panel controls, the PLZ6000R can be controlled remotely using the following interfaces.

- GPIB interface
- RS232C interface
- USB interface

The interface is selected from the front panel.

The remote interface complies to IEEE std. 488.2-1992 and SCPI Specification 1999.0.

See p. 5-8

Please familiarize yourself with SCPI command syntax on the PLZ6000R before actually using the SCPI commands.

5.2 Instrument Interface Standard

The PLZ6000R 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

5.3 VISA Library

In order to use VISA library (VISA COM) in the I/O library, the VISA library is required to be installed in the controller (Windows).

When using an optional USB interface, the device driver which corresponds to USB T&M class (USBTMC) is required. The USBTMC driver can be installed automatically by 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 specified from the following is required.

The version of VISA which is older than specified version does not support USB. The USB feature does not support for Windows95 or NT3.5x/4.0.

- NI-VISA by National Instruments (Ver.3.0 or later for Windows 2000 and Ver. 3.2 for Windows XP)
- Agilent VISA by Agilent Technologies (Agilent IO Libraries M01.00 or later)
- KI-VISA Ver3.0.0 or later

KI-VISA is Kikusui's original VISA library that supports VXIplug&play VISA specifications 3.0. The newest version of VISA library can be downloaded from Kikusui web site (http://www.kikusui.co.jp). KI-VISA is not required if NI-VISA or Agilent VISA is already installed.

5.4 Interface Setup

The factory default remote control interface setting is GPIB.

The GPIB, RS232C, and USB interfaces cannot be used simultaneously.

5.4.1 GPIB Interface

GPIB connection

Use a standard IEEE488 cable to connect the PLZ6000R to the computer.

GPIB address configuration

The GPIB address is set for the “1” as a factory default.

1 Press the “LOAD” switch to turn off the load.

See Table 3-4

2 By menu setting, select 2.Configuration > 3.Interface > Control for GPIB.

3 Select the “Address”.

4 Turn the "Rotary knob" to select the GPIB address (1 to 32).

5 Turn off the “POWER” switch, then turn on the “POWER” switch again.

The setting condition is confirmed.

GPIB function

Table 5-1 GPIB functions table

Function	Subset	Description
Source handshake	SH1	Complete capability
Acceptor handshake	AH1	Complete capability
Talker	T6	Function available
Listener	L4	Function available
Service request	SR1	Complete capability
Remote local	RL1	Complete capability
Parallel poll	PP0	No capability
Device clear	DC1	Complete capability
Device trigger	DT1	Complete capability
Controller	C0	No capability
Electrical interface	E1	Open collector driver

Service request

Service request and serial polling functions are implemented.

5.4.2 RS232C Interface

RS232C connection

The RS232C port on the PLZ6000R is a standard D-sub 9-pin male connector.

Confirm that the Power switch of the computer and the PLZ6000R are turned Off, then connect the standard cross cable (null modem cable) between the computer and the PLZ6000R.。

Use a D-sub 9-pin female-to-female AT type cross cable. Fig.5-1 shows the connector pin assignment.

Because the PLZ6000R does not use hardware handshaking, DTR(4)/DSR(6) and RTS(7)/CTS(8) are not required.

Connect the RS232C cable to the RS232C connector on the rear panel.

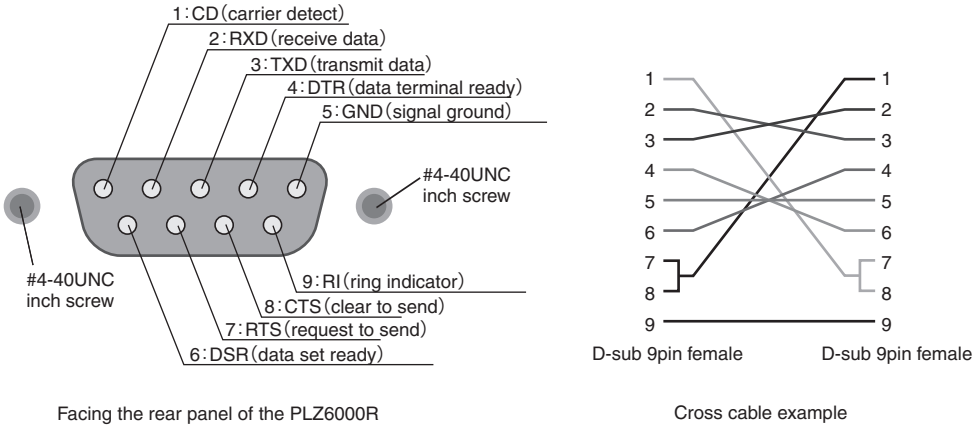


Fig.5-1 9 pin AT type connector

RS232C configuration

See Table 3-4

1. Press the “LOAD” switch to turn off the load.
2. By menu setting, select 2.Configuration > 3.Interface > Control for RS232C.
3. Select Baudrate, then turn the "Rotary knob" to set the baudrate.
4. Same as procedure specified in 3, set the Stop.
5. Turn off the “POWER” switch, then turn on the “POWER” switch again.

   The setting condition is confirmed.

Protocol

Table Table 5-2 shows the RS232C protocol.

Underline indicates the factory default condition.

Table 5-2 RS232C protocol

Item	Setting
Connector	9-pin D-sub terminal on the rear panel
Baudrate	2400 bps/ 4800 bps/ 9600 bps/ <u>19200 bps</u>
Data length	8 bit (fixed)
Stop bit	1 bit/ 2 bit
Parity	None (fixed)

Break signal

The break signal is a function which substitute the message for the IEEE488.1 dcl / sdc (Device Clear, Selected Device Clear).

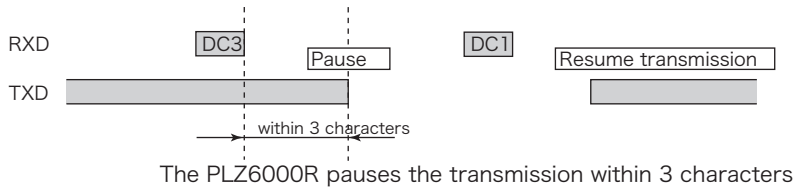
RS232C communication

Use X-Flow control for RS232C communication. DC (device control) codes are used as control codes.

Transmission/reception may not work correctly through unilateral transmission.

Table 5-3 DC codes

Code	Function	ASCII Code
DC1	Transmission request	11H
DC3	Transmission stop request	13H



The PLZ6000R pauses the transmission within 3 characters after receiving DC3.

Fig.5-2 Transmission control from the RS232C terminal to the PLZ6000R.

5.4.3 USB Interface

See p. 5-3

When using an optional USB interface, the device driver which corresponds to USB T&M class (USBTMC) is required. The USBTMC driver can be installed automatically by VISA library.

USB configuration

1 Press the “LOAD” switch to turn off the load.

See Table 3-4

2 By menu setting, select 2.Configuration > 3.Interface > Control for USB.

3 Turn off the “POWER” switch, then turn on the “POWER” switch again.

The setting condition is confirmed.

Service request

Service request and serial polling functions are implemented.

USB function

Complies with USB Specification 2.0.

Complies with USBTMC Specification1.0 and USBTMC-USB488 Specification 1.0

Data rate: 12 Mbps maximum (Full Speed)

VID (Vendor ID): 0x0B3E

PID (Product ID): 0x100C

5.5 Overview of Messages

The information is called as “message” which corresponds between the controller (computer) and the PLZ6000R.

The PLZ6000R uses the SCPI language for the messages.

There are two types of messages, the “command (order)” which is sent from the computer and the “response (reply)” from the PLZ6000R.

Command hierarchy

The SCPI commands are ASCII-based commands designed for the test and measurement devices. The command hierarchy is structured around the common root or node, which is the construction block of the SCPI sub system. A command consists of a program header, parameters, and punctuations.

The hierarchy is explained using the “SOURce” subsystem as an example.

Program header	Parameter	Hierarchy of node
SOURce:		Root node
CURRent		Second level
[:LEVel]		Third level
[:IMMediate]		Fourth level
[:AMPLitude]	<numeric>	Fifth level
TRIGgered		Fourth level
[:AMPLitude]	<numeric>	Fifth level
POWer		Second level
[:LEVel]		Third level
[:IMMediate]		Fourth level
[:AMPLitude]	<numeric>	Fifth level

A higher node is separated from a lower node using a colon (:).

5.5.1 Command Syntax

This manual denotes the SCPI commands using following format.

(Example)

```
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]
{<current>|MINimum|MAXimum}
```

- There are two forms of the SCPI commands, the long form which the command is written out in its entirely and the short form in which the letters written in lowercase are omitted.

  The SCPI commands can be sent in the long form or the short form.

- The SCPI commands are not classified by the capital letter or lower-case letter. CURR, Curr, curr are all accepted as short forms of “CURRent”.

  CURRENT, Current, current are all accepted as long forms.

- A space “_ ” is required between the program header section and the parameter section.
- If there is more than one parameter, use commas “,” for concatenation.
- Compound commands can be created by concatenating between the two commands with a semicolon “;”.

  (Example)

  ```
  SOURce:CURRent MINimum;VOLTage MINimum
  ```

- This compound command is the same as entering the following two commands.

  ```
  SOURce:CURRent MINimum
  SOURce:VOLTage MINimum
  ```

  The first command, “SOURce:CURRent MINimum” sets the paths to “SOURce”. Therefore, the root node, the “SOURce”, can be omitted in the second command.

  An error occurs if a node that is not defined in the current path (except “CURRent” and “VOLTage”) is designated.
- A colon “:” is required between the program headers.
- Commands of different subsystems can be concatenated using combined with colons and semicolons.

  (Example)

  ```
  SOURce:CURRent MINimum;:MEASure:CURRent?
  ```

  This compound command contains two root nodes, the “SOURce” and “MEASure”. When the second or subsequent command starts with a colon, the path specified by the previous command is cleared.
- The maximum number of characters that can transmitted in a single line is 256 bytes.

Special symbols and characters

Special symbols and characters used in this manual to describe the SCPI commands are defined as following table.

Table 5-4 Definitions of special symbols and characters

Symbols or characters	Description
< >	Characters strings inside the < > symbols indicate program data. Do not include these symbols in the actual program.
{ }	Characters and numbers delimited by “|” in braces { } indicate that one of the items is to be selected. Do not include the braces { } in the actual program.
[ ]	Characters strings inside brackets [ ] indicate open data. When option data is not sent with the program, the default value is sent. Do not include the brackets [ ] in the actual program.

Numeric parameters

The following 5 types of numeric parameters are used by the PLZ6000R.

Table 5-5 Numeric parameters

Symbols or characters	Description
NR1	Represents an integer*1
NR2	Represents a real number (floating point)*1
NR3	Represents a real number (exponential)*1, *2
NRf	NRf is a generic term that includes NR1, NR2 and NR3.。
Numeric	Represents a decimal point, optional sign and measurement unit. The numeric representation syntax is the same as NRf. For those MINimum, MAXimum are available as substitutes for declaring certain values. Units such as V,A and W can also be used in a numeric parameter. If a value that can not be assigned is entered, the device rounds the value to the closest possible value. (Example) `POWer 7000` When the setting range of the wattage is 0 to 6300, therefore, in this case it returns 6300 in response to the POW?.

*1. Details are given in the “IEEE 488.2 Standard Digital Interface for Programmable Instrumentation”.

*2. When the response data “380” is returned, the actual data “+3.80000 + E02” is returned. Below the decimal point is 5 digits.

Query

The device settings or status can be queried.

To make query, add a question mark “?” at the end of the program header section. If a query has parameters, enter a space after the question mark followed by the parameters.

(Example)`SOURce:CURRent? MIN`

NOTE

- When transmitting two queries in separate lines, read the response to the first query before transmitting the second line. If you send two lines of query commands at once, an incomplete response may be received.

String termination

All commands must be terminated using a valid terminator.

The available terminators are <new line> (ASCII 0x0A) and EOI (end-or-identify). If either one is assigned, it can be used as a terminator to function.

Since EOI is not available on the RS232C, please be sure to use <new line>.

Also, EOI is not available on the USB, however, an alternative terminator will be assigned besides to the <new line>. It is not required whether the <new line> is assigned or not.

When a command string is terminated, the path is reset to the root level.

NOTE

- CR (ASCII 0x0D) is not a terminator.

Common commands

See p. 5-15

The IEEE-488.2 and SCPI standards contain a set of common commands for reset, self-test, and other functions. These common commands always start with an asterisk. The commands may have one or multiple parameters.

5.5.2 Parameters

The parameter format of SCPI is derived from the program parameter format defined in IEEE 488.2.

The representation system of the program data that is used on the PLZ6000R is indicated below.

Non-numeric parameters

The following 3 types of non-numeric parameters are used by the PLZ6000R.

Table 5-6 Non-numeric parameters

Symbols or characters	Description
Character string data (String)	Used when a series of ASCII characters are requested. Be sure to enclose a string in single quotation mark (‘) or in double quotation mark (“). The start and the end quotation mark must be matched. (Example) `PROGram:MEMO “PROGRAM1”` If you wish to use a quotation mark as a part of the string, enter two quotation marks consecutively with no characters in between. ASCII codes 20H to 7EH can be used.
Character data (Character)	Used when only a limited number of values is available for the program setting. Responses are returned in the short form. (Example) `PROGram:MODE {NCC|NCR|NCV|NCP}`
Boolean data (Boolean)	The boolean data expresses a 1 or 0 condition or an ON or OFF condition. Responses are returned as 1 or 0. (Example) `FUNCtion:CTIME {ON|OFF|1|0}`

Substitute form for the numeric parameter

The special form numeric parameters MINimum and MAXimum can be used as substitute for the limited values when the parameter is numeric.

In the example below, the current limit is set to the minimum value.

```
SOURce:CURRent MINimum
```

CURR MIN is the current value to be set at the minimum value of each model.

The minimum and maximum values can be inquired for most parameters using queries.

```
SOURce:CURRent? MIN
SOURce:CURRent? MAX
```

Measurement unit

The measurement unit of Default can be referred to the following.

- V (Voltage)
- A (Current)
- SIE (Conductance)
- W (Wattage)
- S (second)

The supported optional prefixes can be referred to the following.

- M (milli)
- K (kilo)
- U (micro)

NOTE

- According to the compliance with SI unit, the lower case characters are contained in the unit symbols. The IEEE standards uses uppercase characters. SCPI commands are not case sensitive.
- Commands are accepted even if measurement units are not specified.
- To enter “μ” in the data, use “U” instead.

5.6 Command Description in This Manual

This manual describes the commands in the following manner.

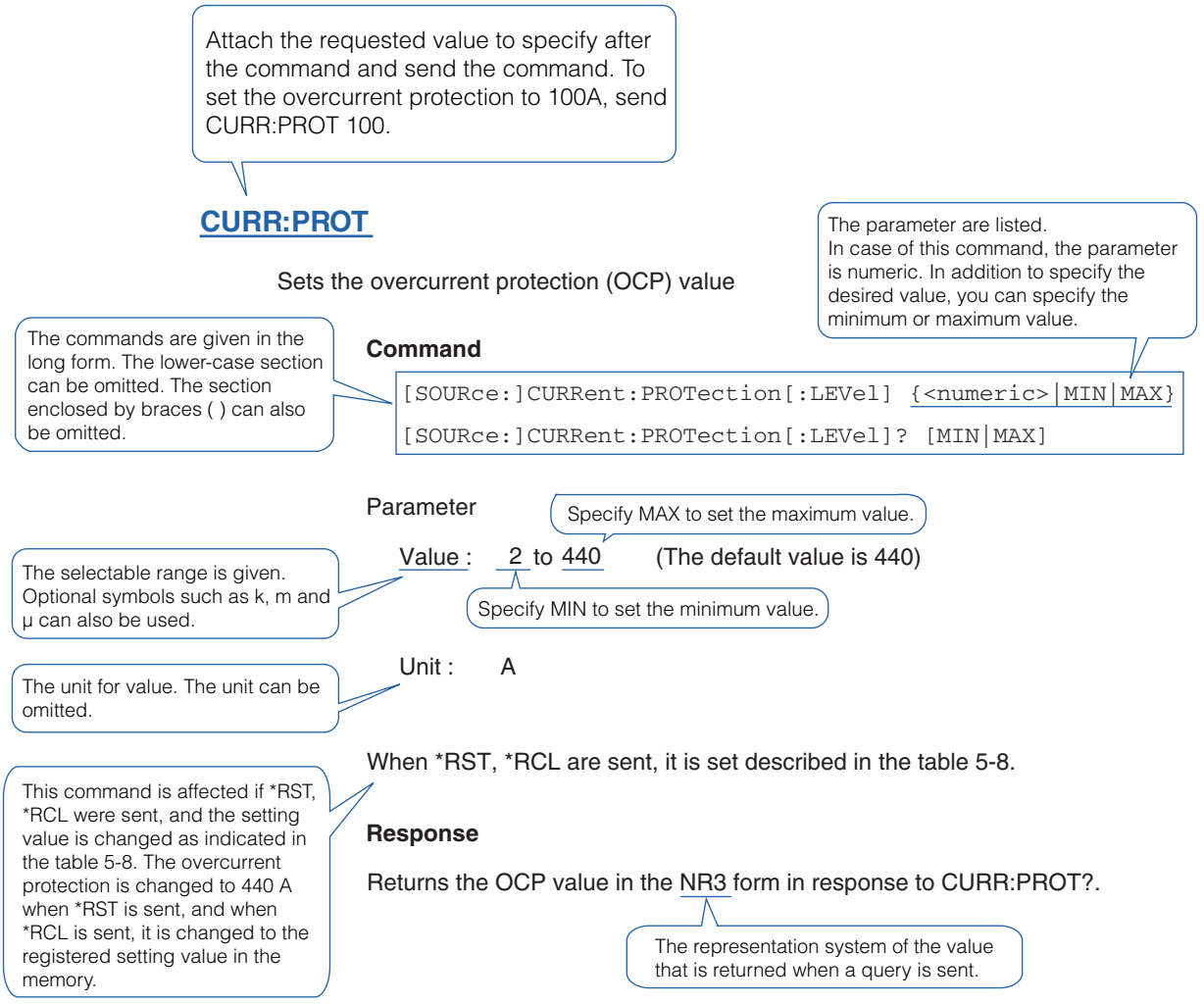


Table 5-7 Command items and reference pages

Item	See Page
Command syntax	5-13
Parameters	5-11
Unit	5-12
Default status	5-14
Query	5-10
List of messages	A-22
List of errors	A-19

5.7 Default settings

See p. 5-16

The PLZ6000R is set at following condition specified in the table Table 5-8 for *RST command, *RCL command and when the Power is turned On.

Table 5-8 *Conditions after sending a RST, *RCL and at power-on

Setup item	Setting				Unit	Function
	*RST*1	*RCL*1, *2	Factory default	At Power On		
FUNC	CC	*3	CC	Setting immediately before turning the POWER switch off.	–	Operation mode setting
CURR	0	*3	0		A	Current setting
CURR:RANG	HIGH	*3	HIGH		–	Current range setting
COND	0	*3	0		SIE	Conductance setting
POW	0	*3	0		W	Wattage setting
VOLT	3	*3	3		V	Voltage setting
VOLT:RANGE	LOW	*3	LOW		–	Voltage range setting
INP/OUTP	0/OFF	*2	0/OFF	*4	–	Load input On/Off
FUNC:RESP FUNC:RESP:CV	1	*3	1	Setting immediately before turning the POWER switch off.	–	Time constant setting of transient response in CC, CR mode.
FUNC:SST	0.02	*3	0.02		S	Soft start time setting in CC, CR mode.
FUNC:CTIM	0/OFF	*3	0/OFF		–	Count time function On/Off
INP:TIM/OUTP:TIM	0/OFF	*3	0/OFF		S	Cut off time setting for the load input
CURR:PROT	440	*3	440		A	Setting the Over current value of the OCP
CURR:PROT:STAT	1/Limit	*3	1/Limit		–	Selecting the protection function (OCP) (LOAD OFF/ LIMIT)
POW:PROT	6 600	*3	6600		W	Setting the Over Power value of OPP
POW:PROT:STAT	1/Limit	*3	1/Limit		–	Selecting the protection function (OPP)(LOAD OFF/ LIMIT)
VOLT:PROT:LOW	0	*3	0		V	Setting the voltage of UVP
PROG:NAME	1	No change	1		–	Specify the program number
PROG:MODE	No change	No change	CC		–	Operation mode setting of the specified program
PROG:CRAN	No change	No change	HIGH		–	Current range setting of the specified program
PROG:VRAN	No change	No change	LOW		–	Voltage range setting of the specified program
CURR:TRIG	0	*3	0	0	A	Current setting (trigger)
COND:TRIG	0	*3	0	0	SIE	Conductance setting (trigger)
POW:TRIG	0	*3	0	0	W	Power setting (trigger)
INIT:CONT	0/OFF	0/OFF	0/OFF	0/OFF	–	Trigger function continuous mode On/Off

*1. The address and the setting value of GPIB, USB and RS232C are not changed when sending *RST, *RCL and power-on.
*2. *RCL is valid only when the load is off.
*3. The setting values which is stored in the memory.
*4. It depends on the setting value of the MENU setting 2.Configration > 2.Pow On > Load On.
When OFF is selected, it is 0/OFF, when ON is selected, it is 1/ON.

5.8 IEEE488.2 Common Commands

*CLS

See p. 5-41

Clears all event registers including the status byte, event status, and error queue.

Command

```
*CLS
```

*ESE

See p. 5-41

Sets the event status enable register that is counted by the event summary bit (ESB) of the status byte.

Command

```
*ESE <NR1>
*ESE?
```

Parameter

Value: 0 to 255

SCPI error (-222, "Data out of range") occurs if outside the range.

(ex.) When *ESE 16 is transmitted, bit 4 of the event status enable register is set. Each time the execution error bit (bit 4) of the event status register is set, the summary bit (ESB) of the status byte is set.

Response

Returns the value of the event status enable register in the NR1 form in response to *ESE?.

*ESR

See p. 5-41

Queries the event status register. Registers that are read are cleared.

Command

```
*ESR?
```

Response

Returns the value of the event status register in the NR1 form in response to *ESR? and clears the register.

*IDN

Queries the model name, serial number, and firmware version of the PLZ6000R.

Command

```
*IDN?
```

Response

Returns to *IDN? for the model name of PLZ6000R as an example specified below.

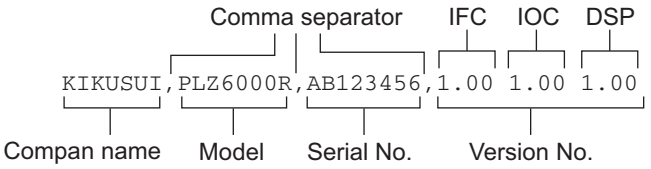


Fig.5-3 Response of *IDN? (Serial No. AB123456, Version No. of each IFC, IOC, DSP, 1.00 as an example)

*OPC

The PLZ6000R does not support this function which waits for the command operation complete while the stand-by status. To correspond this query, always return “1”.

Command

```
*OPC
*OPC?
```

Response

Returns always “1”.

*RCL

See Table 5-8

Recalls the contents saved to the memory (0 to 99). The status for “0” is defined as Read only and it is set as factory default setting.

For the commands that are affected by *RCL, see table Table 5-8.

Command

```
*RCL <NR1>
```

Parameter

Value: 0 to 99

SCPI error (-222, "Data out of range") occurs if outside the range.

*RST

See Table 5-8

Initializes the PLZ6000R.

For the commands that are affected by *RST, see table Table 5-8.

Command

```
*RST
```

*SAV

Saves the current settings of the device to local memory (0 to 99). The parameters that are saved are the same as the parameters recalled by *RCL command.

Command

```
*SAV <NR1>
```

Parameter

Value: 0 to 99

SCPI error (-222, "Data out of range") occurs if outside the range.

*SRE

Sets the service request enable register.

The service request enable register is used to select the summary messages in the status byte register to perform service requests.

To clear the service request enable register, send *SRE 0. If the register is cleared, service requests cannot be generated by status information.

Command

```
*SRE <NR1>
*SRE?
```

Parameter

Value: 0 to 255

SCPI error (-222, "Data out of range") occurs if outside the range.

(ex.) Sending *SRE 8 sets bit 3 of the service request enable register. Each time the summary bit (bit 3) of the QUEStionable status register in the status byte is set, a service request message is generated.

Response

Returns the value of the service request enable register in the NR1 form in response to *SRE.

*STB

See p. 5-41

Queries the contents of the status byte register and the MSS (Master Summary Status) message.

The response is the same as serial polling only with the exception that the MSS message appears in place of the RQS message in bit 6.

Command

```
*STB?
```

Response

Returns the value of the status byte register and the MSS message (bit 6) in NR1 form in response to *STB?.

*TRG

See IEEE 488.2-1992 Section 6.1.4.2.5

This is the trigger command.

This is a substitute command for the IEEE 488.1 get message (Group Execute Trigger).

Command

```
*TRG
```

*TST

Execute a self-test. Use SYST:ERR? to query the errors that occurred.

Command

```
*TST?
```

Response

Returns “0” if there are no errors in response to *TST?. If there is any error occurred, the first error code is returned.

*WAI

The PLZ6000R does not support this function which waits for the command operation complete while the stand-by status.

Command

```
*WAI
```

5.9 SCPI Command Used in the PLZ6000R

5.9.1 Basic Operation

Operation mode setting

FUNC

Sets the operation mode.

Command

```
[SOURce:]FUNCtion[:MODE] {CC|CV|CP|CR|CCCV|CRCV}
[SOURce:]FUNCtion[:MODE]?
```

Parameter

Value:	CC	CC Mode (Default)
	CV	CV Mode
	CP	CP Mode
	CR	CR Mode
	CCCV	CC + CV Mode
	CRCV	CR + CV Mode

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the operation mode to FUNC? in the form of character data.

Current setting

CURR

Sets the current.

Command

```
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	0 to 408	(30 V Range)
	0 to 204	(60 V Range)
	0 (Default)	
Unit	A	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the current to CURR? in the form of <NR3>.

CURR:RANG

Sets the current range.

Command

```
[SOURce:]CURRent:RANGe {LOW|HIGH|MIN|MAX}
[SOURce:]CURRent:RANGe?
```

Parameter

Value:	LOW	60 V (200 A) Range
	HIGH	30 V (400 A) Range (Default)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

It is set for VOLT:RANG LOW in 30 V range, VOLT:RANG HIGH in 60 V range.

Response

Returns the current range to CURR:RANG? in the form of character data.

Conductance setting

COND

Sets the conductance.

Command

```
[SOURce:]CONDuctance[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CONDuctance[:LEVel][:IMMediate][:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	136 to 0	(30 V Range)
	34 to 0	(60 V Range)
	0 (Default)	
Unit	SIE (siemens)	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the conductance to COND? in the form of <NR3>.

Power setting

POW

Sets the Power.

Command

```
[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	0 to 6300	
	0 (Default)	
Unit	W	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the power to POW? in the form of <NR3>.

Voltage setting

VOLT

Sets the voltage.

Command

```
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	3 to 31.5	(30 V Range)
	6 to 63	(60 V Range)
	3 (Default)	
Unit	V	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the voltage to VOLT? in the form of <NR3>.

VOLT:RANG

Sets the voltage range.

Command

```
[SOURce:]VOLTage:RANGe {LOW|HIGH|MIN|MAX}
[SOURce:]VOLTage:RANGe?
```

Parameter

Value:	LOW	30 V (400 A) Range (Default)
	HIGH	60 V (200 A) Range

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

It is set for CURR:RANG LOW in 60 V range, CURR:RANG HIGH in 30 V range.

Response

Returns the voltage range to VOLT:RANG? in the form of character data.

LOAD ON / LOAD OFF

INP / OUTP

Sets the LOAD ON / LOAD OFF.

Command

```
INPut[:STATe][:IMMediate] {ON|OFF|1|0}
OUTPut[:STATe][:IMMediate] {ON|OFF|1|0}
INPut[:STATe][:IMMediate]?
OUTPut[:STATe][:IMMediate]?
```

Parameter

Value:	ON(1)	Load On
	OFF(0)	Load Off (Default)

When *RST is sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the status of LOAD ON/LOAD OFF to INP? or OUTP? in the form of <NR1>.

Other settings

FUNC:RESP / FUNC:RESP:CV

Sets the response speed.

Command

```
[SOURce:]FUNCtion:RESPonse [:CC|CR]
  {<numeric>|MIN|MAX}
[SOURce:]FUNCtion:RESPonse [:CC|CR]? [MIN|MAX]
```

```
[SOURce:]FUNCtion:RESPonse:CV {<numeric>|MIN|MAX}
[SOURce:]FUNCtion:RESPonse:CV? [MIN|MAX]
```

Parameter

Value: 0.1 to 1 (Default is set at 1)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the response speed to FUNC:RESP:CC/CR? or FUNC:RESP:CV? in the form of <NR3>.

FUNC:SST

Sets the soft start time for CC mode or CR mode operation.

Command

```
[SOURce:]FUNCtion:SSTart {<numeric>|MIN|MAX}
[SOURce:]FUNCtion:SSTart? [MIN|MAX]
```

Parameter

Value: 0.02, 0.05, 0.1, 0.2 (Default is set at 0.02)

Unit S (seconds)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the soft start time to FUNC:SST? in the form of <NR3>.

FUNC:CTIM

Sets the status of ON/OFF of Elapsed time display function

Command

```
[SOURce:]FUNCtion:CTIMe {ON|OFF|1|0}
[SOURce:]FUNCtion:CTIMe?
```

Parameter

Value: ON(1) Elapsed time display

OFF(0) No display for an Elapsed time (Default)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the status of ON/OFF of elapsed time display function to FUNC:CTIM? in the form of <NR1>.

INP:TIM / OUTP:TIM

Sets the time for Auto Load Off Timer.

Command

```
INPut:TIMer {<numeric>|MIN|MAX}
INPut:TIMer? [MIN|MAX]
OUTPut:TIMer {<numeric>|MIN|MAX}
OUTPut:TIMer? [MIN|MAX]
```

Parameter

Value: 0 to 3599999
0 -- function off (Default is set at 0)

Unit S (seconds)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the setting time for Auto Load Off Timer to INP:TIM? or OUT:TIM? in the form of <NR1>.

Measurement operation command

For the measurement operation command, please refer to p. 5-27.

5.9.2 Protection Functions

CURR:PROT

Sets the value of Over Current Protection (OCP).

Command

```
[SOURce:]CURRent:PROTection[:LEVel]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent:PROTection[:LEVel]? [MIN|MAX]
```

Parameter

Value: 2 to 440
440 (Default)

Unit A

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the setting value Over Current Protection (OCP) to CURR:PORT? in the form of <NR3>.

CURR:PROT:STAT

Sets the operation status when the Over Current Protection (OCP) is activated.

Command

```
[SOURce:]CURRent:PROTection:STATe {ON|OFF|1|0}
```

```
[SOURce:]CURRent:PROTection:STATe?
```

Parameter

Value:	ON(1)	LIMIT operation (Default)
		limit the current at the value which was set.
	OFF(0)	LOAD OFF operation
		Turn off the load and activate the alarm.

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the protecting operation of Over Current Protection (OCP) to CURR:PROT:STAT? in the form of <NR1>.

POW:PROT

Set the value of Over Power Protection (OPP).

Command

```
[SOURce:]POWer:PROTection[:LEVel] {<numeric>|MIN|MAX}
[SOURce:]POWer:PROTection[:LEVel]? [MIN|MAX]
```

Parameter

Value:	100 to 6600
	6600 (Default)
Unit	W

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the setting value of Over Power Protection (OPP) to POW:PROT? in the form of <NR3>.

POW:PROT:STAT

Sets the operation status when the Over Power Protection (OPP) is activated.

Command

```
[SOURce:]POWer:PROTection:STATe {ON|OFF|1|0}
[SOURce:]POWer:PROTection:STATe?
```

Parameter

Value:	ON(1)	LIMIT operation (Default)
		limit the power at the value which was set.
	OFF(0)	LOAD OFF operation
		Turn off the load and activate the alarm.

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the protecting operation of Over Power Protection (OPP) to POW:PROT:STAT? in the form of <NR1>.

VOLT:PROT:LOW

Set the value of Under Voltage Protection (UVP).

Command

```
[SOURce:]VOLTage:PROTection[:LEVel]:LOWer
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage:PROTection[:MLEVel]:LOWer? [MIN|MAX]
```

Parameter

Value: 0 to 63

0 -- function off (Default is set at 0)

Unit V

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the setting value of Under Voltage Protection (UVP) to VOLT:PROT:LOW? in the form of <NR3>.

VOLT:PROT:STAT

Queries the ON/OFF status of Low Voltage Protection (UVP).

Command

```
[SOURce:]VOLTage:PROTection:STATe?
```

Response

Returns the operation of Under Voltage Protection (UVP) to VOLT:PROT:STAT? in the form of <NR1>. Return “1” when the status of UVP function is ON, and “0” when the status of UVP function is OFF.

5.9.3 Releasing the Alarm

INP:PROT:CLE / OUTP:PROT:CLE

Clears the Alarm.

Command

```
INPut:PROTection:CLEar
OUTPut:PROTection:CLEar
```

5.9.4 Measurement Operation and Trigger Function

Sets the condition related to the measurement operation and trigger function.

The trigger can synchronize the change of setting value. When ABOR is sent, or any change occurred in each setting condition, the setting value changed by the trigger will be cancelled.

The table Table 5-9 shows the responses when the current is set to 100 A(CURR 100), and when the current setting that is applied with a trigger is set to 120 A (CURR:TRIG 120).

Table 5-9 Responses after sending CURR 100;:CURR:TRIG 120

	Response	
	CURR?	CURR:TRIG?
Immediately after the setting	100	120
After a trigger is sent	120	120
After RST is sent	0	0
ABOR is sent before sending a trigger	100	100 (Trigger setting value is cancelled)
Current change CURR 80 is sent before sending a trigger	80	80 (Trigger setting value is cancelled)

CURR:TRIG

Sets the current value that is applied when INIT command and software trigger are sent.

Command

```
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value: 0 to 408 (30 V Range)
0 to 204 (60 V Range)
0 (Default)

Unit A

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the current value that is applied when a trigger is received in the form of <NR3> in response to CURR:TRIG?.

COND:TRIG

Sets the conductance value that is applied when INIT command and software trigger are sent.

Command

```
[SOURce:]CONDuctance[:LEVel]:TRIGgered[:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]CONDuctance[:LEVel]:TRIGgered[:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	136 to 0	(30 V Range)
	34 to 0	(60 V Range)
	0 (Default)	
Unit	SIE (siemens)	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the conductance value that is applied when a trigger is received in the form of <NR3> in response to COND:TRIG?.

POW:TRIG

Sets the wattage value that is applied when INIT command and software trigger are sent.

Command

```
[SOURce:]POWer[:LEVel]:TRIGgered[:AMPLitude]
  {<numeric>|MIN|MAX}
[SOURce:]POWer[:LEVel]:TRIGgered[:AMPLitude]?
  [MIN|MAX]
```

Parameter

Value:	0 to 6300	
	0 (Default)	
Unit	W	

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the wattage value that is applied when a trigger is received in the form of <NR3> in response to POW:TRIG?.

Starting trigger function (Initiate)

Changes the setting conditions after waiting for a software trigger.

INIT

Starts the trigger function (Initiate). The PLZ6000R is in the status of waiting for the software trigger.

The operation of setting change starts after waiting for a software trigger (IEEE488.1 Group Execute Trigger command or *TRG command).

Command

```
INITiate[:IMMediate]
```

Trigger function continue mode

When the continue mode of trigger function is set to ON.

The change starts after waiting for a software trigger, then after it is completed, it will be in the status of waiting for a next trigger.

When the continue mode of trigger function is set to OFF.

The change starts after waiting for a software trigger, then after it is completed, it will be the same condition as ABOR command is sent.

INIT:CONT

Sets the continue mode of trigger function.

Command

```
INITiate:CONTinuous {ON|OFF|1|0}
INITiate:CONTinuous ?
```

Parameter

Value:	ON(1)	Trigger function continue mode On
	OFF(0)	Trigger function continue mode Off (Default)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Response

Returns the status of continue mode in the form of <NR1> in response to INIT:CONT?.

Aborts the trigger operation

ABOR

Aborts the trigger operation.

The trigger status immediately after the power is turned On is the same as the condition when the ABOR command is sent.

Command

```
ABORt[:ALL]
```

Software trigger

When waiting for a software trigger after INIT is received, the change starts once a software trigger is sent. If it is not in the status for waiting a trigger, or the change is already started, the SCPI error (-211,"Trigger ignored") is occurred by rejecting a trigger when a software trigger is sent.

Measurement operation

■ READ command

Queries the measured data after starting a new measurement operation.

■ MEASure command

The PLZ6000R is not equipped with the function (CONFIG command) to set the configuration. The MEAS? operation is equivalent to READ? operation.

READ:CURR / MEAS:CURR

Queries the Current value.

Command

```
READ[:SCALar]:CURRent[:DC]?
MEASure[:SCALar]:CURRent[:DC]?
```

Unit : A

Response

Returns the current value in the form of <NR3> in response to READ:CURR? or MEAS:CURR?.

READ:ETIM / MEAS:ETIM

Queries the elapsed measurement time.

Command

```
READ[:SCALar]:ETIMe?
MEASure[:SCALar]:ETIMe?
```

Unit : S (seconds)

Response

Returns the elapsed measurement time in the form of <NR3> in response to READ:ETIM? or MEAS:ETIM?.

READ:POW / MEAS:POW

Queries the value of power measurement.

Command

```
READ[:SCALar]:POWer[:DC]?
MEASure[:SCALar]:POWer[:DC]?
```

Unit : W

Response

Returns the value of power measurement in the form of <NR3> in response to READ:POW? or MEAS:POW?.

READ:POW:AC:RGEN / MEAS:POW:AC:RGEN

Queries the measurement value of regenerated power.

Command

```
READ[:SCALar]:POWer:AC:RGENerate?
MEASure[:SCALar]:POWer:AC:RGENerate?
```

Unit : W

Response

Returns the measurement value of regenerated power in the form of <NR3> in response to READ:POW:AC:RGEN? or MEAS:POW:AC:RGEN?.

READ:POW:AC:RGEN:ACC / MEAS:POW:AC:RGEN:ACC

Queries the integral power consumption value of regenerated power.

Command

```
READ[:SCALar]:POWer:AC:RGENerate:ACCumulated?
MEASure[:SCALar]:POWer:AC:RGENerate:ACCumulated?
```

Unit : Wh

Response

Returns the integral power consumption value in the form of <NR3> in response to READ:POW:AC:RGEN:ACC? or MEAS:POW:AC:RGEN:ACC?.

READ:VOLT / MEAS:VOLT

Queries the measurement value of voltage.

Command

```
READ[:SCALar]:VOLTage[:DC]?
MEASure[:SCALar]:VOLTage[:DC]?
```

Unit : V

Response

Returns the measurement value of voltage in the from of <NR3> in response to READ:VOLT? or MEAS:VOLT?.

5.9.5 System Settings

Sets the System Setting of the PLZ6000R.

SYST:ERR

Reads the oldest error information from the error queue.

The error queue can store up to 255 error's information.

Command

```
SYSTem:ERRor[:NEXT]?
```

Response

Returns the present error message in the form of <NR1> and in the String data.

(ex.) When there is no error.

0,"No error"

(ex.) When there is a command error.

-100,"Command error"

SYST:KLOC

Sets the lock of panel operation.

Command

```
SYSTem:KLOCk {ON|OFF|1|0}
SYSTem:KLOCk?
```

Parameter

Value:	ON(1)	Lock the panel operation.
	OFF(0)	Release the panel operation lock.

Response

Returns the panel operation lock in the form of <NR1> in response to SYST:KLOC?.

SYST:LOC (RS232C, USB only)

Sets the PLZ6000R to local mode by panel operation. This is a substitute command for the IEEE488.1 REN message (Remote Disable).

SYST:REM, SYST:RWL are used to return to remote mode.

The SCPI error (-100, "Command error") is generated when GPIB is used.

Command

```
SYSTem:LOCal
```

SYST:REM (RS232C, USB only)

Sets the PLZ6000R operation to remote mode. All panel keys except the LOCAL key are locked. This is a substitute command for the IEEE488.1 REN message (Remote Enable) and address designation.

SYST:LOC is used to return to local mode.

The SCPI error (-100, “Command error”) is generated when GPIB is used.

Command

```
SYSTem:REMote
```

SYST:RWL (RS232C, USB only)

Sets the PLZ6000R operation to remote mode. All panel keys are locked (LOCAL key is also locked). This is a substitute command for the IEEE488.1 llo message (Local Lock Out).

SYST:LOC is used to return to local mode.

The SCPI error (-100, “Command error”) is generated when GPIB is used.

Command

```
SYSTem:RWLock
```

SYST:VERS

Queries the version of the SCPI specifications to which the PLZ6000R conforms.

Command

```
SYSTem:VERSion?
```

Response

Returns SCPI 1999.0 in response to SYST:VERS？.

5.9.6 Reset for the Integral Power Consumption Value of Regenerated Power

SENS:POW:CLE

Resets the integral power consumption value of regenerated power.

Command

```
SENSe:POWer:CLEar
```

5.9.7 Sequence Function

Sets the condition related to the Sequence function.

PROG:NAME

Specifies the program number.

Command

```
PROGram[:SELected]:NAME {<numeric>|MIN|MAX}
```

Parameter

Value:	1 to 10	(Default is set as 1)

When *RST, *RCL were sent, the setting is applied to the table specified in Table 5-8.

Editing the Program

PROG:MEMO

Sets the memo to the selected program number.

Command

```
PROGram[:SELected]:MEMO "<string>"
PROGram[:SELected]:MEMO?
```

Parameter

Value:	Up to 15 characters in text.	

Response

Returns the memo in string data for the selected program number in the PROG:NAME.

PROG:MODE

Sets the operation mode to the selected program number in PROG:NAME.

Command

```
PROGram[:SELected]:MODE {NCC|NCR|NCV|NCP}
PROGram[:SELected]:MODE?
```

Parameter

Value:	NCC	CC Mode (Default)
	NCV	CV Mode
	NCP	CP Mode
	NCR	CR Mode

Response

Returns the operation mode in character data for the selected program number in the PROG:NAME.

PROG:CRAN

Sets the current range to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:CRANge {LOW|HIGH}
PROGram[:SELected]:CRANge?
```

Parameter

Value:	LOW	60 V to 200 A
	HIGH	30 V to 400 A (Default)

Response

Returns the current range in character data for the selected program number in the PROG:NAME.

PROG:VRAN

Sets the voltage range to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:VRANge {LOW|HIGH}
PROGram[:SELected]:VRANge?
```

Parameter

Value:	LOW	30 V to 400 A (Default)
	HIGH	60 V to 200 A

Response

Returns the voltage range in character data for the selected program number in the PROG:NAME.

PROG:LOOP

Sets the number of program loops to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:LOOP {<numeric>|MIN|MAX}
PROGram[:SELected]:LOOP? [MIN|MAX]
```

Parameter

Value:	1 to 9999	9999 (infinite loop)

Response

Returns the number of program loops in the form of <NR1> for the selected program number in the PROG:NAME.

PROG:LINP / PROG:LOUT

Sets the load On/Off condition after the program ends to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:LINPut {ON|OFF|1|0}
PROGram[:SELected]:LOUTput {ON|OFF|1|0}
PROGram[:SELected]:LINPut?
PROGram[:SELected]:LOUTput?
```

Parameter

Value:	ON(1)	Load On after the program ends.
	OFF(0)	Load Off after the program ends.

Response

Returns the load On/Off condition after the program ends in the form of <NR1> for the selected program number in the PROG:NAME.

PROG:LVAL

Sets the load value after the program ends to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:LVALue {<numeric>|MIN|MAX}
PROGram[:SELected]:LVALue? [MIN|MAX]
```

Parameter

Value:	The value varies by the condition of range setting, operation mode.

Response

Returns the load value after the program ends in the form of <NR3> for the selected program number in the PROG:NAME.

PROG:CHA

Sets the number of the program to be executed next to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:CHAin {<numeric>|MIN|MAX}
PROGram[:SELected]:CHAin? [MIN|MAX]
```

Parameter

Value:	0 to 10	0 -- chain function off

Response

Returns the number of the program to be executed next in the form of <NR1> for the selected program number in the PROG:NAME.

PROG:CLE

Deletes all the conditions in the sequence program.

Command

```
PROGram:CLEar
```

Editing the steps

■ Current setting value/Conductance setting value/Wattage setting value/Voltage setting value

The setting range by the step editing for those Current value / Conductance value / Wattage value / Voltage value differs by the operation mode and the range setting.

Table 5-10 Setting value of <VALUE_numeric>

Operation Mode	Range	Setting value	Unit
CC Mode	30 V	0 to 408	A
	60 V	0 to 204	
CR Mode	30 V	136 to 0	SIE
	60 V	34 to 0	
CP Mode		0 to 6300	W
CV Mode	30 V	3 to 31.5	V
	60 V	6 to 63	

PROG:NSP:ADD

Add a step after the last step of the selected program number in PROG:NAME.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:ADD
  {<VALUE_numeric>|MIN|MAX},{<TIME_numeric>|MIN|MAX}
```

Parameter `<VALUE_numeric>`

See Table 5-10

Value: The value varies by the condition of range setting, operation mode.

Parameter `<TIME_numeric>`

Value: 0.01 to 3599999.0

Unit S (seconds)

PROG:NSP:EDIT

Edits the selected step to the selected program in PROG:NAME.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:EDIT
  <STEP_nrf>,{<VALUE_numeric>|MIN|MAX},
  {<TIME_numeric>|MIN|MAX},{<INPUT>ON|OFF|1|0},
  {<RAMP>ON|OFF|1|0},{<TRIG>ON|OFF|1|0},
  {<PAUSE>ON|OFF|1|0}
  PROGram[:SELected]:NSPeed[:STEP]:EDIT? <STEP_nrf>
```

Parameter `<STEP_nrf>`

Value: 1 to the selected step.

Parameter `<VALUE_numeric>`

See Table 5-10

Value: The value varies by the condition of range setting, operation mode.

Parameter `<TIME_numeric> Execution time`

Value: 0.01 to 3599999.0

Unit S (seconds)

Parameter `<INPUT>Load On/Load Off`

Value:		
	ON(1)	Load On
	OFF(0)	Load Off

Parameter `<RAMP> Current Ramp`

Value:		
	ON(1)	Slope curve
	OFF(0)	Step curve

Parameter `<TRIG> Trigger signal`

Value:		
	ON(1)	Output On
	OFF(0)	Output Off

Parameter `<PAUSE> Pause`

Value:		
	ON(1)	To pause
	OFF(0)	Not to pause

Response

Returns the setting condition in order of the step selected in PROG:NSP:EDIT? <STEP_nrf> from the setting value, step execution time, load on/off, current ramp, trigger output, pause in the form of <NR3>,<NR3>,<NR1>,<NR1>,<NR1> and <NR3> for the selected program number in the PROG:NAME.

PROG:NSP:INS

Insert one step to the selected program number in PROG:NAME. The new step will be inserted to after the selected step number.behind.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:INSert
  <STEP_nrf>,{<VALUE_numeric>|MIN|MAX},
  {<TIME_numeric>|MIN|MAX}
```

Parameter `<STEP_nrf>`

Value: 1 to the selected step

Parameter `<VALUE_numeric>`

See Table 5-10

Value: The value varies by the condition of range setting, operation mode.

Parameter `<TIME_numeric> Execution time`

Value: 0.1 to 3599999.0

Unit S (seconds)

PROG:NSP:DEL

Deletes the selected step number to the selected program number in PROG:NAME.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:DELete[:STEP] <nrf>
```

Parameter

Value: 1 to the selected step

PROG:NSP:DEL:ALL

Deletes all the steps to the selected program number in PROG:NAME.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:DELete:ALL
```

PROG:NSP:COUN

Queries the number of steps in the selected program number of PROG:NAME.

Command

```
PROGram[:SELected]:NSPeed[:STEP]:COUNt?
```

Response

Returns the number of steps in the form of <NR1> for the selected program number in the PROG:NAME.

PROG:STAT

Execute the selected program number or change the operation status in PROG:NAME.

Command

```
PROGram[:SELected]:STATe
  {RUN|TRUN|PAUSe|STOP|CONTinue}
```

Parameter

Value:	RUN	Execute the selected program.
	TRUN	Set the selected program to standby.
		(execute by the trigger, refer to the “ Software trigger)
	PAUS	Pause the sequence operation.
	STOP	Stop the selected program.
	CONT	Resume the paused sequence operation.

See p. 5-30

PROG:EXEC

Queries the execution status of the selected program number in PROG:NAME.

Command

```
PROGram[:SELected]:EXECuting?
```

Response

Returns the setting condition of the program number in PROG:NAME for the operation status, execution time, the number of loops, step number, program number in order from the character data, <NR2>, <NR1>, <NR1>, <NR1>.

5.10 Status Register and Status Report Function

IEEE488.2 and SCPI registers are used for the status reports.

In each SCPI status register, there are CONDition register, EVENt register, ENABle register, PTRansition filter and NTRansition filter as sub register.

Fig.5-4 shows the SCPI status register structure. The character "+" represents the logic sum of the register bits. Table 5-11 to Table 5-13 describe the bit number, bit weight, and meaning of each bit.

CONDition register

The CONDition register transits automatically and reflects the condition of the PLZ6000R in real-time. Reading this register does not affect the contents.

EVENt register

The EVENt register bits are automatically set according to the changes in the CONDition register. The rule varies depending on the positive and negative transition filters (PTRansition and NTRansition). The EVENt register is reset when it is read.

ENABle register

The ENABle register enables the reports to the summary bit or status bit of the event bit.

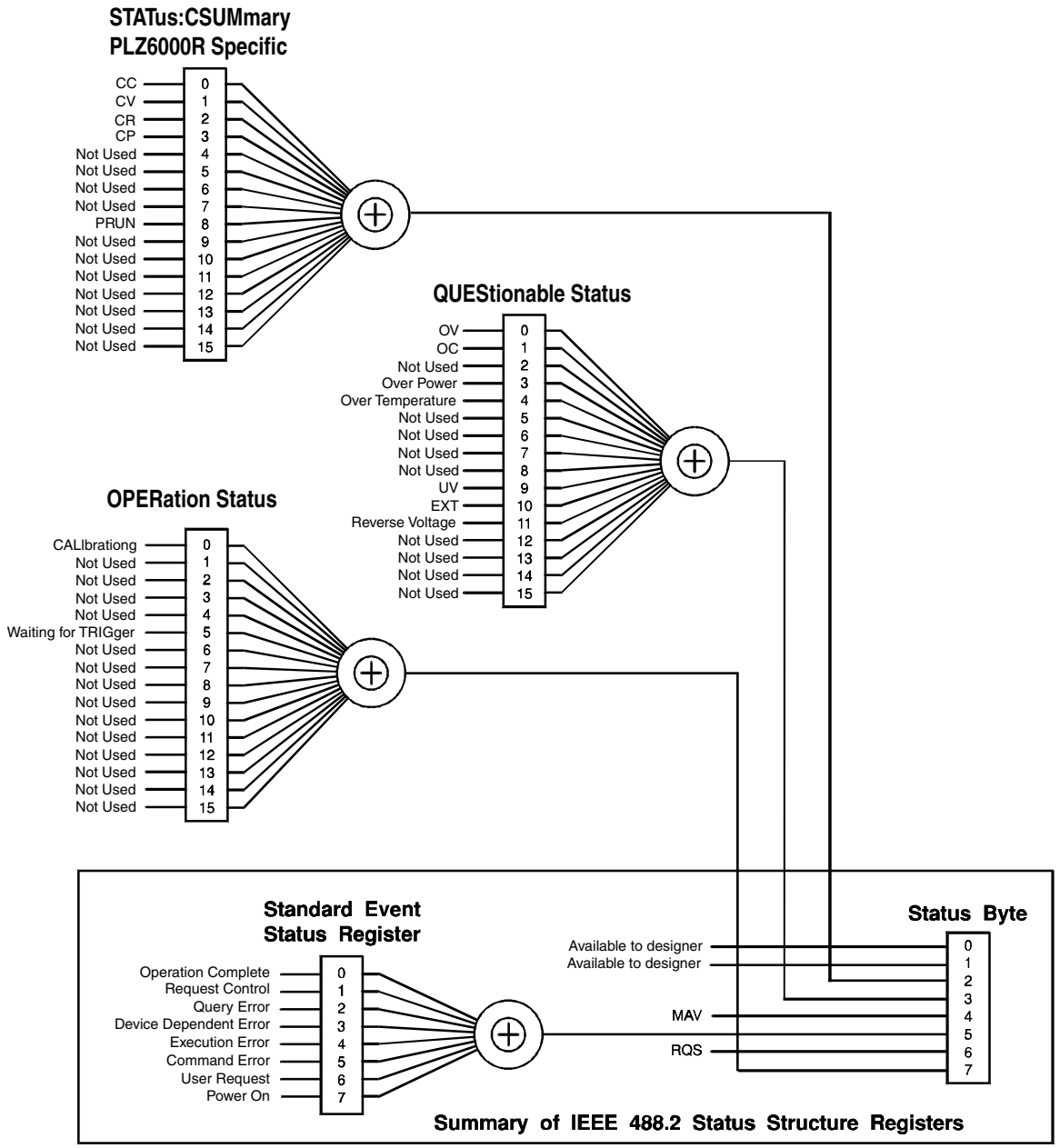
Transition filter

Use the PTRansition (positive transition) filter to report events when the condition changes from false to true.

Use the NTRansition (negative transition) filter to report events when the condition changes from true to false.

If both the positive filter and the negative filter are set to true, events can be reported each time the status changes.

If both filters are cleared, event reporting is disabled.



Partially changed SCPI Standard 1999.0 Volume1 fig.9-1.

Fig.5-4 SCPI Status registers

5.10.1 IEEE488.2 Register Model

Status byte register

The status byte register stores STB and RQS (MSS) messages as defined by the IEEE488.1 standard. The status byte register can be read using IEEE488.1 serial polling or IEEE488.2 common command *SBT?.

When serial polling is carried out, bit 6 responds with the request service (RQS). The status byte value is not changed by serial polling.

*STB? makes the device transmit the contents of the status byte register and the master status summary (MSS) message.

*STB? does not change the status byte, MSS and RQS.

Table 5-11 Status byte register

Bit	Bit Weight	Bit Name	Description
0	1	Reserved	Reserved for future use by the IEEE488. The bit value is notified as zero.
1	2	Not Used	----
2	4	Csummary Status Register (CSUM)	This bit is set to “true” when a bit is set in the CSUMmary status register.
3	8	Questionable Status Register (QUES)	This bit is set to “true” when a bit is set in the QUEStionable event status register and the corresponding bit in the QUEStionable status enable register is “true”.
4	16	Message Available (MAV)	This bit is set to “true” when a request is received from the digital programming interface and the PLZ6000R is ready to output the data byte.
5	32	Standard Event Status Bit Summary (ESB)	This bit is set to “true” when a bit is set in the event status register.
6	64	Request Service (RQS)	This bit is set to “true” when a bit is set in the service request enable register, and the corresponding bit exists in the status byte. The SRQ line of the GPIB is set.
		Master Status Summary (MSS)	This bit is set to “true” when any of the bits in the status byte register is set to 1 and the corresponding bit in the service request enable register is set to 1.
7	128	Operation Status Register (OPER)	This bit is set to “true” when a bit is set in the OPERation event status register and the corresponding bit in the OPERation status enable register is set.
8-15	–	Not Used	----

Event status register

The event status register bits are set when certain events occur during the PLZ6000R is in operation. All bits of the event status register are set by the error queue.

The register is defined by the IEEE488.2 standard and is controlled by the IEEE488.2 common commands *ESE, *ESE?, *ESR?.

Table 5-12 Event status register (Standard Event Status Resister)

Bit	Bit Weight	Bit Name	Description
0	1	Operation Complete (OPC)	It is set when an OPC command is received and all outstanding operations are completed. the Event-800 Operation complete message is loaded to the error/ event queue.
1	2	Request Control (RQC)	----
2	4	Query Error (QYE)	It is set when an attempted action is made to read the data from the output queue if there is no output or the error queue is in waiting status. This indicates that there is no data in the output queue.
3	8	Device Dependent Error (DDE)	It is set when there is a device-specific error.
4	16	Execution Error (EXE)	It is set when the PLZ6000R evaluates the program data following the header is outside the format input range or its data does not match to the performance of the PLZ6000R. This indicates that a valid SCPI command may not be executed correctly depending on the conditions of the PLZ6000R.
5	32	Command Error (CME)	It is set when an IEEE 488.2 syntax error is detected or an unidentified header is received or a group execution trigger is entered into the internal IEEE 488.2 SCPI command input buffer.
6	64	User Request (URQ)	----
7	128	Power ON (PON)	It is set when the POWER is On.
8-15	–	Not Used	----

5.10.2 SCPI Resister Model

OPERation status register

The OPERation status register is a 16-bit register which contains information about conditions which are part of the PLZ6000R normal operation.

Table 5-13 OPERation status register (STATus:OPERation)

Bit	Bit Weight	Bit Name	Description
0	1	CALibrating	Indicates the PLZ6000R is in the calibration (CAL) mode.
1	2	NOT USED	----
2	4	NOT USED	----
3	8	NOT USED	----
4	16	NOT USED	----
5	32	Waiting for TRIGger*1	Indicates whether the PLZ6000R is waiting for a trigger (TRIG).
6	64	NOT USED	----
7	128	NOT USED	----
8	256	NOT USED	----
9	512	NOT USED	----
10	1024	NOT USED	----
11	2048	NOT USED	----
12	4096	NOT USED	----
13	8192	NOT USED	----
14	16384	NOT USED	----
15	32768	NOT USED	----

*1. This is the summary bit of STAT:OPER:TRIG register. More detailed information can be found referring to this register.

STAT:OPER

Queries the event of the OPERation status register.

A query clears the contents of the register.

Command

```
STATus:OPERation[:EVENt]?
```

Response

Returns the event of the OPERation status register in the <NR1> form.

STAT:OPER:COND

Queries the condition of the OPERation status register.

A query does not clear the contents of the register.

Command

```
STATus:OPERation:CONDtion?
```

Response

Returns the condition of the OPERation status register in the <NR1> form.

STAT:OPER:ENAB

Sets the enable register of the OPERation status register.

Command

```
STATus:OPERation:ENABle <NR1>
STATus:OPERation:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register of the OPERation status register in the <NR1> form.

STAT:OPER:PTR

Sets the positive transition of the OPERation status register.

Command

```
STATus:OPERation:PTRansition <NR1>
STATus:OPERation:PTRansition?
```

Parameter

Value: 0 to 32767 (Default)

Response

Returns the positive transition of the OPERation status register in the <NR1> form.

STAT:OPER:NTR

Sets the negative transition of the OPERation status register.

Command

```
STATus:OPERation:NTRansition <NR1>
STATus:OPERation:NTRansition?
```

Parameter

Value: 0 (Default) to 32767

Response

Returns the negative transition of the OPERation status register in the <NR1> form.

QUEStionable status register

The QUEStionable status register is a 16-bit register that stores information related to the questionable events and status during the PLZ6000R is in operation.

These register bits may indicates problems with the measured data of the PLZ6000R.

Table 5-14 QUEStionable status register (STATus:QUEStionable)

Bit	Bit Weight	Bit Name	Description
0	1	OV (Over Voltage)	Detects the over voltage
1	2	OC (Over Current)	Detects the over current
2	4	NOT USED	----
3	8	OP (Over Power)	Detects the over power
4	16	OT (Over Temperature)	Detects the over temperature
5	32	NOT USED	----
6	64	NOT USED	----
7	128	NOT USED	----
8	256	NOT USED	----
9	512	UV (Under Voltage)	Detects the low voltage
10	1024	EXT (External Problem)	Detects the external equipment's alarm
11	2048	REV (Reverse Voltage)	Detects the reverse voltage
12	4096	NOT USED	----
13	8192	NOT USED	----
14	16384	NOT USED	----
15	32768	NOT USED	----

STAT:QUES

Queries the event of the QUEStionable status register.

A query clears the contents of the register.

Command

```
STATus:QUEStionable[:EVENt]?
```

Response

Returns the event of the QUEStionable status register in the <NR1> form.

STAT:QUES:COND

Queries the condition of the QUEStionable status register.

A query does not clear the contents of the register.

Command

```
STATus:QUEStionable:CONDition?
```

Response

Returns the condition of the QUEStionable status register in the <NR1> form.

STAT:QUES:ENAB

Sets the enable of the QUEStionable status register.

Command

```
STATus:QUEStionable:ENABle <NR1>
STATus:QUEStionable:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register of the QUEStionable status register in the <NR1> form.

STAT:QUES:PTR

Sets the positive transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:PTRansition <NR1>
STATus:QUEStionable:PTRansition?
```

Parameter

Value: 0 to 32767 (Default)

Response

Returns the positive transition of the QUEStionable status register in the <NR1> form.

STAT:QUES:NTR

Sets the negative transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:NTRansition <NR1>
STATus:QUEStionable:NTRansition?
```

Command

Value: 0 (Default) to 32767

Response

Returns the negative transition of the QUEStionable status register in the <NR1> form.

CSUMmary status register

The CSUMmary status register indicates the condition of an electrical operation of the PLZ6000R. This is a specific register of the PLZ6000R.

Table 5-15 CSUMmary status register (STATus:CSUMmary)

Bit	Bit Weight	Bit Name	Description
0	1	CC (Regulated as in CC Mode)	Transition to the CC mode
1	2	CV (Regulated as in CV Mode)	Transition to the CV mode
2	4	CR (Regulated as in CR Mode)	Transition to the CR mode
3	8	CP (Regulated as in CP Mode)	Transition to the CP mode
4	16	NOT USED	----
5	32	NOT USED	----
6	64	NOT USED	----
7	128	NOT USED	----
8	256	PRUN (PROGram is being executed)	The program is under execution
9	512	NOT USED	----
10	1024	NOT USED	----
11	2048	NOT USED	----
12	4096	NOT USED	----
13	8192	NOT USED	----
14	16384	NOT USED	----
15	32768	NOT USED	----

STAT:CSUM

Queries the event of the CSUMmary status register.

A Query clears the contents of the register.

Command

```
STATus:CSUMmary[:EVENt]?
```

Response

Returns the event of the CSUMmary status register in the <NR1> form.

STAT:CSUM:COND

Queries the condition of the CSUMmary status register.

A Query does not clear the contents of the register.

Command

```
STATus:CSUMmary:CONDtion?
```

Response

Returns the condition of the CSUMmary status register in the <NR1> form.

STAT:CSUM:ENAB

Sets the enable of the CSUMmary status register.

Command

```
STATus:CSUMmary:ENABle <NR1>
STATus:CSUMmary:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register of the CSUMmary status register in the <NR1> form.

STAT:CSUM:PTR

Set the positive transition of the CSUMmary status register.

Command

```
STATus:CSUMmary:PTRansition <NR1>
STATus:CSUMmary:PTRansition?
```

Parameter

Value: 0 to 32767 (Default)

Response

Returns the positive transition of the CSUMmary status register in the <NR1> form.

STAT:CSUM:NTR

Sets the negative transition of the CSUMmary status register.

Command

```
STATus:CSUMmary:NTRansition <NR1>
STATus:CSUMmary:NTRansition?
```

Parameter

Value: 0 (Default) to 32767

Response

Returns the negative transition of the CSUMmary status register in the <NR1> form.

5.10.3 Preset Status

STAT:PRES

Specific events are reported at a higher level by constructing status data and using the status reporting mechanism. These events are summarized in the required structures, OPERation status register, and QUEStionable register.

STAT:PRES only affects the ENABle register and the transition filter register of the status data structure.

STAT:PRES does not clear any event register or any items from the error/event queue.

To reset all event registers and the queue within the device status reporting mechanism, use *CLS.

For status data required by SCPI, STAT:PRES sets the transition filter registers so that only positive transition are defected and sets the ENABle register to all zeroes. The settings of the service request enable register, parallel poll enable register, memory register related to the *SAV command, the PLZ6000R's address, output queue, and power on status clear flag are not affected by this command.

For the device-dependent status data structure, STAT:PRES sets the ENABle register to all 1's and sets the transition filter registers so that only positive transactions are reported.

Table 5-16 Preset values of the registers that can be set by the user

Register	Filter/Enables	Preset value
QUEStionable OPERation	Enable register	All 0s
	Positive transition filter	All 1s
	Negative transition filter	All 0s
CSUMmary	Enable register	All 1s
	Positive transition filter	All 1s
	Negative transition filter	All 0s

Command

```
STATus:PRESet
```

5.11 Instrument Driver

In addition to using the SCPI commands directly, the PLZ6000R can also be controlled using the IVI instrument driver. The IVI instrument driver conforms to the specifications standardized by the IVI Foundation. It can be used from applications such as Microsoft Visual Studio (6.0,.NET), Office VBA, National Instruments LabWindows/CVI, LabVIEW, Agilent VEE.

The newest version can also be downloaded from KIKUSUI Website (http://www.kikusui.co.jp/en/download).

Maintenance

This chapter describes maintenance of the PLZ6000R.

6.1 Cleaning the Dust Filter

⚠WARNING • **Possible electric shock. Before performing maintenance work, be sure to turn off the POWER switch and disconnect the power cable or turn off the switchboard.**

Two dust filters are installed at the inside of the louver (upper and lower) on the front panel. Periodically clean the filters before the filters are clogged up.

⚠CAUTION • **Clogged filters cause lowering of the cooling effect of the inside of the PLZ6000R and also it may cause a malfunction and shortening of the life cycle.**

- When the PLZ6000R is in operation, air is sucked through the dust filter to cool the inside. If moisture is contained in the dust filter, the temperature or humidity inside the PLZ6000R increases and may cause a malfunction.

Removing the dust filter

1 Remove the lower louver from the front panel.

While lifting the bottom of the removal mark with your finger tips, slide the entire louver to the right. Then, pull it toward you.

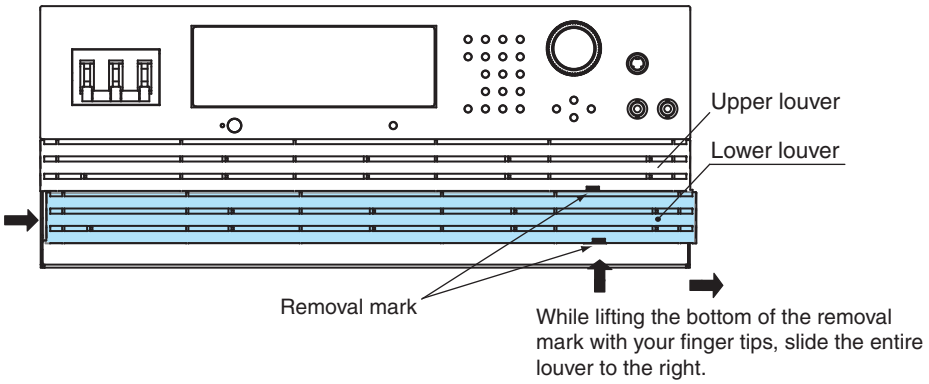


Fig.6-1 Louver removal

2 Remove the upper louver in the same manner as step 1 .

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

There is a hook on the louver tab. Be sure not to get the dust filter caught in the hook when removing the dust filter from the louver.

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.

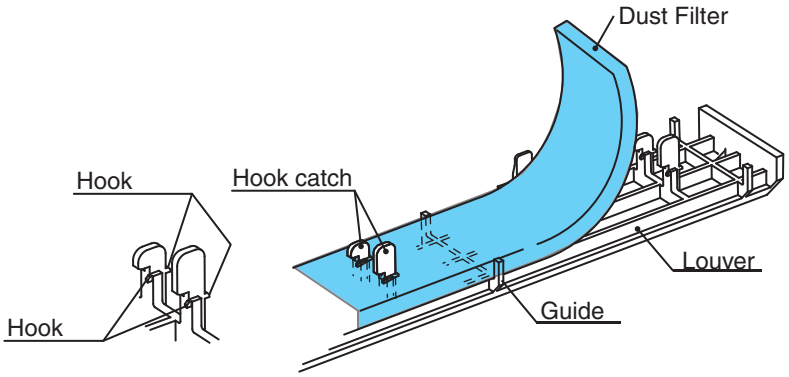


Fig.6-2 Dust filter removal

Attaching the dust filter

1 Align the dust filter along the guide and attach it to the louver.

Be sure to attach it firmly until the tab hooks of the louver completely pass through the cut in the dust filter.

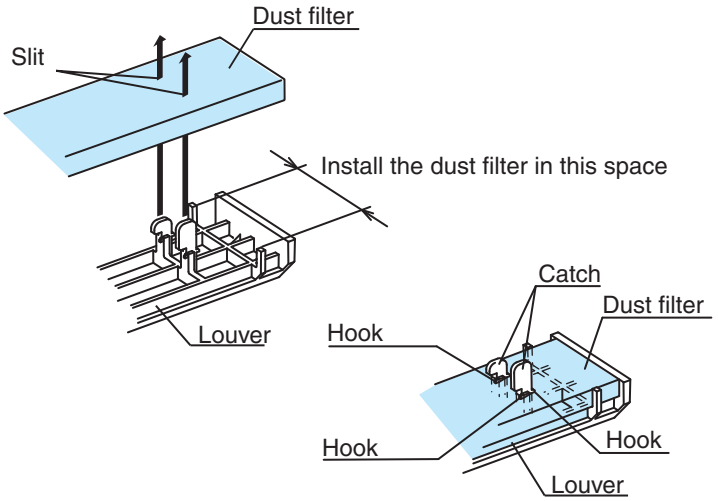


Fig.6-3 Dust filter attachment

2 Attach the upper louver first.

Align the tab on the inner side of the louver to the panel groove and slide the louver to the left to attach it.

You can easily attach the louver by aligning the long tabs (five locations) with the grooves.

Fig.6-4 Dust filter as seen from the rear

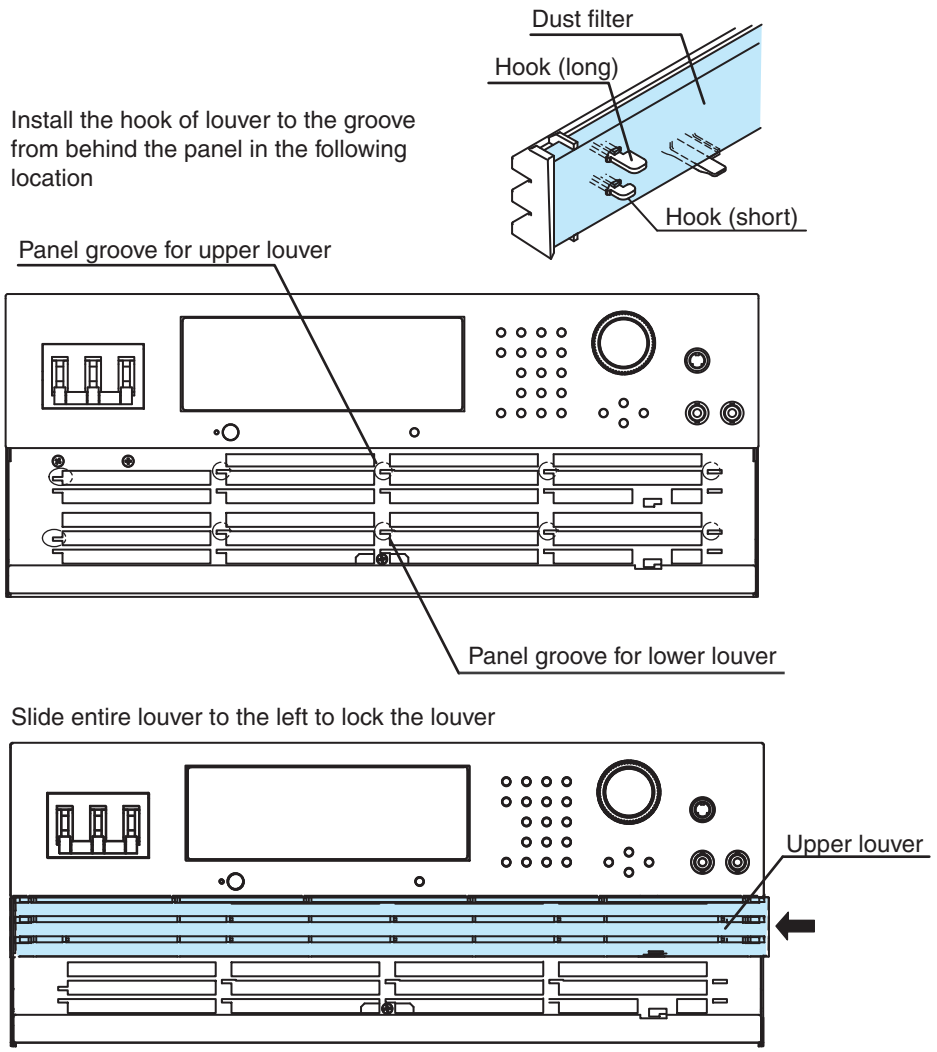


Fig.6-5 Louver attachment

3 Attach the lower louver in the same manner as step 2 .

⚠CAUTION • Pay attention to the shape of the dust filter when attaching the louver to the panel. If you attempt to attach the wrong louver by force, it may break the louver.

6.2 Replacing the Backup Battery

The PLZ6000R employs a battery to back up the panel settings even when the power is turned off. If the panel settings are different at the time the power is turned off and at the time the power is turned on again, the battery is already dead.

The battery life depends on the operating conditions. Three years after purchase is a good estimation. To replace the battery, contact your Kikusui agent or distributor.

6.3 Calibration

The PLZ6000R is shipped after carrying out appropriate calibrations. We recommend periodic calibration to maintain the performance over an extended period.

6.3.1 Calibration Overview

The calibrated items are current and voltage values.

The current values are calibrated with respect to each range (30 V and 60 V).

For each range, the offset and gain values are calibrated.

Offset value: corresponding to 10 % of the range full scale

Gain value: corresponding to 100 % of the range full scale

The relationship between the setting and output during operation is linear. Therefore, a line is defined by calibrating the offset and gain at 2 points. During operation, the relationship between the setting and output is achieved along the calibrated line.

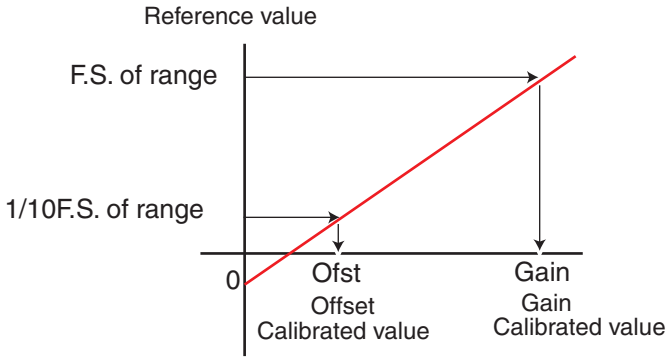


Fig.6-6 Offset and gain calibration

Calibration items

The following six calibration items are available. They are calibrated in the current (30 V range, 60 V range) and the voltage (60 V range).

- Offset of the output voltage
- Gain of the output voltage
- Offset of the measured value
- Gain of the measured value
- Offset of the protection function voltage
- Gain of the protection function voltage

The Offset and Gain value of the output voltage/protection function voltage are calibrated for the internal reference voltage of the output setting and the protection function. The following explanation and the procedure of calibration describes that the term of “output voltage” is used to mean the internal reference voltage for output

setting, and the term of “protection function voltage” is used to mean the internal reference voltage for protection function setting. The offsets of the internal reference voltage for output setting and the measured value are calibrated simultaneously. The same also applies for the gain value.

Therefore, the number of calibration points is in total of 12 points (4 points X 3 ranges).

6.3.2 Preparation

Leave the PLZ6000R turned on for at least 30 minutes (warm-up) before carrying out a calibration. This is to reduce measurement errors due to initial drift. Keep the ambient temperature at 23 ±5 ° C with humidity less than 80 % rh.

Table 6-1 Required instruments

Description	Required accuracy	Required rating
DC Voltmeter (DVM)	within 0.02 %	Measurement voltage range: 0 V to 63 V
Shunt resistor	0.1 %	For 20 A, for 200 A For 50 A, for 500 A
Regulated DC power supply (constant voltage power supply)	–	Voltage: more than 60 V Current: 400 A

Connect the cables as shown in Fig.6-7. Select the shunt resistor according to the calibration item.

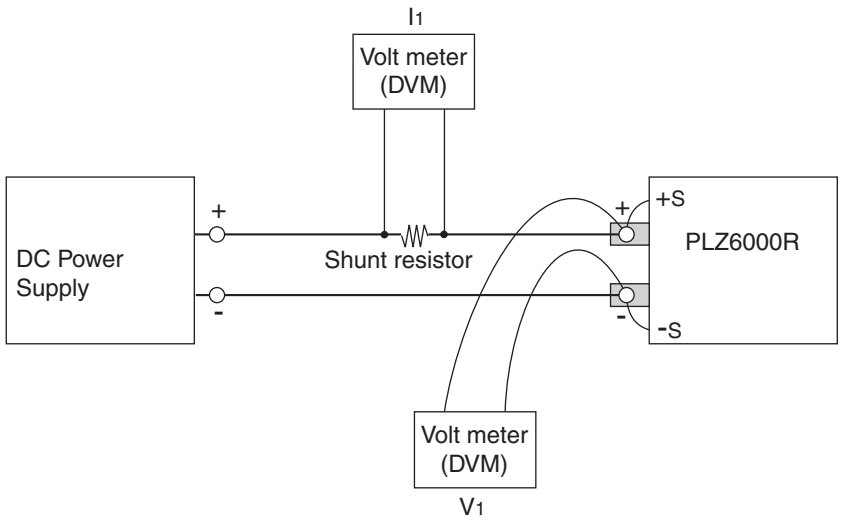


Fig.6-7 Connection diagram for calibration

6.3.3 Calibration Procedure

Calibration is required to be performed in order from “the output voltage and the offset of measured value,” “the offset of the protection function voltage”, “the output voltage and the gain of measured value”, “the gain of the protection function voltage”. Once the calibration is completed, be sure to save the calibrated data to the internal memory. If the data is not saved to the memory, the calibrated data are invalid.

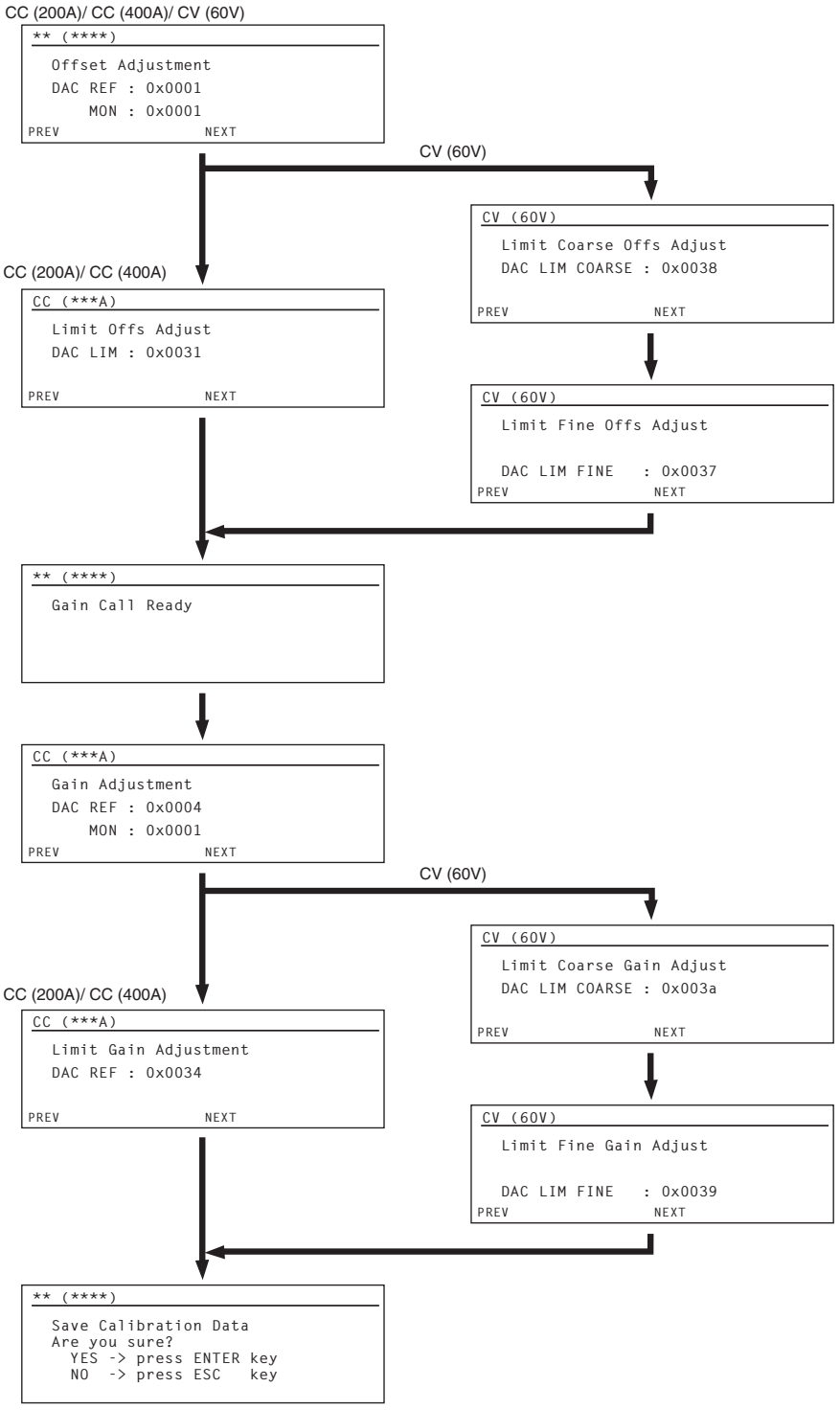


Fig.6-8 Calibration screens and the procedure

CC mode calibration

Carry out calibration on the 60 V (200A) range first. Then carry out calibration for 30 V (400A).

Calibration for the 60 V (200 A) range

1 Connect a shunt resistor suitable for 20 A.

See Table 3-4

2 From the menu setting, select 3.Calibration > 1.CC (200A).

3 Apply 5 V to the load input terminal of the connected power supply. Set the current value of the power supply at +2 % to 5 % of the rated current value of the load unit.

4 Press the “ENTER” key.

The load automatically turns on, and the “CC (200 A) Offset Adjustment” will appear on the screen.

5 Turn the "Rotary knob" to set the current within 20 A ± 0.1 % which flows into the shunt resistor.

Calibrates the offset of the output voltage and the measured value. MON is automatically set as the offset of the measured value.

6 Press the “ENTER” key.

The “CC (200 A) Limit Off Adjust” will be appeared on the screen.

7 Turn the "Rotary knob" to set the current within 20 A ± 0.1 % which flows into the shunt resistor.

Calibrates the offset of the protection function voltage.

8 Press the “ENTER” key.

The load automatically turns off and the “Gain Call Ready” will appear on the screen.

9 Connect a shunt resistor suitable for 200 A.

10 Press the “ENTER” key

The load automatically turns on, and the “CC (200 A) Gain Adjustment” will appear on the screen.

11 Turn the "Rotary knob" to set the current within 200 A ± 0.1 % which flows into the shunt resistor.

Calibrates the gain of the output voltage and the measured value. MON is automatically set as the gain of the measured value.

12 Press the “ENTER” key

The “CC (200 A) Limit Gain Adjust” will appear on the screen.

13 Turn the "Rotary knob" to set the current within 200 A ± 0.1 % which flows into the shunt resistor.

Calibrates the gain of the protection function voltage.

14 Press the “ENTER” key

The load automatically turns off and “ the saving of calibrated values ” will appear on the screen.

15 Press the “ENTER” key to save the calibrated data.

The calibrated data is stored in the internal memory.

Calibration for the 30 V (400 A) range

1 Connect a shunt resistor suitable for 40 A.

See Table 3-4

2 From the menu setting, select 3.Calibration > 1.CC (400 A).

3 Apply 5 V to the load input terminal of the connected power supply. Set the current value of the power supply at +2 % to 5 % of the rated current value of the load unit.

4 Press the “ENTER” key.

The load automatically turns on, and the “CC (400 A) Offset Adjustment” will appear on the screen.

5 Turn the "Rotary knob" to set the current within 40 A ± 0.1 % which flows into the shunt resistor.

Calibrates the offset of the output voltage and the measured value. MON is automatically set as the offset of the measured value.

6 Press the “ENTER” key.

The “CC (400A) Limit Off Adjust” will appear on the screen.

7 Turn the "Rotary knob" to set the current within 40 A ± 0.1 % which flows into the shunt resistor.

Calibrates the offset of the protection function voltage.

8 Press the “ENTER” key.

The load automatically turns off and the “Gain Call Ready” will appear on the screen.

9 Connect a shunt resistor suitable for 400 A.

10 Press the “ENTER” key.

The load automatically turns on, and the “CC (400 A) Gain Adjustment” will appear on the screen.

11 Turn the "Rotary knob" to set the current within 400 A ± 0.1 % which flows into the shunt resistor.

Calibrates the gain of the output voltage and the measured value. MON is automatically set as the gain of the measured value.

12 Press the “ENTER” key.

The “CC (400A) Limit Gain Adjust” will appear on the screen.

13 Turn the "Rotary knob" to set the current within 400 A ± 0.1 % which flows into the shunt resistor.

Calibrates the gain of the protection function voltage.

14 Press the “ENTER” key.

The load automatically turns off and “the saving of calibrated values” will appear on the screen.

15 Press the “ENTER” key to save the calibrated data.

The calibrated data is stored in the internal memory.

CV mode calibration

Carry out calibration on the 60 V range. It is not required to carry out calibration for 30 V. Though it is not required to use the shunt resistor, calibration can be performed while the shunt resistor is connected.

Calibration for the 60 V range

See Table 3-4

1 From the menu setting, select 3.Calibration > 3.CV (60 V).

2 Apply 0.3 A to the load input terminal of the connected power supply. Set the voltage value of the power supply at more than 15.5 V.

3 Press the “ENTER” key.

The load automatically turns on, and the “CV (60 V) Offset Adjustment” will appear on the screen.

4 Turn the "Rotary knob" while monitoring by the external voltmeter to set the input voltage within 6 V ± 0.05 %.

Calibrates the offset of the output voltage and the measured value. MON is automatically set as the offset of the measured value.

5 Press the “ENTER” key.

The “CV (60 V) Limit Coarse Off Adjust” will appear on the screen.

6 Turn the "Rotary knob" while monitoring by the external voltmeter to set the input voltage within 6 V ± 0.05 %.

Calibrates the offset (Coarse) of the protection function voltage.

7 Press the “ENTER” key.

The “CV (60 V) Limit Fine Off Adjust” will appear on the screen.

8 Turn the "Rotary knob" while monitoring by the external voltmeter to set the input voltage within 6.1 V ± 0.05 %.

Calibrates the offset (Fine) of the protection function voltage.

9 Press the “ENTER” key.

The load automatically turns off and the “Gain Call Ready” will appear on the screen.

10 Press the “ENTER” key.

The load automatically turns on, and the “CV (60 V) Gain Adjustment” will appear on the screen.

11 Turn the "Rotary knob" while monitoring with the external voltmeter to set the input voltage within 60 V ± 0.05 %.

Calibrates the offset of the output voltage and the measured value. MON is automatically set as the gain of the measured value.

12 Press the “ENTER” key.

The “CV (60 V) Limit Coarse Gain Adjust” will appear on the screen.

13 Turn the "Rotary knob" while monitoring by the external voltmeter to set the input voltage within 60 V ± 0.05 %

Calibrates the gain (Coarse) of the protection function voltage.

14 Press the “ENTER” key.

The “CV (60 V) Limit Fine Gain Adjust” will appear on the screen.

15 Turn the "Rotary knob" while monitoring by the external voltmeter to set the input voltage within 7 V ± 0.05 %.

Calibrates the gain (Fine) of the protection function voltage.

16 Press the “ENTER” key.

The load automatically turns off and the “the saving of calibrated values” will appear on the screen.

17 Press the “ENTER” key to save the calibrated data.

The calibrated data is stored in the internal memory.

6.4 Troubleshooting

This section introduces troubleshooting measures. Typical symptoms are listed. Check whether any of the items below apply to your case. In some cases, the problem can be solved quite easily.

See p. 3-18

If none of the items apply to your case, we recommend that you initialize the PLZ6000R to factory settings (in this case, the stored memory will be cleared). If the remedy does not correct the problem, contact your Kikusui agent or distributor.

The power does not turn on

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Is rated voltage applied for the input power supply (AC) ?	No	Broken (Snapping) power cable.	Replace the power cable.	2-6
		Bad connection at the AC LINE connector on the rear panel.	Secure the connection of the AC LINE connector.	
	Yes	Malfunction	Immediately stop the use of product, and request for the repair service.	—
Did you allow a time interval of more than 20 seconds between powering ON and OFF?	No	The protection of inrush current control circuit is activated.	Leave enough time interval (more than 20 seconds) between switching the POWER On and Off.	—

The display is dark

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Is the contrast being adjusted?	No	Bad contrast adjustment.	Adjusts the contrast.	3-17

Key operation does not work

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Is the key lock mode enabled?	No	Malfunction	Immediately stop the use of the product, and request repair.	—
	Yes	Panel operation is locked.	Release the lock by pressing the LOCK (SHIFT+LOCAL) key.	3-16
Is the unit set as the slave unit?	Yes	The unit is set as the slave unit.	Set the unit as the master unit by menu setting.	4-37

Load input current is unstable or oscillates

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Does the ALARM light on?	Yes	Abnormal incident occurred either inside or outside of the unit.	Take the appropriate counter measure according to the type of alarm.	3-5
Does the load wiring from a large loop?	Yes	Load wiring forms a large loop.	Twist the load cables.	2-8
Is the load wiring too long?	Yes	A long load wiring.	Arrange remote sensing wiring.	4-19

ALARM is activated

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Is the fan stopped?	Yes	Over heat protection is activated.	Immediately stop the use of product, and request for the repair service.	—
Is the air intake or outlet obstructed?	Yes	Over heat protection is activated.	Keep the air outlet at least 20 cm from the wall. Do not block the air outlet or place any objects between it and the wall.	2-3
Is the air intake or outlet clogged up?	Yes	Over heat protection is activated.	Clean the clogged filter.	6-2
Is the over current protection (OCP) activated?	Yes	The setting value of over current protection is low.	Reset the OCP value by the setting display.	3-6
Is the over power protection (OPP) activated?	Yes	The setting value of over power protection is low.	Reset the OPP value by the setting display.	3-6

The load can not be turned on

Item to check		Possible Cause	Remedy	See Page
Description	Status			
Is the sequence in operation?	Yes	Sequence is activated.	Wait for the sequence operation to finish. Or shut down the sequence operation by the STOP key.	4-17
	No	The logical status of Load On/ Load Off (Load ON IN) is LOW	Set HIGH by the menu setting.	4-28

Specifications

This chapter gives description on the electrical and mechanical specifications of the PLZ6000R and its options.

7.1 Specifications

Unless specified otherwise, the specifications are defined by the following terms and conditions.

- The warm-up time is 30 minutes (with current flowing)
- Temperature: 20 ° C to 30 ° C
- Humidity: 20 %rh to 85 %rh
- rdng: Indicates the reading
- set: Indicates the setting.

Electrical specifications

Rating			
	Operating voltage (DC)	30 V Range	3 V to 30 V
		60 V Range	6 V to 60 V
	Current	30 V Range	400 A
		60 V Range	200 A
	Power		6000 W
Constant Current Mode (CC mode)			
	Operating range	30 V Range	0 A to 400 A
		60 V Range	0 A to 200 A
	Setting range	30 V Range	0 A to 408 A
		60 V Range	0 A to 204 A
	Resolution		10 mA
	Accuracy of setting		± (0.4 % of set + 400 mA)
	Input voltage variation*1		400 mA
	Ripple	Setting Current above 5 A	500 mArms*2 2 Ap-p*3
		Setting Current less than 5 A	1.2 Arms*2 5 Ap-p*3
Constant Resistance Mode (CR mode)			
	Operating range	30 V Range	134 S to 2.5 mS (7.4627 mΩ to 400 Ω)
		60 V Range	34 S to 2.5 mS (29.412 mΩ to 400 Ω)
	Setting range	30 V Range	136 S to 0 S (7.3529 mΩ to OPEN)
		60 V Range	34 S to 0 S (29.412 mΩ to OPEN)
	Resolution		2.5 mS
	Accuracy of setting		± (0.5 % of set*4 + 2 A)
Constant Voltage Mode (CV mode)			
	Operating range	30 V Range	3 V to 30 V
		60 V Range	6 V to 60 V
	Setting range	30 V Range	3 V to 31.5 V
		60 V Range	6 V to 63 V
	Resolution		1 mV
	Accuracy of setting		± (0.1 % of set + 60 mV)
	Input current variation*5		12 mV
Constant Power Mode (CP mode)			
	Operating range		0 W to 6000 W
	Setting range		0 W to 6300 W
	Resolution		0.1 W
	Accuracy of setting		± (1 % of set + 60 W)

Voltmeter			
	Display		0.000 V to 60.000 V
	Resolution		0.002 V
	Accuracy		± (0.1 % of rdng + 60 mV)
Ammeter			
	Display		0.00 A to 400.00 A
	Resolution		0.01 A
	Accuracy		± (0.3 % of rdng + 300 mA)
Wattmeter*6			
	Display		0.0 W to 6000.0 W
	Resolution		0.1 W
Protection function			
	DC side	Over voltage protection (OVP)	Turns off the load, shut down the load input by the relay at 110 % of the rated voltage of range
		Over current protection (OCP)	2.0 A to 440.0 A or 110 % of the maximum current of each range
		Over power protection (OPP)	1 W to 6600 W
		Over heat protection (OHP)	Turns off the load when the heat sink temperature reaches 80 ˚C
		Reverse connection protection (REV)	Turns off the load, shut down the load input by the relay with reverse current
		Under voltage protection (UVP)	Can be set in the range of 0 V to 60 V or Off
	AC side	Abnormal voltage range	Turns off the load, shut down the input breaker except the range of 170 V to 240 V.
		Abnormal frequency range	Turns off the load, shut down the input breaker except the range of 45 Hz to 65 Hz.
		Open phase	Turns off the load, shut down the input breaker when any open phase appeared from 3 phase.
		Abnormal current	Turns off the load, shut down the input breaker when the current exceeds 32 A.
Soft start			
	Operation mode		CC mode
	Selectable time range		20 ms, 50 ms, 100 ms, 200 ms
	Setting time accuracy		± (30 % of set + 100 µs)
Remote sensing			
	Voltage that can be compensated		2 V for a single line
Sequence function			
	Operation mode		CC, CR, CV, CP
	Maximum number of steps		256
	Step execution time		10 ms to 999 h 59 min.
	Time resolution		10 ms (10 ms to 1 min.) 100 ms (1 min to 1 h) 1 s (1 h to 10 h) 10 s (10 h to 100 h) 1 min. (100 h to 999 h 59 min.)
Others			
	Elapsed time display		Measures the time from load on to load off. On/Off selectable. Can be set in the range of 1 s to 999 h 59 min. 59 s or set to Off.
	Auto load off timer		Automatically turns off the load after the specified time elapses. Can be set in the range of 1 s to 999 h 59 min 59 s or set to Off

*1. When the input voltage is varied by operating range of the rated voltage at a current of rated power 60 V (30 V).
*2. Measurement frequency bandwidth: 10 Hz to 1 MHz
*3. Measurement frequency bandwidth: 10 Hz to 20 MHz
*4. set = Vin/Rset
*5. With respect to a change in the current of 40 A to 400 A of the rating at an input voltage of 3 V (during remote sensing).
*6. Displays the multiplier result of the voltage value and current value.

Interface

Common specifications	Messaging protocol	IEEE std. 1488.2-992
		SCPI Specification 1999.0
GPIB complies with IEEE Std.488.1-1987	Subset	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E1
	Device address	1 to 30 (selectable range)
RS232C	Connector	9 pin D-sub connector
	Baudrate	2400 bps / 4800 bps / 9600 bps / 19200 bps
	Data length	7 bits or 8 bits
	Stop bit	1 bit or 2 bits
	Parity	None (fixed)
	Flow control	X-Flow/None
USB USB specification 2.0 Self powered	Device class	USB Test and Measurement Class (USMTMC Specification 1.0, USMTMC-USB488 Specification 1.0)
	Communication speed	Maximum 12 Mbps (Full Speed)

External control

External control*1	EXT-V CC/CR/CP CONT (CC/CR/CP external voltage control)	Applying 0 V to 10 V is equal to the proportional value of 0 % to 100 % to control up to the maximum of either 400 A or 6 kW (CC, CP mode) as well at for minimum resistance value to the maximum resistance value (CR mode)
	EXT-R CC/CR/CP CONT*2 (CC/CR/CP external resistance control)	Applying 0 Ω to 10 kΩ is equal to the proportional value of 0 % to 100 % to control up to the maximum of either 400 A or 6 kW (CC, CP mode) as well at for minimum resistance value to the maximum resistance value (CR mode)
	EXT-V CV CONT (CV external voltage control)	Applying 0 V to 10 V is equal to the proportional value of 0 % to 100 % to control up to the maximum of 60 V (CV, CC + CV, CR + CV mode)
	EXT-R CV CONT*2 (CV external resistance control)	Applying 0 Ω to 10 kΩ is equal to the proportional value of 0 % to 100 % to control up to the maximum of 60 V (CV, CC + CV, CR + CV mode)
	LOAD ON/OFF CONT	It turns LOAD ON by the L (or H) of the TTL level signal. It turns LOAD OFF by the H (or L) of the TTL level signal.
	RANGE CONT	It is set 60 V range by the L of the TTL level signal. It is set 30 V range by the H of the TTL level signal.
	MODE CONT	Mode settings for CC/CR/CP/CV/CC + CV/CR + CV can be made by combination of the H and L of TTL signal of MODE CONT 0, MODE CONT 1,MODE CONT 2.
	PRESET A/B/C CONT	Recalls of the preset A/B/C with L of the TTL level signal.
	TRIG INPUT	When in pause status, it can be released from the pause status by applying H of the TTL signal for more than 100ms.

*1. J1 connector on the rear panel.
*2. Voltage/Current/Power can be set either proportional control or inverse proportional control by the control signal. It can be set by the control panel.

Output signals

Monitor signal output	V MON (Voltage)	5 V f.s (30 V range), 10 V f.s (60 V range)
	I MON (Current)	10 V f.s (30 V range), 5 V f.s (60 V range)
	I MON (Current)Front panel BNC terminal*1	
Status signal output	LOAD ON STATUS*2	Turns on when the LOAD is ON
	ALARM STATUS*2	Turns on when an alarm (OVP, OCP, OPP, OHP, REV, UVP, AC OVP, AC OCP) is activated and an external alarm input is applied.
	RANGE STATUS*2	Turns on when 30 V is selected
Trigger signal output	TRIG OUT Front panel BNC terminal	Output impedance: Approx. 500 Ω, Output voltage: Approx. 4.5 V, Pulse width: 1 ms or above

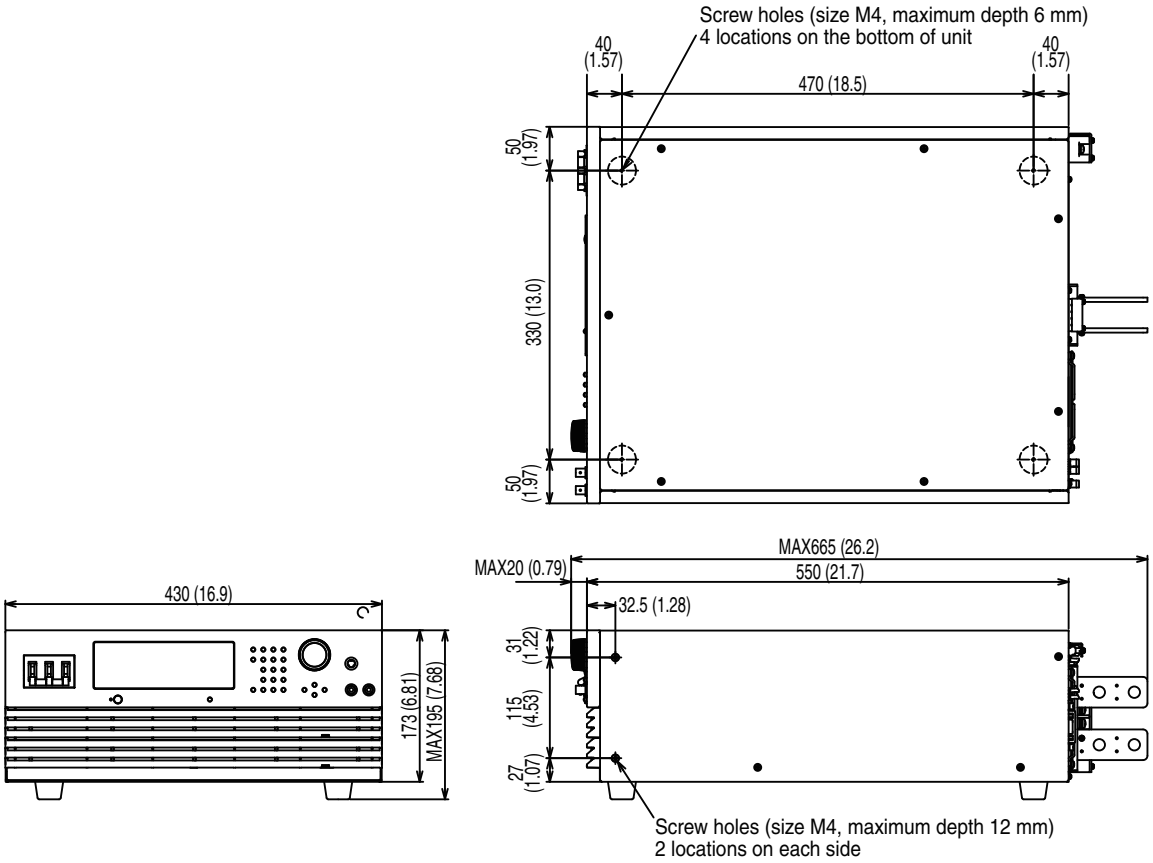
*1. Isolated from the internal common. (connected to the chassis potential).
*2. Output by the relay contact. The contact make is set by ON status.

General Specifications

Nominal input rating		200 Vac, 50 Hz to 60 Hz, Three phase three wires	
Input voltage range		180 Vac to 220 Vac, Three phase three wires	
Input frequency range		47 Hz to 63 Hz	
Power consumption		200 VA (when no load is applied)	
Maximum regenerative power		5600 VA	
Regenerative efficiency		85 % or above	
Inrush current		50 A	
Operating temperature, humidity range		Temperature: 0 °C to 40 °C (32 °F to 104 °F), Humidity: 20 %rh to 85 %rh (without condensation)	
Storage temperature, humidity range		Temperature: -25 °C to 70 °C (-13 °F to 158 °F), Humidity: less than 90 %rh (without condensation)	
Isolation voltage		±500 V	
Insulation resistance	Primary - input terminal Primary - chassis Input terminal - chassis	500 Vdc, 30 MΩ or more (ambient humidity of 70 %rh or less)	
Withstand voltage	Primary - input terminal Primary - chassis	No abnormalities at 1.5 kVac for 1 minute	
Dimensions		See outline drawing	
Weight		Approx. 43 kg (95 lb)	
Battery Life time		Approx. 3 years	
Safety*1		Complies with the requirement of the following standard. IEC 61010-1 Class I Pollution degree 2	
Accessories		Load input terminal screw (M12 x 25 mm bolts, nuts, and spring washers)	4 sets
		Input terminal cover	1 set
		Lock plate	2 pcs.
		Lock plate fixed screws	4 pcs.
		J1/PARALLEL OUT/PARALLEL IN protection socket*2	3 pcs.
		Operation manual	1 pc.

*1. Not applicable to custom order models.
*2. Those sockets are equipped with the unit.

7.2 Dimensions



Unit: mm (inch)

Fig.7-1 PLZ6000R outline drawing

Appendix

The appendix contains explanations of basic operation modes, operation regions, the regenerative power function, the new sequence program table, examples of sequence programs, lists of messages, and lists of command errors.

A.1 Operating Area of the PLZ6000R

As shown in Fig.A-1, the PLZ6000R can be used within the operating area indicated in dark gray (the operating area where specifications are guaranteed). The actual operatig area is indicated in light gray. Specifications are not guaranteed in this area.

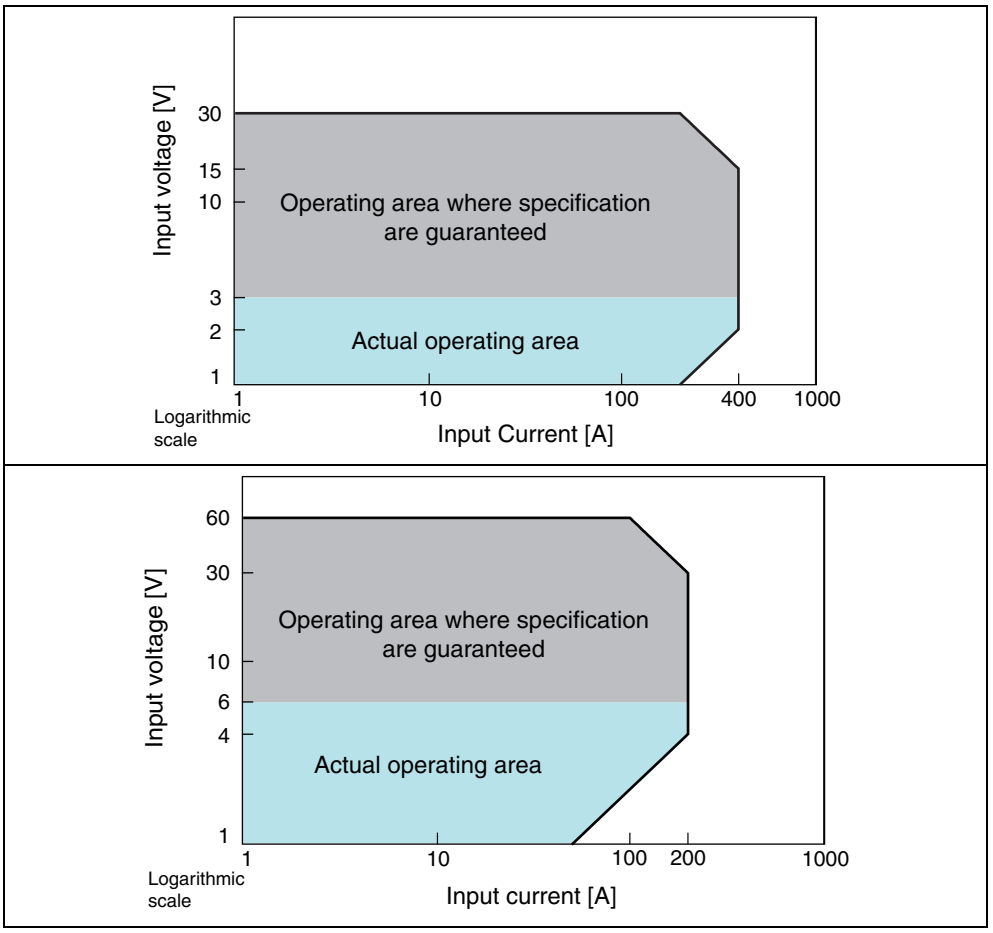


Fig.A-1 Operating area

A.2 Basic Operation Modes

The following six operation modes are available on the PLZ6000R.

- Constant current mode (CC mode)
- Constant resistance mode (CR mode)
- Constant voltage mode (CV mode)
- Constant power mode (CP mode)
- Constant current and constant voltage mode (CC+CV mode)
- Constant resistance and constant voltage mode (CR+CV mode)

A.2.1 Operation of the CC Mode

In CC mode, the current is kept constant even when the voltage changes.

■ CC mode operation

When the PLZ6000R is used in CC mode, the PLZ6000R operates as a constant current load as shown in Fig.A-2. The PLZ6000R sinks the specified current (I) independent of the output voltage of the constant-voltage power supply (V1).

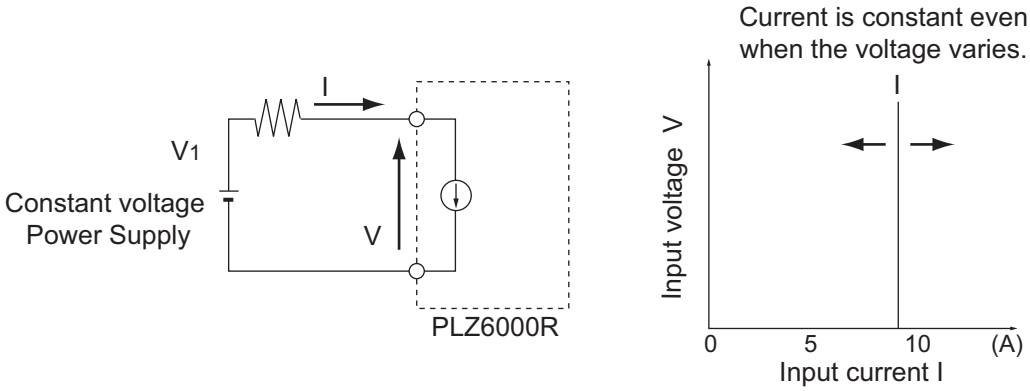


Fig.A-2 Equivalent circuit of the constant current load and operation

■ Transition of the operating point: Overpower protection (OPP)

Consider the case of checking the load characteristics of the constant voltage power supply under the CC mode described in Fig.A-3.

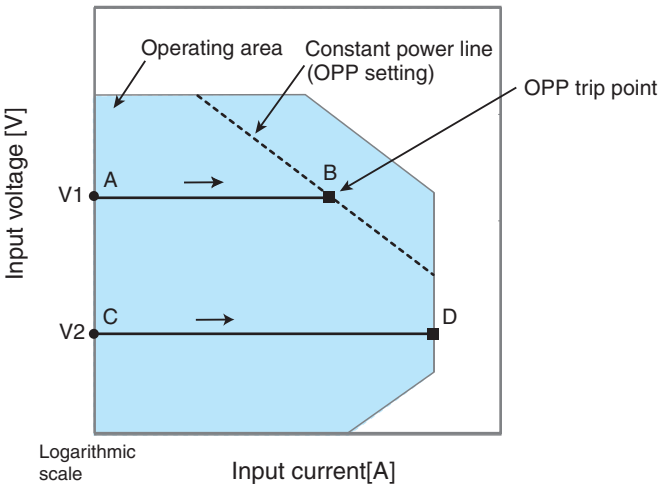


Fig.A-3 Transition of the operating point in CC mode (OPP trip point)

Fig. 3-5: Operation on segment AB

If the voltage of the constant-voltage power supply is set to V1 and the input current (load current) of the PLZ6000R is increased, the operating point moves along segment AB.

When point B is reached, overpower protection (OPP) trips. At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OPP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant power load at point B. Even if you attempt to increase the input current, the current is limited at point B. If you decrease the input current, the OPP is cleared. The PLZ6000R returns to CC mode, and the operating point moves along segment AB.

Table A-1 OPP action (protect action)

Point B	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CC mode ends. OPP continues, and the PLZ6000R sinks current as a constant power load.

Fig. 3-5: Operation on segment CD

If the voltage of the constant-voltage power supply is set to V2 and the input current (load current) of the PLZ6000R is increased, the operating point moves along segment CD. Point D is the maximum current at the range being used.

A.2.2 Operation of the CR Mode

In CR mode, the PLZ6000R sinks current proportional to the voltage variation.

■ CR mode operation

When the PLZ6000R is used in CR mode, the PLZ6000R operates as a resistive load as shown in Fig.A-4. When the voltage (V1) of the constant-voltage power supply is varied, the PLZ6000R sinks current to meet I=V/R according to the specified resistance R.

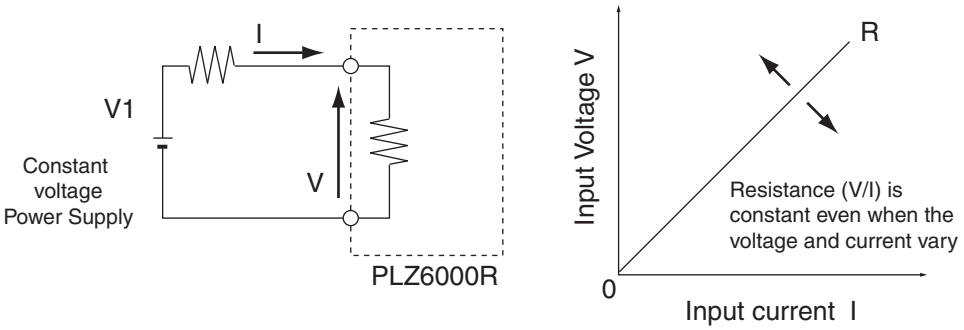


Fig.A-4 Equivalent circuit of the constant resistance load and operation

■ Transition of the operating point: Overpower protection (OPP)

We will consider the case when checking the load characteristics of the constant voltage power supply of Fig.A-4 using CR mode.

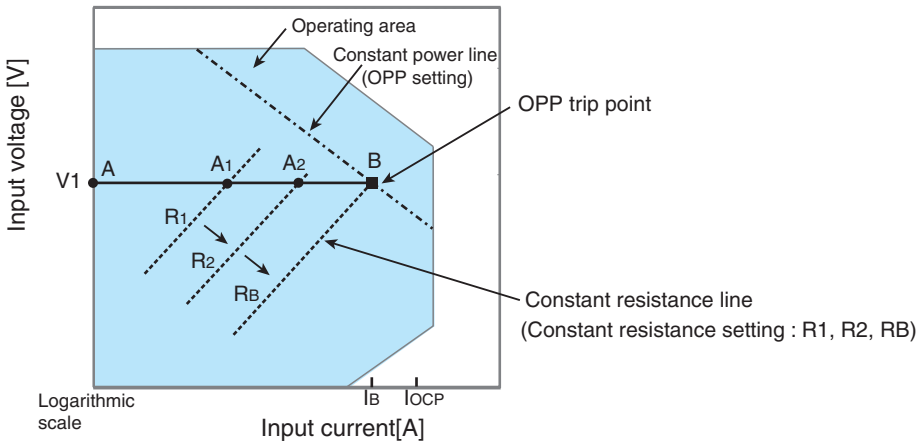


Fig.A-5 Transition of the operating point in CR mode (OPP trip point)

If the overcurrent protection (OCP) setting IOCP is greater than the current value IB at point B, when the PLZ6000R resistance is decreased (R1→R2→RB) and the input current (load current) is increased with the voltage of the constant-voltage power supply at V1, the operating point moves along segment AB (A1→A2→B). When point B is reached, overpower protection (OPP) trips.

At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OPP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant power load at point B. Even if you attempt to increase the input current by decreasing the resistance, the current is limited at point B. If you decrease the input current by increasing the resistance, the OPP is cleared. The PLZ6000R returns to CR mode, and the operating point moves along segment AB.

Table A-2 OPP action (protect action)

Point B	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CR mode ends. OPP continues, and the PLZ6000R sinks current as a constant power load.

■ Transition of the operating point: Overcurrent protection (OCP)

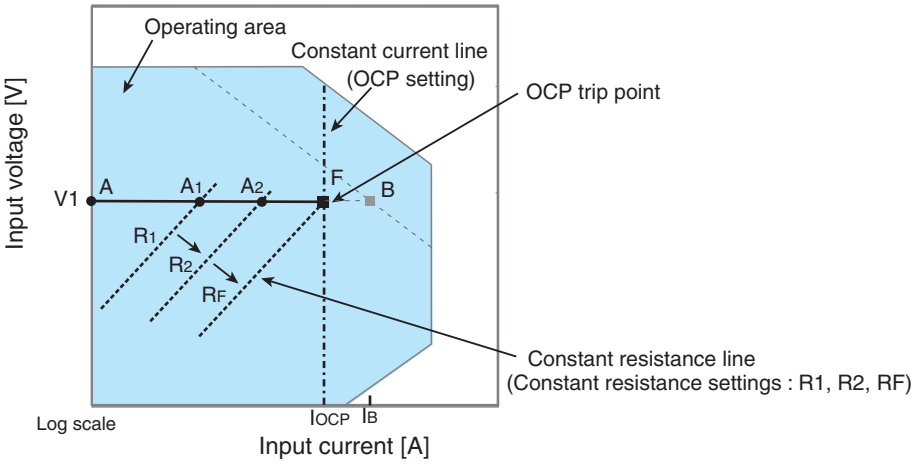


Fig.A-6 Transition of the operating point in CR mode (OCP trip point)

If the overcurrent protection (OCP) setting IOCP is less than the current value IB at point B, when the PLZ6000R resistance is decreased (R1→R2→RF) and the input current (load current) is increased with the voltage of the constant-voltage power supply at V1, the operating point moves along segment AF (A1→A2→F). When point F is reached, overcurrent protection (OCP) trips.

At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OCP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant current load at point F. Even if you attempt to increase the input current by decreasing the resistance, the current is limited at point F. If you decrease the input current by increasing the resistance, the OCP is cleared. The PLZ6000R returns to CR mode, and the operating point moves along segment AF.

Table A-3 OCP action (protect action)

Point F	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CR mode ends. OCP continues, and the PLZ6000R sinks current as a constant current load.

A.2.3 Operation of the CP Mode

In CP mode, the PLZ6000R sinks current so that the power consumed inside the electronic load is constant.

■ CP mode operation

When the PLZ6000R is used in CP mode, the PLZ6000R operates as a constant power load as shown in Fig.A-7. When the voltage (V1) of the constant-voltage power supply increases the input current (I) decreases so that the power consumed by the PLZ6000R P = V × I is kept constant. In Fig.A-7, P = V2 × I2 = V3 × I3.

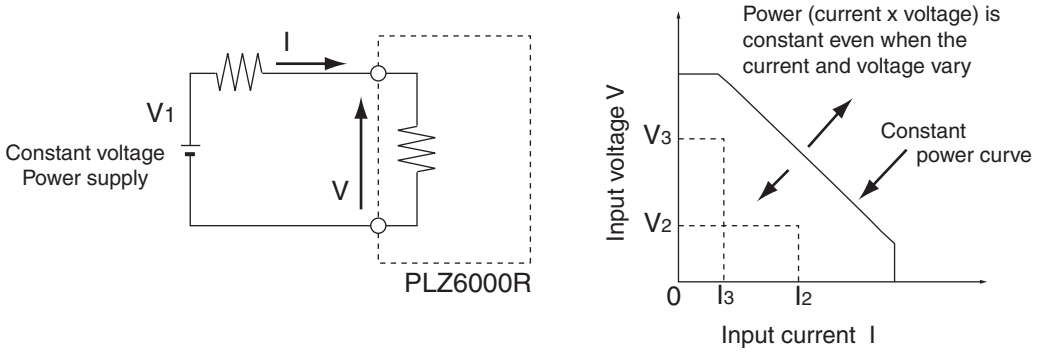


Fig.A-7 Equivalent circuit of the CP mode and operation

■ Transition of the operating point: Overcurrent protection (OCP)

We will consider the case when checking the load characteristics of the constant voltage power supply of Fig.A-7 using CP mode.

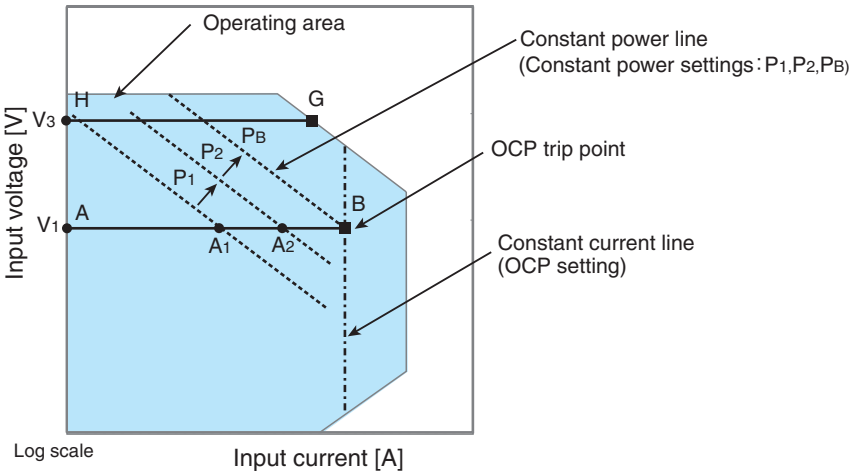


Fig.A-8 Transition of the operating point in CP mode (OCP trip point)

Fig. A-8: Operation on segment AB

If the voltage of the constant-voltage power supply is set to V1 and the power of the PLZ6000R is increased (P1→P2→PB), the operating point moves along segment AB (A1→A2→B).

When point B is reached, overcurrent protection (OCP) trips. At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OCP.

Appx

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant current load at point B. Even if you attempt to increase the input current, the current is limited at point B. If you decrease the input current, the OCP is cleared. The PLZ6000R returns to CP mode, and the operating point moves along segment AB.

Table A-4 OCP action (protect action)

Point B	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CP mode ends. OCP continues, and the PLZ6000R sinks current as a constant current load.

Fig. A-8: Operation on segment GH

If the voltage of the constant-voltage power supply is set to V3 and the power of the PLZ6000R is increased (P1→P2→PB), the operating point moves along segment GH.

Point G is the maximum power at the range being used.

A.2.4 Operation of the CV Mode

In CV mode, the PLZ6000R sinks current so that the voltage at the load input end of the PLZ6000R is constant.

■ CV mode operation

When the PLZ6000R is used in CV mode, the PLZ6000R operates as a constant voltage load (shunt regulator) as shown in Fig.A-9. When V1 is greater than V, the input voltage V is kept constant even when the input current I varies. Current does not flow when V1 is less than or equal to V.

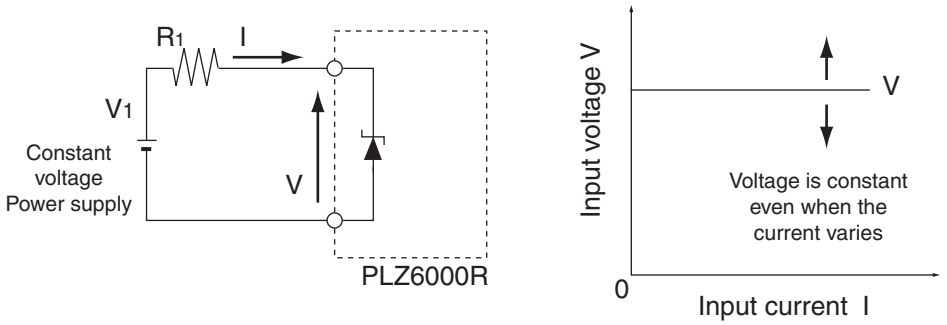


Fig.A-9 Equivalent circuit of the CV mode and operation

■ Transition of the operating point: Overpower protection (OPP)

We will consider the case when checking the load characteristics of the constant voltage power supply of Fig.A-9 using CV mode.

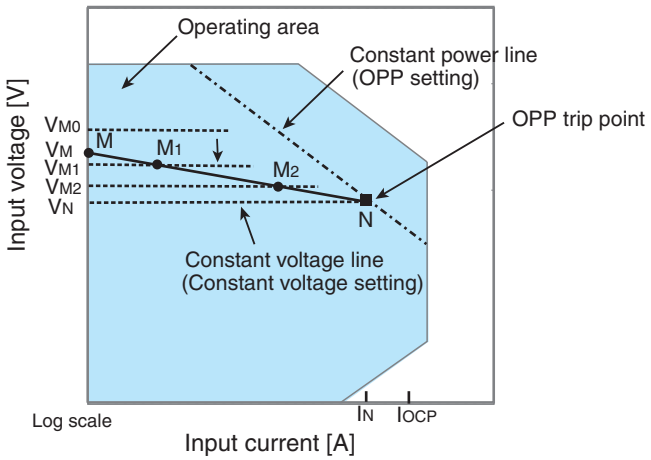


Fig.A-10 Transition of the operating point in CV mode (OPP trip point)

We assume that the overcurrent protection (OCP) setting IOCP is greater than current IN at point N and denote the voltage of the constant voltage power supply as VM. When the voltage of the PLZ6000R is equal to VMO (VMO > VM), no current flows. When the voltage of the PLZ6000R is decreased to a point in which VMO is smaller than VM, the current starts flowing. If the voltage is decreased further (VM1→VM2→VN) to increase the input current (load current), the operating point moves along segment MN (M1→M2→N).

When point N is reached, overpower protection (OPP) trips. At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OPP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant power load at point N. Even if you attempt to decrease the voltage, the current is limited at point N. If you increase the voltage, the OPP is cleared. The PLZ6000R returns to CV mode, and the operating point moves along segment MN.

Table A-5 OPP action (protect action)

Point N	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CV mode ends. OPP continues, and the PLZ6000R sinks current as a constant power load.

■ Transition of the operating point: Overcurrent protection (OCP)

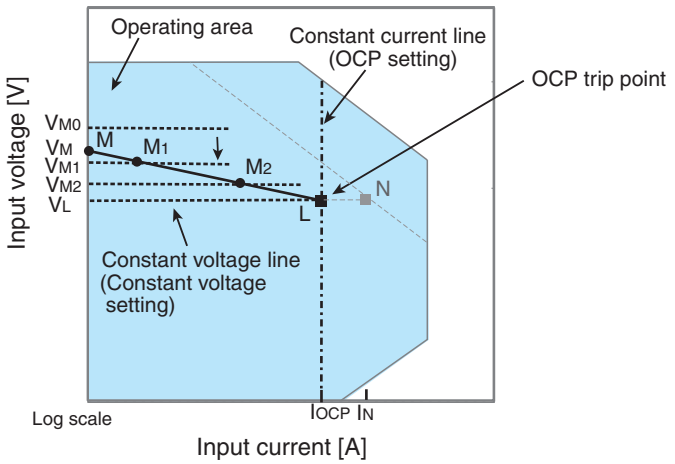


Fig.A-11 Transition of the operating point in CV mode (OCP trip point)

We assume that the overcurrent protection (OCP) setting IOCP is less than current IN at point N and denote the voltage of the constant voltage power supply as VM. When the voltage of the PLZ6000R is equal to VMO (VMO > VM), no current flows. When the voltage of the PLZ6000R is decreased to a point in which VMO is smaller than VM, the current starts flowing. If the voltage is decreased further (VM1→VM2→VL) to increase the input current (load current), the operating point moves along segment ML (M1→M2→L).

When point L is reached, overcurrent protection (OCP) trips. At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OCP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant current load at point L. Even if you attempt to decrease the voltage, the current is limited at point L. If you increase the voltage, the OCP is cleared. The PLZ6000R returns to CV mode, and the operating point moves along segment ML.

Table A-6 OCP action (protect action)

Point L	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CV mode ends. OCP continues, and the PLZ6000R sinks current as a constant current load.

A.2.5 Operation of the CC+CV Mode

The PLZ6000R allows you to add CV mode to CC mode.

■ CC+CV mode operation

When the PLZ6000R is used in CC+CV mode, the PLZ6000R operates as a constant current load and a constant voltage load (shunt regulator) as shown in Fig.A-12. When operating as a constant current load, the PLZ6000R sinks the specified current (I) independent of the output voltage of the constant-voltage power supply (VM). When operating as a constant voltage load and VM is greater than V, the input voltage V is kept constant even when the input current I varies. Current does not flow when VM is less than or equal to V.

The switching between the modes is automatic.

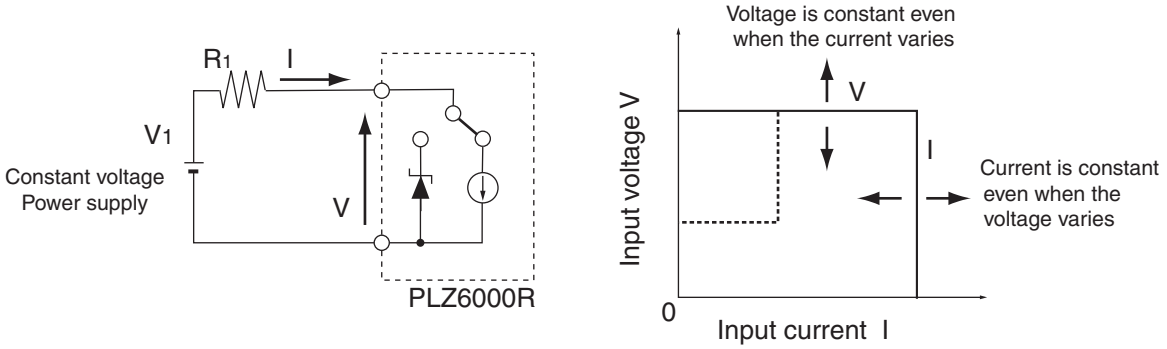


Fig.A-12 Equivalent circuit of the CC+CV mode and operation

■ Transition of the operating point: Overpower protection (OPP)

We will consider the case when checking the discharge characteristics of a battery of Fig.A-12.

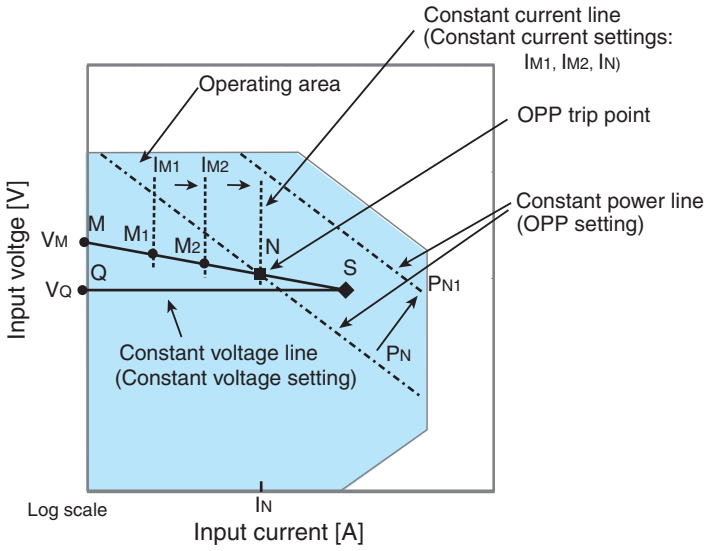


Fig.A-13 Transition of the operating point in CC+CV mode (OPP trip point)

We denote the voltage of the battery as VM. In CC mode, if the current is increased (IM1→IM2→IN) to increase the input current (load current), the operating point moves along segment MN (M1→M2→N).

When the overpower protection (OPP) setting is PN, the OPP trips when point N is reached.

At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OPP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant power load at point N. Even if you attempt to increase the current, the current is limited at point N. If you decrease the current, the OPP is cleared. The PLZ6000R returns to CC mode, and the operating point moves along segment MN.

Table A-7 OPP action (protect action)

Point N	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CC mode ends. OPP continues, and the PLZ6000R sinks current as a constant power load.

If the overpower protection (OPP) setting is PN1, the OPP does not trip as the current is increased, and the operating point reaches point S.

Here, the operation mode is CV. The voltage is fixed to voltage VQ set in advance.

In this case, the operating point moves along segment QS. The current is determined by the battery voltage and its internal resistance.

A.2.6 Operation of the CR+CV Mode

The PLZ6000R allows you to add CV mode to CR mode.

■ CR+CV mode operation

When the PLZ6000R is used in CR+CV mode, the PLZ6000R operates as a constant resistance load and a constant voltage load (shunt regulator) as shown in Fig.A-14.

When operating as a constant resistance load and the voltage (VM) of the constant voltage power supply is varied, the PLZ6000R sinks current to meet I=V/R according to the specified resistance R. When operating as a constant voltage load and VM is greater than V, the input voltage V is kept constant even when the input current I varies. Current does not flow when VM is less than or equal to V.

The switching between the modes is automatic.

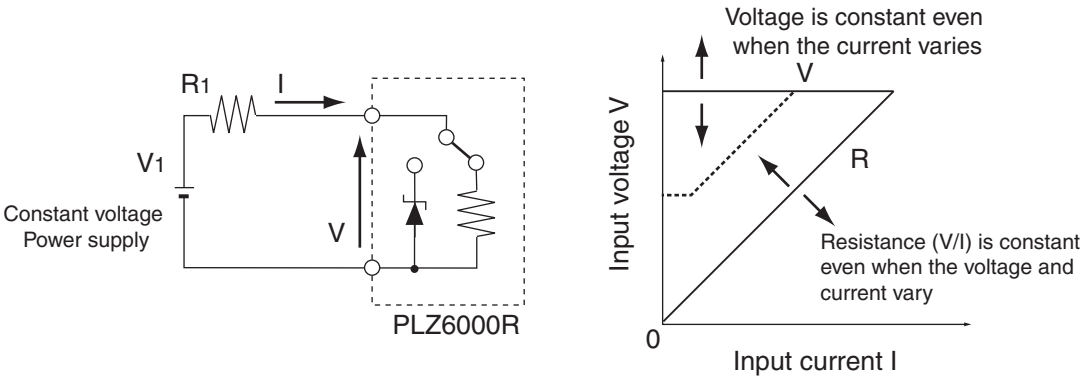


Fig.A-14 Equivalent circuit of the CR+CV mode and operation

■ Transition of the operating point: Overpower protection (OPP)

We will consider the case when checking the discharge characteristics of a battery of Fig.A-14.

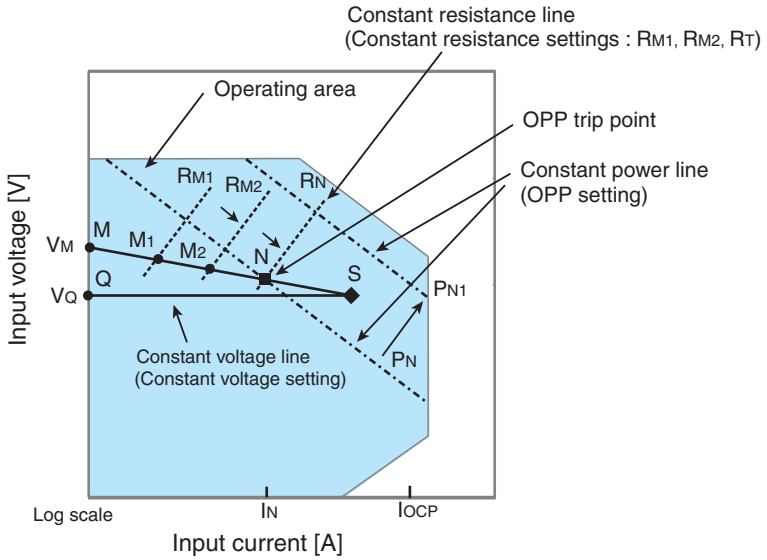


Fig.A-15 Transition of the operating point in CR+CV mode (OPP trip point)

We assume that the overcurrent protection (OCP) setting IOCP is greater than current IN at point N and denote the voltage of the battery as VM. In CR mode, if the resistance is decreased (RM1→RM2→RN) to increase the input current (load current), the operating point moves along segment MN (M1→M2→N).

When the overpower protection (OPP) setting is PN, the OPP trips when point N is reached.

At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OPP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant power load at point N. Even if you attempt to increase the current by decreasing the resistance, the current is limited at point N. If you decrease the current by increasing the resistance, the OPP is cleared. The PLZ6000R returns to CR mode, and the operating point moves along segment MN.

Table A-8 OPP action (protect action)

Point N	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CR mode ends. OPP continues, and the PLZ6000R sinks current as a constant power load.

If the overpower protection (OPP) setting is PN1, the OPP does not trip as the resistance is decreased to increase the current. Consequently, the operating point reaches point S.

Here, the operation mode is CV. The voltage is fixed to voltage VQ set in advance.

In this case, the operating point moves along segment QS. The current is determined by the battery voltage and its internal resistance.

■ Transition of the operating point: Overcurrent protection (OCP)

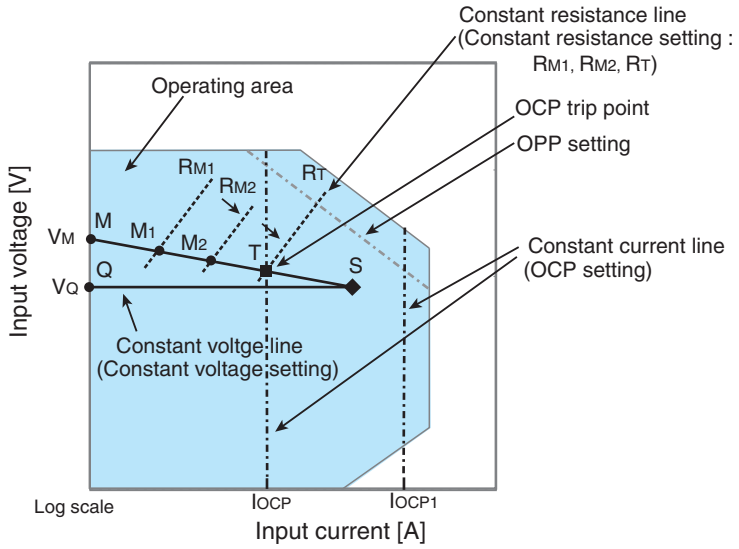


Fig.A-16 Transition of the operating point in CR+CV mode (OCP trip point)

We assume that the overcurrent protection (OCP) setting IOCP is less than the current produced by the tripping of the overpower protection (OPP) and denote the voltage of the battery as VM. In CR mode, if the resistance is decreased (RM1→RM2→RT) to increase the input current (load current), the operating point moves along segment MT (M1→M2→T).

When the overcurrent protection (OCP) setting is IOCP, the OCP trips when point T is reached. At this point, two types of operation are available on the PLZ6000R depending on the protection action setting of the OCP.

If Protect Action is set to LOAD OFF, the load is turned off.

If protection action is set to LIMIT, the PLZ6000R sinks current as a constant current load at point T. Even if you attempt to increase the current by decreasing the resistance, the current is limited at point T. If you decrease the current by increasing the resistance, the OCP is cleared. The PLZ6000R returns to CR mode, and the operating point moves along segment MT.

Table A-9 OCP action (protect action)

Point T	LOAD OFF	Turns off the load (stops the current flow). The PLZ6000R no longer operates as a load.
	LIMIT	CR mode ends. OCP continues, and the PLZ6000R sinks current as a constant current load.

If the overcurrent protection (OCP) setting is IOCP1, the OCP does not trip as the resistance is decreased to increase the current. Consequently, the operating point reaches point S.

Here, the operation mode is CV. The voltage is fixed to voltage VQ set in advance.

In this case, the operating point moves along segment QS. The current is determined by the battery voltage and its internal resistance.

A.3 About the Regenerative Power Function

The PLZ6000R's regenerative power function regeneraters the load power to the AC LINE which conventional load units normally consume as heat.

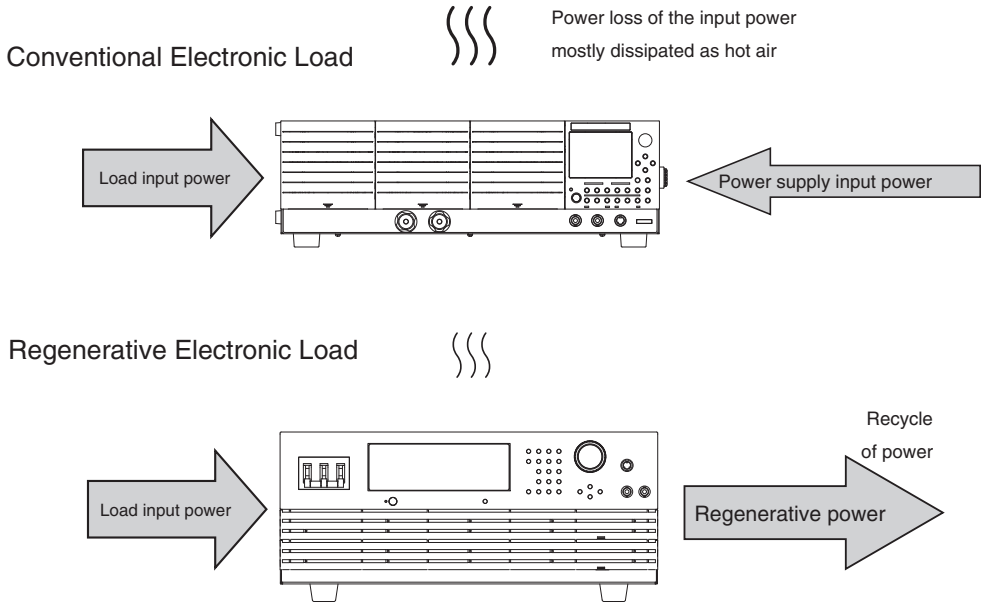


Fig.A-17 Regenerative function of the PLZ6000R

The regenerative efficiency of the PLZ6000R is more than 85 % (Maximum 90 %), so when applying the input load power of 6 kW, the regenerative power estimates 5.1kW. In this case, the internal loss would be 900 W. The calorific value is estimated to be less than 1/6 of the consumption of conventional 6 kW electronic loads.

Regenerated power of 5.1 kW returns to the AC LINE which can then be used as recycled power.

NOTE

- The PLZ6000R is designed for limited use for the regenerative flow of an in-house power line. Each unit of the PLZ6000R requires more than 5.4 kW of the power consumption that other devices constantly consume in the same power line. Otherwise, the PLZ6000R cannot be used if the total power consumption does not reach the required level.

A.4 Sequence Program Creation Table

Program name: Date: By:	
Program number (1 to 10)	
Memo (Up to 11 characters)	
Operation mode	CC, CR, CV, CP
Range	
Loop (1 to 9999)	
Last Load (OFF/ON)	OFF, ON
Last Set	
Chain (OFF, 1 to 10)	

Step number	Setting (mA,mS,V,W)	Execution time (h:min:s:ms)	LOAD	RAMP	TRIG	PAUSE	Note
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							

A.5 Sample Program

Program name: Example sequence program 1 Date: By:	
Program number (1 to 10)	1
Memo (Up to 11 characters)	Program1
Operation mode	CC,
Range	30 V
Loop (1 to 9999)	0001
Last Load (OFF/ON)	OFF
Last Set	0
Chain (OFF, 1 to 10)	2

Step number	Setting (mA,mS,V,W)	Execution time (h:min:s:ms)	LOAD	RAMP	TRIG	PAUSE	備考
1	7 A	200 s	ON	ON	OFF	OFF	
2	7 A	150 s	ON	OFF	OFF	OFF	
3	0.5 A	80 s	OFF	OFF	ON	OFF	

Program name: Example sequence program 2 Date: By:	
Program number (1 to 10)	2
Memo (Up to 11 characters)	Program2
Operation mode	CC,
Range	30 V
Loop (1 to 9999)	0002
Last Load (OFF/ON)	OFF
Last Set	0
Chain (OFF, 1 to 10)	OFF

Step number	Setting (mA,mS,V,W)	Execution time (h:min:s:ms)	LOAD	RAMP	TRIG	PAUSE	備考
1	10 A	200 s	ON	ON	OFF	OFF	
2	5 A	50 s	ON	OFF	OFF	OFF	
3	8 A	150 s	ON	ON	OFF	OFF	

A.6 A List of Errors

Command errors

An error in the range [-199, -100] indicates that an IEEE 488.2 syntax error has been detected by the instrument's parser. The occurrence of any error in this class shall cause the command error bit (bit 5) in the event status register to be set.

Table A-10 Command errors

Error Code		Error Message Description
-100	Command error	Generic syntax error.
-101	Invalid character	A syntactic element contains a character which is invalid.
-102	Syntax error	An unrecognized command or data type was encountered.
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character.
-104	Data type error	The parser recognized a data element different than one allowed.
-105	GET not allowed	A Group Execute Trigger was received within a program message.
-108	Parameter not allowed	More parameters were received than expected for the header.
-109	Missing parameter	Fewer parameters were received than required for the header.
-110	Command header error	An error was detected in the header.
-120	Numeric data error	Generated when parsing a data element which appears to be numeric, including the non decimal numeric types.
-130	Suffix error	Generated when parsing a suffix.
-131	Invalid suffix	The suffix does not follow the syntax, or the suffix is inappropriate for the PLZ6000R.
-134	Suffix too long	The suffix contained more than twelve characters.
-138	Suffix not allowed	A suffix was encountered after a numeric element which does not allow suffixes.
-140	Character data error	Generated when parsing a character data element.
-141	Invalid character data	Either the character data element contains an invalid character, or the element is not valid.
-144	Character data too Long	The character data element contains more than twelve characters.
-148	Character data not allowed	A legal character data element was encountered where prohibited by the PLZ6000R.
-150	String data error	Generated when parsing a string data element.
-160	Block data error	Generated when parsing a block data element.
-170	Expression error	Generated when parsing an expression data element.
-180	Macro error	Generated when defining a macro or executing a macro.

Execution errors

An error in the range [-299, -200] indicates that an error has been detected by the instrument' s execution control block. The occurrence of any error in this class shall cause the execution error bit (bit 4) in the event status register to be set.

Table A-11 Execution error

Error Code		Error Message Description
-200	Execution error (generic)	A generic error for the PAT.
-203	Command protected	Password protected program or query command cannot be executed.
-210	Trigger error	A trigger error occurred.
-211	Trigger ignored	A trigger was received but discarded.
-213	Init ignored	Measurement initiate operation was ignored because measurement is in progress.
-214	Trigger deadlock	Dead lock occurred because a query was received before the software trigger.
-220	Parameter error	A program data element related error occurred.
-221	Settings conflict	Received a command that cannot be executed in the current condition of the PLZ6000R.
-222	Data out of range	Received a command that cannot be executed in the current condition of the PLZ6000R.
-223	Too much data	Too many parameters were received than the requirements.
-224	Illegal parameter value	Too many parameters were received than the requirements.
-230	Data corrupt or stale	Received a data query before the measurement was completed.
-241	Hardware missing	Cannot be executed because the optional hardware is not installed.

Query errors

An error in the range [-499, -400] indicates that the output queue control of the instrument has detected a problem with the message exchange protocol described in IEEE 488.2, chapter 6. The occurrence of any error in this class shall cause the query error bit (bit 2) in the event status register to be set.

Table A-12 Query errors

Error Code		Error Message Description
-400	Query error (generic)	A generic query error of the PLZ6000R that is used when other types of errors do not apply.
-410	Query INTERRUPTED	An INTERRUPTED query error as defined by IEEE488.2 (6.3.2.3) occurred.
-420	Query UNTERMINATED	An UNTERMINATED query error as defined by IEEE488.2 (6.3.2.2) occurred.
-430	Query DEADLOCKED	A DEADLOCKED query error as defined by IEEE488.2 (6.3.1.7) occurred.
-440	Query UNTERMINATED after indefinite response	Another query was specified after a query that generates an indefinite response in a same program message. (Example: when SYST:ERR? is received after a *IDN? query and a semicolon separator)

Operation complete event errors

An error in the range [-899, -800] is used when the PLZ6000R wishes to report an IEEE488.2 operation complete event. This event occurs when the instrument's synchronization protocol, having been enabled by an *OPC command, completes all selected pending operations.

This event also sets the operation complete bit (bit 0) of the event status register.

Table A-13 Operation complete event errors

Error Code		Error Message Description
-800	Operation complete	All selected pending operations in accordance with the IEEE 488.2, 12.5.2 synchronization protocol has completed.

A.7 Lists of Messages

SCPI command: Command name in the short form

Affected command: Yes for commands that are affected by *RST or *RCL

R/W: Query command (R)/set command (W).

*: 1, 2, and 3 indicate SCPI standard command, command in review, and KIKUSUI original command, respectively.

Table A-14 INPut | OUTPut subsystem

SCPI Command		Setting		Default	Response	Affected Command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
INPut										
[:STAT][:IMM]	bool			OFF	NR1	Yes	*1	Turn ON/OFF the load.	R/W	1
:PROT:CLE								Clears the alarm.	W	1
:TIM	numeric	0 to 3599999 (0 is function disabled)	S	0	NR1	Yes	Yes	Sets the Load off timer.	R/W	3
OUTPut										
[:STAT][:IMM]	bool			OFF	NR1	Yes	*1	Turn ON/OFF the load.	R/W	1
:PROT:CLE								Clears the alarm.	W	1
:TIM	numeric	0 to 3599999 (0 is function disabled)	S	0	NR1	Yes	Yes	Sets the Load off timer.	R/W	3

*1. *RCL is only valid when the Load is off.

Table A-15 MEASure | READ subsystem

SCPI Command		Setting		Default	Response	Affected Command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
MEAS[:SCAL][*1]										
:CURR[:DC]			A		NR3			Reads the measured current.	R	1
:ETIM			S		NR3			Reads the elapsed time of measurement.	R	3
:POW										
[:DC]			W		NR3			Reads the measured voltage.	R	1
:AC:RGEN			W		NR3			Reads the measured regenerative power.	R	3
AC:RGEN:ACC			Wh		NR3			Reads the integrated value of regenerative power.	R	3
:VOLT[:DC]			V		NR3			Read the measured voltage.	R	1
READ[:SCAR][*2]										
:CURR[:DC]			A		NR3			Reads the measured current.	R	1
:ETIM			S		NR3			Reads the elapsed time of measurement.	R	3
:POW										
[:DC]			W		NR3			Reads the measured regenerative power	R	1
:AC:RGEN			W		NR3			Reads the measured regenerative power	R	3
:AC:RGEN:ACC			Wh		NR3			Reads the integrated value of regenerative power.	R	3
:VOLT[:DC]			V		NR3			Read the measured voltage.	R	1

*1. Query the measured value after starting the measuring action. (because of the PLZ6000R does not equipped with the CONFIG command, the action is the same as READ.)

*2. Query the measured value after starting the measuring action.

Table A-16 PROGram subsystem

SCPI Command		Setting	Default	Response	Affected Command		Description	R/W	*
Program header	Parameter				*RST	*RCL			
PROG[:SEL]									
:CHA	numeric	0 to 10 (0 is function disabled)		NR1			Sets the number of the program to be executed next.	R/W	3
:CLE							Deletes the all the steps of the selected program.	W	3
:CRAN	char	LOW | HIGH	HIGH	char			Sets the current range of the selected program.	R/W	3
:EXEC				*1			Queries the number of the program currently in operation.	R	3
:LINP	bool			NR1			Sets the load on/off condition after the sequence ends.	R/W	3
:LOOP	numeric	1 to 9999 (9999 is an endless loop)		NR1			Sets the number of program loops of the selected program.	R/W	3
:LOUT	bool			NR1			Sets the load on/off condition after the sequence ends.	R/W	3
:LVAL	*2	<numeric> |MIN | MAX		NR3			Sets the load setting value after the sequence ends	R/W	3
:MEMO	“string”			char			Sets the memo of the selected program.	R/W	3
:NAME	numeric	1 to 10	1		Yes		Specify the program name.	W	3
:MODE	char	NCC | NCV | NCP | NCR	CC	char			Sets the mode of the selected program.	R/W	3
:NSP[:STEP]									
:ADD	*3	*4					Adds a sequence step to the selected program.	W	3
:COUN				NR1			Queries the number of steps of the selected program.	R	3
:DEL									
[:STEP]	nrf	1 to specified step					Deletes the selected program sequence step.	W	3
:ALL							Deletes the all the steps of the selected program.	W	3
:EDIT	*5	*6		*7			Edits an existing sequence step.	R/W	3
:INS	*8	*9					Inserts a normal sequence step into the selected program.	W	3
:STAT	char	RUN | TRUN | PAUS | STOP | CONT					Sets the status of the selected program.	W	3
:VRAN	char	LOW | HIGH	LOW	char			Sets the voltage range of the selected program.	R/W	3

*1. Character data, <NR2>, <NR1>, <NR1>, <NR1>
*2. depending on the range settings, operation mode.
*3. VALUE_numeric, TIME_numeric
*4. VALUE: depending on the range settings, operation mode, TIME: 0.01 to 3599999 (unit: S)
*5. STEP_nrf, VALUE_numeric, TIME_numeric, INPUT_bool, RAMP_bool, TRIG_bool, PAUSE_bool
*6. STEP: 1 to the preset step, VALUE: depending on the range settings, operation mode, TIME: 0.01 to 3599999 (unit: S), ON(1)/OFF(0), ON(1)/OFF(0), ON(1)/OFF(0), ON(1)/OFF(0)
*7. <NR3>, <NR3>, <NR1>, <NR1>, <NR1>
*8. STEP_nrf, VALUE_numeric, TIME_numeric
*9. STEP: 1 to the preset step, VALUE: depending on the range settings, operation mode, TIME: 0.01 to 3599999 (unit: S)

Table A-17 SYSTem subsystem

SCPI Command		Setting	Default	Response	Affected Command		Description	R/W	*
Program header	Parameter				*RST	*RCL			
SYST									
:ERR[:NEXT]				*1			Reads the error message from the error queue.	R	1
:KLOC	bool			NR1			Sets the key lock of the panel operation.	R/W	1
:LOC*2							Switches to local mode operation.	W	3
:REM*2							Switches to remote mode operation. Local switch enable.	W	3
:RWL*2							Switches to remote mode operation. Local switch disable.	W	3
:VERS				char			Queries the SCPI version to which the PLZ6000R conforms.	R	1

*1. NR1, string data
*2. RS232C, USB only

Table A-18 SOURce subsystem

SCPI Command		Setting		Default	Response	Affected Command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
[SOUR:]										
CURR[:LEV]										
[:IMM][:AMPL]	numeric	30V range: 0 to 408 60V range: 0 to 204	A	0	NR3	Yes	Yes	Sets the current value.	R/W	1
:TRIG[:AMPL]	numeric	30V range: 0 to 408 60V range: 0 to 204	A	0	NR3	Yes	Yes	Current value changed by the trigger	R/W	1
:PROT										
[:LEV]	numeric	2 to 440	A	440	NR3	Yes	Yes	Over current protection settings	R/W	1
:STAT	bool			ON	NR1	Yes	Yes	Protection function settings of the over current protection	R/W	1
:RANG	char	LOW | HIGH		HIGH	char	Yes	Yes	Current range	R/W	3
:COND[:LEC]										
[:IMM][:AMPL]	numeric	30V ragne: 136 to 0 60V ragne: 34 to 0	SIE	0	NR3	Yes	Yes	Conductance settings	R/W	3
:TRIG[:AMPL]	numeric	30V ragne: 136 to 0 60V ragne: 34 to 0	SIE	0	NR3	Yes	Yes	Conductance settings changed by the trigger	R/W	3
FUNC										
[:MODE]	char	CC | CV | CP | CR | CCCV | CRCV		CC	char	Yes	Yes	Operation mode	R/W	3
:CTIM	bool			OFF	NR1	Yes	Yes	Elapsed time display ON/OFF	R/W	3
:SST	numeric	0.02, 0.05, 0.1, 0.2	S	0.02	NR3	Yes	Yes	Soft start time	R/W	3
:RESP										
[:CC][:CR]	numeric	0.1 to 1		1	NR3	Yes	Yes	Response speed	R/W	3
CV	numeric	0.1 to 1		1	NR3	Yes	Yes	Response speed	R/W	3
POW										1

SCPI Command		Setting		Default	Response	Affected Command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
[:LEV][:IMM][:AMPL]	numeric	0 to 6300	W	0	NR3	Yes	Yes	Power settings	R/W	1
[:LEV]:TRIG[:AMPL]	numeric	0 to 6300	W	0	NR3	Yes	Yes	Power settings changed by the trigger	R/W	1
:PROT										
[:LEV]	numeric	100 to 6600	W	6600	NR3	Yes	Yes	Over power protection settings	R/W	1
:STAT	bool			ON	NR1	Yes	Yes	Protection function settings of the over power protection	R/W	1
VOLT										
[:LEV][:IMM][:AMPL]	numeric	30V ragne: 3 to 31.5 60V ragne: 6 to 63	V	3	NR3	Yes	Yes	Voltage settings	R/W	1
:PROT[:LEV]:LOW	numeric	0 to 63	V	0	NR3	Yes	Yes	Low voltage protection settings	R/W	1
:PROT:STAT					NR1			Queries low voltage protection function	R	1
:RANG	char	LOW | HIGH		LOW	char	Yes	Yes	Voltage range	R/W	3

Table A-19 STATus subsystem

SCPI Command		Setting		Default	Response	Affected Command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
STAT										
:CSUM*1										
[:EVEN]					NR1			Queries the event	R	3
:COND					NR1			Queries the condition or register	R	3
:ENAB	nr1	0 to 32767			NR1			Sets the enable of register	R/W	3
:PTR	nr1	0 to 32767		32767	NR1			Sets the positive transition of register	R/W	3
:NTR	nr1	0 to 32767		0	NR1			Sets the negative transition of register	R/W	3
:OPER*2										
[:EVEN]					NR1			Queries the event	R	1
:COND					NR1			Queries the conditions of register	R	1
:ENAB	nr1	0 to 32767			NR1			Sets the enable of register	R/W	1
:PTR	nr1	0 to 32767		32767	NR1			Sets the positive transition of register	R/W	1
:NTR	nr1	0 to 32767		0	NR1			Sets the negative transition of register	R/W	1
:PRES								Presets the status data	W	1
:QUES*3										
[:EVEN]					NR1			Queries the event	R	1
:COND					NR1			Queries the condition of register	R	1
:ENAB	nr1	0 to 32767			NR1			Sets the enable of register	R/W	1
:PTR	nr1	0 to 32767		32767	NR1			Sets the positive transition of register	R/W	1
:NTR	nr1	0 to 32767		0	NR1			Sets the negative transition of register	R/W	1

*1. CSUMmary Status register
*2. OPERation Status register
*3. QUEStionable Status register

Table A-20 Other commands

SCPI Command		Setting		Default	Response	Affected command		Description	R/W	*
Program header	Parameter		Unit			*RST	*RCL			
ABOR[:ALL]								Stops the trigger function	W	1
INIT										
[:IMM]								Starts the trigger function	W	1
:CONT	bool			OFF	NR1	Yes	Yes	Sets the continous mode of the trigger function	R/W	1
SENS:POW:CLE								Resets the integral value of the regenerative power	W	3

Table A-21 IEEE488.2 common commands

IEEE488.2 common command		Setting	Description	R/W
Program header	Parameter			
*CLS			Clears the status data structures	W
*ESE	NR1	0 to 255	Sets the event status enable register bits	R/W
*ESR			Queries the event status register	R
*IDN			Queries the identification string. (Manufacturer information)	R
*OPC			Causes the device to generate the operation complete message in the event status register when all pending selected device operations have been finished.	R/W
*RCL	NR1	0 to 99	Read the stored data in the memory.	W
*RST			Performs to reset the device. Configures the PLZ6000R to a known condition independent from the usage history of the device.	W
*SAV	NR1	0 to 99	Stores the current settings of the device to the memory.	W
*SRE	NR1	0 to 255	Sets the service request enable register bits.	R/W
*STB			Reads the status byte and the master summary status bit.	R
*TRG			Trigger command	W
*TST			Execute the self test	R

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