OPERATION MANUAL

BIPOLAR POWER SUPPLY
PBX Series

PBX20-5
PBX20-10
PBX20-20
PBX40-2.5
PBX40-5
PBX40-10

KIKUSUI
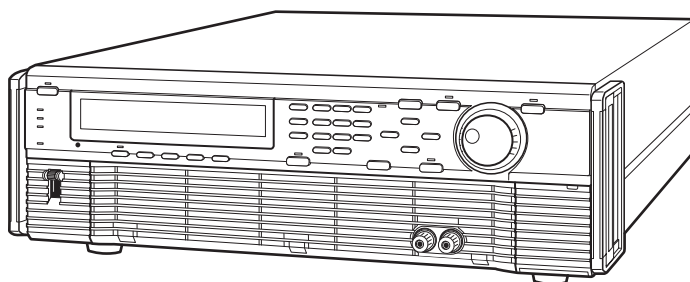
Use of Operation Manual

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

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

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

ROM Version Number

This manual is applicable to the power supplies which have the following version of ROM (read only memory).

2.0∗
(∗ denotes 0 to 9.)

When making any inquires on your power supply, please indicate the following:

- Model No.
- ROM Version No.
- Serial No.

To find the ROM Version No., please refer to Section 2.3 "Power Turn-on" under Chaper 2 "PRECAUTIOS AND PREPARATIVE PROCEDURES."
The Serial No. is indicated on the rear panel.

WARNINGS and Caution

Before start using the power supply and during using it, be sure to read and strictly observe the instructions given in the following:

"WARNINGS AND CAUTIONS" (next page)
Chapter 2 "PRECAUTIONS AND PREPARATIVE PROCEDURES"

WARNINGS AND CAUTIONS

Although the power supply incorporates various protective features, you must handle it very carefully in order to avoid electric shock hazards to yourselves and to prevent damage to the equipment.
Strictly observe the (WARNINGS) and (Caution) given below.

(WARNINGS)
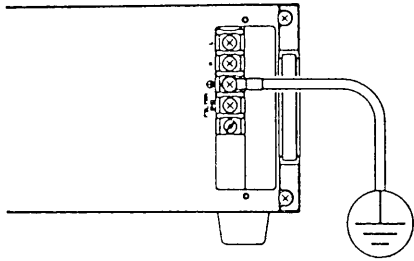
◎Be sure to ground the power supply.

· In order to prevent electric shock hazards, ground the gronud terminal ⊕ of the power supply by using the GND wire (Green or Greeen / Yellew) of the AC input power cable.
· If you neglect grounding the power supply or if the grounding line is made open, serious electric shock hazards may result.
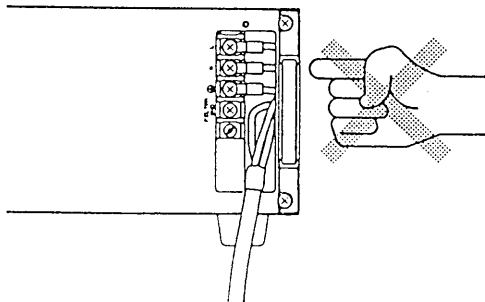
◎Do not touch the input terminals.

· The AC input power cable connection task involves danger. The task must be undertaken only by qualified personnel.
· Before handling the AC input power cable or moving the power supply, be certain that the cable has been disconnected from the AC power source.
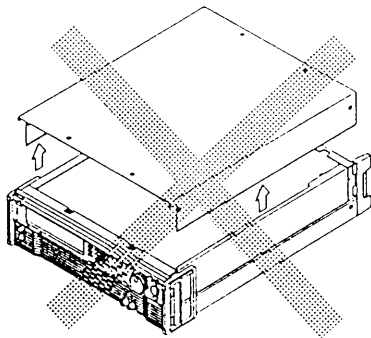
◎Do not touch the internal components.

· Do not touch the internal components of the power supply. Do not open the casing of the power supply.
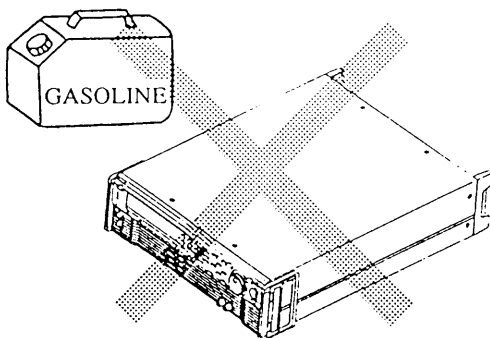
◎Do not use the power supply in an explosive atmosphere.

· Do not operate the power supply in an flammable, explosive, or otherwise hazardous area.

II

◎Do not attempt to carry the power supply by your-self alone.
· The power supply is heavy (its weight is shown at a lower position on its rear panel). It must be carried by two or more persons.
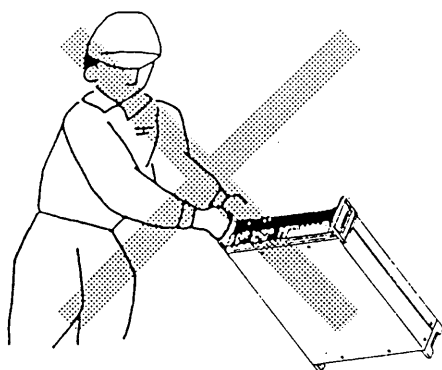
· Do not attempt to move the power supply by holding it by only one of its handles.

Caution
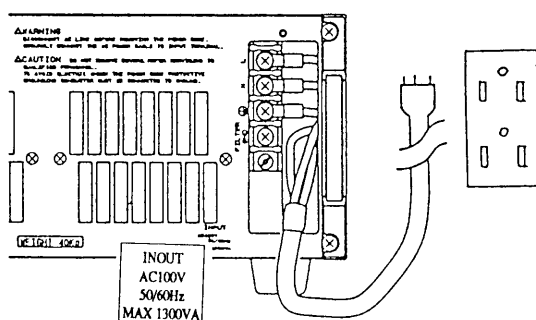
◎Operate the power supply on a correct AC power source.
· Be certain that the AC input voltage and frequency are within the specified ranges. (The AC line requirements are shown near the AC terminals.)
· Use the AC input power cable which is supplied accompanying the power supply. Do not use other cable.

INOUT
AC100V
50/60Hz
MAX 1300VA
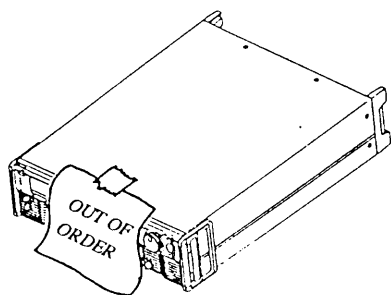
◎Do not use a failed power supply.
· When the power supply has failed or has become malfunctioning, immediately stop using it and disconnect its AC input power cable from the AC power source--the AC line outlet or the AC power distribution panel.
· Indicate on the power supply clearly that it is out of order and must not be used.

Signs and Marks

The signs and marks put on the power supply are as follows.

WARNINGS

Sign for possible electric shock hazards
- This sign warns you that the place involves a danger- a matter of electric shock hazards to the personnel and damage to the equipment.
- When handling the matter related to the place, be sure to observe strictly the instructions given in the text of this manual.
- Unless you strictly observe the instructions, you will be exposing yourself to a danger of electric shock hazards.
- Until you fully understand the matters related to the **WARNING**, do not proceed to further steps of operation procedure.

CAUTION

Sign for possible damage
- This sign alertyou to that the place involves a matter which can lead to damage to the power supply and/or the devices connected to it.
- When handling the matter related to the place, be sure to observe strictly the instructions given in the text of this manual.
- Unless you strictly observe the instructions, the power supply and/or the devices connected to it may be damaged.
- Until you fully understand the matters related to the **CAUTION**, do not proceed to further steps of operation procedure.
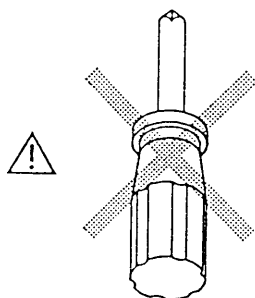
Mark for inhibition of disassembly or removal
- This mark appears on the AC input terminal cover.
- The mark means that the cover must not be removed by other persons than qualified electronics personnel.
- Before removing the cover, be certain that the AC input power cable has been disconnected from the power source the AC line outlet or the power distribution panel.

Mark to refer to operation manual
- This mark requests you to refer to the corresponding section of the operction manual.

Earth ground

Chassis ground

Warnings, Cautions and Notes

The warnings, cautions, and notes given in this operetion manual deal with matters as follows:

(WARNINGS)   · *A matter which can lead to electric shock hazards.*

(Caution)   · *A matter which can lead to damage to the power supply and/or the devices connected to it.*

(NOTE)   · *Supplemental information.*

RECEIVING INSPECTION

The power supply is shipped by the vendor upon full mechanical and electrical inspection and test to warrant that it meets the specifications. Upon receipt of the power supply, please immediately inspect it for damage which might have occurred during transportation. Also check that the accessories are present. If there are any signs of damage or missing accessories, please immediately notify the transporation company and/or your Kikusui agent as cases may call for.

The power supply (main instrument) and its accessories delivered to you should be as follows:
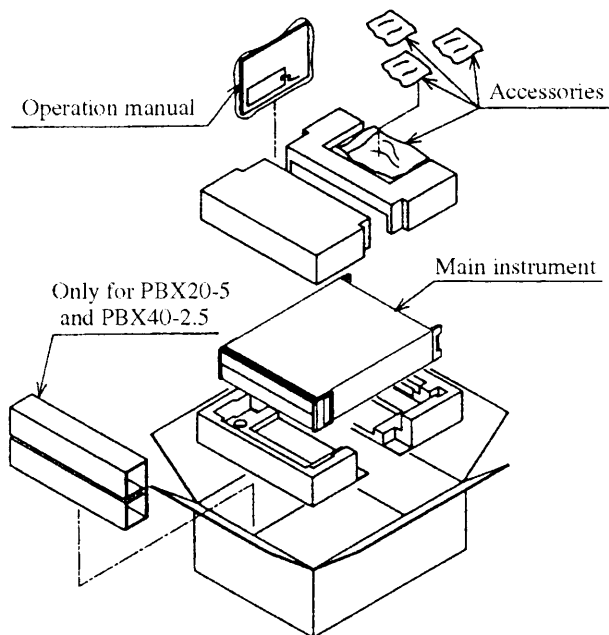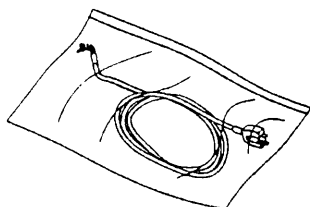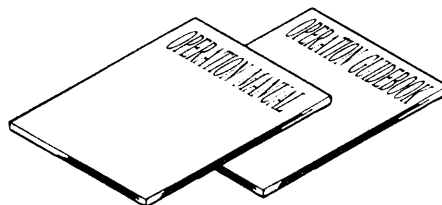
Operation manual

Accessories

Only for PBX20-5 and PBX40-2.5

Main instrument

Accessories

- AC input power cable (1)

- Operation manual (1 copy)
- Sequence operation guidebook (1 copy)

- Terminals for analog remote control (20)
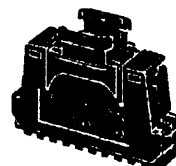
- Hood cover (1 set)

- Seals (2 sheets)

PACKING FOR RE-SHIPMENT

To re-ship the power supply, use the packing materials in which the power supply was delivered to you. For packing, refer to the illustration on the preceding page.

- When packing the power supply, disconnect the AC input power cable, load cables, and control connectors.
- If you have discarded the packing materials, please order your Kikusui agent for new ones.

MEMO

COMPOSITION OF THE OPERATION MANUAL

This Operation manual is composed of seven chapters and appendices as follows:

Chapter 1. GENERAL
Introduces an outline and features of the power supply.

Chapter 2. PRECAUTIONS AND PREPARATIVE PROCEDURES
Describes the procedures for installation, AC input power cable connection, power-on test, operation mode selection, and load connection.

Chapter 3. OPERATING METHOD
The former half of this chapter introduces the names and functions of keys, indicators and other panel items, and describes the basic operation method of the power supply; the latter half describes procedures for sequence operation and applied types of operation.

Chapter 4. REMOTE PROGRAMMING
Describes the procedures to remote-control the power supply via an interface board (optional) from an external controller.

Chapter 5. PANEL DESCRIPTION
Introduces the names of and describes the functions of the switches and other items of the front and rear panels.

Chapter 6. MAINTENANCE AND CALIBRATION
Describes the maintenance, inspection, and calibration methods.

Chapter 7. SPECIFICATIONS
Gives tables of electrical specifications, mechanical specifications, accessories, and optional items.

APPENDICES
Provides an error message table, a troubleshooting chart, a table of factory-defaults, a menu configuration chart, sequence coding sheets, and a table of ID codes for calibration.

TABLE OF CONTENTS

Chapter 1.
GENERAL

This chapter introduces an outline and features of the PBX Series Bipolar Power Supplies.

Contents

1.1 Outline

The PBX Series Bipolar Power Supplies are regulated power supplies of a bipolar-type, featured by performance reliability and safety. They employ a power amplifier system, thereby rendering advantageous features such as low ripple noise, high stability, and rapid response.

Being a 4-mode type, they serve also as a source or a sink of power, or as a booster of a function generator. They are microprocessor-based instruments and provide advanced functions and ease of operation.

Each of them can operate either in a constant-voltage mode (C.V mode) or in a constant-current mode (C.C mode), mutually independently. This allows you to use them also as a constant-current source or as a voltage-controlled current source.

You may remote-controlled them via an optional GPIB, RS-232C, or MCB(Multi-channel Bus) interface, thereby making them applicable to various purposes. Typical applications are for research systems in laboratories and for automatic production and inspection lines in manufacturing plants.

1.2 Features

Each PBX Power Supply is incorporated or can be optionally incorporated with the various advantageous features as follows:

■Four operating modes

The power supply allows you to select one of the following four types of operating modes.

- Fast C.V mode : Operates with rapid rise/fall time--selectable for [50 μ s], [500 μ s] or [5 ms]. Frequency response is 30 kHz with respect to the external control signal when in "Through" setting.
- Normal C.V mode : Operates stably with low ripple noise. Since the power supply employs a power amplifier system, the output noise is small.
- Dynamic C.C mode: Operates with rapid response to load change--response time selectable for [100 μ s], [500 μ s] or [5 ms]. Frequency response is "Through"5-10 kHz with respect to an external signal when in the "THRU" setting.
- Static C.C mode : Operates stably even against large load change.

■Sequence control of output

You can enter sequence control patterns locally from the front panel or remotely from a personal computer via GPIB or other interface bus, and store them as sequence files on the internal memory.

The stored files can be recalled locally from the front panel or remotely from the personal computer via the interface bus.

Control sequences can be programmed in either one of the following two types:

(a) Fast speed sequence : You can program sequences with minimum 100 μ s per step.

(b) Normal speed sequence : You can program sequences with a ramp waveform per step.

■Variable-amplitude power booster function

You can use the power supply as a variable-amplitude power booster to boost the output current of an external signal generator. Thus, you can obtain a boosted current from the power supply without changing the output level of the external signal generator.

By operating the power supply in the C.C mode, you can directly control the load current with an external control signal. Thus, you can attain a voltage-controlled current source.

■Various interface boards (optional)

The power supply can be controlled over a GPIB, RS-232C, or MCB interface bus. This feature, as combined with the programmed sequence control function, allows you a high flexibility of power supply system configuration.

The MCB is a unique bus system developed by Kikusui. It allows you to control up-to-fifteen instruments (power supplies and electronic load devices) in an on-line mode over a standard bus system (GPIB or RS-232C).

■Ease of operation

Numeric entry keypad, arrow keys, and JOG/SHJUTTLE dials are provided on the front panel, to facilitate entry of numerical values and selection of menu items.

Operation of the power supply in memory and recall them whenever you need them. Up to four different patterns of voltage/current settings can be programmed and stored in different locations of memory.

This feature is convenient especially when you want to repeat tests with the same of the power supply.

■A large backlight LCD

The power supply has a large backlighted-type LCD (liquid crystal display), which indicates output voltage or current settings, readbacks, and other operation data.

■Ease of calibration

The power supply can be calibrated easily with the keys on the front panel, without requiring any sophisticated calibration procedures (but requiring a digital voltmeter and a shunt resistor).

■Various protective provisions

The power supply has a software/hardware postive/negative output voltage limit function ($\pm$V limit function) and a software/hardware postive/negative output current limit function ($\pm$I limit function). You can set the software limits by key entry and the hardware limits by potentiometer settings. Of the software limit and hardware limit of the same objective item, the one which is of a lower value (safer value) becomes effective. Typically, you may use the software limits as more frequently-changeable shallow limits and use the hardware limits as less frequently changeable deep limits. In this manner of use, you can be safer even when you have entered a wrong software limit by a key stroke error or have committed a similar mistake, as you will be backed up by the hardware limit.

The power supply provides also a percentage method for automatic setting of software limits. If you specify an allowable percentage for the existing output voltage or current setting, the same percentage is maintained even when the setting is changed. That is, the limit value automatically slides with respect to the output voltage or current setting.

The power supply has an OVP (overvoltage protector). You can select either [POWER switch OFF] or [OUTPUT OFF] for the protective action to be taken when the protector has tripped.

The power supply incorporates an overtemperature protector and an AC input overcurrent protector, also.

As above, the power supply incorporates various protective provisions to protect the power supply itself and its load.

■Analog remote control

You can remote-control the output voltage or current with an external voltage signal or resistance signal. You can also remote-control turning OFF of the AC POWER switch and turning ON/OFF of the output. The power supply provides various status signals, also.

■Output monitor function

The power supply allows you to monitor the output voltage and current in rms values. It allows also to monitor the maximum and minimum peak values of the load current under the C.V mode, and other data.

■Exclusive remote controller (optional)

The remote controller allows you to extend virtually the front panel to a remote position convenient for you. The control functions of the remote controller are identical with those of the front panel of the power supply. The remote controller has a 20-column 2-row LCD display which indicates the same data as that indicated on the display of the power supply (main instrument).

Chapter 2.
PRECAUTIONS AND PREPARATIVE PROCEDURES

This chapter gives you information on precautions you must observe and preparative procedures you must follow before start operating the power supply.

Contents

2.1 Installation

2.1.1 Environments

Avoid using the power supply in adverse or hazardous environments as mentioned below.
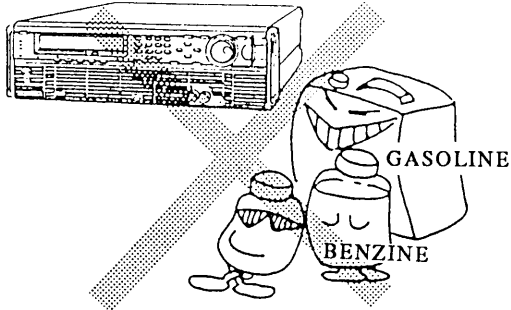
◎**Flammable atmosphere**
Do not use the power supply in flammable or explosive atmosphere, to prevent fire or explosion hazards.
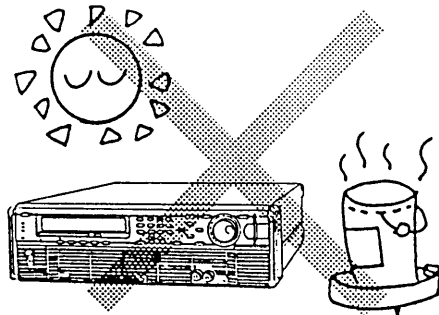
◎**High temperature**
Do not expose the power supply to a source of heat, such as direct sunlight (near a window), a space heater, etc. Avoid a place where temperature may change rapidly.
(The temperature range for the guaranteed performance is 0 to 40℃ or 32°F to 104°F .)
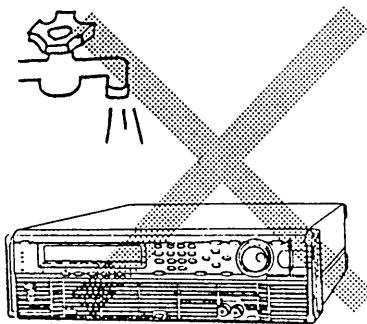
◎**High humidity**
Do not expose the power supply to high humidity--do not place it near a water heater, a humidifier, a water faucet, or a bath. (The humidity range for the guaranteed performance is 30 to 80% RH.)
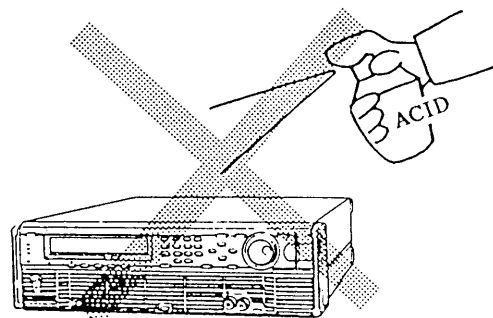
◎**Corrosive atmosphere**
Do not expose the power supply to corrosive atmosphere--such as of sulfuric acid mist.

◎**Dusty place**
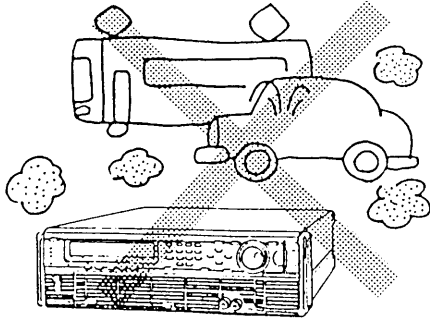
◎**Blocked ventilation air flow**
Do not block the cooling air flowing through the air intake and exhaust louvers of the power supply.
Provide an ample space (30 cm or more) behind the rear panel of the power supply.
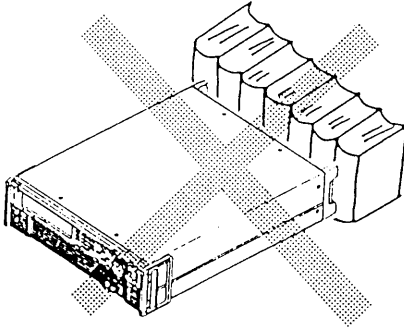
◎**Unstable position**
Do not place the power supply on a swaying table, slanted bench, or otherwise unstable position.
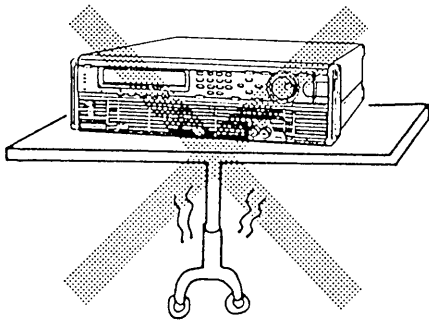
◎**Strong electric or magnetic field**
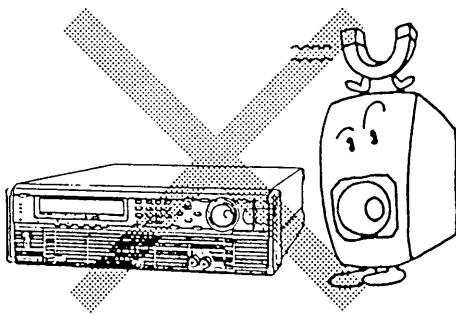
2.1.2 Precautions for Moving the Power Supply

(WARNINGS)
- *Be sure to disconnect the AC input power cable from its power source before moving the power supply.*
- *The power supply is heavy (its weight is shown at a lower position on its rear panel). Do not attempt to carry it by yourself alone--it must be carried by two or more persons.*

(Caution)
- *Do not attempt to move the power supply by holding it by only one of its handles. (For how to use the handles, see the description which follows.)*

■ How to Use the Handles
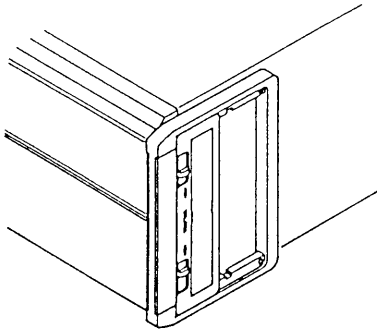
① Slide the two lock switches simultaneously in the "UN-LOCK" direction, and the handles will become movable.
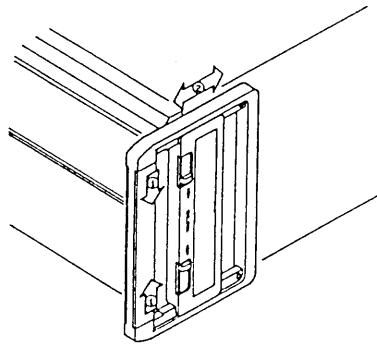
② Fully pull-out or push-in the handles until they click.

2.2 Conncting the AC Input Power Cable

WARNINGS
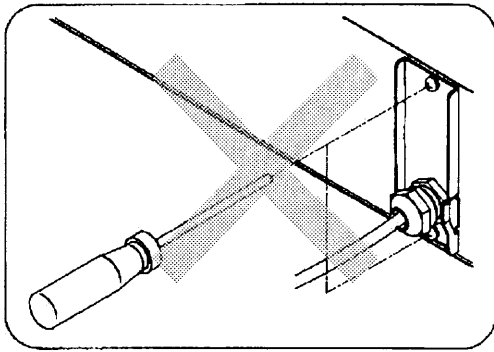
◎ The task of connecting the AC input power cable to the AC input terminals of the power supply and to an AC power distribution panel involes danger. The task must be undertaken only by qualified electronics personnel.

◎ Before handling the AC input power cable, make certain that the cable has been disconnected from the AC power source.

◎ Be sure to ground the power supply.
• In order to avoid electric shock hazards, be sure to connect the GND (⊕) terminal of the power supply to an earth ground by using the GND wire (green or green/yellow wire) of the AC input power cable.

• Note that, unless the GND terminal is securely connected to an earth ground, serious electric shock hazards can result.

◎ Be sure to put back the AC input terminal cover.
• Never run the power supply with its terminal cover left removed. Be sure to put it back in order to guard against inadvertently touching the input terminals.

Caution

◎ Use the AC input power cable that is supplied accompanying the power supply. When it is unavoidable to use other cable, use a one which has sufficient voltage and current ratings and is nonflammable and has been determined to be appropriate by a qualified electronics engineer.

• Make certain that the AC source voltage and frequency are within the specified ranges.

AC Input Power Cable Connection Procedure
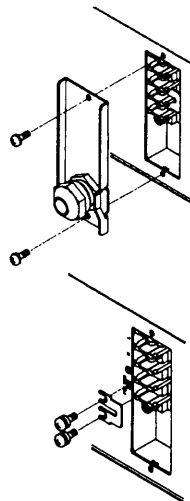
◎ The AC input power cable connection task involves danger. The task must be undertaken only by qualified electronics personnel.

① Remove the AC input terminal cover at a right hand position on the panel.

② If the leak current is not permissible, disconnect the short piece from between the GND (⊕) terminal and the FILTER GND terminal. If the leak current is permissible, proceed to Step ③.
• For the leak current, see the subsequent page.
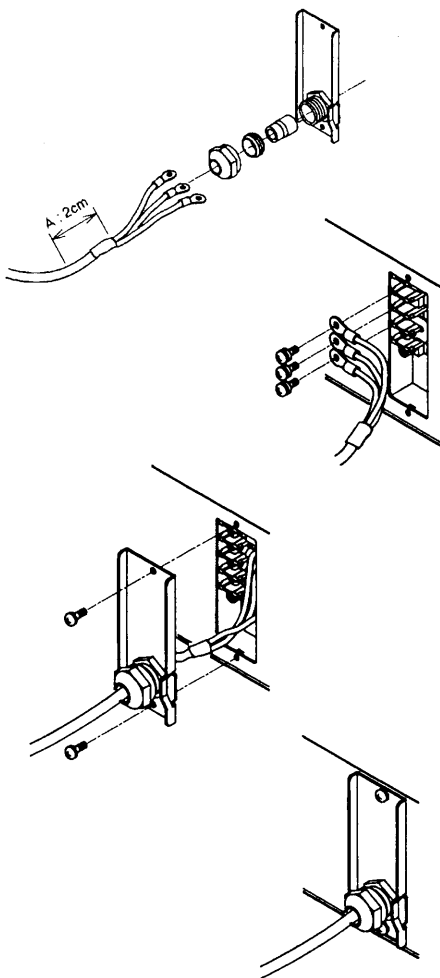
③ Pass the AC input power cable through the input terminal cover.
* To pass the cable more easily, you may disassemble the cable clamp as illustrated.
* Clamp the cable by its sheath end (A).

④ Connect the cable to the input terminals.
* The core wires of the cable are color coded as shown below. Be sure to connect the correct wires to the correct terminals.

L (live)	: Black or Brown
N (neutral)	: White or Blue
GND (⏚)	: Green or Green/Yellow

A section of screw on this terminal board is 4 mm (M4).

⑤ Put back the terminal cover.

⑥ Securely tighten the cable clamp.
* Make certain that the cable is securely clamped and is not loose.

Connecting the power supply to a switchboard

Depending on model or input voltage of the power supply, the supplied AC input power cable may not be equipped with a plug. To connect the AC input power cable, put crimping terminals which are suited to the terminals of the switchboard on AC input power cable.
Work to connect the power supply to the switchboard must be performed by qualified personnel.
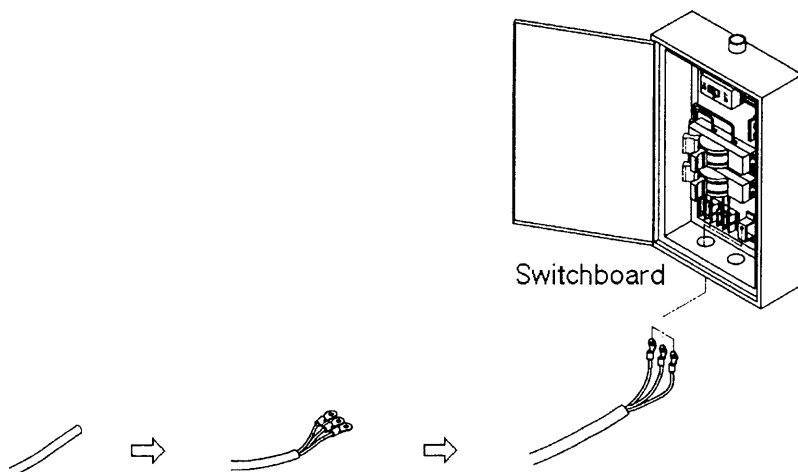
Switchboard

Check terminal polarity of the switchboard, and connect the AC input power cable surely.

L (live): Black or Brown

N (neutral): White or Blue

GND (⏚): Green or Green/Yellow

Leak Current

A noise filter is provided in the input circuit of the power supply, in order to reduce the common-mode noise which could be generated between the AC line and the chassis. The noise filter has capacitors connected between the L (live) line and the N (neutral) line. A leak current flows through these capacitors.
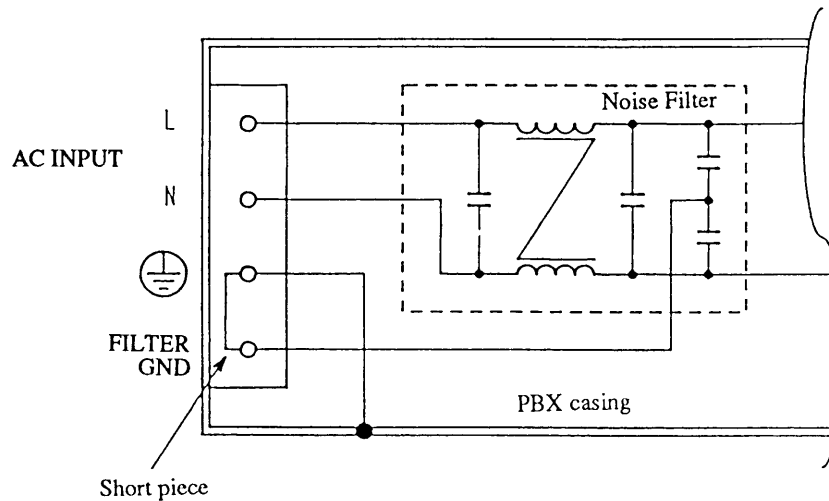
When a multiple number of power supply units are operated together (typically, being installed on a rack) and the leak current is untolerably large, execute the procedure of Step ② of the preceding page and provide other noise filter on the AC input side as shown below.
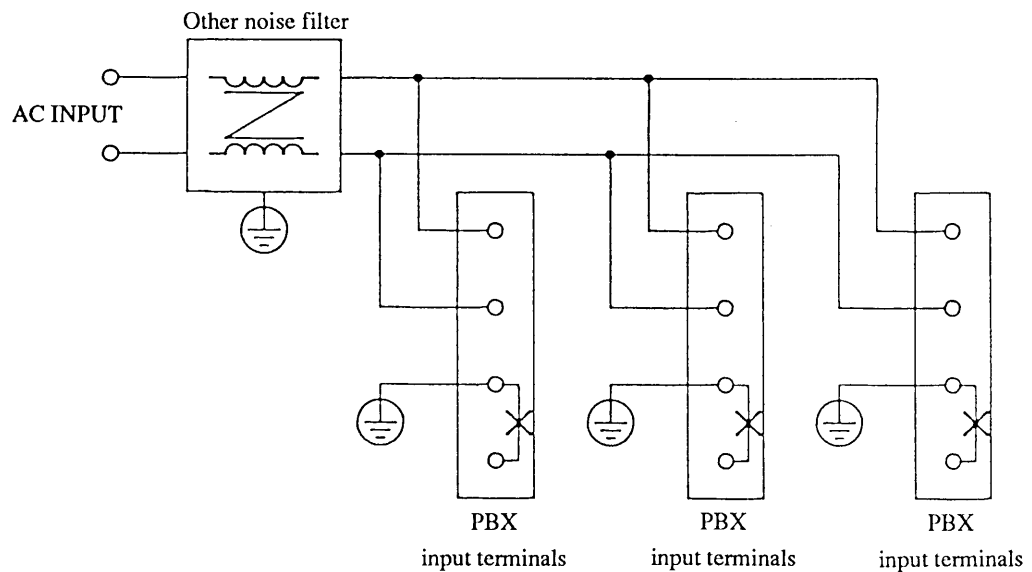
2.3 Power-on Test

Perform power-on test of the power supply as follows:

■ **Power-on Test Procedure**

---

① Make certain that the POWER switch is OFF.

▼

---

② Make certain that the instrument-side end of the AC input power cable is connected to the power supply.

(WARNINGS)　· *If the cable is not connected yet, connect it observing the instructions given in "WARNINGS AND CAUTIONS, Chapter 1 "GENERAL" and Chapter 2 "PRECAUTIONS AND PREPARATIVE PROCEDURES."*

---

③ Connect the power-source-side end of the AC input power cable to an AC line receptacle or power distribution panel.

▼

(Caution)　· *Make certain that the AC line voltage and frequency are within the specified ranges.*

---

④ Turn-on the POWER switch of the power supply.

Normal indications

If the power supply is normal, a sign-on display (Model No. and ROM Version No.) will appear for about 2 seconds and then a root display will appear as shown below.

(An example of sign-on display)　　　　　　(An example of root display)

```
P B X   2 0 - 5        V e r 1 . 0 0
N O N E          K I K U S U I
```
▶
```
O U T      0 . 0 0 0 V     0 . 0 0 A
```

Mode indicator C.V to the left of the display will illuminate.
(The factory-default for mode setting is C.V.)

Abnormal Indications

If one of the below-mentioned states occurs, the power supply is abnormal. If this is the case, follow the instructions indicated below. If the abnormal state is not remedied still, order your Kikusui agent for repair.

· The display screen backlight does not illuminate and nothing is displayed on the screen.
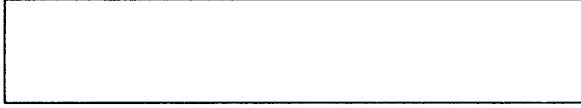
☞ Make certain that the AC input power cable is connected correctly. Then turn-on the POWER switch again.

· Although the display screen backlight illuminates, nothing is displayed on the screen.

☞ Adjust the CONTRAST control (varies depending on temperature). Then turn-on the POWER switch again.

· Although a cursor is displayed, no characters are displayed.
  Cursor

■

☞ If an interface board (optional) has been installed, remove it and then turn-on the POWER switch again. If the display is remedied by this procedure, install the interface board and then turn-on the POWER switch.

· The output voltage or current value indicated on the root display is abnormal.

(This is an example.)

OUT -36.234V -11.01A
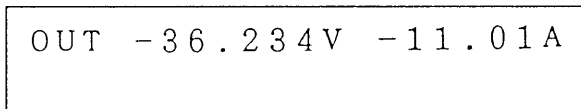
☞ Turn-on the POWER switch again.

· An error message appears.

(This is an example.)

EEP ROM W Error.
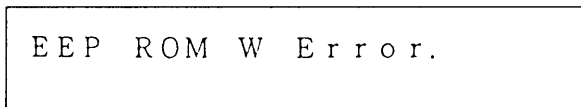
☞ Refer to Appendix 1 "Table of Error Messages" and take the actions as instructed there. Then turn-on the POWER switch again.

· Both C.V and C.C indicators illuminate or do not illuminate.

▼   ☞ Turn-on the POWER switch again.

⑤ Turn-off the POWER switch.

The power-on test procedure is complete by the above.

2.4 Operating Mode Selection ⚠

The power supply can operate in one of the four modes mentioned below. Select one of them.

Fast C.V mode:

This mode is for rapid rise up and fall down (selectable for [50 μ s], [500 μ s], [5ms], or [Through]).

Dynamic C.C mode:

This mode is for rapid response to load change. For a resistive load, the current can rapidly rise up or fall down (selectable for [100 μ s], [500 μ s], [5ms], or [Through]).

(Caution)
- *If a capacitor whose high-frequency impedance is small is connected directly to the output terminal, the setup may oscillate depending on conditions of the load.*
- *If you select the dynamic C.C mode when the load is inductive, the setup may oscillate due to phase rotation. To prevent this, nullify the phase rotation by connecting in parallel to the load a circuit consisting of a capacitor and a resistor connected in series.*

Normal C.V mode:

The internal electrolytic capacitor of the power supply is connected in parallel to the output terminals and consequently the power supply delivers a stable output voltage with less noise.

Static C.C mode:

The internal electrolytic capacitor is connected in parallel to the output terminals and consequently the power supply delivers a stable output current even against large load changes and the ripple noise of the output current is small.

Operating Mode Selection

To select an operation mode, call out a configuration menu with the 【SHIFT】 + 【0】 CONFIG keys. Switching between the fast C.V mode and normal C.V mode or between the dynamic C.C mode and static C.C mode can be done with the mode select terminals on the rear panel.

■ Switching between C.V mode and C.C mode

The C.V mode is to operate the power supply as a constant voltage source and the C.C mode is to operate it as a constant current source. To change between these modes, turn-on the POWER switch, make certain that the power supply operates normally with the procedure of Section 2.3 " Power-on Test," call out a configuration menu with the 【SHIFT】 + 【0】 CONFIG keys, and select the C.V or C.C mode from 1: [CV/CC] of 2: [Start Up] of the configuration menu. Refer also to Section 3.5.1 "Configuration."

① In the output OFF state, press the 【SHIFT】 + 【0】 CONFIG keys.

```
> 1 :   L o c a l / R e m o t e
  2 :   S t a r t   U p
```

(Configuration menu)
· Items 1 and 2 (among total items 1 - 9) of configuration menu will appear.

② Press the 【2】 key to select [Start Up].

```
> 1 :   C V / C C
  2 :   O u t p u t
```

(Startup menu)
· Items 1 and 2 (among total items 1 - 3) of menu will appear.

③ Press the 【1】 key to select [CV/CC].

```
> 1 :   C V / C C
    >   1 : < C V >
```

(Startup menu)
· The items enclosed in <> is the one currently selected. There are menu items 1: [CV] and 2: [CC], which you can check with the 【△】 and 【▽】 keys.

④ Select the [CV] mode with the 【1】 key or the [CC] mode with the 【2】 key.

```
P o w e r   o n   C V / C C
  C C
```

· This example is for the [CC] mode.

▼ At about 1 second later

```
> 1 :   C V / C C
  2 :   O u t p u t
```

· When the setting is over, the startup menu resumes.
· Starting by the next power turn-on, the power supply will operate in the C.C mode.

(Caution) · The C.V and C.C indicators denote the operating modes of the power supply. When the modes are changed between [CV] and [CC] with a procedure as above, the indications by these indicators remain unchanged.

⑤ Press the [ESC] keys twice.

```
OUT      0.000V      0.00A
```
· The root display resumes.

⑥ Turn-off the POWER switch. Check the type of the load and the connection to the load, and then turn-on the POWER switch again. The power supply will operate in the C.C mode and the C.C indicator will illuminate.

(*Caution*) · *Be sure to select the correct one of the C.V and C.C modes. If you select a wrong mode, overvoltage or overcurrent may result and the load can be damaged.*

■ **Switching between two types of C.V mode or between those of C.C mode**

(Caution) · *Before switching between fast C.V mode and normal C.V mode or between dynamic C.C mode and static C.C mode, be certain that the POWER switch has been turned off. If the load is capacitive, disconnect it.*
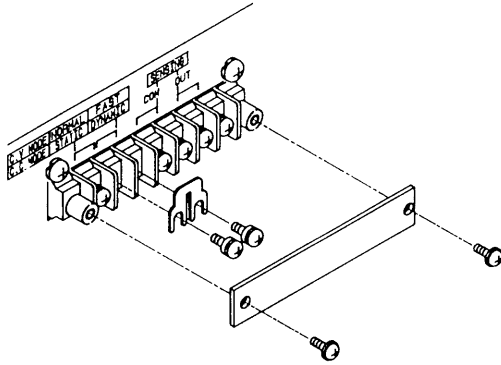
① Remove the cover of the mode select terminal block on the rear panel.
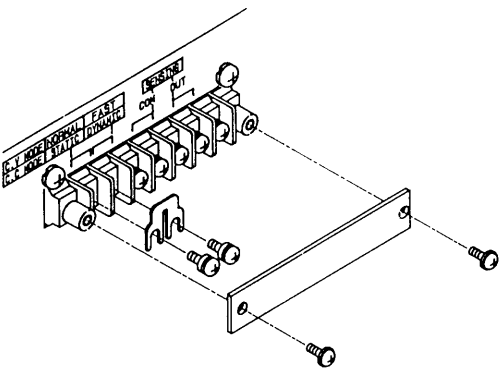
② Connect the mode select short piece to the terminals corresponding to the mode you want to select.

③ Put back the cover.

(Caution) · *Be sure to put back the cover of the mode select terminal block.*

2.5 Load Connection Procedure
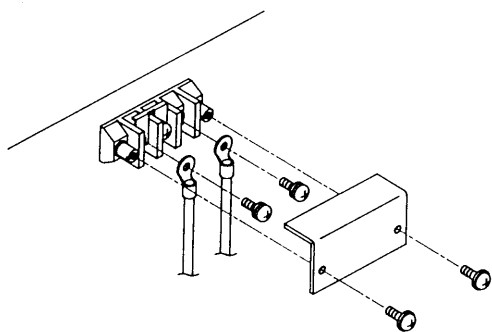
① Remove the rear output terminal cover. Connect the load-connection cables to the output terminals of the power supply. The output terminals are M4.

② Put back the terminal cover.

(Caution) · Be sure to put back the terminal cover.

2.5.1 Notes for Particular Types of Loads
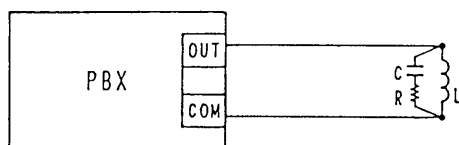
◎If you select the dynamic C.C mode when supplying a constant current to an inductive load, the setup may oscillate due to phase rotation. To prevent this, compensate for the phase rotation by connecting in parallel to the load a circuit consisting of a capacitor and a resistor connected in series.
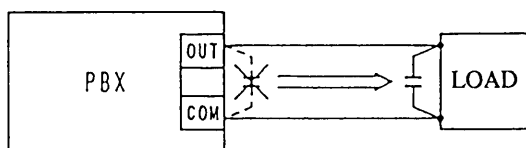
◎If a capacitor whose high-frequency impedance is small is connected directly to the output terminal, the setup may oscillate depending on conditions of the load.
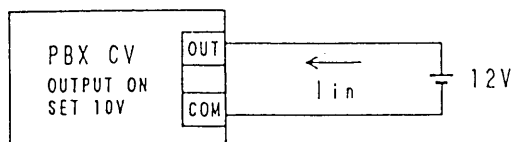
◎If the load is regenerative and its output voltage is higher than the power supply output voltage, the power supply output circuit will draw from the load a current of up to the I limit setting of the power supply. When this state has occurred, even if the output voltage limit setting is +11 V for example, the output terminal voltage will become +12V if that of the load is +12V for example. When the output circuit is set to OFF, however, it draws almost no substantial current because it is in a high impedance state.

Caution

· *Pay attention so that no voltage higher than the rated output voltage of the power supply is applied to its output circuit, and that no current larger than the rated output current of the power supply is fed to or drawn from the power supply.*

◎When a current with peaks is drawn from the power supply operating in the constant-voltage mode, the LIMIT LED may not illuminate even when peaks have exceeded the ±I limit setting and the power supply is driven into the current limit state for very short periods. When this state has occurred, the power supply will not maintain the constant-voltage function and the voltage will drop.

(The same applies also when a voltage with peaks is to be delivered from the power supply operating in the constant-current mode.)
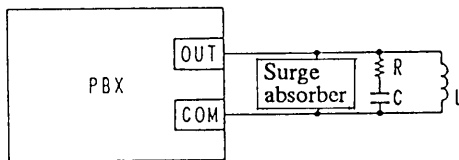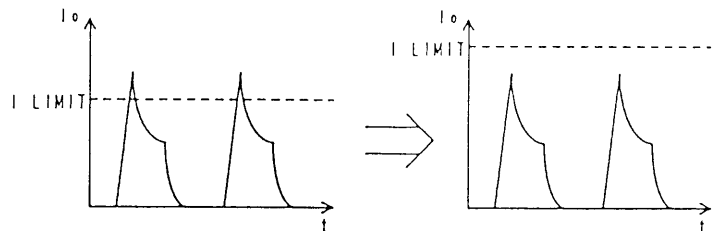
◎If the power supply is in the dynamic C.C mode and the load is inductive and the current setting is high, the output voltage may sharply rise and the OVP may trip when the output is turned on. To prevent such OVP trip, set the output at a low value when turning it on and then gradually increase it, or use the static C.C mode. When turning the output off, the OVP may trip due to a reverse voltage. The reverse voltage can be so large that it damages the power supply. To prevent such reverse voltage, provide an appropriate surge voltage absorber or gradually lower the setting and then turn the output off.

2.5.2 Notes for Load Connection

When connecting a load to the power supply, note the following:

· Use large cables. Make the connection distance as short as possible.
· Strand the OUT cable and COM cable.
· Pay attention so that no loops are formed.
· Wire gauges (nominal cross section areas) recommended by Kikusui are as follows:

Up to 5A .... 1.25 mm²
Up to 10A .... 2 mm²
Up to 20A .... 5.5 mm²
Up to 30A .... 8 mm²

MEMO

Chapter 3
OPERATING METHOD

The former half of this chapter introduces the names and functions of keys, indicators and other panel items, and the basic operating methods of the power supply; the latter half describes procedures for sequence operation and other applied types of operation.

MEMO

3.1 Descriptions of Front and Rear Panels

3.1.1 Front Panel

Refer to chapter 5. "5.1 Front Panel".

3.1.2 Rear Panel

Refer to chapter 5. "5.2 Rear Panel".

MEMO

3.1.3 Functiona Block Diagram
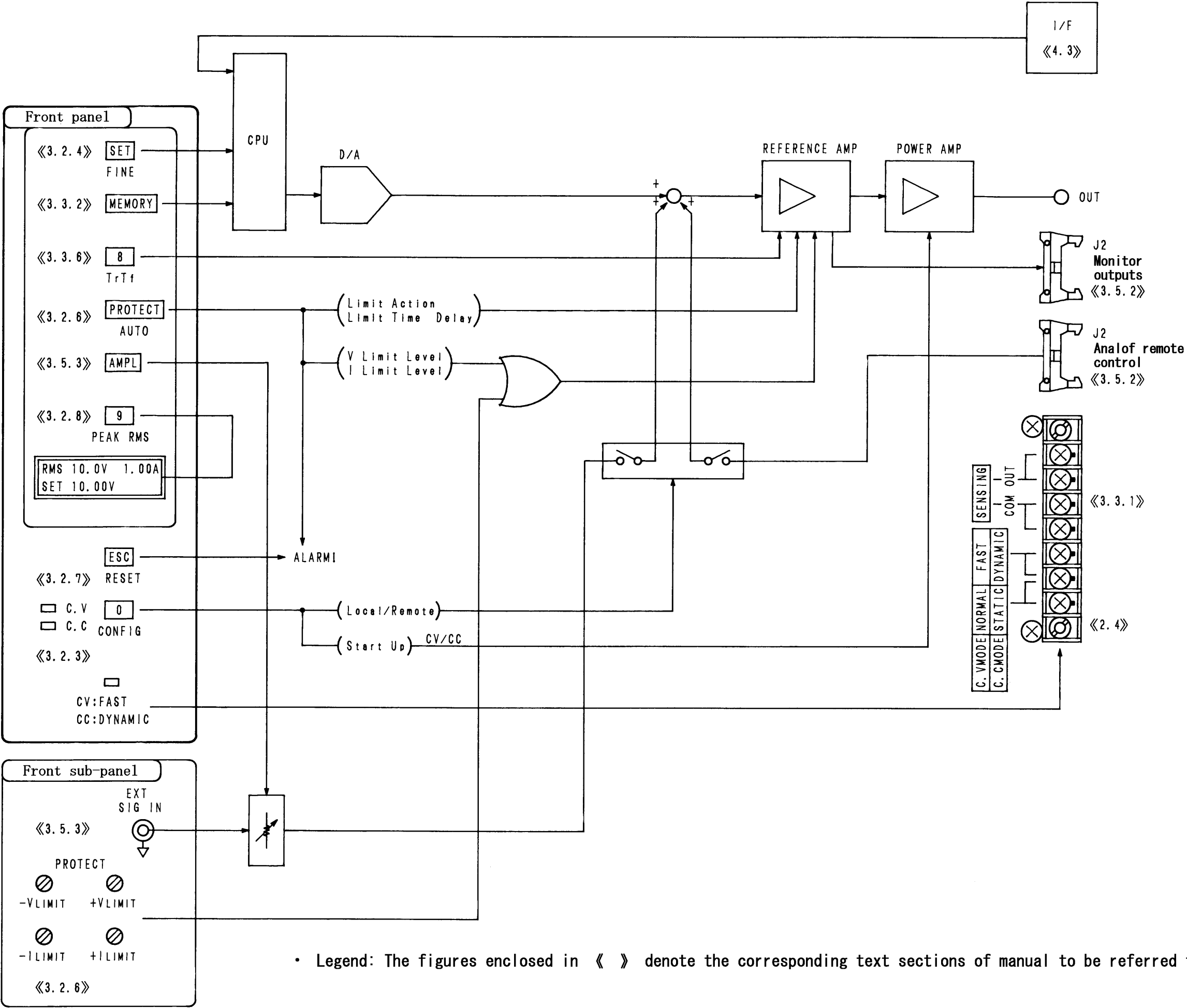
• Legend: The figures enclosed in 《 》 denote the corresponding text sections of manual to be referred to.

3.2 Basic Operating Method 1

This section describes the basic panel operating method and messages displayed, the basic voltage/current setting method, and the protective functions of the power supply.

3.2.1 Turning ON/OFF the POWER Switch

The top position of the POWER switch is for ON and the bottom position for OFF. As you turn ON the POWER switch, a sign-on display will appear and, after about 2 seconds, a root display will appear.

(Sign-on display)

```
P B X   2 0 - 1 0        V e r 1 . 0 0
```

· Model No. and ROM version No.

▼ At about two seconds later

(Root display)

```
O U T      0 . 0 0 1 V      0 . 0 0 A
```

· Actual output voltage and current

The sign-on messages differ depending on whether an interface board is installed on the power supply or not. If an interface board is installed, its type is displayed on the bottom row.

```
P B X   2 0 - 1 0        V e r 1 . 0 0
× × × ×          K I K U S U I
```

Examples of message " × × × × "
  [NONE]   : No interface board
  [GP01]   : GPIB interface board (Device address: 01)
  [RS96]   : RS-232C interface board (Transmission rate 9600 bps)
  [MC01]   : MCB interface board (Device address: 01)

(NOTE)

· *This chapter takes Model PBX20-10 power supply (rated voltage ±20V, rated current ±10A) as an example for descriptions.*

3.2.2 Basic Panel Operation Method

This section describes the basic front panel operating method and the menus displayed.

[1] To select a function

ESC

RESET

- If you press a function key, the function indicated with black letters on top of the key is selected.
- If you want to select the function indicated with blue letters below a function key, press at first the [SHIFT] key and check that the LED immediately above it has lighted, and then press the function key. For example, if you want to select the RESET function which is indicated below the [ESC] key, press at first the [SHIFT] key and then press the [ESC] key.

In this book, a key operation which involves pressing of the [SHIFT] key is expressed as follows:

[SHIFT] + [ESC] RESET ... Means that you should press the [SHIFT] key first and the [ESC] key next, to select the RESET function.

[2] To increase/decrease a numeric entry value

A numeric value to be entered can be increased or decreased with the numeric keys or with the JOG/SHUTTLE dials.

Direct entry with numeric keys

Type a value on the display with the numeric keys and then press the [ENTER] key.

To enter a "+" or "−" sige press the [SHIFT] + [·] +/− keys or the [·] key twice. Each time as you press the keys, the sige will change between "+" and "−".

- To amend a value you have typed by mistake, use the following keys.
- [CLR] : To clear all letters you have typed
- [BS] : To delete the only one letter you typed last

Increase/decrease with JOG dial
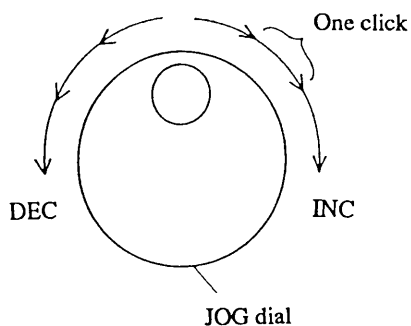
The value increases as you turn the dial clockwise, and vice versa. The value is entered automatically.

One click

DEC   INC

JOG dial

- The amount of change per one click is adjustable. Refer to Section 3.3.5 "Setting the Click Resolution."
- The factory default for click resolutionis 0.1V/0.1A per click.
- One full turn of the dial is equivalent to 10 clicks.

Increase/decrease with SHUTTLE dial
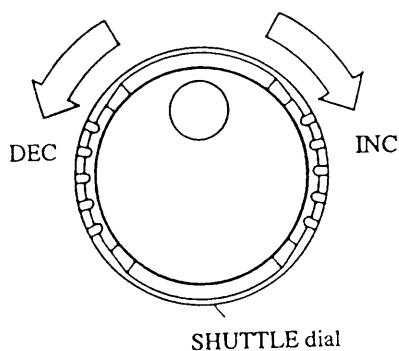
During the period you keep the dial in a clockwise position, the typed value increases continuously, and vice versa. The value is entered automatically.

DEC   INC

SHUTTLE dial

- The larger the angle you have turned the dial, the larger is the change rate.

Increase/decrease with ARROW keys

Each time you press the 【△】 key, the value increases; each time you press the 【▽】 key, the value decreases.
- The increment/decrement is identical with the click resolution of the JOG dial.

[3] Menu Selection

When a menu is displayed, a prompt ">" appears at the left hand end of the display. You can move the prompt with the numeric keys, JOG dial, or 【△】 and 【▽】 keys.

- **To select with numeric keys**

    You can directly select one of the menu items by pressing the corresponding one of the numeric keys.

- **To select with JOG dial**

    The prompt ">" moves downward as you turn the JOG dial clockwise, and vice versa. (The prompt circulates along the menu items.) Move the prompt to the item you need and then press the 【ENTER】 key.

- **To select with ARROW keys**

    The prompt ">" moves upward as you press the 【△】 key and it moves downward as you press the 【▽】 key. (The prompt circulates along the menu items.) Move the prompt to the item you need and then press the 【ENTER】 key.

    For example, when there are four menu items, the prompt circulates along the items as follows as you press the 【△】 or 【▽】 keys or turn the JOG dial.

```
          :
    3: xxxxxxxx
    4: xxxxxxxx
    1: xxxxxxxx
    4: xxxxxxxx
    1: xxxxxxxx
  ↑ >2: xxxxxxxx
    3: xxxxxxxx
    4: xxxxxxxx
    1: xxxxxxxx
    2: xxxxxxxx
          :
```

```
          :
    3: xxxxxxxx
    4: xxxxxxxx
    1: xxxxxxxx
  ↓ >2: xxxxxxxx
    3: xxxxxxxx
    4: xxxxxxxx
    1: xxxxxxxx
    2: xxxxxxxx
```
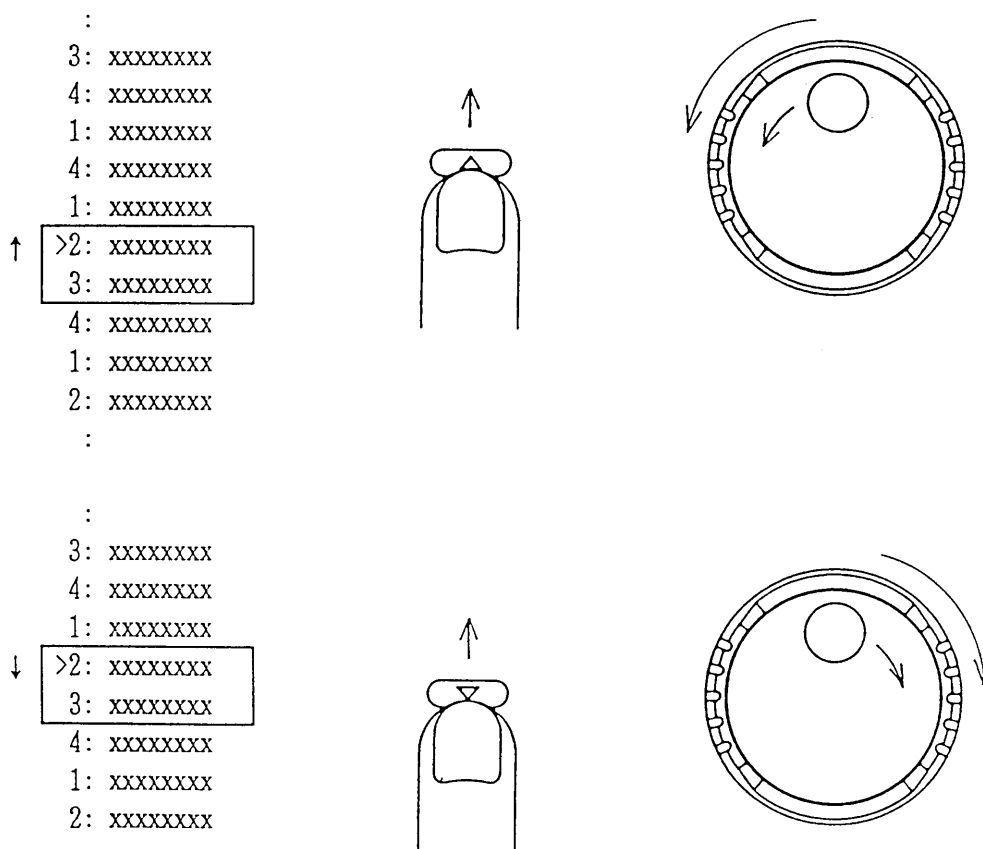
(NOTE)
- *The power supply has an intelligent feature that it memorizes the menu number item you selected. When you call up the menu next time, the item number you selected last time number will appear in the top row of the menu.*

[4] To escape from procedure

If you want to escape from the current procedure, press the [ESC] key. Each time you press the [ESC] key, the menu which is higher by one level (the immediately preceding menu) will appear.
  · Even when you have press the [ESC] key, the [OUTPUT] key is not reset.

[5] Turning ON/OFF the output

Each time you press the [OUTPUT] key, the power supply output is turned ON or OFF alternately. When in the ON state, the <OUTPUT> LED will light.

In the subsequent Sections 3.2.3 through 3.2.8, the basic operating procedures of the power supply are explained. For the explanation, the factory defaults are assumed for all settings.

3.2.3 Selecting the C.V or C.C Mode

The item you must select first for operation configuration of the power supply is either the C.V mode (constant voltage mode) or the C.C mode (constant current mode). To select a mode, proceed as follows. (Refer also to Section 3.5.1 "Configuration.")

① When the root display is displayed directly after turning ON the POWER switch, press the 【SHIFT】 + 【0】 CONFIG keys.

```
>1:  L o c a l / R e m o t e
  2:  S t a r t   U p
```

(Configuration menu)

② Press the 【2】 key to select [Start Up].

```
>1:  C V / C C
  2:  O u t p u t
```

(Startup menu)

③ Press the 【1】 key to select [CV/CC].

```
>1:   C V / C C
   >1 : < C V >
```

· The item enclosed in <> is the currently existing setting.
· There are two menu items, namely, 1: [CV] and 2: [CC]. You can check them with the JOG dial or the 【△】 and 【▽】 keys.

④ Press the 【2】 key to select [CC] or the 【1】 key to select [CV].

```
P o w e r   o n   C V / C C
  C C
```

```
P o w e r   o n   C V / C C
  C V
```

The above message will appear if you select [CC].   The above message will appear if you select [CV].

▼ At about 1 second later

```
>1:   C V / C C
  2:  O u t p u t
```

· When the above setting is over, the startup menu resumes.

⑤ Turn ON the POWER switch again.

```
O U T      0 . 0 0 0 V      0 . 0 0 A
```

· Switching between C.V mode and C.C mode becomes effective as you turn ON the POWER switch after turning it OFF once. The CV or CC LED illuminates to indicate the mode in which the power supply is operating.

(*Caution*)   · *Be sure to disconnect the load when changing the modes between C.V and C.C.*

3.2.4 Voltage (or Current) Setting and Output ON/OFF

The most basic setting procedures for operating the power supply are to set its output voltage (when in the C.V mode) or its output current (when in the C.C mode) and to turn ON or OFF its output.

To set the output voltage (or current), press the 【SET】 key to enable setting of the output voltage (or current) and then specify the required value with the JOG/SHUTTLE dials, 【△】 and 【▽】 keys, or numeric keys.

■ Examples of Voltage Setting and Output ON/OFF Procedures (when in the C.V mode)

Assume that you want to set the output voltage at 5.0V directly with the numeric keys, to turn ON the output, to change the set value with the JOG dial or 【▽】 key or SHUTTLE dial, and then to turn OFF the output. For these operations, proceed as follows:

① Press the 【SET】 key.

```
OUT    0.001V - 0.01A
SET    0.000V
```

- The <SET> LED will light, indicating that the voltage setting mode is enabled.
- The top row of the display indicates the readback values of the actual output voltage and current.
- The bottom row of the display indicates the values set for the output voltage and current.

② Press the 【5】 , 【.】 , 【0】 , 【0】 , and 【ENTER】 keys in this order.
(Direct setting with the numeric entry keys)

```
OUT    0.001V - 0.01A
SET    5.000V
```

- The typed value is entered and set as you press the 【ENTER】 key.

③ Press the 【OUTPUT】 key.

```
OUT    4.999V    1.23A
SET    5.000V
```

- The <OUTPUT> LED will light, indicating that the output is ON.

④ Turn the JOG dial clockwise.

```
OUT    5.098V    1.25A
SET    5.100V
```

(Setting with the JOG dial)
- As you turn the dial clockwise, the voltage will increase with a resolution of 0.1V per click.
- The typed value is automatically entered and set each time you change it.

⑤ Press the 【▽】 key

```
OUT    4.999V    1.23A
SET    5.000V
```

(Setting with the 【▽】 key)
- As you press the 【▽】 key, the voltage will decrease.
- The typed value is entered and set each time you change it.
- The resolution of change is the same as that with one click of the JOG dial.

⑥ Turn the SHUTTLE dial clockwise and then return it.

```
OUT    5.248V    1.28A
SET    5.250V
```

(Setting with the SHUTTLE dial)
- As you turn the dial clockwise, the voltage will increase.
- The typed value is automatically entered and set each time you change it.

⑦ Press the 【ESC】 key.

```
OUT    5.248V    1.28A
```

- The root display will resume.
- The <SET> LED will go out, indicating that voltage setting mode is disabled.

⑧ Press the 【OUTPUT】 key.

```
OUT    0.001V - 0.01A
```

- The <OUTPUT> LED will go out, indicating that the output is turned OFF.

(NOTE)
- *By using the JOG dial, 【△】 or 【▽】 key, voltage or current is able to set with resolution of 0.001V.*
- *For the procedure to change the resolution of voltage or current change with the JOG dial, 【△】 or 【▽】 keys, refer to Section 3.3.5 "Setting the Click Resolution".*
- *While you may set the output voltage with the highest resolution of 1mV at any time, the resolution of the actual output voltage is corresponding to it only when you have set the Auto Fine function to be ON. If you have set it to OFF, even when you have set, for example, the output voltage at 10.003V, the actual output voltage will be the same as that when the output is set at 10.00V.*

■ Examples of Current Setting (when in the C.C mode)

To set the output current, follow a similar procedure as above. An example of current setting display is shown below.

```
OUT    0.001V - 0.01A
SET              0.00A
```

Although the display is down only to 10mA, the internal processing is with a resolution of 1mA. When setting with the numeric entry keys, if you type 5.003 for example, the display will be 5.003A and, as you press the 【ENTER】 key, the figure of the least-significant digit (1mA digit) will be rounded, and yet the actual setting within the instrument remains at 5.003A.

```
OUT    4.999V    1.23A
SET              5.003A
```

Press the 【ENTER】 key

```
OUT    4.999V    1.23A
SET              5.00A
```

(NOTE)
- *If you have selected the 0.001A resolution, the 0.01A digit changes by a unit per 10 clicks with the JOG dial, 【△】 or 【▽】 key.*
- *While you may set the output current with the highest resolution of 1mA at any time, the resolution of the actual output current is corresponding to it only when you have set the Auto Fine function to be ON. If you have set it to OFF, even when you have set, for example, the output current at 5.003A, the actual output current will be the same as that when the output is set at 5.00A.*

3.2.5 Fine Setting of Output Voltage (or Current)

The output voltage (or current) can be set more finely than can be set with the regular resolution. For fine setting, an offset value is added to the value set by the [SET].

```
                                          |
       (+) ------------------------------------¥---------- Fine setting (with a "+" offset)
SET ──▶ ─────────────────────────────────────────────
       (-) ------------------------------------▲----------
                                          |


       0V ──────────────────────────────────────
```
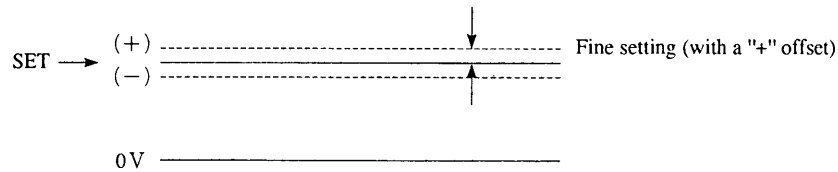
■ An example of Fine setting procedure (when in the C.V mode)

① When the Root display is shown, press the 【SHIFT】 + 【SET】 FINE keys.

```
OUT  11.999V   0.50A
V Fine +000
```

- Indicates that the Fine voltage setting is enabled.
- (The <SET> LED will light.)
- The bottom row indicates the Fine value.

② Turn the JOG dial clockwise.

```
OUT  12.002V   0.50A
V Fine +015
```

(Fine setting with the JOG dial)
- As you turn the JOG dial clockwise, the Fine value increases.
- The value is automatically entered each time it is changed.

③ Turn the SHUTTLE dial counterclockwise and then return it.

```
OUT  11.978V   0.48A
V Fine -040
```

(Fine setting with the SHUTTLE dial.)
- As you turn the SHUTTLE dial counterclockwise, the Fine value decreases.
- The value is automatically entered each time it is changed.

④ Press the 【ESC】 key.

```
OUT  11.978V   0.48A
```

- The Root display will resume.
- The above Fine setting is maintained.

⑤ Press the 【SET】 , 【1】 , 【2】 and 【ENTER】 keys in this order to set the output voltage.

```
OUT  11.999V   0.50A
SET  12.000V
```

- At this point, the Fine value setting is automatically reset to 0.

(*NOTE*)
- *Fine setting of the output current when in the C.V mode can be done in the same manner as above.*

An example of display for Fine current setting is shown below.

```
OUT   0.001V - 0.01A
I Fine +000
```

- *The Fine values are variable in 256 steps within a range of from -128 to +127.*
- *During a Fine value setting procedure, you can reset the Fine value to 0 by pressing the* [CLR] *key or* [0] *key.*
- *If you set again the output voltage (or current), its Fine value is automatically set to 0 at that moment.*

■ Auto Fine Function

Auto Fine function is to automatically adjust the output to let it conform with the 1mV order of voltage setting or 1mA order of current setting.

When in the Auto Fine mode, software inside the instrument searches for values to make the actual voltage and current shown on the top row of the display are made equal with the set values. Due to this, a certain time (1.5 seconds maximum) is needed before the output voltage and current are settled at the set values.

You can use neither the CC Auto Fine function in the C.V mode nor the CV Auto Fine function in the C.C mode. For the setting procedure of the Auto Fine function, refer to Section 3.3.1 "Configuration".

3.2.6 Setting of Protective Functions

The primary objective of the protective functions is to protect the power supply and load against overvoltage and overcurrent. The protective functions the power supply incorporates are for output voltage limits (±V limits), input/output current limits (±I limits), power limit (P limit), overvoltage protection (OVP), and overheat protection (OHP). The V limit (this term denoting all of ±V limits) and I limit (this term denoting all of ±I limits) can be set by both hardware and software.

■ V limit and I limit functions and settings

The +V limit is a positive voltage limit for the C.V or C.C mode; the −V limit is a negative voltage limit for the CV or CC mode.

The +I limit is a positive current limit for the C.V or C.C mode; the −I limit is a negative current limit for the C.V or C.C mode.The V limit and I limit settings can be done by both hardware with the potentiometers on the front sub-panel and software with the front panel keys via a D/A converter. (As used in this manual, term "hardware limit" means a limit that is set directly with a potentiometer and term "software limit" means a limit that is set from keys via a D/A converter.) Of the software limit and hardware limit of the same objective item, the one which is of a lower value (safer value) becomes effective.

The power supply incorporates a limit delay function also. That is, it allows you to specify a delay time to be allowed before taking a protective action or actions when the limit circuit has tripped.

■ Overvoltage protection (OVP) function

There are mutually independent circuits for the V limit function and the OVP function in the power supply. Functionally, however, the setting for the V limit function and that for the OVP function are mutually related on a mutually exclusive basis. That is, only either one of them is effective as an adjustable setting at a time. Typically, the V limit function is used as an adjustable setting and the OVP function as a fixed setting at approximately 120% of the rated output voltage of power supply.

When your load is vulnerable to overvoltages, however, you may select the OVP function to be effective for adjustable setting and specify a voltage limit value at which to trip the OVP circuit to protece your load. Only when you have selected the OVP function, the crowbar circuit is enabled. (The crowbar circuit is optional and needs factory installation.)

■ Power limit (P limit) function

The power supply can operate in four quadrants as shown below. When it is operating in quadrant 2 or 4, however, a portion of the quadrant area is limited as shown below due to the heat dissipation capacity of the power supply. When the P limit circuit has tripped, the output current is limited so that the power does not exceed the power limit of the power supply.
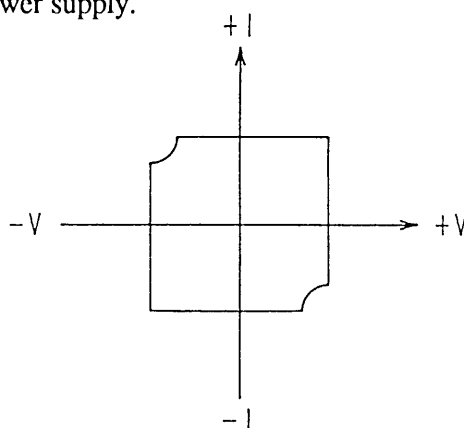
Model	PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10
Power limit (approx.)	90W	180W	100W	90W	180W	180W

■ Overheat protection (OHP) function

When the internal heat sink temperature of the power supply has become higher than a certain limit, the OHP circuit automatically turns OFF the output.

Protection Menu Configuration and Functions

Initial protection menu

—1: [V Limit Level] "Voltage protection setting menu"
  Voltage limit level setting
  ———— 1: [Software +V Limit]
          Setting of "+" voltage limit level by software.
          (Can be set also with [SHIFT] + [PROTECT] AUTO keys)
  ———— 2: [Software −V Limit]
          Setting of "−" voltage limit level by software.
          (Can be set also with [SHIFT] + [PROTECT] AUTO keys)
  ———— 3: [Hardware V Limit]
          Display of hardware voltage limit value that is set by the potentiometer on the front sub-panel.

—2: [I Limit Level] "Current protection setting menu"
  Current limit level setting
  ———— 1: [Software +I Limit]
          Setting of "+" current limit level by software.
          (Can be set also with [SHIFT] + [PROTECT] AUTO keys)
  ———— 2: [Software −I Limit]
          Setting of "−" current limit level by software.
          (Can be set also with [SHIFT] + [PROTECT] AUTO keys)
  ———— 3: [Hardware I Limit]
          Display of hardware current limit value that is set by the potentiometer on the front sub-panel.

—3: [Limit Action] "Protective action menu"
  Menu of protective actions to be taken when output voltage or current has reached the limit
  ———— 1: [Output OFF]
          To turn OFF the output
  ———— 2: [Power OFF]
          To turn OFF the output and also the POWER switch

—4: [Limit Time Delay]
  Time to be allowed before taking the protective action or actions. (0.05 s to 9.99 s)

—5: [V Limit/OVP] "V limit/OVP function select menu"
  ———— 1: [V Limit]
          Voltage protection by the V limit function. Protective action or actions are as selected by [Limit Action].
  ———— 2: [OV Output OFF]
          Voltage protection by OVP. Protective action is output OFF.
  ———— 3: [OV Power OFF]
          Voltage protection by OVP. Protective action is power OFF.
  ———— 4: [OV Crowbar ON]
          Voltage protection by OVP. Protective action is crowbar ON.

—6: [MCB Protection] "MCB protective action menu"
  ———— 1: [None]
          Do nothing.
  ———— 2: [Output OFF]
          When any one of the devices connected to MCB has tripped for protection, the output of this power supply is turned OFF.

(NOTE) · *Protection by the MCB takes place in synchronization with a trip of a protector of other equipment connected to the power supply via an MCB interface board (optional).*

■ **Examples of setting a V limit value and selecting a protective action**

① Press the [PROTECT] key.

```
> 1 :   V   L i m i t   L e v e l
   2 :   I   L i m i t   L e v e l
```

(Initial menu for protection setting)
· Items 1 and 2 of total six menu items (1 through 6) will appear.
· To scroll the menu items, use the JOG dial or 【△】 and 【▽】 keys.

② Press the 【5】 key to select [V Limit/OVP].

```
> 5 :   V   L i m i t / O V P
    > 1 : < V   L i m i t >
```

(V Limit/OVP select menu)
· The item enclosed in <> is the currently existing setting.

Caution   · 4: [OV Crowbar ON] is optional function. If select it on default status, [Does not Exist] will appear.

③ Press the 【1】 key to select [V Limit].

```
> 5 :   V   L i m i t / O V P
    > 1 : < V   L i m i t >
```

· Since the item to be selected is the same with the currently existing setting, you may press the 【ESC】 key to escape from the procedure.

▼ At about 1 second later

```
> 5 :   V   L i m i t / O V P
   6 :   M C B   P r o t e c t i o n
```

· The initial menu for protection setting will resume.

④ Press the 【1】 key to select [V Limit Level].

```
> 1 :   S o f t w a r e   + V L i m i t
   2 :   S o f t w a r e   - V L i m i t
```

· (V limit level setting menu)

⑤ Press the 【ENTER】 key to select [Software +V Limit] of the top row.

```
S o f t w a r e   + V L i m i t
                2 2 . 0 V
```

· Setting of software + V limit voltage level is enabled.
· The bottom row indicates the currently existing setting.

⑥ Press the 【2】 , 【0】 , and 【ENTER】 keys in this order.

```
S o f t w a r e   + V L i m i t
                2 0 . 0 V
```

· Set the software +V limit voltage level.
· You may adjust the value with the JOG/SHUTTLE dials, instead. In this case, the value is entered as you press the 【ESC】 key.

▼ At about 1 second later

```
> 1 :   S o f t w a r e   + V L i m i t
   2 :   S o f t w a r e   - V L i m i t
```

· The V limit level setting menu will resume.

⑦ Press the 【3】 key to select [Hardware V Limit].

```
V   L i m   - 2 5 . 1 V       2 5 . 0 V
```

• The hardware -V limit and hardware +V limit voltage levels are displayed.

⑧ Adjust the +V and -V limit voltage levels with the potentiometers on the front sub-panel.

```
V   L i m   - 2 0 . 1 V       2 2 . 0 V
```

• Monitoring the limit values on the display, adjust them to the values you may require with the potentiometers.

⑨ Press the 【ESC】 key twice.

```
> 1 :   V   L i m i t   L e v e l
  2 :   I   L i m i t   L e v e l
```

• The initial menu for protection setting

⑩ Press the 【3】 key to select [Limit Action].

```
> 3 :   L i m i t   A c t i o n
    > 1 : < O u t p u t   O F F >
```

(Protective action select menu)
• The item enclosed in <> is the currently existing setting.

⑪ Press the 【1】 key to select [Output OFF]

```
L i m i t   A c t i o n
O u t p u t   O F F
```

• Since the item to be selected is the same with the currently existing setting in this example, you may press the 【ESC】 key to escape from the procedure.

▼ At about 1 second later

```
> 3 :   L i m i t   A c t i o n
  4 :   L i m i t   T i m e   D e l a y
```

• When the setting is over, the initial menu for protection setting will resume.

⑫ Press the 【4】 key to select [Limit Time Delay].

```
L i m i t   T i m e   D e l a y
          2 . 0 0 s e c
```

⑬ Press the 【2】 and 【ENTER】 keys to set the limit delay time at 2 seconds.

```
L i m i t   T i m e   D e l a y
          2 . 0 0 s e c
```

⑭ Press the 【ESC】 key twice.

```
OUT    0.001V     -0.00A
```

· The root display will resume.

(*NOTE*) · *The I limit level and other protective items also can be set or selected in a similar manner as above.*

■ Examples of AUTO protection level setting

The AUTO protection level setting is such that the software limit level is automatically set at a certain percentage (110%, 120% or 130%) of the absolute value of the output voltage setting (or output current setting).
For examples, when the output voltage setting is 15V in the C.V mode and the percentage for the AUTO protection is 110%, the software +V limit level is automatically set at 16.5V and the software −V limit level at −16.5V.

① When the root display is shown, press the [SHIFT] + [PROTECT] AUTO keys.

```
OUT    15.000V      2.50A
Auto  Protection  110%
```

· This is an example of display for automatic setting of software limit level.
  In this example, the percentage for AUTO protecage setting (or current setting).

▼ At about 1 second later

```
OUT    15.000V      2.50A
```

(NOTE)
· *The factory default for the AUTO protection percentage is 110%.*
· *For the percentage change procedure, refer to Section 3.5.1 "Configuration."*
· *When in the C.V mode, the V limit level is automatically set; when in the C.C mode, the I limit level is automatically set.*

3.2.7 To Reset from Protection Alarm Status

To reset the power supply from the alarm status caused by a protective function, press the [SHIFT] + [ESC] RESET keys.

■ **Examples of procedure for resetting from protection alarm status (when in C.V mode)**

① Set the software +V limit level at 15V, the [Limit Action] to [Output OFF], and the output voltage setting at 14V.
Then, turn ON the output.

```
OUT     14.000V        1.00A
SET     14.000V
```

② Turn clockwise the JOG dial to increase intentionally the output voltage until it exceeds the +V limit.

```
OUT     15.000V        1.03A
SET     15.000V
```

· In this example, the +V limit circuit will trip at 15V and the output will be turned OFF as specified for the protective action and an alarm state will result.

▼ +V limit alarm

```
OUT      0.000V        0.00A
Alm          LIM
```

· The alarm is annunciated by the buzzer and <LIMIT> LED.

③ Press the [SHIFT] + [ESC] RESET keys.

```
OUT      0.000V        0.00A
```

· The alarm will be reset.
· The output will remain OFF.

④ Set again the output voltage at 14V and then press the [OUTPUT] key.

```
OUT     14.000V        1.00A
```

· Eliminate the cause of the alarm.
· The <OUTPUT> LED will light.

(NOTE)   · Be sure to reset the alarm before doing any other panel operation.

Examples of alarm displays

Limits (including power limit)   OVP

```
┌─────────────────────────────────┐     ┌─────────────────────────────────┐
│ OUT    0.000V      0.00A         │     │ OUT      0.000V      0.00A       │
│ Alm       LIM                    │     │ Alm  OVP                         │
└─────────────────────────────────┘     └─────────────────────────────────┘
```

MCB   OHP

```
┌─────────────────────────────────┐     ┌─────────────────────────────────┐
│ OUT    0.000V      0.00A         │     │ OUT    0.000V      0.00A         │
│ Alm                   MCB        │     │ Alm                   OHP        │
└─────────────────────────────────┘     └─────────────────────────────────┘
```

NOTE
- *If two or more alarms occur simultaneously, the contents of respective alarms are displayed.*
- *The OHP is a built-in overtemperature protector of the power supply. The protective action taken in response to a trip of the OHP is "Output OFF." If the alarm cannot be reset by pressing the RESET key, fully cool off the power supply and then press the RESET key again.*

3.2.8 Meter functions

The power supply has the various meter functions to measure and display the output in DC value, in RMS value, or in maximum/minimum value as mentioned below.

Meter function menu

```
|
|———1: [Peak RMS]   Display function select menu
|        |———1: [DC]              Display of output in DC value
|        |———2: [RMS]             Display of output in RMS value
|        |———3: [+Peak Vout]      Display of positive peak of output voltage
|        |———4: [−Peak Vout]      Display of negative peak of output voltage
|        |———5: [+Peak Iout]      Display of positive peak of output current
|        |———6: [−Peak Iout]      Display of negative peak of output current
|
|———2: [Display Time]    Period for which the peak value is held displayed (1 to 30 sec)
|
|———3: [Min Max Record]    Display of minimum/maximum recorded
          (The minimum/maximum value that is recorded after turning-on the POWER switch or after setting the
          [Peak RMS] is displayed.
```

NOTE

- *The [DC] mode is to measure the output in DC value. This mode is used for regular operation.*
- *The [RMS] mode is to measure the output in the effective value. Typically, this mode is used when the output has an AC component superimposed on its DC component.*
- *The [+Peak Vout] mode (or the [+Peak Iout] mode) is to measure the positive peak output value. For example, the values are measured at points shown by dots in the below illustration, and the measured values are shown at the right hand end on the top row of the display.*
- *Referring to the below illustration for example, the maximum value A of the data acquired during display time (1) is shown during display time (2) at the left hand end of the top row of the display. The same applies for measurement of −Peak values, also.*
- *If the output is negative when the measuring mode is set for +Peak, measurement is disabled; if the output is positive when the measuring mode is set for −Peak, measurement is disabled.*
- *The minimum/maximum record mode is to keep record of the minimum or maximum value for the period from the instant of setting the DC, RMS, or PEAK mode to the instant you have selected this menu item. In the below example, the minimum value is B and the maximum value is C.*
- *The data displayed by the minimum/maximum record function is cleared as you change the display mode or as you select again the same display mode.*
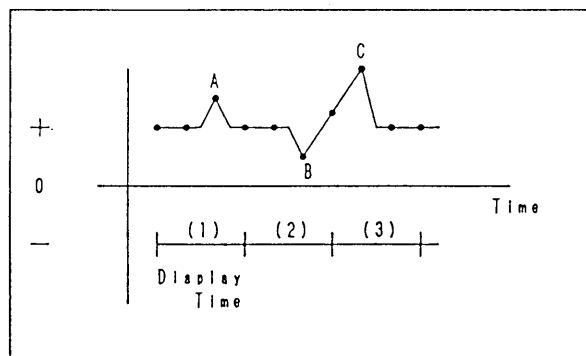
■ Example of use of meter functions

① Press the 〔SHIFT〕 + 〔9〕 PEAK RMS keys.

```
>1:   P e a k   R M S
 2:   D i s p l a y   T i m e
```

(Initial menu of meter functions)
· Items 1 and 2 of menu items 1 through 3 appear.
· You can check all menu items with the JOG dial or 〔△〕 and 〔▽〕 keys.

② Press the 〔1〕 and 〔3〕 keys to select [+Peak Vout].

```
P e a k   R M S
 + P e a k   V o u t
```

▼ At about 1 second later

```
>1:   P e a k   R M S
 2:   D i s p l a y   T i m e
```

· After the setting is over, the initial menu of meter functions will resume.

③ Press the 〔2〕 key to select [Display Time].

```
D i s p l a y   T i m e
                 1 s e c
```

· Set the display time with the numeric key or the JOG /SHUTTLE dials. The auailable time range is 1 to 30 seconds.
· After setting the display time with the JOG/SHUTTLE dials, press the 〔ESC〕 key.

④ Press the 〔5〕 and 〔ENTER〕 keys to set the display time.

```
D i s p l a y   T i m e
                 5 s e c
```

· In this example, the display time is set at 5 seconds.

```
>2:   D i s p l a y   T i m e
 3:   M i n   M a x   R e c o r d
```

· After the setting is over, the initial menu of meter functions will resume.

⑤ Press the 〔ESC〕 key to return to the root display.

```
P E A K  +  0 . 7  V  +  0 . 7  V
```

· Data corresponding to the selected meter function will appear. In this example, it is for [+Peak Vout].
· As shown in this example, you can change the items that appear on the root display by using the meter functions.

⑥ After changing the output voltage (or current), press the [SHIFT] + [9] PEAK, RMS and [3] keys to select [Min Max Record].

```
MAX    2.0    V
MIN-   0.0    V
```

• After the meter function setting is over, the minimum /maximum output values will appear. In this example, they are of [+Peak Vout].

• **Examples of displays for different measuring modes are shown below.**

< DC >

```
OUT    0.027V    0.04A
```

Indication of actual output

< RMS >

```
RMS    0.0  V    0.0  A
```

Indication of actual output

< PEAK >   (Example for +PEAK)

```
PEAK   +0.4  V    +0.4  V
```

└─Indication of actual output
   • If the actual output is negative when the measuring mode is for +Peak, the indication will be [+0.0V]. The same relationship applies also when the measuring mode is for –Peak.

└──────── The peak value within the [Display Time]

(NOTE)   • *For a peak value, either a positive sign (+) or negative sign (–) appears.*

The data items displayed when in the [Min Max Record] mode will differ depending on the meter functions selected. Examples are given below.

< DC >
< RMS >

```
MAX    2.0    V       0.0    A
MIN-   0.0    V    -  0.0    A
```

< +Peak Vout >
< –Peak Vout >

```
MAX    0.0   V
MIN-   0.0   V
```

< +Peak Iout >
< –Peak Iout >

```
MAX                  0.0   A
MIN              -   0.0   A
```

MEMO

3.3 Basic Operating Method 2

3.3.1 Remote Sensing Function

The remote sensing is to sense the supply voltage at the load and feed back the sensed voltage to the power supply to compensate for the voltage drops that are caused by cable resistances and contact resistances in the connection from the power supply to the load.
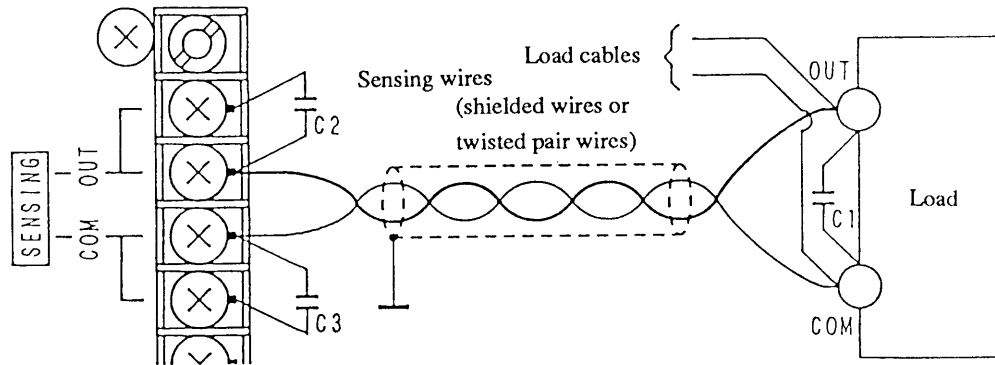
(Caution)
- The remote sensing function is only for the power supply operating in the normal C.V mode. (When in the fast C.V mode, the performance specifications of the power supply may not be met. When in the C.C mode, you cannot use the remote sensing function.)
- Be certain that the sensing wires and the load cables are securely connected. If even a single one of these wires or cables is disconnected and its circuit is made open, both power supply and load can be seriously damaged.
- Be sure to install the cover of the terminal block.
- When the load is a battery or other regenerative type of device, connect the load cables before connecting the sensing wires.
- If you are installing an ON/OFF switch in the load cable line, install also in the sensing wire line an ON/OFF switch which is linked to the ON/OFF switch of the load cable line.
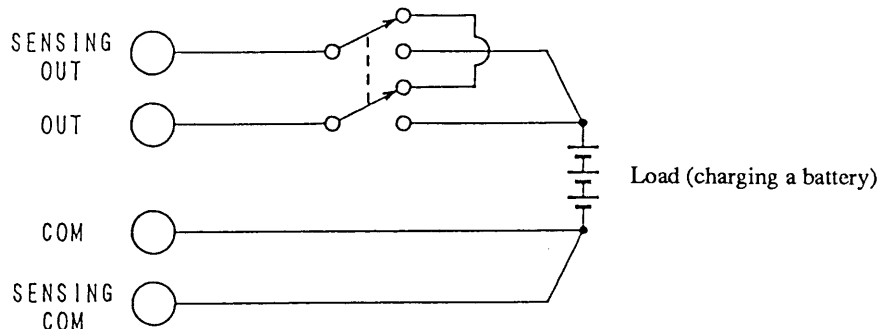
- The remote sensing function is unrecommendable for a load whose current changes rapidly. The output voltage will be more stable without the remote sensing.

(NOTE)
- Connect the SENSING OUT terminal of the power supply to the OUT terminal of the load and connect the SENSING COM terminal of the power supply to the COM terminal of the load by using a shielded cable or a pair of twisted wires.
- Up to 0.5V of voltage drop per one way of cable connection from the power supply to the load can be compensated for.
- Be sure to connect a large capacitor (C1 in the above illustration) to the sensing point. Be certain that the working voltage of the capacitor is sufficiently high. Make the connection distance minimal.
- If the sensing distance is long and the voltage is unstable, connect capacitors C2 and C3 as shown in the above illustration. (Their working voltages must be 50WV or higher.)

3.3.2 Memory Function

The memory function allows you to store up-to-four settings of voltage (or current) in four locations of internal memory and to recall the stored settings from internal memory.

[1] To store voltage (or current) setting data in memory

To save the currently existing output voltage (or current) setting and the fine voltage (or current) setting, when the root display is shown, press the [SHIFT] + [3] MEM STORE keys, and press one of the [A] through [D] keys or turn the JOG dial to select a memory unit, and then press the [ENTER] key. The setting data will be saved in the corresponding one of the internal memory units A, B, C, and D.

■ **Example of procedure to store a setting data (when in C.V mode)**

```
OUT    15.321V      1.51A
```

· Specify the voltage setting and the fine voltage setting in beforehand.

① When the root display is shown, press the [SHIFT] + [3] (MEM STORE) keys.

```
OUT    15.321V      1.51A
S  A    0.000V
```

· The bottom row indicates the currently selected memory (memory A in this example).
· You can check the contents of memory A through D by turning the JOG dial.

② Press the [A] key.

```
OUT    15.321V      1.51A
S  A*  15.300V
```

· The voltage setting data has been saved.
· To save the setting data, you may press the [ENTER] key instead of the [A] key.
· The bottom row indicates the newly saved data.
· The asterisk (*) means that the fine value of voltage is not zero.

▼ At about 1 second later

```
OUT    15.321V      1.51A
```

· The root display will resume.

(NOTE) · *An example of display for storing a setting data when in the C.C mode is shown below.*

```
OUT    15.321V     20.00A
S  A            *  20.00A
```

· *The factory-defaults for the setting data stored in memory are voltage at 0.000V and fine voltage at 0.*

[2] To recall voltage (or current) setting data from memory

To recall the saved voltage (or current) setting and the fine value, press the [MEMORY] key, press one of the [A] through [D] keys or turn the JOG dial to select a memory location, and then press the [ENTER] key.

■ Example of procedure to recall a setting data (when in C.V mode)

```
OUT      0.001V      0.01A
SET      0.000V
```

· For convenience of explanation, the settings assumed here are that the voltage is zero and the output is ON.

① Press the [MEMORY] key.

```
OUT      0.001V      0.01A
M  A*  15.000V
```

· The <MEMORY> LED will light.
· The bottom row shows the setting data recalled from memory(memory A in this example).
· You can recall the contents of memory A through D by turning the JOG dial.

② Press the [A] key.

```
OUT     14.999V       1.00A
M  A*  15.000V
```

· The voltage data of memory A is recalled and set.
· The asterisk (*) means that the fine voltage value is not zero.

③ Recall data from memory D by turning the JOG dial.

```
OUT     14.999V      1.00A
M  D   14.750V
```

④ Press the [ENTER] key.

```
OUT     14.751V       0.98A
M  D   14.750V
```

· The voltage data of memory D is recalled and set.

⑤ Press the [ESC] key.

```
OUT     14.751V       0.98A
```

· The root display will resume.
· The <MEMORY> LED will go out.

(Caution) · If you directly recall the stored voltage (or current) setting with the [A] or other memory key, the power supply will immediately start operating with the recalled setting. For the sake of safety, before recalling the stored setting, check it by turning the JOG dial when in the start that the <MEMORY> LED is illuminating. Press the [ENTER] key after making it certain that the stored setting is of a safe value.

(NOTE) · An example of data recalled from memory when in the C.C mode is shown below.

```
OUT     15.321V      3.00A
M  A              *   3.00A
```

3.3.3 Setup Function

The power supply can store the various items of setting data, including settings of output voltage (or current), protective functions, and Tr and Tf. You can save and recall these settings as a group of data items for a setup.

Setup Menu Configuration and Functions

Setup Menu

```
|————————1: [Recall]        : To recall the setup data from the specified setup memory.
|————————2: [Store]         : To save the setup data in the specified setup memory.
|————————3: [Store to #0]   : To save the setup data in setup memory [#0]
|————————4: [Initialize]    : To initialize the settings.
```

Conceptual Diagram of the Setup Functions

Setup Items

Setup memory

| V SET   (I SET)
V FINE   (I FINE)
V RESOLN
     (I RESOLN)
Software
    V Limit Level
    I Limit Level
Protective Actions
V Limit OVP
Limit Time Delay
MCB Action
Tr Tf
Output Display Mode
Display Time
Amplitude Setting
Memory A, B, C, D |

Initialize ←—————— <Existing data>

Power-on recall ←—————— Setup memory [#0]

Store [#0] ——————→

Setup memory [#1]

Recall ←——————

Store ——————→ Setup memory [#9]

Internal non-volatile memory (up to 10 memory locations)
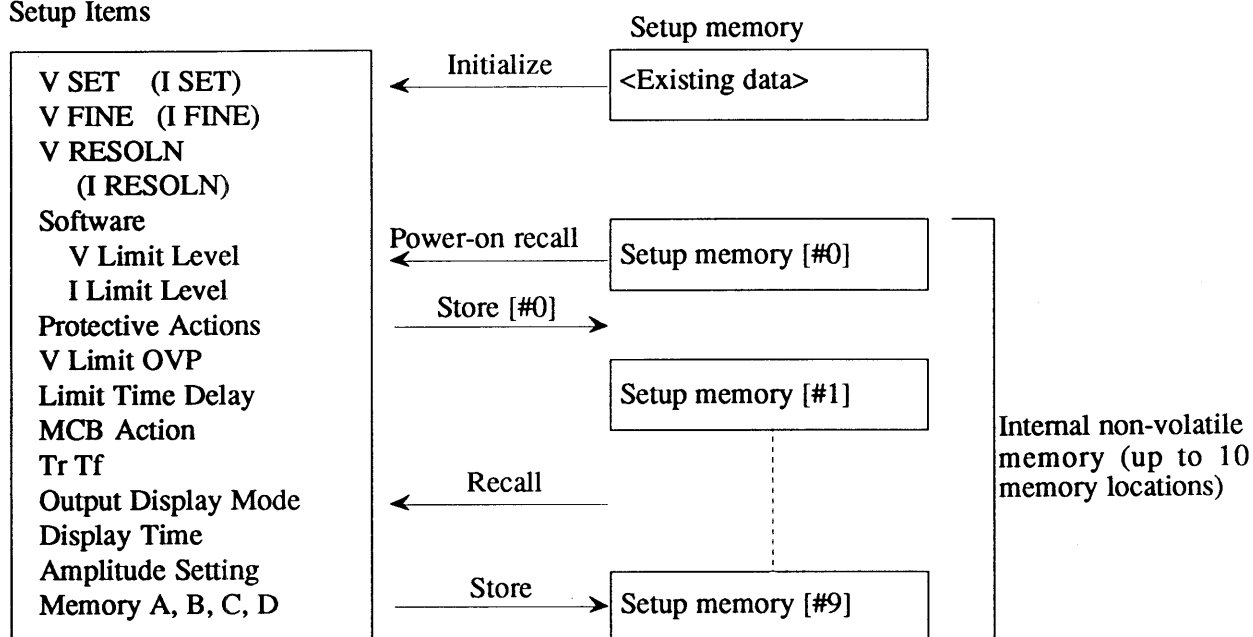
The items enclosed in ( ) are those
when in the C.C mode.

NOTE
· When the POWER switch is turned ON, the data of setup memory [#0] is recalled. (Power-ON recall function)
· Such setting also is possible that the output is automatically turned ON when the POWER switch is turned ON. (For more information, refer to Section 3.5.1 "Configuration.")

Displays of Setup Functions

■ When in the C.V mode

```
┌─R: Recall
│  S: Store
│      ┌─Setup memory No.
│      │     ┌─Voltage setting
┌──────────────────────────────┐
│ R # 0 0    0 . 0 0 V          │
│ V L i m  - 2 2 . 0 V   2 2 . 0 V │
└──────────────────────────────┘
│          │              └── Software +V Limit level
│          └──Software -V Limit level
└──Item name
```

■ When in the C.C mode

```
┌─ R: Recall
│  S: Store
│      ┌─Setup memory No.
│      │                  ┌─ Current setting
┌──────────────────────────────┐
│ R # 0 0              5 . 0 0 A │
│ V L i m  - 2 2 . 0 V   2 2 . 0 V │
└──────────────────────────────┘
│          │              └── Software +V Limit level
│          └──Software -V Limit level
└── Item name
```
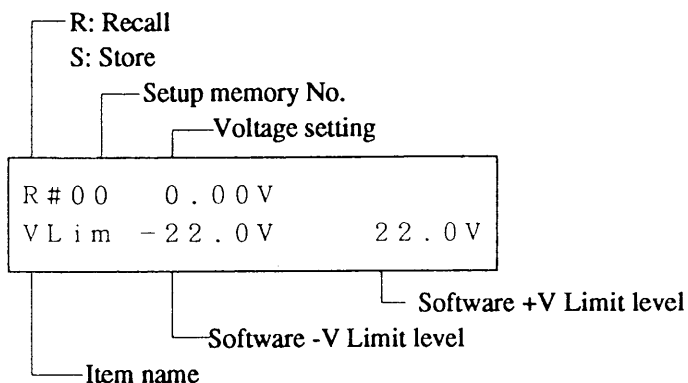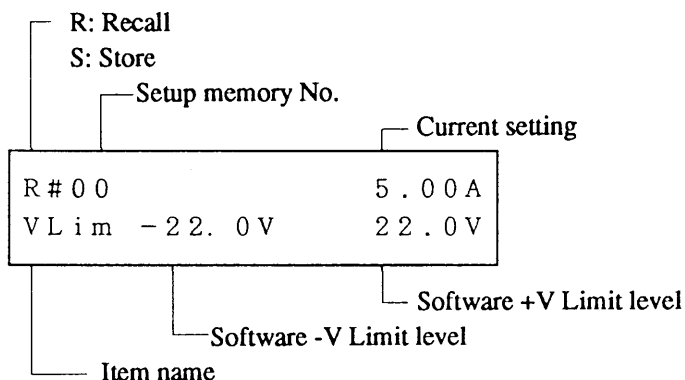
As you press the 【◁】 【▷】 keys, the indications on the bottom row of the display will change as follows:

【◁】 ↑ ↓ 【▷】 Software I Limitlevel	I L i m - 2 2 . 0 A 2 2 . 0 A
【◁】 ↑ ↓ 【▷】 Fine voltage setting	F i n e + 0 5 0
【◁】 ↑ ↓ 【▷】 Click resolution	R e s o 0 . 5 0 0 V
【◁】 ↑ ↓ 【▷】 Tr Tf time	T r T f 5 0 μ s e c
【◁】 ↑ ↓ 【▷】 Protective action	L i m A c t i o n O u t O F F
【◁】 ↑ ↓ 【▷】 Limit Time delay	L i m D e l a y 2 . 0 0 s e c
【◁】 ↑ ↓ 【▷】 V Lim/OVP	V L i m / O V P P o w e r O F F

【◁】 ↑ ↓ 【▷】
MCB protective action

| MCB Prot. None |

【◁】 ↑ ↓ 【▷】
Output measurement mode

| Measure Mode DC |

【◁】 ↑ ↓ 【▷】
Display time

| Display Time 1sec |

【◁】 ↑ ↓ 【▷】
Amplitude setting

| Amplitude 0.0% |

【◁】 ↑ ↓ 【▷】
Memory function

| MA * 0.000V |

(The asterisk means that the fine value setting is not zero.)

Examples of displays when in the C.C mode (only the ones which differ from those when in the C.V mode)

Fine current value

| Fine +000 |

Click resolution

| Reso 0.100A |

Amplitude setting

| Amplitude 0.0% |

Memory function

| MA * 20.00A |

(The asterisk means that the fine value setting is not zero.)

[1] Recall

This function is to recall the setup data from the specified memory.

■ Example of procedure to recall a setup from memory (when in C.V mode)

① Press the 【SHIFT】 + 【7】 SETUP keys.

```
> 1 :   R e c a l l
  2 :   S t o r e
```

(Setup menu)
· Menu items 1 and 2 (of total menu items 1 through 4) are displayed.

② Press the 【ENTER】 key to select the [Recall] of the top row.

```
R # 0 0      0 . 0 0 0 V
V L i m  - 2 2 . 0   V      2 2 . 0 V
```

③ Press the 【▷】 key.

```
R # 0 0      0 . 0 0 0 V
F i n e      + 0 0 0
```

· Other items of the same setup can be displayed with the 【◁】 【▷】 keys.

④ Press the 【▽】 key.

```
R # 0 1      5 . 0 0 0 V
F i n e      + 0 0 0
```

· The setup memory numbers can be changed with the 【△】 【▽】 keys or JOG dial.

⑤ Press the 【ENTER】 key.

```
R e c a l l   S e t u p
  C o m p l e t e d .
```

· The setup has been recalled.

▼ At about 1 second later

```
O U T      0 . 0 0 1 V      0 . 0 1 A
```

⑥ Press the 【OUTPUT】 key.

```
O U T      5 . 0 0 0 V      1 . 0 0 A
```

· The power supply will operated with the recalled setup.

(Caution)
· For the sake of safety, the output is automatically turned OFF when the contents of a setup memory is recalled.
· You cannot recall for the C.C mode or C.V mode of operation a setup which has been stored in the C.V mode or C.C mode of operation, respectively.

[2] Store

This function is to save the setup data in the specified setup memory.

■ **Example of procedure to save a setup in memory (when in the C.V mode)**

① Press the 【SHIFT】 + 【7】 SETUP keys.

```
>1 :   R e c a l l
 2 :   S t o r e
```

(Setup menu)
· Menu items 1 and 2 (of total menu items 1 through 4) are displayed.

② Press the 【2】 key to select the [Store].

```
S # 0 0    0 . 0 0 0 V
V L i m   - 2 2 . 0   V    2 2 . 0   V
```

③ Press the 【▷】 key.

```
S # 0 0    0 . 0 0 0 V
F i n e    + 0 0 0
```

· Other items of the same setup can be displayed with the 【◁】 【▷】 keys.

④ Press the 【▽】 key.

```
S # 0 1    5 . 0 0 0 V
F i n e    + 0 0 0
```

· The setup memory numbers can be changed with the 【△】 【▽】 keys or with the JOG dial.

⑤ Press the 【ENTER】 key.

```
S t o r e   S e t u p
  C o m p l e t e d.
```

· The setup data has been stored in memory.

▼ At about 1 second later

```
O U T    0 . 0 0 0 V  -  0 . 0 0 A
```

[3] Store #0

When the POWER switch of the power supply is turned on, the power supply recalls the contents of setup memory #0 by its Power-ON Recall function. The function saves the currently existing setup in setup memory #0 and, when the POWER switch is turned ON the next time, the function lets the power supply recall the setup that has been saved in setup memory #0 and starts operating with the setup parameters.

■ Example of procedure to save a setup in setup memory [#0]

① Press the 【SHIFT】 + 【7】 SETUP keys.

```
>1 :    R e c a l l
  2 :    S t o r e
```

② Press the 【3】 key to select [Store to #0].

```
S t o r e    t o    # 0
  C o m p l e t e d.
```

• The setup data has been stored in setup memory #0.

▼ At about 1 second later

```
O U T      5 . 0 0 1 V        1 . 0 0 A
```

(NOTE)   • The [Store to #0] procedure in effect is identical with the [Store] procedure to save the setup data in setup memory [#0].

[4] Initialize

This function is to initialize the settings to the factory-defaults.

■ Example of procedure to initialize the settings

① Press the 【SHIFT】 + 【7】 SETUP keys.

```
>1 :   R e c a l l
  2 :   S t o r e
```

(Setup menu)

② Press the 【4】 key to select the [Initialize].

```
I n i t i a l i z e   S e t u p
      S u r e   ?
```

· A message requesting your acknowledge will appear.

③ Press the 【ENTER】 key to select the [Initialize].

```
I n i t i a l i z e   S e t u p
      C o m p l e t e d .
```

· The settings have been initialized to the factory-defaults.

▼ At about 1 second later

```
O U T      0 . 0 0 0 V      0 . 0 0 A
```

· The power supply has been initialized its output is OFF.

(NOTE) · For the factory-default settings, refer to Appendix 3 "Table of Factory-defaults."
· This procedure is not for formatting the setup memory.

3.3.4 Keylock Function

This function disables all front panel keys and controls including the JOG/SHUTTLE dials, but enables only the keylock release procedure ([SHIFT] + [1] KEYLOCK keys) and alarm reset procedure ([SHIFT] + [ESC] RESET keys).

■ **Example of keylock procedure**

① Press the [SHIFT] + [1] KEYLOCK keys.

```
OUT     0.001V     0.01A
   <<  Keys  Locked  >>
```

· The keys are locked.

② Press again the [SHIFT] + [1] KEYLOCK keys.

```
OUT     0.001V     0.01A
SET       5. V
```

· The keylocked state is released and the former state resumes.
· In this example, the display indicates that the keylock function was effected when in voltage setting (immediately after pressing the [SET] , [5] and [.] keys).

③ Press the [ESC] key.

```
OUT     0.001V     0.01A
```

· The root display will resume.

(*Caution*) · *When the Limit or other protector has tripped and an alarm has occurred while in the keylock state, reset the alarm at first by pressing the* [SHIFT] + [ESC] *RESET keys. Then the keylock state will be automatically released.*

3.3.5 Setting the Click Resolution

This procedure is to set a click resolution for the JOG dial and 【△】　【▽】 keys. When in a state that the voltage (or current) setting is enabled, press the 【SHIFT】 + 【6】 RESOLN keys and adjust the click resolution with the JOG/SHUTTLE dials or the numeric keys.

■　**Example of click resolution setting (when in C.V mode)**

① Press the 【SET】 key.

```
OUT      0.001V      0.01A
SET      0.000V
```

· The state for voltage setting is enabled.
· The <SET> LED will light.

② Press the 【SHIFT】 + 【6】 RESOLN keys.

```
OUT      0.001V      0.01A
Resolution    0.100V
```

· The state for click resolution setting is enabled.
· The bottom row indicates the currently existing click resolution.

② Press the 【.】 , 【5】 and 【ENTER】 keys.

```
OUT      0.001V      0.01A
Resolution    0.500V
```

(Setting with numeric keys)
· You may use JOG/SHUTTLE dials instead. When you do this, the setting ends as you press the 【ESC】 key.

▼　At about 1 second later

```
OUT      0.001V      0.01A
SET      0.000V
```

④ Press the 【△】 key and set a relative voltage.

```
OUT      0.001V      0.01A
SET      0.500V
```

· The click resolution for voltage setting has been changed to 0.5V.

(NOTE) · The click resolution for current setting when in the C.C mode of operation also can be set with a procedure similar as above.

Example of display
when in C.C mode

```
OUT      0.001V      0.01A
Resolution    0.100A
```

· The adjustable range of click resolution is from 0.001 to a little less than a half of the rated output. The factory-defaults are 0.100V for the C.V mode and 0.100A for the C.C mode.

3.3.6 Setting the Rise/Fall Time and The Frequency Response for an External Signal

This procedure is to set the rise time (Tr) and fall time (Tf) of the output voltage (or current). To do this, when the output is OFF, press the [SHIFT] + [8] Tr Tf keys to call out the Tr Tf time select menu. For the fast C.V mode, you can select [50 μ s], [500 μ s], [5ms] or [Through]. For the dynamic C.C mode, you can select [100 μ s], [500 μ s], [5ms] or [Through].

■ Example of rise/fall time setting procedure

① Be certain that the output is OFF. If it is ON, turn it OFF by pressing the [OUTPUT] key.

```
OUT     0.001V      0.01A
```

· Before setting Tr Tf, make it double sure that the output is OFF.

② Press the [SHIFT] + [8] Tr Tf keys.

```
Tr  Tf
  >1:<50  usec>
```

(Tr Tf select menu)
· The value enclosed in <> is the existing Tr Tf time setting.

③ Turn the JOG dial clockwise by two clicks.

```
Tr  Tf
  >3:  5 msec
```

· This example is for setting the value with the JOG dial. You may set it with the numeric keys instead.

④ Press the [ENTER] key.

```
Tr  Tf
  5. msec
```

▼ At about 1 second later

```
OUT     0.001V      0.01A
```

· Setting of the Tr Tf time is complete.

(NOTE) · Setting of Tr Tf time cannot be done when the output is ON or when in the normal C.V mode (or static C.C mode).
· The factory-default for Tr Tf time is 50 μ s for the C.V mode or 100 μ sec for the C.C mode.
· The Tr Tf time is not applicable to rise up or fall down of the output when the output is turned ON or OFF.
· The [Through] setting is effective only when driving the power supply directly with an external signal. Refer to Section 3.5.1 [1] "Remote control with external analog signal." When in this mode of operation, the frequency response of the power supply is 30kHz for the C.V mode or 10kHz/5kHz for the C.C mode.

3.3.7 Displaying the Interface Status

This procedure is to display the status of the optional interface board. To display the status, when the root display is shown, press the [SHIFT] + [CLR] IBST keys. As you press these keys again, the status display will disappear.

■ **Example of procedure for displaying the interface status**

① Press the [ESC] key to call out the root display.

```
OUT     0.001V     0.01A
    <<  Remote  >>
```

* The message [<<Remote>>] means that the power supply is being remote-controlled via the interface.

② Press the [SHIFT] + [CLR] IBST keys.

```
OUT     0.001V     0.01A
    <<  Remote  >>   TLS
```

* [T] stands for talker, [L] for listener, and [S] for service request.

③ Press the [SHIFT] + [CLR] IBST keys.

```
OUT     0.001V     0.01A
    <<  Remote  >>
```

(NOTE)
* *The interface status is effective when the power supply is being remote-controlled through GPIB.*
* *You can return the power supply to the local control mode (mode that the front panel keys are enabled) by pressing the* [SHIFT] + [BS] *LOCAL keys.*

3.4 Sequence Operation

The sequence operation is such that the power supply automatically executes a programmed sequence of output voltage (or current). By using the sequence mode of operation, you can let the power supply generate voltage (or current) in waveforms as you may require. Each sequence control program can be saved as a "sequence file" in the internal memory , and can be recalled as you require it.

3.4.1 Description of Sequence Operation

[1] Modes of sequence operation

The modes of sequence operation are classified as follows by the execution speed and by the output voltage (or current).

```
                                              ┌─ Output voltage sequence mode   (NV mode)
                          ┌─ Normal speed mode ┤
                          │                    └─ Output current sequence mode   (NI mode)
Sequence operation ──────┤
                          │                    ┌─ Fast output voltage sequence mode (FV mode)
                          └─ Fast speed mode ──┤
                                               └─ Fast output current sequence mode (FI mode)
```
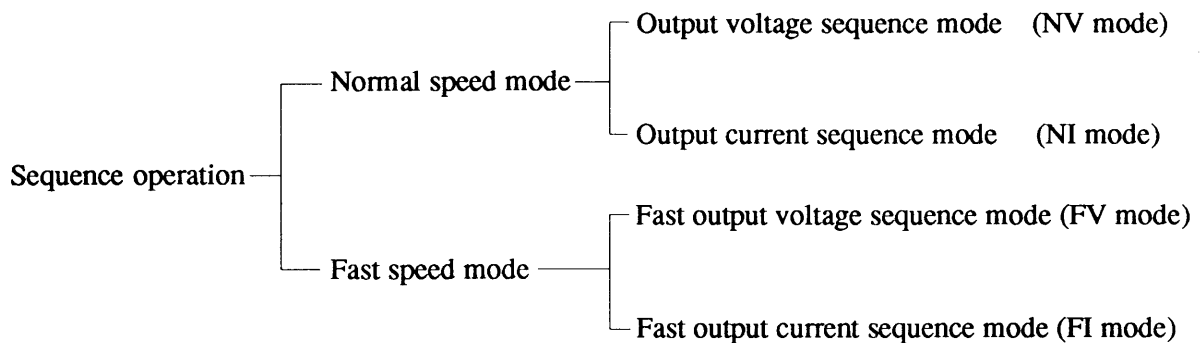
(NOTE) · *Individual modes are as described below.*
  NV mode   : The output voltage alone is sequence-controlled.
  NI mode   : The output current alone is sequence-controlled.
  FV mode   : The output voltage alone is sequence-controlled in the Fast mode.
  FI mode   : The output current alone is sequence-controlled in the Fast mode.
· *For C.V operation, the NV mode and FV mode are available; for C.Coperation, the NI mode and FI mode are available.*

Examples of output voltage waveforms generated by sequence operation

Normal speed sequence (NV mode)

Output voltage

10V

|100sec| 150sec |80sec| Time
|ramp | step |ramp|
|10V | 10V |0V|

Fast speed sequence (FV mode)

Output voltage

5V

3V

|100/ᵃ|100/ᵃ|100/ᵃ|100/ᵃ| Time
|0V |5V |0V |3V |
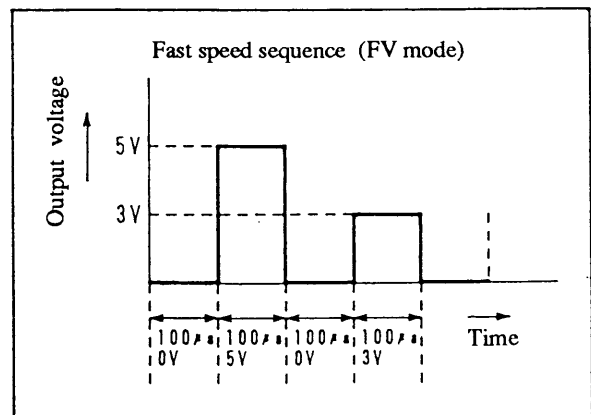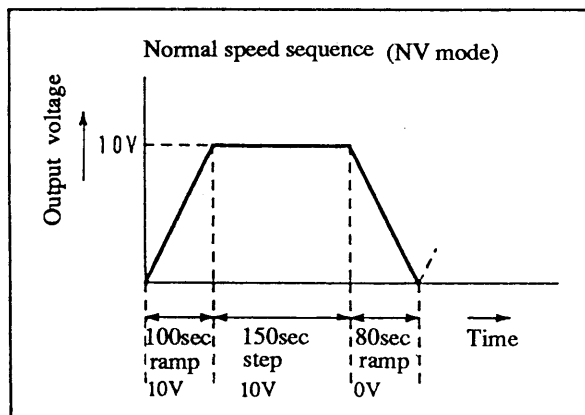
The features of the Normal speed mode and Fast speed mode of sequence operation are compared in the following table.

	Normal speed mode	Fast speed mode
Availabe output (Mode)	NV mode and NI mode	FV mode and FI mode

Execution time per step (Time unit)	1. Millisecond range (0, 1ms to 9999ms)
	2. Second range (0, 0.1s to 999.9s)
	3. Minute range (0, 1s to 999min 59s)
	4. Hour range (0, 1min to 999h 59min)
	    (Can be set as required for each
	    step within the same range)
	    (Execution time 0 means that
	    the step is to be skipped.)
		0.1ms to 100.0ms
		
		(Per step; fixed time)

Type of output change	Step change or ramp change	Step change
Trigger input/output function (TRIG I/O terminal)	Available (Select either trigger input or trigger output.)	Available (Trigger output only)
Output ON/OFF	Available	Unavailable (To be kept in the ON state)
Pause function	Available	Unavailable
Maximum number of steps	256	1024
Number of loops	1 to 9998, and infinitive (by specifying 9999)	1 to 9998, and infinitive (by specifying 9999)
Number of sequences	8	8
Number of programs	16	16

Caution

- *The Fast speed sequence is available only when the power supply is in the fast C.V mode or dynamic C.C mode. (Refer to Section 2.4 "Operating Mode Selection".)*
- *The output voltage (or current) rises or falls with the Tr Tf time setting. Therefore, when the programmed execution time for one step is shorter than Tr Tf time, the output may not reach the values specified by the program.*
- *At the fast speed sequence operation mode when two programs of one step or two steps chained each other are executed at high speed, normal processing may not be done by the occurrence of a reception error for a message through RS-232C. Change programming of the sequence or control the Electronic Load via GPIB.*
- *It takes several tens milliseconds for processing time when the output of PBX series is turned ON or OFF.*
  Pay attention to the execution time per step when using the output ON/OFF function in the normal speed sequence operation.
  When the execution time per step is less than about100 ms, the step may not be executed in the setting time.

[2] Sequence File Configuration

For sequence operation, you must prepare sequence files which contain operation parameters such as voltage, current, and time. The sequence file can be stored in the internal memory (nonvolatile) of the power supply.

The sequence files are classified by the execution speed into two types as follows:

Sequence file for normal speed mode

Mode NV/NI	·········· Mode of operation
Time unit	·········· Step execution time (unit)

Sequence 1
  Execution program No. (Pxx)
  Number of loops (Lxxxx)
  End program No. (Exx)
 	
  Chain sequence No. (Cx)
	·········· Parameters for "how to execute"
	·········· The program number of the program to be executed.
	·········· The number of repetitions of program Pxx
	·········· The program number of the end program after completing the execution.
	  (The first step alone of the end program is executed.)
	·········· The sequence number of the sequence to be executed next.

Sequences 2 through 8	·········· The parameters of sequences 2 through 8 are the same as those of sequence 1.
Program 01 Number of steps n	·········· Parameters for "what to execute" ·········· The number of steps (1 to 256)

Step 1
  S/R
  V value (I value)
  Trigger output 1/0
  Output ON/OFF
  Pause 1/0
  Execution time
	·········· S (step) or R (ramp) for C.V change (or C.C change)
	·········· Target C.V value (target C.C value)
	·········· To deliver a trigger output or not
	·········· To turn ON or OFF the output
	·········· To pause the step or not
	·········· Execution time of the step

Steps 2 to n	
Programs 02 to 16	* The parameters of programs 02 through 16 are the same as those of program 01.

Sequence file for fast speed mode

Mode FV/FI	·········· Mode of operation

Sequence 1
  Execution program No. (Pxx)
  Number of loops (Lxxxx)
  End program No. (Exx)
 	
  Chain sequence No. (Cx)
  Execution time (Time)
	·········· Parameters for "how to execute"
	·········· The program number of the program to be executed.
	·········· The number of repetitions of program Pxx
	·········· The program number of the end program after completing the execution
	  (The first step alone of the end program is executed.)
	·········· The sequence number of the sequence to be executed next.
	·········· Step execution time

Sequences 2 through 8	* The parameters of sequences 2 through 8 are the same as those of sequence 1.
Program 01 Number of steps n	·········· Parameters for "what to execute" ·········· The number of steps (1 to 1024)

Step 1
  V value (I value)
  Trigger output 1/0
	·········· Step number
	·········· Target C.V value (target C.C value)
	·········· To deliver a trigger output or not

Steps 2 to n	
Programs 02 to 16	* The parameters of programs 02 through 16 are the same as those of program 01.

[3] Description of sequence operation parameters

Steps

Steps define the voltage (or current) and other sequence parameters.The steps are sequentially executed starting by Step No. 1. The steps are the most basic parameters of sequence operation.

Programs

Each program consists of steps. Up to 256 steps (1024 steps when in FV or FI mode) can be assigned to up to 16 programs. The programs define the basic patterns of sequence operation. Even a single program can be executed.

Sequences

Sequences define what programs should be executed in what manner. For example, the sequence define the number of repetitions of the program and the end state of the program.

The relationships among the steps, programs, and sequences are as shown below:

```
Step ─┐
Step  ├──── Program ─┐
Step  │             │
  :   │             ├──────── Sequence
  :   │             │            :
Step ─┘             │            :
Step  ├──── Program ┘            :
Step  │
  :   │
  :  ─┘

Step ─┐
Step  ├──── Program ──────── Sequence
Step  │                         :
  :   │                         :
  :  ─┘
```
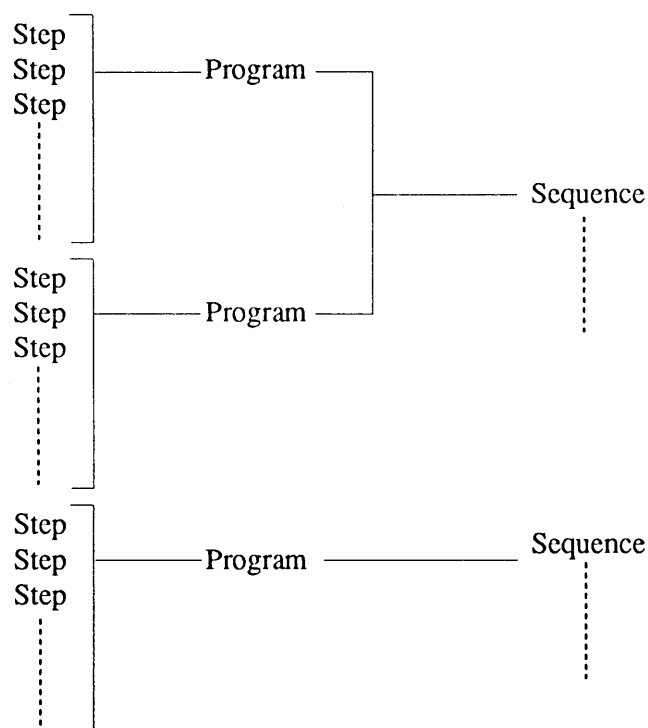
Output change

Step change: The output changes stepwise.   Ramp change: The output changes rampwise.
                                                            (only when in NV or NI mode)

· Example of step change by 1sec/10V   · Example of ramp change by 1sec/10V
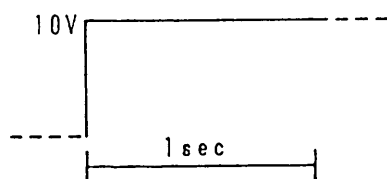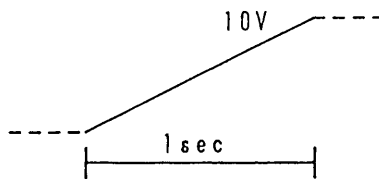
Trigger output

This parameter is for delivering a trigger pulse output via TRIG I/O terminal on the front sub-panel, each pulse representing an event of program step change.

Step n+1
trigger

Step n

TRIG OUT
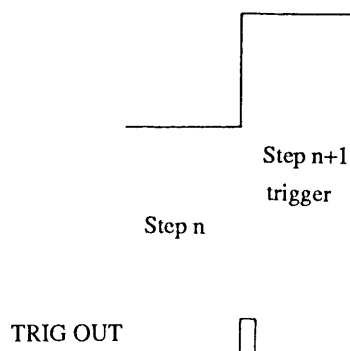
Pause and trigger input (for NV or NI mode only)

You can pause the sequence operation by pressing the 〔PAUSE〕 key. The sequence operation resumes as you press the 〔PAUSE〕 key again or a trigger input is applied via the TRIG I/O terminal of the front sub-panel.

• Example of pause by 〔PAUSE〕 key and resumption by trigger input

Pause period

T1

T2   T1+T2 = Execution time setting

[PAUSE] key   TRIG IN signal
or 〔PAUSE〕 key
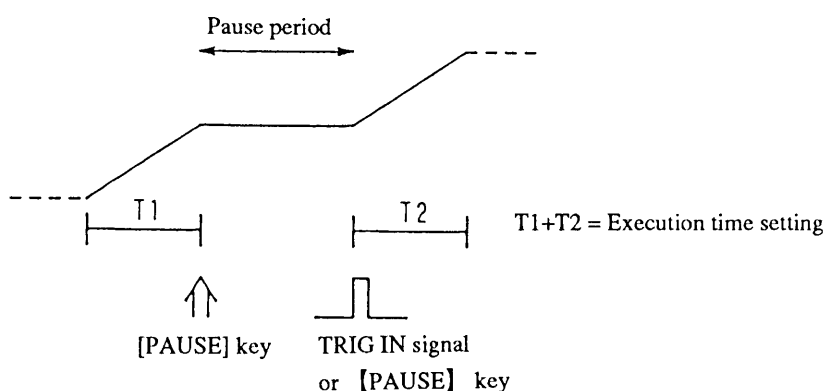
• Example of pause by program and resumption by trigger input

Pause period

Programmed PAUSE

TRIG IN signal
or 〔PAUSE〕 key
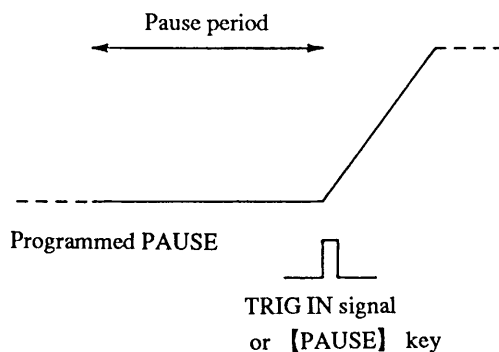
NOTE   • *For the electrical specifications of the TRIG I/O terminal, refer to Section 7.1 "Electrical Specifications."*

■ Example of sequence operation (normal speed mode)

An example of sequence operation is introduced below to show the functions of steps, programs, and sequences.

In this example, as sequence 1 is executed, the power supply performs a sequence operation of a configuration as shown below.

Sequence 1: Execute program 1 once, and chain it to sequence 2.

Sequence 2: Execute program 2 twice, and chain it to sequence 3.

Sequence 3: Execute program 3 once, and terminate the operation at the first step of program 16 (end program).
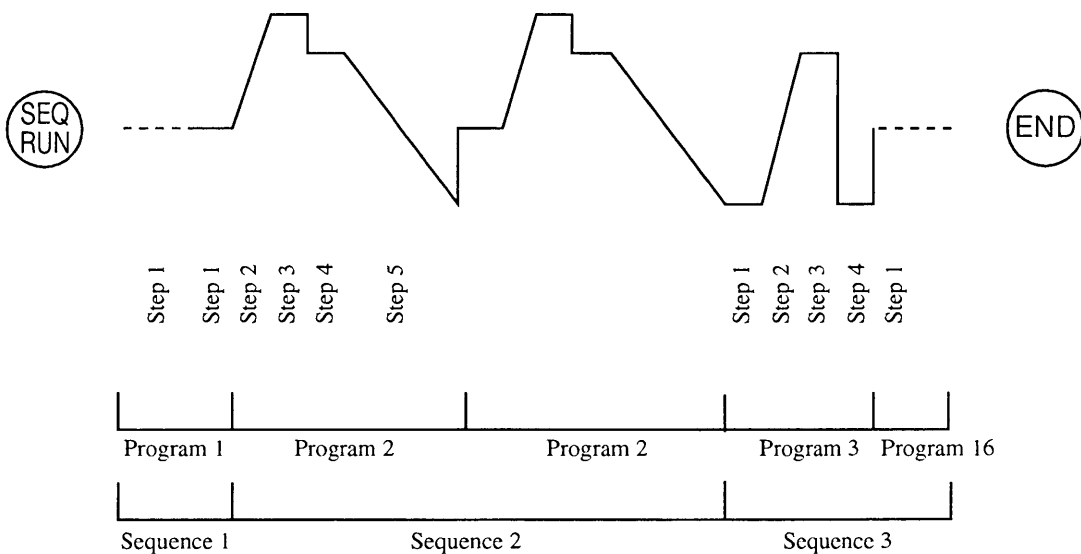
NOTE

Note on Sequence Executing

- *You can specify the sequences and programs in any order.*
- *You cannot chain a program to another sequence which is stored in another file.*
- *Of the end program, the first step alone is executed. Therefore, its pause and time data is meaningless.*
- *Before entering the end program, a certain time interval (several milliseconds to several tens milliseconds) is necessary.*
- *When chain operation is specified, the end program is not executed and the operation advances to the sequence number of the destination of chain operation.*
- *If you stop the sequence operation by hardware (by pressing the* 【STOP】 *key or other means), the first step of the end program of the currently-executed sequence number is executed. If no end program is specified (no end program is specified when "E ✱ ✱"), the operation terminates at the step which was being execution when the stop command was given.*

Note on Fast Sequence Executing

- *When sequences are chained, the final step execution time of a program is not guaranteed. Use great care when using the chained sequence.*

3.4.2 Outline of Settings for Sequence Operation

For sequence operation, you must manage sequence files, create and edit sequence parameters, and then execute the sequences. Set the required items by following the procedure indicated by menus.

Sequence operation menu configuration and functions

Initial sequence menu

```
├── 1: [File]  : File manage menu
│
│       ├── 1: [List Files]        : To display the sequence files
│       ├── 2: [Load File]         : To load the sequence file onto the sequence execution memory
│       └── 3: [Save File]         : To save the sequence execution memory data into the sequence file
│
├── 2: [Edit] : Edit menu
│
│       ├── 1: [Edit Program]      : To add, edit, or delete programs of sequence execution memory
│       ├── 2: [Edit Sequence]     : To create or edit sequence parameters of sequence execution memory
│       └── 3: [New]               : To initialize sequence execution memory
│
├── 3: [Run] : menu              : To run the contents of sequence execution memory
│
└── 4: [Configuration] : menu

        ├── 1: [TRIG Direction]    : To define input/output direction of trigger

        └── 2: [Auto Run]          : To specify either the sequence is to be run or not when the power switch is turned on
```

Conceptual diagram of sequence operation
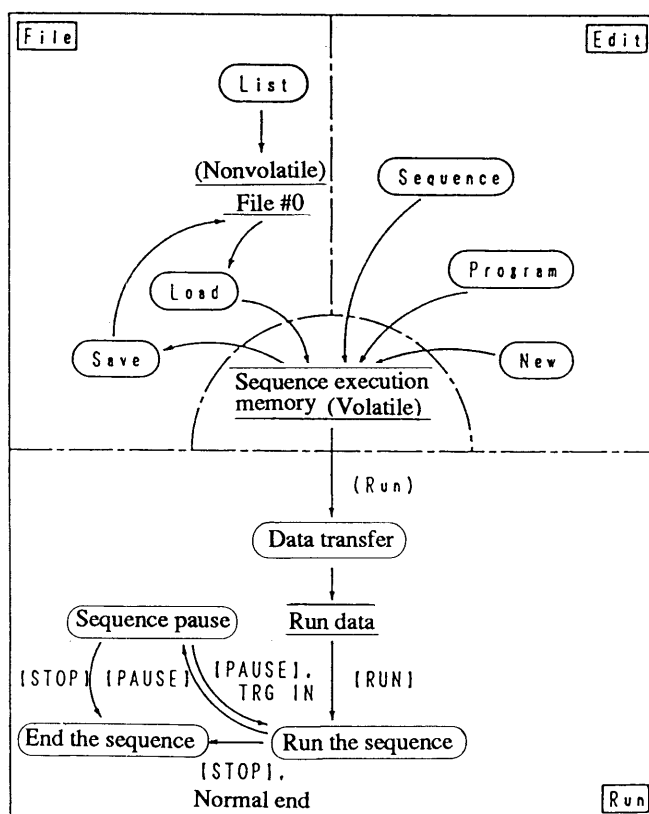
Caution

· When the power switch is turned on, sequence file #0 (non-volatile memory built in the power supply) is automatically loaded onto the sequence execution memory.

· When in the [File] or [Edit] mode, files of either for the C.V mode or C.C mode can be handled. When in the [RUN] mode, however, the modes must conform.

· The factory-defaults for sequence file #0 are as follows:

    Mode   : NV
    Time unit : msec
    Step data : 11 steps

3.4.3 Procedures for Sequence Operation

For sequence operation, it is most recommendable to prepare beforehand a coding data sheet on which the values for the required parameters are listed. (For coding data sheets, refer to Appendix 5. The examples of coding given below refer to the examples given in the appendix.)

The subsequent Items [1] and [2] introduce examples of procedures for entering the data written on a coding sheet into the sequence execution memory.

[1] To create a new sequence execution file

For sequence operation, you must create a sequence execution file first of all. (For the procedure of using an already existing file, refer to [3] "To save or load a file.")

■ **Example of procedure for setting sequence operation parameters and initializing the sequence execution memory**

① When the root display is shown on the LCD, press the 【EDIT】 key.

```
> 1 :   E d i t   P r o g r a m
   2 :   E d i t   S e q u e n c e
```

(Editing menu)
· The <SEQ> LED will light.
· Items 1 and 2 of the menu items (1 to 3 in all) will appear on the LCD. You can scroll the menu items with the JOG dial, the 【△】 【▽】 keys or numeric keys.

② Press the 【3】 key to select [New].

```
C r e a t e   N e w   S e q u e n c e
       S u r e   ?
```

· A message requesting your confirmation on initializing the sequence execution memory will appear.
· If you press the 【ESC】 key, the initialize procedure will be aborted and the former menu will resume.

③ Press the 【ENTER】 key to enter into the initialize mode.

```
M o d e : N V
```

· This is for setting the sequence mode.
· Select the mode with the JOG dial or 【△】 【▽】 keys.
· Press the 【ENTER】 key to enter into the sequence mode.

④ Select the [NV] mode with the JOG dial and then press the 【ENTER】 key to select the [NV] mode.

```
M o d e : N V
U n i t : m s e c
```

· Select a step execution time unit for the [NV]or[NI] mode.For the [FV] or [FI] mode, this menu does not appear.
· Select the mode with the 【△】 【▽】 keys and press the 【ENTER】 key.

⑤ Select [msec] with the JOG dial and press the 【ENTER】 key.

```
M o d e : N V
   C o m p l e t e d.
```

· Initialize the sequence execution memory.

▼ At about 1 second later

```
> 3 :   N e w
   1 :   E d i t   P r o g r a m
```

· When the initialization is complete, the edit menu will resume.

⑥ Press the 【ESC】 key, and the initial sequence menu will resume.

(Initial sequence menu)

```
> 2 :   E d i t
   3 :   R u n
```

(Caution)   · If you initialize the sequence execution memory, the existing sequence file will be erased. If you need the existing file for future use, save it. For the save procedure, refer to [3] "To save or load a file."

[2] To edit sequences and programs

An example of editing a sequence execution file is introduced below.

■ Example of editing a program

① From the edit menu, select [Edit Program] by pressing the 【1】 key.

```
P r o g r a m : 0 1   N e w
0 0 0
```

· The figure of the bottom row denotes the total num-
ber of the steps in the program.
· You can check the contents of programs Nos. 1 thro-
ugh 16 with the JOG dial or 【△】 【▽】 keys.

② Press the 【ENTER】 key.

```
N 0 0 1
  N E W
```

· This message appears as there are no step parameters
in the program in this example.
· When there are step parameters, a program edit menu
will appear.

③ Press the 【ENTER】 key.

```
N 0 0 1
  > 1 :   M o d i f y
```

1: Modify -- To modify a program parameter or parame-
ters.
2: Insert -- To insert a program step or steps.
3: Delete -- To delete a program step or steps.
When creating a new program, you must specify the num-
ber of steps with [Insert].

④ Press the 【2】 key to select [Insert].

```
I n s e r t : 0 0 1
  H o w   m a n y   s t e p s ?     ■
```

· Enter the number of steps to be used by the program,
with the numeric keys.

⑤ Press the 【1】 key and then the 【ENTER】 key to secure an area for entry of one step.

```
I n s e r t   S t e p s
  C o m p l e t e d .
```

```
N 0 0 1   S   0 . 0 ■ V
    · · ·                 0 0 1 m s
```

(Display for program edit)
· The cursor (■) will blink on the character.
· Entry method

       Numeric value -- Numeric keys, 【ENTER】
                      JOG dial
       To move on items -- 【◁】 【▷】 keys
       To move on steps -- 【△】 【▽】 keys

```
N 0 0 1   S   0 . 0 0 V
    · · ·                 0 0 1 m s
```

· Settings of S/R for step change, TRIG, OUT, or
PAUSE can be done also by using the 【1】 or 【0】
key.

The items shown on the program edit display are as follows:

```
┌─ Step No. (N: Normal speed, F: Fast speed)
│      ┌─ Voltage change (S: Step change, R: Ramp change) ─┐
│      │                                                    ├─ When in C.V mode
│      │  ┌─ Output voltage                                 ┘
│      │  │
│      │  │        ┌─ Current change
│      │  │        │  (S: Step change, R: Ramp change)─┐
│      │  │        │                                    ├─When in C.C mode
│      │  │        │     ┌───── Output current          ┘
┌──────────────────────────────────┐
│ N 0 0 1   S   3.  4 5 V   R   1.  2 5 A │
│ ? ? ?         T O P         0 1 2 3 m s │
└──────────────────────────────────┘
│          │              └── Execution time (when in NV or NI mode)
│          └── Trigger, output, or pause setting (T: Trigger, O: Output on, P: Pause)
└── Annunciation for trigger, output, or pause setting
```
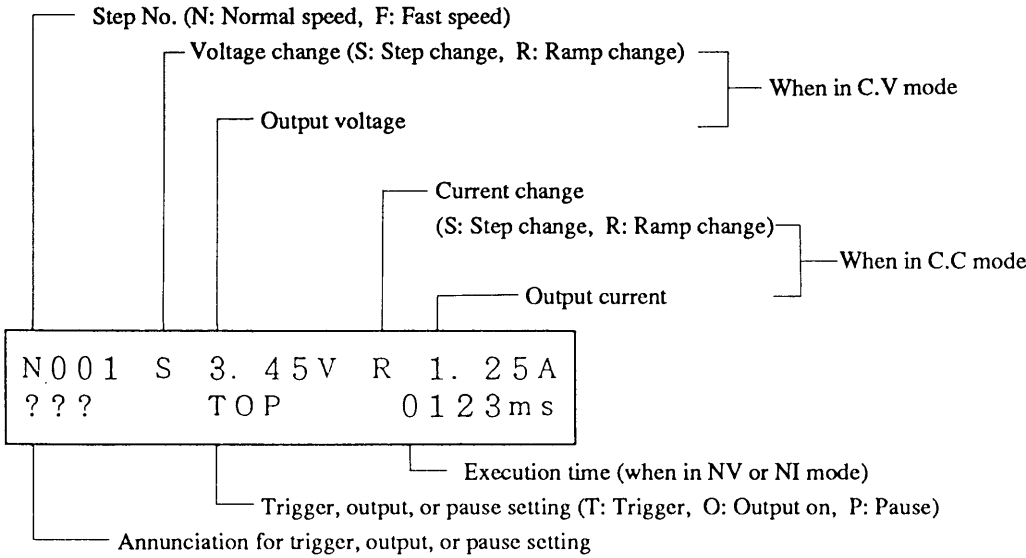
⑥ Press the 【ESC】 key.

```
┌──────────────────────┐
│ N 0 0 1   S   0 . 0 0 V │
│         · O ·     0 0 5 0 m s │
└──────────────────────┘
```

· The cursor disappears from the program edit display.
· When in this state, you can check the steps of the program with the JOG dial or 【△】 【▽】 keys. If you specify the step which immediately follows the final step, message [EOS] (End of Step) will appear.

⑦ Edit other programs also in the same procedure as Steps ① to ⑥.

```
┌──────────────────────┐
│ N 0 0 1   S   0 . 0 0 V │
│         T O ·     0 0 1 0 m s │
└──────────────────────┘
```

· This display example is for edit of Step No. 1 of Program 2.

```
┌──────────────────────┐
│ N 0 0 2   R   1 5 . 0 0 V │
│         · O ·     0 0 2 0 m s │
└──────────────────────┘
```

· This display example is for edit of Step No. 2 of Program 2.

```
┌──────────────────────┐
│ N 0 0 3   S   1 5 . 0 0 V │
│         · O ·     0 0 3 0 m s │
└──────────────────────┘
```

· This display example is for edit of Step No. 3 of Program 2

```
┌──────────────────────┐
│ N 0 0 4   S   1 0 . 0 0 V │
│         · O ·     0 0 4 0 m s │
└──────────────────────┘
```

· This display example is for edit of Step No. 4 of Program 2.

```
┌──────────────────────┐
│ N 0 0 5   R - 1 0 . 0 0 V │
│         · O ·     0 0 5 0 m s │
└──────────────────────┘
```

· This display example is for setting of Step No. 5 of Program 2.

```
N 0 0 1   S - 1 0 . 0 0
              · 0 ·         0 0 3 0 m s
```

· This display example is for edit of Step No. 1 of Program 3.

```
N 0 0 2   R  1 0 . 0 0 V
              · 0 ·         0 0 2 0 m s
```

· This display example is for edit of Step No. 2 of Program 3.

```
N 0 0 3   S  1 0 . 0 0 V
              · 0 ·         0 0 3 0 m s
```

· This display example is for edit of Step No. 3 of Program 3.

```
N 0 0 4   S - 1 0 . 0 0 V
              · 0 ·         0 0 3 0 m s
```

· This display example is for edit of Step No. 4 of Program 3.

```
N 0 0 1   S    0 . 0 0 V
              · · ·         0 0 0 1 m s
```

· This display example is for edit of Step No. 1 of Program 16.

⑧ Press the 【ESC】 key thrice to return to the initial sequence menu.

```
> 2 : E d i t
  3 : R u n
```

■ Example of sequence edit

① When the initial sequence menu is on the LCD, press the 〖EDIT〗 key and the 〖2〗 key in this order.

```
S : 1   P 0 1   L 0 0 0 1   N e w
C *   E * *
```

- You can check the contents of sequences Nos. 1 through 8 with the JOG dial or 〖△〗 〖▽〗 keys.

②Press the 〖ENTER〗 key.

```
S : 1   P 0 ■   L 0 0 0 1
C *   E * *
```

```
S : 1   P 0 1   L 0 0 0 1
C 2   E 1 6
```

(Sequence edit display)
- Cursor ■ will blink on the character.
- Entry procedure
  Numeric entry: With numeric keys and 〖ENTER〗 key, or with JOG dial
  Item change : With 〖◁〗 〖▷〗 keys.
- The asterisk (*) of the end program and that of the chain command mean that the indicated item is not executed.
- The number of loops "9999" means infinitive repetitions.
- To escape from the edit mode, press the 〖ESC〗 key.

③ Changing the sequence numbers, edit the contents of sequences by using the 〖ESC〗 key, JOG dial, and 〖ENTER〗 key.

```
S : 2   P 0 2   L 0 0 0 2
C 3   E 1 6
```

- The examples of displays shown are for edit of Sequences Nos. 2 and 3.
- Sequence No. 2 is to loop Program 2 twice and then chain it to Sequence No. 3.

```
S : 3   P 0 3   L 0 0 0 1
C *   E 1 6
```

- Sequence No. 3 is to loop Program 3 once and finally execute the first step alone of Program 16 to stop. There is no chain.

The items shown on the sequence edit display are as follows:

```
┌─── Sequence No.
│   ┌─── Program No.
│   │   ┌─── Number of loops
│   │   │   ┌─── Comments
│   │   │   │
S : 1   P * *   L 0 0 0 0   N e w
C *   E * *           0 . 1 m s
│   │           │
│   │           └─ Execution time (when in FV or FI mode)
│   └─────────── End program No.
└─── Program to be chained
```
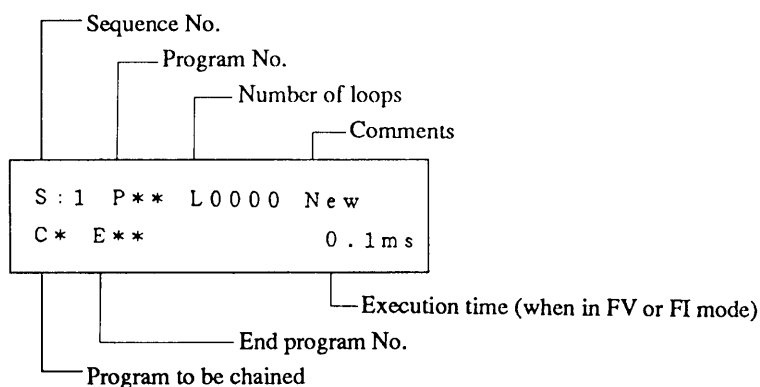
④ Press the 〖ESC〗 key twice, and the edit menu will resume.

```
> 2 :   E d i t   S e q u e n c e
  3 :   N e w   S e q u e n c e
```

- The sequence edit procedure is complete.

■ Example of procedure to add or delete steps

① Press the 【1】 key when the edit menu is shown on the LCD.

```
Program: 01  A
002
```

- The columns following [A] of the top row are for entry of comments. You can enter comments via GPIB or other bus interface.
- The figure on the bottom row indicates the total number of the steps of the program.

② Press the 【ENTER】 key.

```
N001  S  0.00V
        ...      0001ms
```

(Program edit display)
- You can check the contents of the steps with the JOG /SHUTTLE dials or 【△】 【▽】 keys.

③ Press the 【ENTER】 key.

```
N001  S  0.00V
    >1:  Modify
```

Select one of the following:
1: Modify
2: Insert
3: Delete

④ Press the 【3】 key to select [Delete].

```
Delete: 001
How many  steps?
```

(To delete steps)
- Enter the number of steps to be deleted, with the numeric keys.
- The specified number of steps, starting by the currently displayed step, will be deleted.

⑤ Press the 【1】 key and then the 【ENTER】 key to delete the steps.

```
Delete  Step
  Completed.
```

▼ At about 1 second later

```
N001  S  0.00V
        •0•      0001ms
```

- In this example, step 1 has been deleted and step 2 has become step 1.

⑥ Press the 【ESC】, 【ENTER】 and 【2】 keys to select [Insert].

(To insert steps)

```
Insert: 001
  How many  steps?
```

⑦ Press the 【2】 key and then the 【ENTER】 key.

```
Insert  Step
  Completed.
```

· Specify the number of steps to be inserted (two in this example).

```
N001  S  0.0■V  S  5.00A
    ·0·          0001ms
```

· In this example, two steps have been inserted.
· Data of the steps to be inserted is undefined yet.
· After the [Insert] mode is over, the [Modify] mode will resume.

(NOTE)
· *Repeating the above procedure, enter the sequences and programs as written on the coding sheets.*
· *After the entry is over, check the contents of entry by using the sequence display menu and program display menu.*
· *You may directly call out the edit menu by pressing the* 【EDIT】 *key when the root display is shown on the LCD.*

[3] To save or load a file

The sequence execution memory is volatile and its contents are lost if you turn OFF the POWER switch of the power supply. To keep the memory contents (sequence files), you must store them in the nonvolatile memory of the power supply. This section gives examples of procedures to save, load, a file.

■ Example of procedure to save a file

① When the initial sequence menu is displayed, press the 【1】 key and then the 【3】 key.

```
S a v e : 0 0 0
N V     S t e p : 0 0 0 2
```

· Specify the file number of the file to be saved, with the JOG dial or 【△】 【▽】 keys.
· The bottom row shows major information about the file already saved.

② Press the 【ENTER】 key.

```
S a v e : 0 0 0
   C o m p l e t e d.
```

· The sequence file has been saved.

▼ At about 1 second later

```
> 3 :   S a v e   F i l e
  4 :
```

· After the file saving is complete, the file management menu will resume.

■ Example of procedure to load a file

① When the file management menu is displayed, press the 【2】 key.

```
Load:000
NV   Step:0002
```

- Specify the file number of the file to be loaded, with the JOG dial or 【△】 【▽】 keys.
- The bottom row shows major information about the file saved already.

② Press the 【ENTER】 key.

```
Load  File
  Completed.
```

- The sequence operation file has been loaded onto the sequence execution memory.

▼ At about 1 second later

```
>2:  Load  File
 3:  Save  File
```

- After the file loading is complete, the file management menu will resume.

[4] To select the trigger in/out direction and auto-run function

This section introduces the procedures for setting a trigger input/output direction and the auto-run mode of sequence operation.

■ Example of procedure for trigger input/output setting

① When the initial sequence menu is displayed, press the 【4】 key and then the 【1】 key.

```
>1:  TRIG  Direction
   >1:<In>
```

· Select the required item with the JOG dial or 【△】 【▽】 keys.

② Press the 【△】 key and 【ENTER】 key. (Instead, you may directly select the required item by press ing the numeric key corresponding to the item number.)

```
Trigger  Direction
Out
```

· In this example, the output direction is selected for the trigger.

▼ At about 1 second later

```
>1:  TRIG  Direction
2:  Auto  Run
```

· After the setting is over, the configuration menu will resume.

③ Press the 【ESC】 key.

```
>4:  Configuration
1:  File
```

· The initial sequence menu will resume.

(NOTE)
· If you set the [TRIG Direction] to [OUT], the trigger setting in the step is enabled and the power supply will deliver a trigger output signal through the TRIG I/O terminal of the front sub-panel.
· If you set the [TRIG Direction] to [IN], triggering with an external signal applied through the TRIG I/O terminal of the front sub-panel for terminating the PAUSE state is enabled.
· The Trigger OUT function is applicable to all of the [NV], [NI], [FV], and [FI] modes. The Trigger IN function is applicable only to the [NV] and [NI] modes.

■ Example of setting procedure for auto-run

The auto-run function is such that, when the POWER switch is turned on, the power supply automatically executes the sequence [#01].

① When the initial sequence menu is displayed, press the [4] key and then the [2] key.

```
> 2 :  A u t o   R u n
    > 1 : < O F F >
```

· Select the required item with the JOG dial or [△] [▽] keys.

② Press the [△] key and then the [ENTER] key. (Instead, you may directly select the item by pressing the numeric key corresponding to the item number.)

```
A u t o   R u n
  O N
```

▼ At about 1 second later

```
> 2 :  A u t o   R u n
  1 :  T R I G   D i r e c t i o n
```

· After the setting is over, the configuration menu will resume.

③ Press the [ESC] key.

```
> 1 :  F i l e
  2 :  E d i t
```

· The initial sequence menu will resume.

(Caution)

· Be careful when using the Auto Run function. Althoughit is a very convenient function, it involves a danger. Should you inadvertently turn ON the POWER switch by forgetting that the power supply has been set to the Auto Run, the power supply will immediately deliver its output at the instant you have turned it on.

· Even when the [Auto Run] function has been set to [ON], the function can be disabled by pressing the [SHIFT] + [ENTER] keys when the initial power-on display is shown on the LCD.

[5] Run, end, and pause of sequences and programs

■ Example of procedure for program run

① As you press the 【RUN】 key when the program number is displayed, the program will be executed once.
Press the 【EDIT】 key and then the 【1】 key in this order.

```
Program:01  A
002
```

(Program number display)
· Specify a program number with the JOG dial or 【△】 【▽】 keys.

② Press the 【RUN】 key.

```
OUT    0.000V    0.00A
RU  S1, P01, L0002    2
```

(Display during sequence operation)

──────────

Caution · *When in the [NV] or [NI] mode, operation proceeds with the time parameter specified in the step; when in the [FV] or [FI] mode, the execution time is automatically fixed at approximately 100ms per program.*

■ Example of procedure for sequence run

An example of procedure for running a sequence operation is shown below.

① When the initial sequence menu is displayed, press the 【3】 key.

```
S:1  P01  L0001
C2  E16
```

(Run menu)
· Specify the sequence number of the sequence to be executed, with the JOG dial or 【△】 【▽】 keys.
· Instead of the above, you may directly call out the run menu by pressing the 【RUN】 key when the root display is shown on the LCD.

② Press the 【RUN】 key.

```
OUT    0.000V    0.00A
RU  S1, P01, L0002    2
```

(Display during sequence operation)
· Instead, you may directly specify the sequence number with the numeric keys.

③ To pause the sequence operation, press the 【PAUSE】 key.

```
OUT    0.000V    0.00A
PA  S1, P01, L0002    3
```

(Display of paused sequence operation)
· The [FV] and [FI] modes of operation cannot be paused.

④ To resume the sequence operation, press the [PAUSE] key again.

```
OUT     0.000V      0.00A
RU  S1, P01, L0002, 0002
```

⑤ To stop the sequence operation forcibly, press the [STOP] key.

```
S:1  P01  L0001
C2  E16
```

(Run menu)
· The forcible stop is effective even when in pause.

(NOTE) · *The power supply asynchronously accepts the command given from the [PAUSE] key. When it is released from the pause state, it advances to the next step after executing the operation for the remaining period of the step currently executed.*
· *You can call out the run menu by pressing the [RUN] key when the root display is shown on the LCD.*

(Caution) · *During the sequence operation, the software V limit level and software I limit level which existed immediately before entering the sequence operation remain effective.*

⑥ The items displayed during the sequence operation are as follows:

```
OUT     0.000V      0.00A
PA  S1, P01, L0002, 0003
```

· The top row indicates the actual output.

Step number (currently executed)
Number of remaining loops
Program number (currently executed)
Sequence number (currently executed)
Annunciation of run (RU) or pause (PA) (RU : RUN, PA : PAUSE)
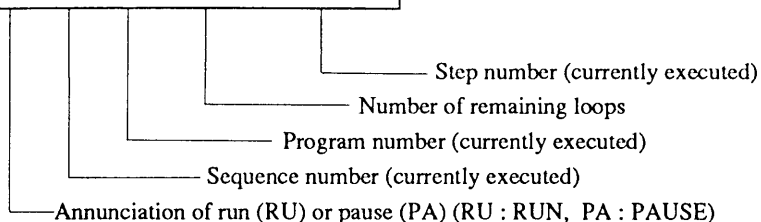
MEMO

3.5 Applied Types of Operation

3.5.1 Configuration

The parameters and other selectable items of operation of the power supply can be configured to best suit the purpose and conditions of use of the power supply. The established configuration can be saved in the nonvolatile memory of the power supply and be loaded when the POWER switch is turned on.

As you press the [SHIFT] + [0] CONFIG keys, the configuration menu will appear. The menu allows you to enter the various settings and selections.

For the [Calibration] which appears as one of the selectable items on the configuration menu, refer to Section 6.2 "Calibration."

Structure and Functions of Configuration Menu

Configuration Menu

  1: [Local/Remote] :   Menu to select the local control or the remote control with an external analog signal.

      1: [Local] :   The output voltage (or current) is locally controlled from the front panel.

      2: [From J2] :   The output voltage (or current) is remote-controlled by an external signal aplied via connector J2 on the rear panel.

      3: [From BNC] :   The output voltage (or current) is remote-controlled by an external signal aplied via EXT SIG IN (BNC) connector on the front sub-panel.

      4: [From J2 and BNC] :   The output voltage (or current) is remote-controlled with an external analog signal aplied via the J2 connector on the rear panel and the BNC connector on the front sub-panel.

  2: [Start Up] :   Start up menu

      1: [CV/CC] :   To select [CV or CC] when starting up the power supply.

          1: [CV] :   To start up in the C.V mode.

          2: [CC] :   To start up in the C.C mode.

      2: [Output] :   To turn ON or OFF the [OUTPUT] key when the power supply is started up.

          1: [OFF] :   The [OUTPUT] key is OFF.

          2: [ON] :   The [OUTPUT] key is ON.

      3: [Key Lock] :   To lock or unlock the keys when the power supply is started up.

          1: [OFF] :   Unlock the keys.

          2: [ON] :   Lock the keys.

  3: NULL

  4: NULL

  5: [Auto Fine] :   Auto Fine menu

      1: [CV Auto Fine] :   ON/OFF setting of CV Auto Fine

          1: [OFF]

          2: [ON]

      2: [CC Auto Fine] :   ON/OFF setting of CC Auto Fine

          1: [OFF]

          2: [ON]

6: [Auto Protection] :   To select an auto-protection level for V Limit (or I Limit)

   1: 110% V Limit (110% I Limit)

   2: 120% V Limit (120% I Limit)

   3: 130% V Limit (130% I Limit)

8: [Interface] :   Interface board setting menu

   1: [GPIB Address] :   For GPIB address setting

   2: [MCB Address] :   For MCB bus address setting

   3: [RS-232C Speed] :   For transmission speed selection

      1: [9600 bps]

      2: [4800 bps]

      3: [2400 bps]

      4: [1200 bps]

   4: [RS-232C Data bit] :   For data bit size selection

      1: [8 bits]

      2: [7 bits]

   5: [RS-232C Stop bit] :   For stop bit size selection

      1: [1 bit]

      2: [1.5 bits]

      3: [2 bits]

   6: [RS-232C Parity] :   For parity bit selection

      1: [None]

      2: [Odd]

      3: [Even]

   7: [Power-on SRQ] :   For power-on service request selection

      1: [Disable]

      2: [Enable]

9: [Calibration] :   Calibration menu (Setting for calbration is necessary.)

   1: [Voltage] :   For voltage calibration

      Voltage offset calibration (manual)

      "+" full-scale voltage calibration (manual)

      "-" full-scale voltage calibration (manual)

      Software (hardware) V Limit offset calibration (auto)

      Software (hardware) V Limit full-scale calibration (auto)

      RMS display offset calibration (auto)

      RMS display full-scale calibration (auto)

   2: [Current] :   For current calibration

      Current offset calibration (manual)

      "+" full-scale current calibration (manual)

      "-" full-scale current calibration (auto)

      Software (hardware) I Limit offset calibration (auto)

      Software (hardware) I Limit full-scale calibration (auto)

[1] Remote control with an external analog signal

The output voltage or current of the power supply can be remote-controlled with an external analog signal (a voltage signal of 0 to approximately ±10V or a resistance signal of 0 to approximately 10kΩ).

■Example of procedure for remote control with an external analog signal

① Make certain that the output is OFF. Press the [SHIFT] + [0] CONFIG keys.

```
>1:   Local/Remote
 2:   Start Up
```

(Configuration menu)
· Items 1 and 2 among (of the total configuration menu items 1 through 9) will appear.

② Press the [1] key to select [Local/Remote].

```
>1:   Local/Remote
   >1:<Local>
```

(Controlled item select menu)
· The item enclosed in <> is the currently selected item.

③ Press the [2] key to select [From J2].

```
Ext.   Local/Remote
 From  J2
```

· The remote control mode has been selected.

▼ At about 1 second later

```
>1:   Local/Remote
 2:   Start Up
```

· After the mode has been selected, the configuration menu will resume.

④ Press the [ESC] key.

```
OUT     0.000V      0.00A
```

· The root display will resume.

(NOTE)
· If you are not going to use the remote control with an external analog signal, select [Local].
· The [From J2] mode is to remote-control the output voltage when in the C.V mode or the output current when in the C.C mode, with an external analog control signal applied via the remote control connector (J2) on the rear panel. For the external control signal, you may use a voltage signal or a resistance signal.
· The [From BNC] mode is to remote-control the output voltage when in the C.V mode or the output current when in the C.C mode, with an external analog control signal applied via the EXT SIG IN terminal on the front sub-panel. For the external control signal, you must use a voltage signal.
· The [From J2 & BNC] mode is to remote control the output voltage when in the C.V mode or the output current when in the C.C mode, by adding the output component controlled by an external analog control signal applied via the remote control connector (J2) on the rear panel and that via the EXT SIG IN terminal on the front sub-panel.
· When in the [From BNC] or [From J2 & BNC] mode of remote control operation with an external signal applied via the EXT SIG IN terminal on the front panel, the output amplitude can be set with the [AMPL] key. (Refer to Section 3.5.3"Amplitude Setting Function.")
· For the external analog control signal connection methods and specifications, refer to Section 3.5.2 "Analog Remote Control" and Chapter 7 "Specifications."

(Caution)
· At the instant the remote control with an external analog signal is selected, the local setting of the output voltage (or current) from the front panel is automatically becomes 0V (or 0A).
· You cannot select the remote control with an external analog signal when the output is ON.

[2] Settings of Power-on parameters

This section describes the setting procedures of parameters and other items the power supply should assume when its power is turned on.

CV/CC

To specify either the power supply should operate in the C.V mode or in the C.C mode when its power is turned on.

[CV] : To operate in the C.V mode
[CC] : To operate in the C.C mode

(WARNINGS) · *This setting is very important for this power supply which is a bi-polar type. Of a conventional uni-polar power supply, modes are automatically switched over between C.V and C.C. For this bi-polar power supply, on the contrary, you must select either the C.V mode or the C.C mode manually--they are not automatically switched over between them.*

· *When in the C.V mode, the current limit value can be set as an I Limit value; when in the C.C mode, the voltage limit value can be set as a V Limit value.(They can be set as protection menu items.)*

(WARNINGS) · *Before changing between the C.V mode and the C.C mode, be sure to disconnect the load from the power supply for the sake of safety.*

(NOTE) · *The factory default for the CV/CC setting is [CV].*

OUTPUT switch

To select ON or OFF for the output switch when the power supply is turned on.
[OFF]: The output is OFF when at power-on.
[ON] : The output is ON when at power-on.

(NOTE) · *The factory-default is [OFF].*

KEYLOCK

To specify either the keys are to be locked or not when the power supply is at power-on.
Even when the power supply has been started with KEYLOCK, the keys can be unlocked by pressing again the [SHIFT] + [1] KEYLOCK keys.

(NOTE) · *The factory-default is [UNLOCK].*

■ **Example of procedure for power-on setting (C.V or C.C)**

① Press the 【SHIFT】 + 【0】 (CONFIG) keys and then the 【2】 key in this order.

```
>1 :   C V / C C
  2 :   O U T P U T
```

(Start up menu)
• Items 1 and 2 (of total menu items 1 through 3) are displayed.

② Press the 【1】 key to select [CV/CC].

```
>1 :   C V / C C
    >1 : < C V >
```

• The item enclosed in <> is the currently selected item.

③ Press the 【2】 key to select [CC].

```
P o w e r - o n   C V / C C
  C C
```

▼ At about 1 second later

```
>1 :   C V / C C
  2 :   O u t p u t
```

• After the setting is over, the start up menu will resume.
• The supply hereafter will operate in the [CC] mode when at power-on.

④ Turn OFF the POWER switch once. Turn ON the POWER switch again.

```
O U T      0 . 0 0 1 V      0 . 0 1 A
```

• The <CC> LED will illuminate to indicate that the power supply is in the C.C mode.

(*Caution*)

• *Change of modes between C.V and C.C is not effected until the next power-on event. So, when you have changed the mode setting between C.V and C.C, be sure to turn OFF once the POWER switch and then turn it ON again.*

Example of procedure for power-on setting (Output ON/OFF)

① Press the 【SHIFT】 + 【0】 CONFIG keys and the 【2】 key in this order.

```
>1:  CV/CC
  2:  OUTPUT
```

(Start up menu)
• Item 1 and 2 (of total menu items 1 through 3) are displayed.

② Press the 【2】 key to select [OUTPUT].

```
>2:  OUTPUT
   >1:<Off>
```

• The item enclosed in < > is the currently selected item.

③ Press the 【2】 key to select [ON].

```
Power-ON  Output
 On
```

▼   At about 1 second later

```
>2:  Output
  3:  Key Lock
```

• After the setting is over, the start up menu will resume.
• The supply hereafter will operate with its output ON when at power-on.

④ Press the 【ESC】 key.

```
OUT    0.000V      0.00A
```

• The root display will resume.

___Caution___ • *Be careful when using the Power-on Output function. Although it is a very convenient function, it involves a danger. Should you inadvertently turned ON the POWER switch forgetting that the power supply has been set to Power-on Output, the power supply will immediately deliver its output.*
• *Even when the Power-on Output function has been set to [ON], the function can be disabled by pressing the* 【SHIFT】 + 【ENTER】 *keys when the initial power-on display is shown on the LCD.*
• *In a similar procedure as above, you can set the [Key Lock] function shown in the start up menu.*

[3] Setting of Auto Fine

Auto Fine function is to automatically adjust the output to let it conform with the 1mV order of voltage setting or 1mA order of current setting.

Example of procedure for setting of Auto Fine

① Press the 【SHIFT】 + 【0】 CONFIG, and 【5】 keys in this order.

```
>1:  CV   Auto Fine
  2:  CC   Auto Fine
```

(Auto Fine menu)

② Press the 【1】 key.

```
>1: CV   Auto Fine
   >1: <OFF>
```

③ Press the 【2】 key to select the [ON].

```
CV   Auto Fine
   ON
```

▼   At about 1 second later

```
>1: CV   Auto Fine
    2: CC   Auto Fine
```

• After the formatting is over, the configuration menu will resume.

④ Press the 【ESC】 key twice.

```
OUT   0.000V      0.00A
```

• The root display will resume.

NOTE   • *When in the Auto Fine mode, software inside the instrument searches for values to make the actual voltage and current shown on the top row of the display are made equal with the set values. Due to this, a certain time (1.5 seconds maximum) is needed before the output voltage and current are settled at the set values.*

[4] Setting of auto-protect level in percentage

This section describes the setting procedure of an auto-protect level in terms of percentage for software V Limit (or software I Limit). For the percentage, you can select 110%, 120%, or 130% of the voltage (or current) setting which existed immediately before setting the auto-protect level.

Example of procedure for setting an auto-protect level (when in C.V mode)

① Press the 【SHIFT】 + 【0】 CONFIG keys and 【6】 key in this order.

```
>6: Auto Protection
   >1:<110%>
```

(Auto-protect menu)

② Press the 【2】 key to select [120%].

```
Auto Protection
   120%
```

▼   At about 1 second later

```
>6: Auto Protection
    7: Format MC
```

• After the setting is complete, the configuration menu will resume.

③ Press the 【ESC】key.

```
OUT    0.000V      0.00A


```

• The root display will resume.

NOTE
• *The auto-protect level can be set in terms of percentage of the voltage (or current) which has been set for the SET item. The allowable setting ranges for the software V Limit (or I Limit) is from 10% to 110% of the rated output voltage (or current).*
• *If you attempt to set for the auto-protect limit a value greater than 110% or less than 10% of the rated output voltage (or current), the power supply will automatically set it at 110% or 10%, respectively.*
• *The factory-default setting is 110%.*

[5] Setting the operation parameters for interface boards

This section describes the setting procedure of operation parameters of interface boards for GPIB, RS-232C, or MCB (multichannel bus). When using an interface board through which to control the power supply, you must set an address for the board.

Caution • *When you have changed any of the parameters, be sure to turn OFF once the POWER switch and then turn it on again.*

Example of procedure to set operation parameters of GPIB interface board

① Press the 【SHIFT】 + 【0】 CONFIG keys and then the 【8】 key in this order.

```
>1: GPIB Address
 2: MCB  Address
```
(Interface board parameter setting menu)

② Press the 【1】 key to select [GPIB Address].

```
GPIB Address
        01
```
• The bottom row shows the currently ADDRESS 01 existing address number.

③ Type a new address number with the numeric entry keys and then press the 【ENTER】 key.

```
GPIB Address
        03
```
• In this example, the address number is set to 3.

④ Press the 【ESC】 key twice.

```
OUT   0.000V    0.00A
```
• The root display will resume.

NOTE • *For an RS-232C or MCB interface board also, specify an address number in the same procedure as above.*
• *For the factory-default for address setting, refer to Chapter 4 "REMOTE PROGRAMMING."*

3.5.2 Analog Remote Control

[1] Analog Remote Control Connector (J2)

The analog remote control connector (J2) on the rear panel is for remote-control of the power supply with an external analog signal. To remote-control the output voltage (or current) with the signal applied via the J2 connector, you must select the corresponding mode on the configuration menu. (Refer to Section 3.5.1 "Configuration.")
Connector J2 is a 26-pin plug of MIL type. Its pin assignment is as shown on the below table. When using it, insert the pins (supplied) in the connector cover which is attached to the connector.

(As viewed from rear panel)
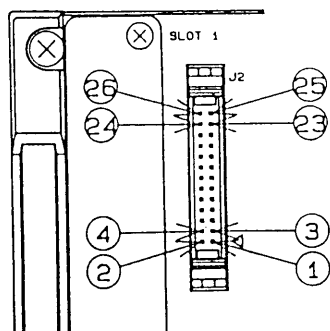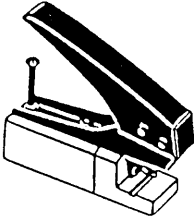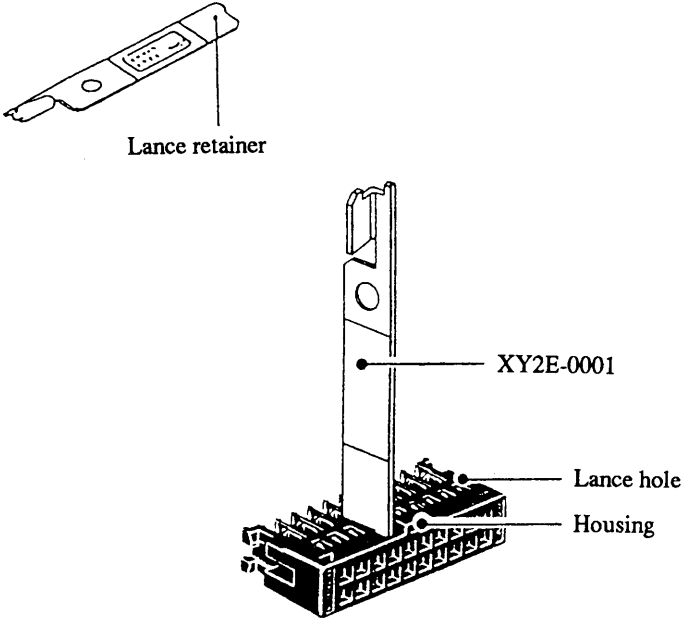
Pin Assignment of Analog Remote Control Connector (J2)

Pin No.	Signal	Pin No.	Signal
㉖	NO CONNECTION	㉕	+REFERENCE
㉔	ANALOG COMMON*	㉓	REMOTE CONTROL INPUT
㉒	NO CONNECTION	㉑	-REFERECE
⑳	NO CONNECTION	⑲	+REFERENCE
⑱	ANALOG COMMON*	⑰	NO CONNECTION
⑯	NO CONNECTION	⑮	-REFERENCE
⑭	NO CONNECTION	⑬	CV MONITOR*
⑫	ANALOG COMMON*	⑪	ANALOG COMMON*
⑩	OUTPUT ON/OFF	⑨	CC MONITOR*
⑧	CV MODE SIGNAL	⑦	POWER OFF
⑥	CC MODE SIGNAL	⑤	OPTION
④	OUTPUT ON SIGNAL	③	DIGITAL COMMON
②	ALARM SIGNAL	①	SIGNAL COMMON

∗ See the Caution below.

Caution
- *The analog common line is connected internally to the sensing common line. The common line of the monitor output signal and that of the control voltage signal are connected to the analog common line. Pay attention to this when grounding the output or other line.*
- *The digital common line is connected internally to the sensing common line. Lest the control circuits should be disturbed, make no external connections for the analog common line and sensing common line.*
- *Before making connection to the analog remote control connector, be certain that the POWER switch of the power supply is OFF.*
- *The signal common line is floating.*

Tools for press-connect terminals	Tool Remarks
XY2B-7006 Press-connect tool (OMRON Corp.)	• For the press-connect method, refer to the instrution sheet which accompanies the tool.
XY2E-0001 Contact Remover (OMRON Corp.)	• Remove the hood cover before using the tool. Lance retainer XY2E-0001 Lance hole Housing

<div style="text-align:center">(NOTE)</div> • *Kikusui Corporation does not distribute these tools. For these tools please contact a sales agent of OMRON Corporation.*

[2] Analog Remote Control of Output Voltage (or Current)

(Caution) · When in the analog remote control, the object of control differs depending on whether the power supply is in the C.V mode or the C.C mode. When in the C.V mode, the output voltage is remote-controlled; when in the C.C mode, the output current is remote-controlled.

■ Output control with an external voltage signal

You can remote-control the output voltage (or current) of the power supply with an external voltage signal of 0 to approximately ±10V. To do this, set the power supply to the remote-control state (state that its output can be controlled with an external analog signal). (Refer to Section 3.5.1 "Configuration.")

Connect one of the two wires of the control voltage signal to the analog common line.

$$Eo \fallingdotseq |Em| \cdot Ein / 10$$
$$(Io \fallingdotseq |Im| \cdot Ein / 10)$$

Eo: Output voltage (V)   (Io: Output current (A))
Em: Rated voltage (V)   (Im: Rated current (I))
Ein: Control voltage (V)
$0 \leqq Ein \leqq$ Approx. ±10V
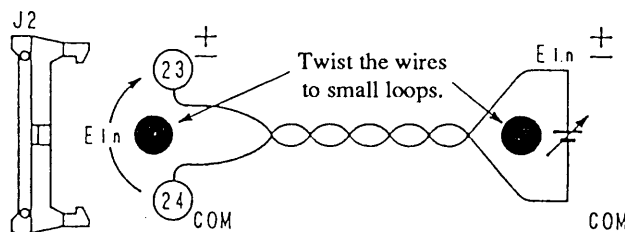
(Caution) · Connect one of the two wires of the Ein signal to the analog common line.
· The analog common line is connected to the sensing common line.
· For the sake of safety, use for Ein a voltage source which is isolated from the casing of the supply. (If it is connected to other potential, it may cause damage to the control circuit of the power supply.)

(NOTE) · The output voltage is the sum of the voltage corresponding to the signal applied via the analog remote control connector plus the voltage set locally from the front panel or remotely via the GPIB, RS-232C, or MCB interface. For example, assuming that the rated voltage of the power supply is ±40V, if Ein= – 1V is applied via the connector, a voltage of approximately - 4.0V will be added to the locally-set voltage. If the locally-set voltage is +20V, the output voltage (Eo) will be 20V + (–4V) = +16V. The above example is for output voltage control in the C.V mode. The same is applicable also for output current control in the C.C mode.
· The input impedance between pins ㉓ and ㉔ of the analog remote control connector is 1M Ω.
· For the control voltage signal (Ein), use a quality and stable voltage of less noise.
· When the external control voltage (Ein) circuit is made open, a noise of approximately 0.5% of the rated output may be superimposed on the output.

■ Output control with an external resistance signal (by using a 3-terminal variable resistor)

You can remote-control the output voltage (or current) of the power supply continuously variably from the "-" rated value to the "+" rated value by using a 10kΩ variable resistor.

To do this, set the power supply to the remote-control state (state that its output can be controlled with an external analog signal). (Refer to Section 3.5.1 "Configuration.")

$$Eo \doteq |\,Em\,| \cdot Ein / 10$$
$$(I\,o \doteq |\,I\,m\,| \cdot Ein / 10)$$

Eo : Output voltage (V)   (Io: Output current (A))
Em: Rated voltage (V)   (Im: Rated current (I))
Ein: Voltage between terminal ②of variable resis tor and analog common terminal (pin 23 of J2)
Approx. -10.8V ≦ Ein ≦ Approx. +10.8V
Rin: Resistance between terminals②and③of vari able resistor
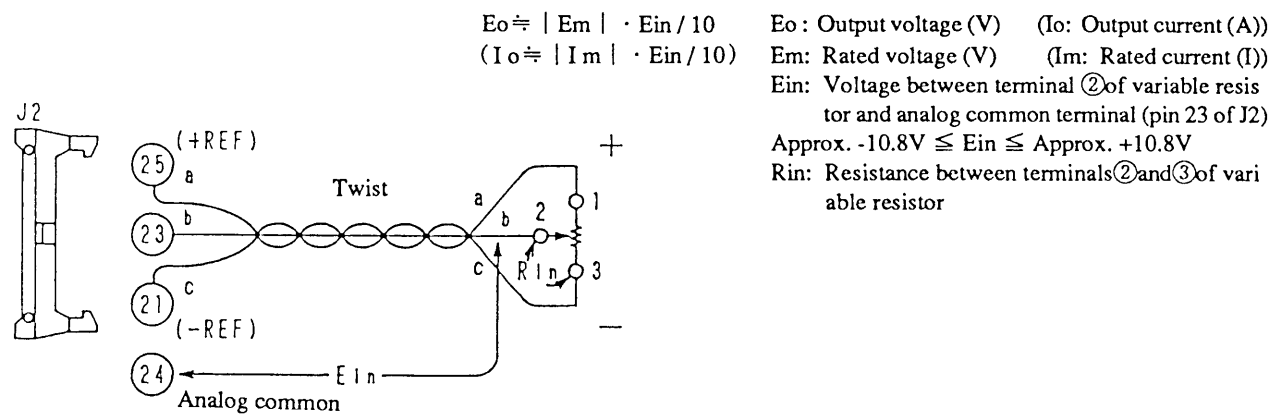
NOTE

- The relationship between Rin and Ein is 0Ω $\doteq$ -10.8V, 5kΩ $\doteq$ 0Ω, and 10kΩ $\doteq$ +10.8V. As you change Rin from 0Ω to 10kΩ, the output will change approximately from -108% to +108% of the rated output.

- If you want to change the range adjustable with the 10kΩ resistor to approximately -100% to +100% of the rated output, connect a series resistor Rx of approximately 250Ω (adjustable form 0Ω to approximately 800Ω) between pin㉕of J2 and terminal ① of the variable resistor and another identical resistor between pin㉕ of J2 and terminal ①of the variable resistor.

- The output is the sum of the output corresponding to the control signal applied via the analog remote control connector plus the output set locally from the front panel or remotely via the GPIB, RS-232C, or MCB interface. For example, assuming that the rated voltage of the supply is ±40V, if Ein= - 1V, a voltage of approximately -4.0V will be added to the locally-set output voltage. If the locally-set voltage is +20V, the output voltage (Eo) will be 20V + (-4V) = +16V.

- A current of approximately 2mA constantly flows through Rin and Rx. For resistors Rin and Rx, use metallic film resistors or wire wound resistors of ½W or more. The resistor should be a quality one, with good stability against temperature change and aging.

[3] ON/OFF control of output

The output of the power supply can be ON/OFF-controlled with an external contact signal. When the output is turned OFF by the external contact signal, the OUTPUT LED blinks. The external contact "make" is for output OFF.
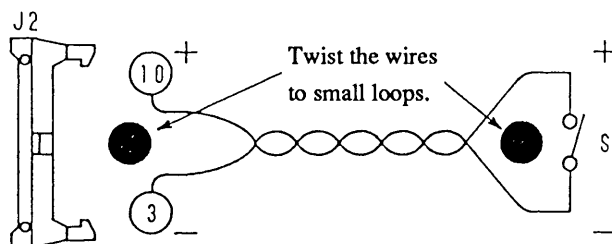
Terminal ⑩ is pulled up to +5V with a 10kΩ resistor within the power supply.
Terminal ③ is of the digital common line. (It is connected to the sensing common line within the power supply.)

NOTE · The output OFF command has a priority over the output OFF action. The output of the power supply is not turned ON unless the output signal fed from the front panel or via the interface board (GPIB, RS-232C, or MCB) and that fed via the analog remote control terminal are both for ON.
· The current that flows through the contact (switch S) is 0.5mA or less. The open-contact voltage is +5V DC.

[4] Turning OFF the POWER switch

The POWER switch of the power supply can be turned OFF with an external contact signal. The external contact "make" is for output OFF.
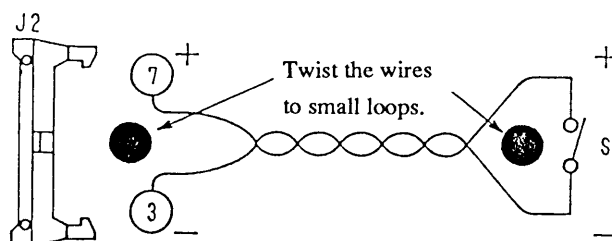
Terminal ⑦ is pulled up to +15V with a 12kΩ resistor within the power supply.
Terminal ③ is of the digital common line. (It is connected to the sensing common line within the power supply.)

NOTE · The current that flows through the contact (switch S) is approximately 1mA. The open-contact voltage is +15V DC.

[5] Voltage monitor and current monitor

Voltage Monitor

The power supply delivers a monitor signal of approximately 0V to approximately ±2V to represent the output voltage of 0V to the rated value.
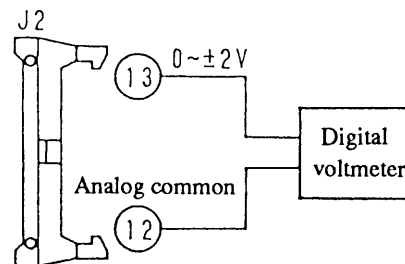
Current Monitor

The power supply delivers a monitor signal of approximately 0V to approximately ±2V to represent the output current of 0A to the rated value.
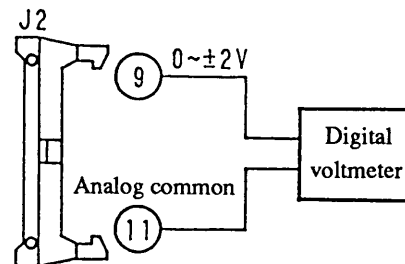
NOTE
- The monitor signals do not indicate waveforms.
- The common line terminals of the monitor signals are terminals ⑪ and ⑫. They are connected to the sensing common line.

[6] Status output signals

The power supply delivers its status signals as mentioned below. The signals are isolated from the power supply by photocouplers.

Pin assignment of remote control connector J2 on rear panel

- ⑥ C.C mode signal
- ⑧ C.V mode signal
- ④ Output ON signal
- ② Alarm signal
- ① Signal common (floating)
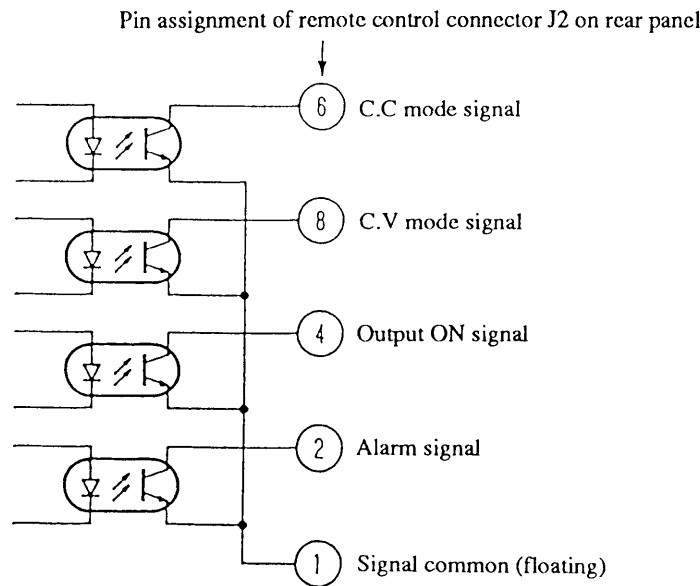
Description of signals

C.C mode signal ·········ON when power supply is in C.C mode
C.V mode signal ·········ON when power supply is in C.V mode
Output ON signal·········ON when the output is ON
Alarm signal··············ON when OVP or OHP has tripped
Signal common ·········Common line of the above signals

NOTE · *If the OVP trips when the power supply is set to power-OFF or crowbar-ON, the alarm signal is turned ON for only approximately 50ms following the trip.*

· *The photocouplers are Toshiba TLP521-1 or equivalent.*

(Ta = 25℃)

Item		Symbol	TLP521-1	Unit
Detector side	Collector-emitter voltage	V_{CEO}	55	V
	Emitter-collector voltage	V_{ECO}	7	V
	Collector current	I_c	50	mA
	Collector power dissipation (per circuit)	P_c	150	mW
	Collector power dissipation reduction (Ta=25 ℃ up) (per circuit)	$\Delta P_c/℃$	-1.5	mW/℃
Operating temperature		Topr	-55 to 100	℃
Storage temperature		Tstr	-55 to 125	℃
Allowable loss (per circuit)		Pt	250	mW
Allowable-loss reduction (Ta=25℃ up) (per circuit)		$\Delta Pt/℃$	-2.5	mW/℃
Withstanding voltage (Note 1)		BVs	2500	Vrms

Note 1: AC, for 1 minute, relative humidity 40% to 60%

3.5.3 Amplitude Setting Function

When you have selected the <From BNC> or <From J2 & BNC> from the [Local/Remote] configuration menu, you can set an amplitude factor for the external voltage signal applied via the EXT SIG IN terminal on the front sub-panel. This function allows you to change the output voltage (or current) level (amplitude) without changing the input signal level (amplitude). The amplitude factor is adjustable within a range of 0% to 100%. The factory-default setting is 0%. Press the 【AMPL】 key, and set the amplitude factor for with the JOG/SHUTTLE dials or the numeric keys.

This function is effective when the power supply is used as a power booster (increasing output current capacity of an oscillator), a external voltage controlled current source that can obtain output current in proportion to output waveform of an oscillator for any kind of load and so on.

When in the C.V mode of operation, the output voltage is expressed as follows (The output current is depended on a load):

$$\text{Output voltage} = \frac{Vin}{\text{Approx. +10V}} \times \text{Rated output voltage} \times \frac{AMPL}{100}$$

$$+(\text{Setting from front paenl} + \text{Input from J2} \times \text{Gain})$$

Where, Vin : External control voltage signal applied
via EXT SIG IN terminal.
AMPL : Amplitude factor (%)
Gain : Refer to table of the next page.

When in the C.C mode of operation, the output current is expressed as follows (The output voltage is depended on a load):

$$\text{Output current} = \frac{Vin}{\text{Approx. +10V}} \times \text{Rated output current} \times \frac{AMPL}{100}$$

$$+(\text{Setting from front paenl} + \text{Input from J2} \times \text{Conductance})$$

Where, Vin : External control voltage signal applied
via EXT SIG IN terminal
AMPL : Amplitude factor (%)
Conductance : Refer to table of the next page.

Input from J2, Refer to Section 3.5.2 [2] "Analog Remote Control of Output Voltage (or Current).

A block diagram of the amplitude setting circuit
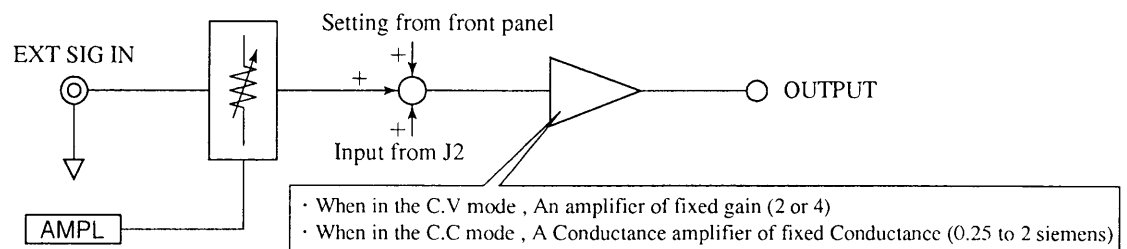
Example of amplitude setting

For example, if you apply an external control voltage signal of +10V and set the amplitude factor at 100%, the power supply will deliver its rated output.
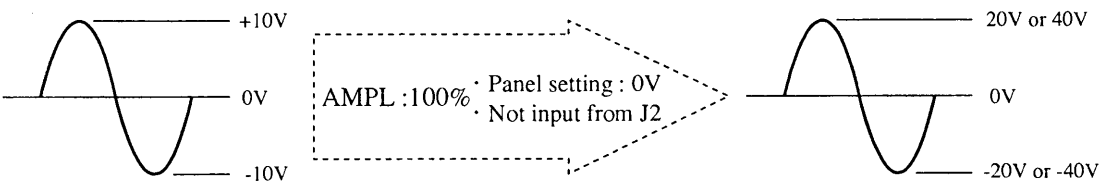
When in the C.V mode, an amplifier (voltage output to voltage input) which has a gain of 2 or 4.

When in the C.C mode, a conductance amplifier (current output to voltage input) which has a conductance of 0.25 to 2 siemens.

Relationship of input voltage and output voltage (or output current) is as shown on the right table.

	C.V mode	C.C mode
	Gain	Conductance (siemens)
PBX20-5	2	0.5
PBX20-10	2	1.0
PBX20-20	2	2.0
PBX40-2.5	4	0.25
PBX40-5	4	0.5
PBX40-10	4	1.0

NOTE
- *The amplitude factor is displayed in a percentage unit of down to 0.1%. The actual resolution, however, is 1/256 (≒0.4%).*
- *The frequency response changes with setting of the Rise/Fall time. Refer to Section 3.5.6 " Setting the Rise/Fall Time and the frequency response for an external signal."*

Chapter 4.
REMOTE PROGRAMMING

This chapter describes the method to control the power supply remotely from a controller via an interface board (optional).

Contents   Page

You can remote-control the power supply from a personal computer or other controller via an optional interface board (refer to Section 7.4 "Optional Items"). This chapter explains commands that you may use for this type of remote control.

(*NOTE*)   · *For the installation method of the interface board, refer to its operation manual.*

Applicable Interface Boards

The remote-control commands introduced in this chapter are applicable to the following three types of interface boards:

> · IB11   : GPIB Interface Board
> · RS11   : RS-232C Interface Board
> · MC11S   : MCB (multi-channel bus) Interface Board

(*NOTE*)   · *As the command for the remote control status is given to the power supply via the interface, the power supply becomes the interface status. To return it to the local status, press the* [SHIFT] + [BS] *LOCAL keys.*
>   · *For the displays that appear when in the interface status, refer to Section 3.3.7 " Displaying the Interface Status."*

4.1 Initial Setting of Interface

4.1.1 GPIB Interface

[1] Setting the GPIB address

For the setting procedure of the GPIB address, refer to Section 3.5.1 "Configuration."

(NOTE)   • The factory-default for the GPIB address is "1".

[2] Setting the response message terminator (delimiter)

For the response message terminator, select one of the following:

* CRLF+EOI
* CR+EOI   CR   : Carriage Return
* LF+EOI   LF   : Line Feed
* EOI   EOI : End of Identify

The response message terminator can be set by using the TERM command. For data transaction between the controller and the IB11, it is necessary that their response message terminators mutually conform. If the terminators do not conform, data transaction between them may be unsuccessful. For the TERM command, refer to Section 4.3.2, [11] "System Commands."

(NOTE)   • The factory-defaults for the response message terminator is CRLF+EOI.

[3] Setting the Power-on SRQ

For the setting method of the Power-on SRQ (service request), refer to Section 3.5.1 "Configuration."

(NOTE)   • The factory-default for the Power-on SRQ is <Disable>.

4.1.2 RS-232C Interface

[1] Setting the RS-232C protocols

When you have selected the RS-232C, be sure to set the items mentioned below. For setting of these items, refer to Section 3.5.1 "Configuration." The figures enclosed in the parentheses are factory-defaults.

- Transfer rate (9600 bps)
- Data bit size (8 bits)
- Stop bit size (2 bits)
- Parity bit (none)

[2] Setting the response message terminator (delimiter)

For the response message terminator (delimiter), select one of the following:

- CRLF
- CR   CR   :   Carriage Return
- LF   LF   :   Line Feed
- None

The response message terminator can be set by using the TERM command. For data transaction between the controller and the RS11, it is necessary that their response message terminators mutually conform. If the terminators do not conform, data transaction between them may be unsuccessful. For the TERM command, refer to Section 4.3.2, [11] "System Commands."

NOTE   · *The factory-defaults for the response message terminator is* CRLF.

[3] Resetting to the local status

The power supply cannot be reset to the local status by a command given via the RS-232C interface. It must be reset locally from the front panel by pressing the [SHIFT] + [BS] LOCAL keys.

4.1.3 MCB Interface

[1] Setting the MCB device address

When you have selected the MCB, be sure to set the device address for it. For the setting procedure of the MCB device address, refer to Section 3.5.1 "Configuration."

(*Caution*) · *Set the device addresses as follows.*
  Master : 0 (fixed)
  Slaves : Any of 1 to 15

[2] Resetting to the local status

The power supply cannot be reset to the local status by a command given via the MCB interface. It must be reset locally from the front panel by pressing the [SHIFT] + [BS] LOCAL keys.

4.2 Programming Format

This section describes the structure of the general-type programming format.

For convenience of description, the following symbols are used in this chapter.

☐	: Required characters such as header and data
⌐⌐	: Data that may not be required depending on mode
⟨⟩	: Pronominal characters
()	: Characters for substitution
[]	: Unit characters
xxh	: Hexadecimal data

4.2.1 Commands

These are the commands that are fed from the GPIB controller or RS-232C terminal to the power supply.

[1] Program message

This command is to operate the power supply. It consists of a header and data, and is in a form of strings of ASCII code characters.
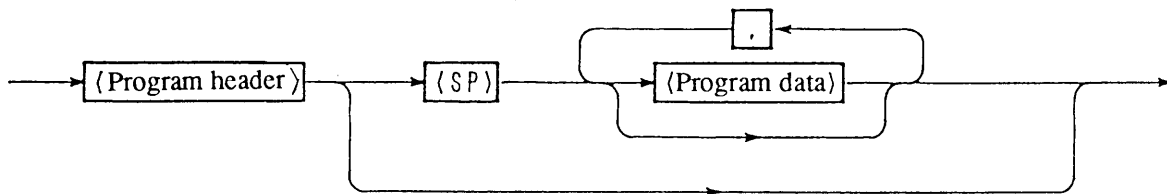
[2] Query message

This command is to obtain information from the power supply. It consists of a header (with a "?") and data, and is in a form of strings of ASCII code characters.

[3] Compound message

This message consists of two or more program messages and a query message.
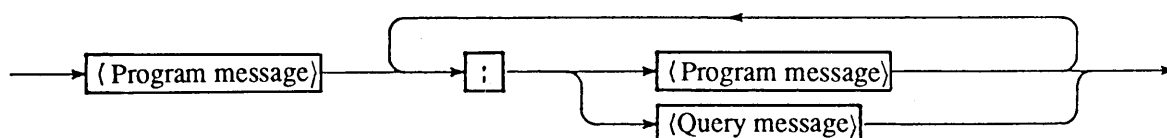
[4] Hold-off (GPIB)

By suffixing an "@"(40h) at the end of a program message or a query message, the GPIB can be held off until the execution of the message is complete. However, in the event of a command message terminator with only EOI, use "@@".

NOTE   • *The hold-off function is applicable to the GPIB interface board (IB11) only.*

4.2.2 Response Message

The response message is a message returned by the power supply to the GPIB controller or RS-232C terminal, in response to a query message.
The response message consists of a header and data, and is in the form of strings of ASCII code characters.
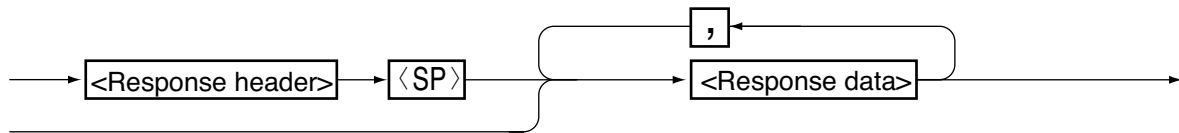
4.2.3 Acknowledge Message (RS-232C)

An acknowledge message corresponding to a program message is sent from the power supply to the RS-232C terminal, notifying that the processing for the program messsage is complete. The acknowledge message consists only of a header, and is in a form of strings of ASCII code characters.
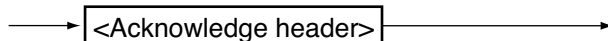
NOTE   • *The acknowledge message is applicable to the RS-232C interface board (RS11) only.*
           • *There are three types of acknowledge headers as follows:*
             [OK] .... Normally ended.
             [ERROR] .... Syntax error or other error occurred.
             [TIME OUT] .... MCB address error, etc.
           • *The acknowledge message can be turned ON/OFF with the* SILENT *command.*
           • *The factory-default for the acknowledge message is <SILENT ON>.*

4.2.4 Flow Control (RS-232C)

The transmit/receive operation of the RS11 can be controlled with XON/XOFF. These control codes are DC (device control) codes.

	Action	ISO, EIA Codes
DC1	Request to send	11h
DC3	Request to stop sending	13h

[1] To control transmission from RS-232C terminal to RS11

Signal name   DC3   DC1

RXD

TXD

            Pause   Resume

NOTE   · *The RS11 pauses transmission within 3 characters after receiving DC3.*

[2] To control transmission from RS11 to RS-232C terminal

Signal name   DC3   DC1

TXD

RXD

            Pause   Resume

NOTE   · *The terminal should stop transmission within 10 characters after receiving DC3.*

Caution   · *Transmission/reception must be controlled by means of flow control or acknowledge messages. Communication may not be successful with mere transmission.*

4.3 Description of Commands

4.3.1 Terminology

This section explains the terms used in the commands.

[1] Header

The header is a keyword of a command and is composed of a string of ASCII code characters. You may use either uppercase or lowercase letters for headers, although uppercase letters are used throughout in this manual for ease of identification. You cannot put, however, a space character or the like within a header.

[2] Data

This item is an argument that immediately follows a header. The format of data differs depending on the type of header.

Type of data

NR1	1 (ON) / 0 (OFF)	
NR2	Decimal integer	
NR3	Hexadecimal	
NR4	Real number	*1
[string]	Alphanumeric string	*2
	Must be enclosed in double-quotes (").	
sp	Space code (20h)	
?	Character [?] (3Fh)	
,	Character [,] (2Ch)	

*1: • Accepts integer, fraction, and exponent types.
      Examples: 8, 1.25, 2.56E+1
    • The following units can be identified.
      Voltage: kV, V, mV ([V] for default)
      Current: kA, A, mA ([A] for default)
      Time: s, ms, μ s ([s] for default)

NOTE   • For programming, use "US" instead of "μ s".

*2: • The control code must not include a space or spaces.
    • Lowercase letters are automatically converted into uppercase letters by the system.

[3] Response messages

All character strings of response headers and response data are with uppercase letters of ASCII Codes.

4.3.2 Structures and Descriptions of Commands

[1] Voltage, current, and output control commands (1/2)
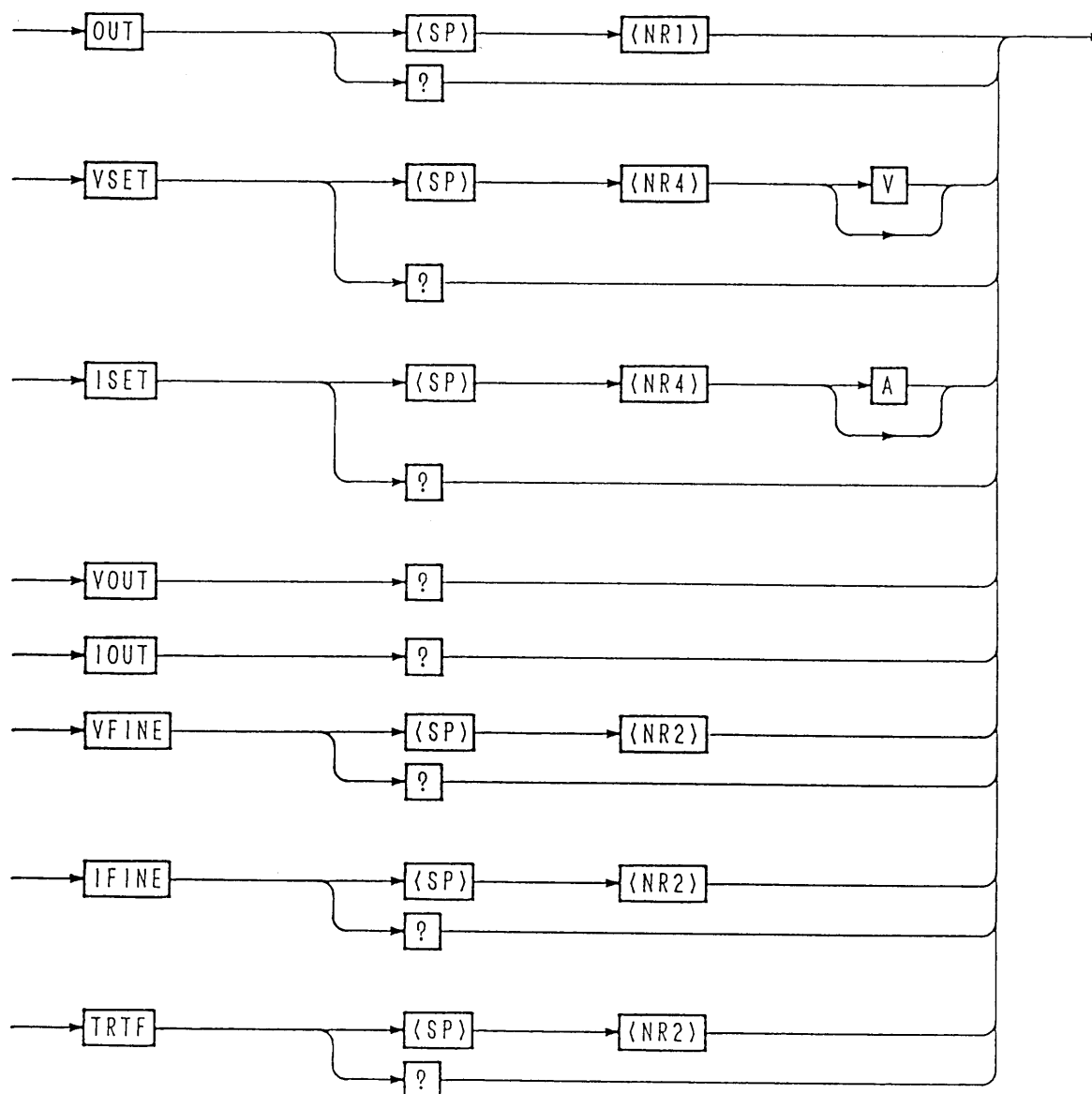
Header	Data	Action	Remarks
OUT	0 (OFF)	Turn OFF the output	
	1 (ON)	Turn ON the output	
OUT?		Return 0 or 1	
VSET	Real number [V]	Set the voltage	Unavailable when in C.C mode
VSET?		Return the set voltage	
ISET	Real number [A]	Set the current	Unavailable when in C.V mode
ISET?		Return the set current	
VOUT?		Return the actual output voltage	
IOUT?		Return the actual output current	
VFINE	−128 to +127	Set the Fine-adjust voltage	Unavailable when in C.C mode
VFINE?		Return the set Fine-adjust voltage	
IFINE	−128 to +127	Set the Fine-adjust current	Unavailable when in C.V mode
IFINE?		Return the set Fine-adjust current	
TRTF	1	Set Tr Tf time to 50 (100) μs	(100) μs is for C.C mode.
	2	Set Tr Tf time to 500μs	
	3	Set Tr Tf time to 5ms	
	4	Set Tr Tf time to Through	
TRTF?		Return 1, 2, 3 or 4	

NOTE

• *For the operating procedures, refer to Section 4.7 "Examples of Remote Programming",*
[1] "Examples of Voltage Settings and Monitor Readback (C.V Operation)".

[2] Voltage, current, and output control commands (2/2)
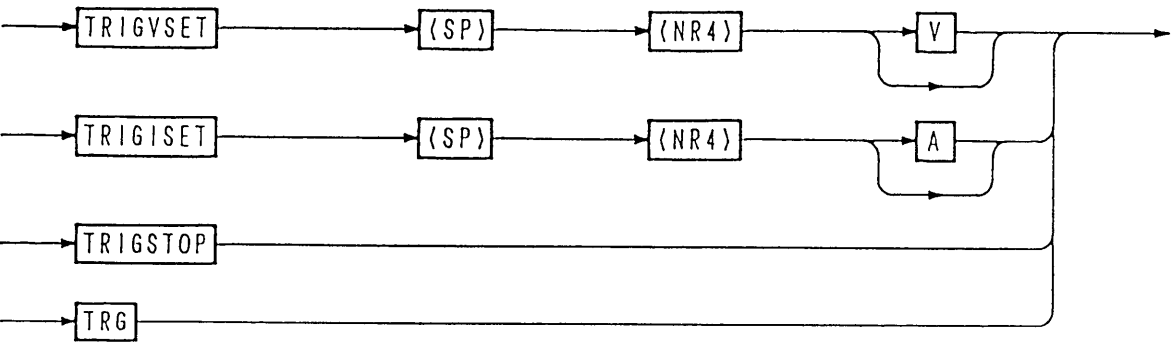
Header	Data	Action	Remarks
TRIGVSET	Real number [V]	Set the voltage value to be output to the trigger buffer	Unavailable when in C.C mode
TRIGISET	Real number [A]	Set the current value to be output to the trigger buffer	Unavailable when in C.V mode
TRIGSTOP		Clear the contents of trigger buffer	
TRG		Execute the contents of trigger buffer	

NOTE
- *The contents of the trigger buffer will be cleared if the trigger buffer is set by the* TRIGxxx *command and then another command is executed before executing the* TRG *command.*
- *If the trigger buffer is empty, nothing will occur even when the* TRG *command is given.*
- *When execution of the* TRG *command is over, the trigger buffer will become empty.*
- *Because there is only one trigger buffer, only one setting is done per one* TRG *command.*
- *The* TRIGVSET + TRG *and* TRIGISET + TRG *commands do not have the function that the Fine value automatically becomes zero.*
- *For the operation procedures, refer to Section 4.7 "Examples of Remote Programming, "[6] "Example of MCB path address designation and simultaneous operation."*

[3] Memory operation, and setup functions
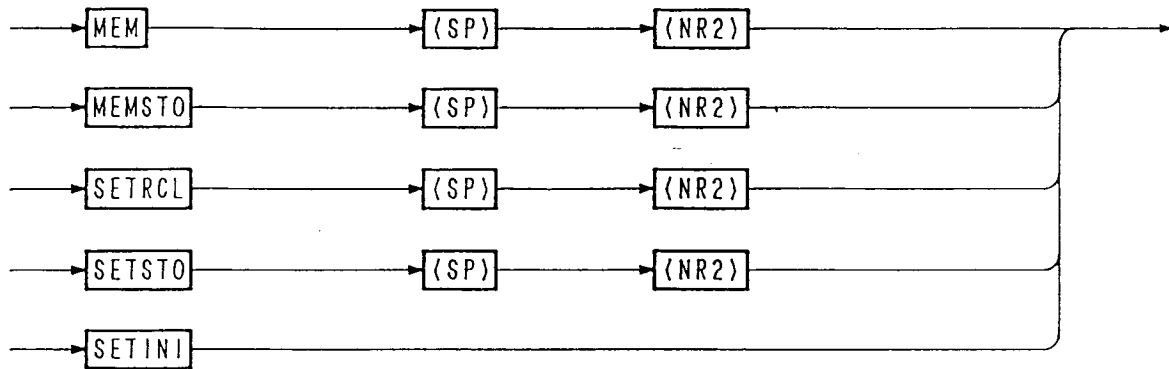
Header	Data	Action	Remarks
MEM	1 to 4	Set the output voltage (or current) with data stored in specified memory (1 for A, 2 for B, 3 for C, and 4 for D)	
MEMSTO	1 to 4	Store the currently existing voltage and current setup data onto memory	
SETRCL	0 to 9	Recall the setup file from specified memory	
SETSTO	0 to 9	Store the setup data into setup file of specified memory.	
SETINI		Initialize the setup to the factory-defaults.	

___NOTE___   · *For the operation procedures, refer to Section 4.7 "Examples of Remote Programming," [4]" Example of use of memory function."*

[4] Protection Commands
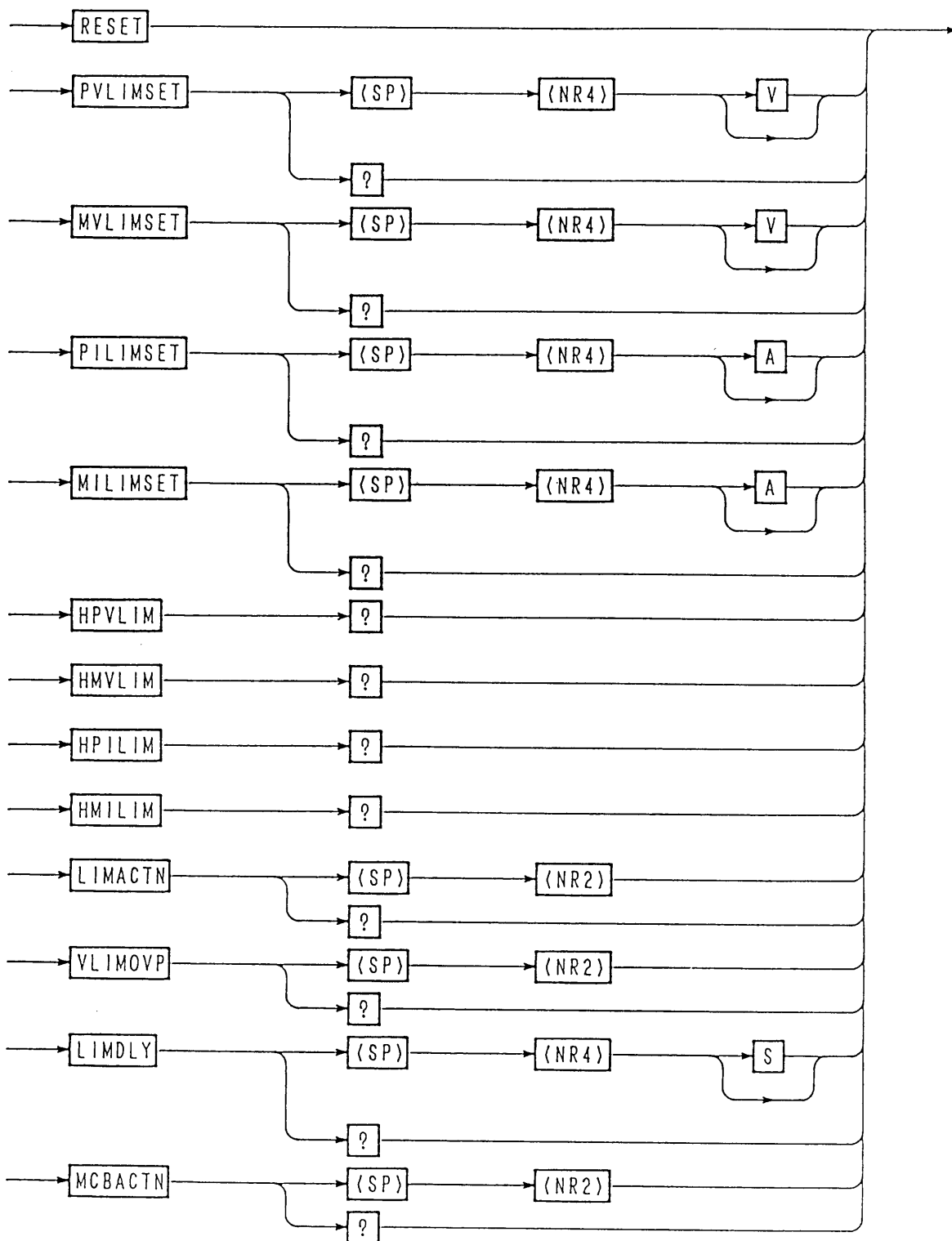
Header	Data	Action	Remarks
RESET		Reset from alarm status	
PVLIMSET	Real number [V]	Set the software +V Limit	
PVLIMSET?		Return the software +V Limit	
MVLIMSET	Real number [V]	Set the software −V Limit	
MVLIMSET?		Return the software −V Limit	
PILIMSET	Real number [A]	Set the software +I Limit	
PILIMSET?		Return the software +I Limit	
MILIMSET	Real number [A]	Set the software −I Limit	
MILIMSET?		Return the software −I Limit	
HPVLIM?		Return the hardware +V Limit	
HMVLIM?		Return the hardware −V Limit	
HPILIM?		Return the hardware +I Limit	
HMILIM?		Return the hardware −I Limit	
LIMACTN	1	Set <OUTPUT OFF>	
	2	Set <POWER OFF>	
LIMACTN?		Return 1 or 2	
VLIMOVP	1	Set <V Limit>	
	2	Set <OV Output OFF>	
	3	Set <OV Power OFF>	
	4	Set <OV Crowbar ON> *	
VLIMOVP?		Return 1, 2, 3 or 4	
LIMDLY	0.05-9.99 [s]	Set the limit delay time	
LIMDLY?		Return the limit delay time	
MCBACTN	1	Disable the MCB protective action	
	2	Enable the MCB protective action	
MCBACTN?		Return 1 or 2	

* When VLIMOVP4 command is sent, Error 061 (I/F Can't Excute) is returned.

[5] Measurement commands

```
  ──────►┤MEASMODE├───────────┬──►┤(SP)├──────►┤(NR2)├──────────────────────────────┐
                              │                                                     │
                              └──►┤?├─────────────────────────────────────────────┐ │
                                                                                  │ │
  ──────►┤VMAX├───────────────────►┤?├────────────────────────────────────────┐   │ │
                                                                              │   │ │
  ──────►┤VMIN├───────────────────►┤?├────────────────────────────────────┐   │   │ │
                                                                          │   │   │ │
  ──────►┤IMAX├───────────────────►┤?├────────────────────────────────┐   │   │   │ │
                                                                      │   │   │   │ │
  ──────►┤IMIN├───────────────────►┤?├────────────────────────────┐   │   │   │   │ │
                                                                  │   │   │   │   │ │
  ──────►┤AMPLSET├───────────┬──►┤(SP)├──────►┤(NR4)├──────────┐  │   │   │   │   │ │
                            │                                 │  │   │   │   │   │ │
                            └──►┤?├─────────────────────────┐ │  │   │   │   │   │ │
```
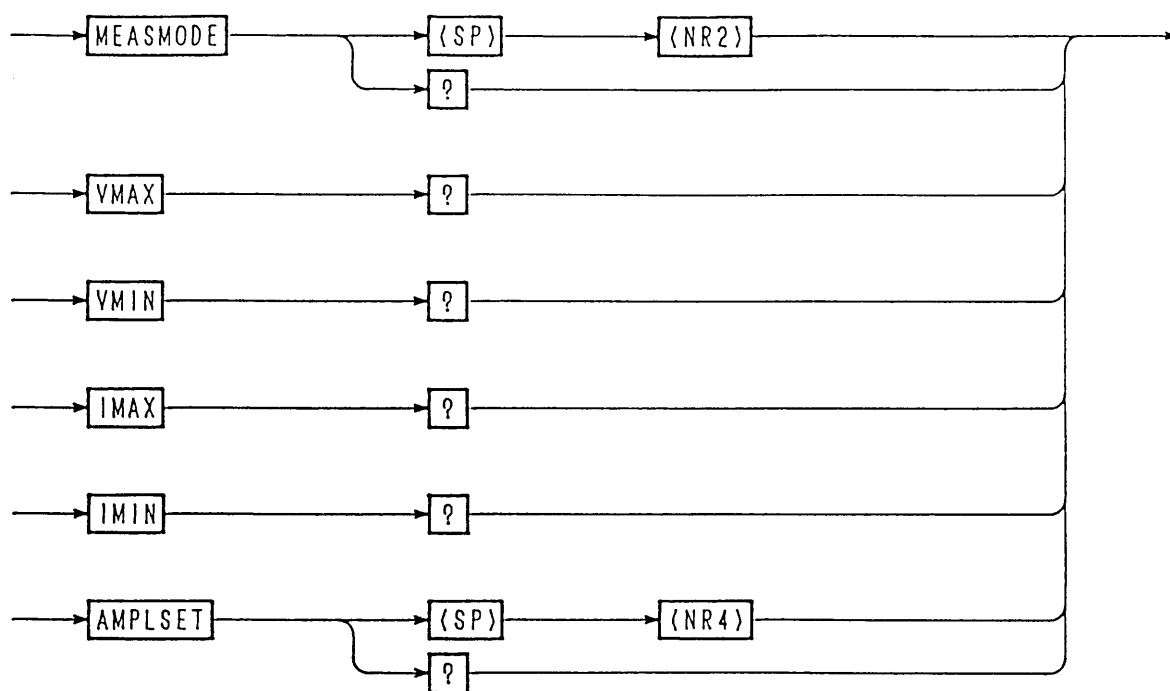
Header	Data	Action	Remarks
MEASMODE	1	Set to <DC>	*1
	2	Set to <RMS>	
	3	Set to <+Peak Vout>	
	4	Set to <−Peak Vout>	
	5	Set to <+Peak Iout>	
	6	Set to <−Peak Iout>	
MEASMODE?		Return 1, 2, 3, 4. 5 or 6	
VMAX?		Return the maximum voltage	*2
VMIN?		Return the minimum voltage	*2
IMAX?		Return the maximum current	*3
IMIN?		Return the minimum current	*3
AMPLSET	0.0 - 100.0	Set the amplitude factor [%]	*4
AMPLSET?		Return the amplitude factor	

*1: Measurement of analog data in response to │VOUT?│ or other query with a │MEASMODE│ command takes certain time (several hundreds milliseconds). When using a │MEASMODE│ command, specify a hold-off (@) for GPIB or an acknowledge message for RS-232C.

*2: This query is invalid for <+/− Peak Iout> measurement.

*3: This query is invalid for <+/− Peak Vout> measurement.

*4: Applicable only to the analog remote control via the front sub-panel.

4-17

[6] Sequence commands (1/2)
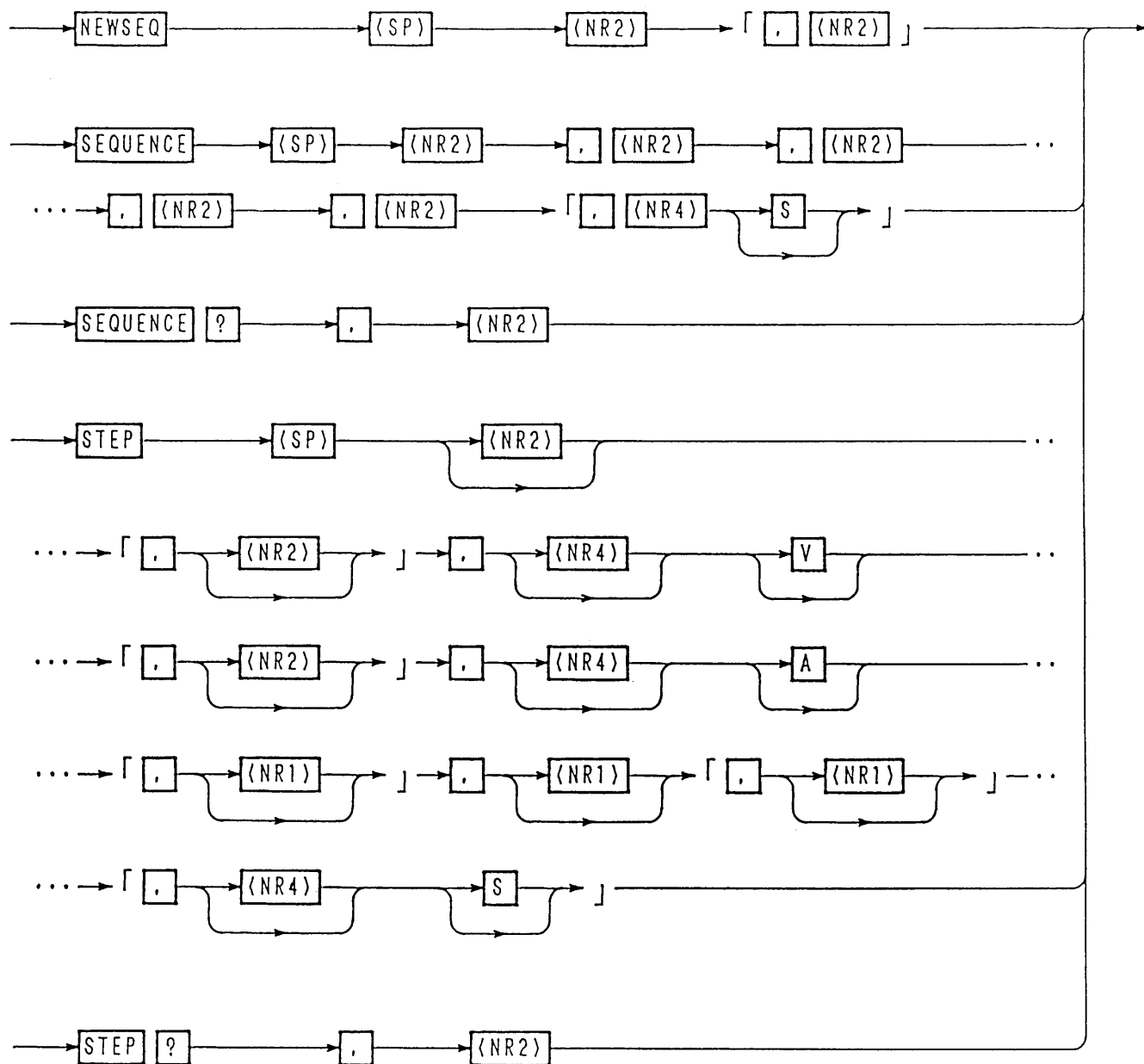
Header	Data		Action	Remarks
NEWSEQ * No. 2 program data ② is not needed for FV and FI modes.	①	1	Set to NV mode	
		2	Set to NI mode	
		10	Set to FV mode	
		11	Set to FI mode	
	②	1	Set the time unit to msec	
		2	Set the time unit to sec	
		3	Set the time unit to minute	
		4	Set the time unit to hour	
SEQUENCE * No. 6 program data ⑥ is not needed for NV and NI modes.	①	1-8	Specify the sequence number	
	②	1-16	Specify the program to be run	
	③	1-9999	Specify the number of loops (9999 for infinitive repetitions)	
	④	0, 1-8	Specify the sequence number for chain destination (0 for no chain)	
	⑤	0, 1-16	Specify the end program number (0 for no end designation)	
	⑥	0.1-[ms]	Execution time in FV/FI mode	
SEQUENCE?		1-8	Return the parameter of specified sequence number	
STEP No. 2, 5, 6, and 7 program data ②, ⑤, ⑥, and ⑦ are not needed for FV and FI modes.	①	1-256 (1-1024)	Specify the step number (Up to 1024 for FV or FI mode) (Default:Preceding step No.+1)	
	②	0	Specify stepwise change of output voltage (or current)	
		1	Specify rampwise change of output voltage (or current)	
	③	Real number [V] [A]	Set the voltage (or current)	
	④	0 (OFF)	Set the trigger output to OFF	
		1 (ON)	Set the trigger output to ON	
	⑤	0 (OFF)	Set the output to OFF	
		1 (ON)	Set the output to ON	
	⑥	0 (OFF)	Set the PAUSE to OFF	
		1 (ON)	Set the PAUSE to ON	
	⑦	Real number[s]	Set the time data (in the unit of [sec] regardless of the unit set by NEW SEQ)	
STEP?		1-256 (1-1024)	Return the parameter of the specified step number (The numbers enclosed in the parentheses are for FV and FI modes.)	

NOTE • *You may omit the program data of* STEP *command. If you omit it, the step parameter is not overwritten. For the operation method, refer to Section 4.7 "Examples of Remote Programming," [7] and [8] "Example of sequence operation."*

[7] Sequence commands (2/2)


```
──▶│FLOAD│──────────▶│(SP)│──────▶│(NR2)│──────────────────────▶

──▶│FSAVE│──────────▶│(SP)│──────▶│(NR2)│─────────

──▶│PROGRAM│────────▶│(SP)│──────▶│(NR2)│─────────
                     │?│─────────

──▶│EOS│────────────▶│(SP)│──────▶│(NR2)│─────────

──▶│EXECUTE│────────▶│(SP)│──────▶│(NR1)│─────────

──▶│RUN│────────────▶│(SP)│──────▶│(NR2)│─────────

──▶│PAUSE│──────────▶│(SP)│──────▶│(NR1)│─────────

──▶│STOP│─────────────────────────────────

──▶│RUNNING│────────▶│?│───────────────────

──▶│SEQMODE│────────▶│?│───────────────────

──▶│TEXTIDX│────────▶│(SP)│──────▶│"(string)"│─────────

──▶│TEXTSEQ│──▶│(SP)│──▶│(NR2)│──▶│,│──▶│"(string)"│─────────

──▶│TEXTPROG│─▶│(SP)│──▶│(NR2)│──▶│,│──▶│"(string)"│─────────
```
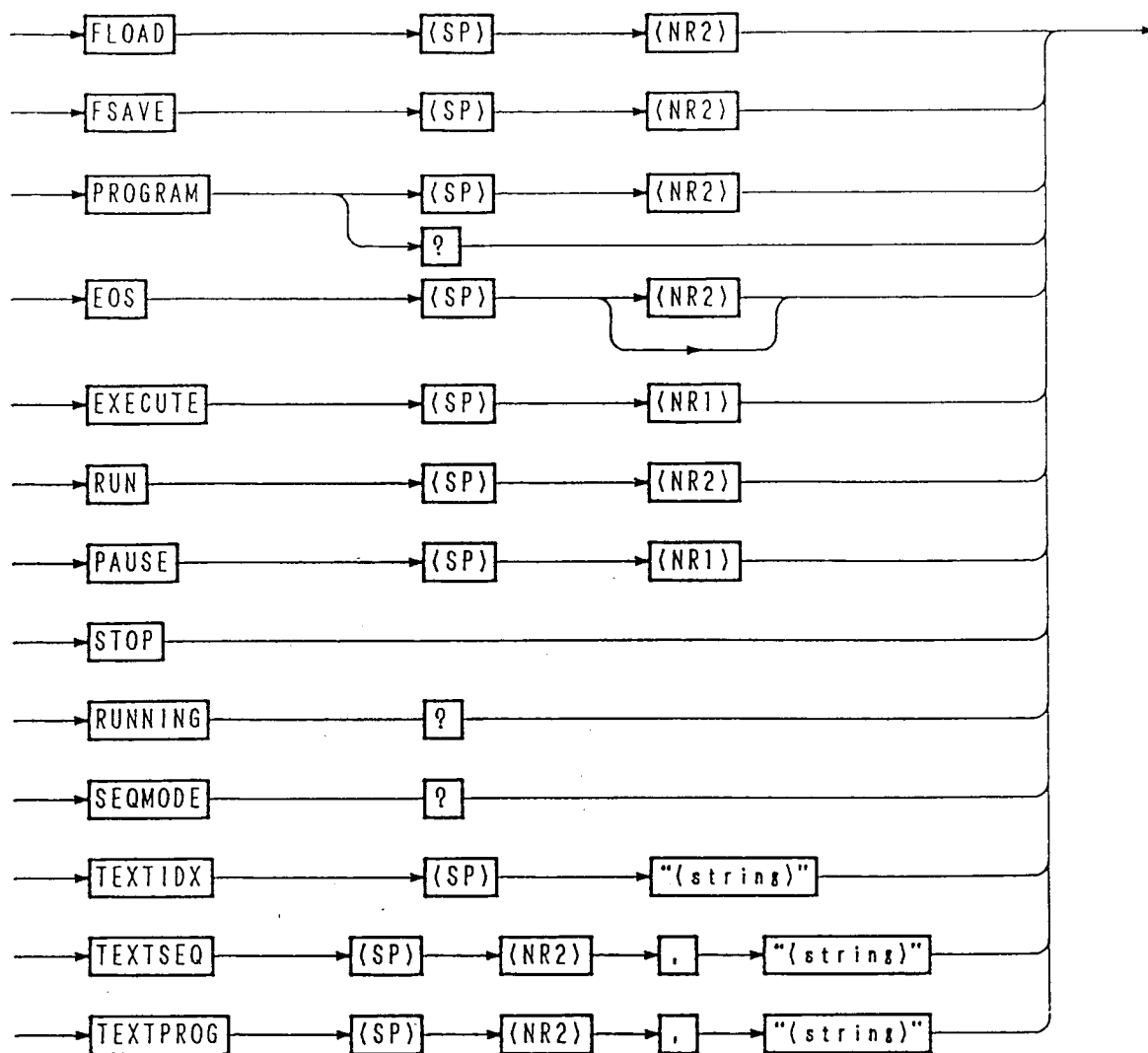
Header	Data		Action	Remarks
FLOAD	0		Load the specified file to the sequence execution memory	
FSAVE	0		Save the sequence execution memory contents into the specified file	
PROGRAM	1-16		Specify the program number (Thereafter, effective for STEP and EOS commands)	
PROGRAM?			Return the specified program number	
EOS	1-256 (1-1024)		Set the final step number of the specified program (Default: previous step number + 1)	
EXECUTE	1 (ON)		Set to the execute mode (RUN, STOP, PAUSE enabled)	
	0 (OFF)		Release from the execute mode	
RUN	1-8		Run the specified sequence number	*1
PAUSE	1 (ON)		Pause the sequence	*1
	0 (OFF)		Release from the pause	
STOP			Stop the sequence forcibly	*1
RUNNING?			Return the sequence run status data (<STOP:1, RUN:2, PAUSE:3>, <SEQ. NO.>, <PROG. NO.>, <LOOP>, <STEP NO.>)	
SEQMODE?			Return the sequence mode data (<NV: 1, NI: 2, FV: 10, FI: 11>)	
TEXTIDX	String of characters		Provide an index with a string of up to six characters, for execution sequence memory	
TEXTSEQ	①	1-8	Specify the sequence number	
	②	String of characters	Write a comment with a train of up to six characters, for the specified sequence number	
TEXTPROG	①	1-16	Specify the program number	
	②	String of characters	Write a comment with a string of up to six characters, for the specified program number	

*1: During the EXECUTE mode, other program commands than RUN, STOP, PAUSE and RESET are ineffective. When in the state released from the EXECUTE mode, the RUN, STOP and PAUSE commands are ineffective.

[8] Utility Commands
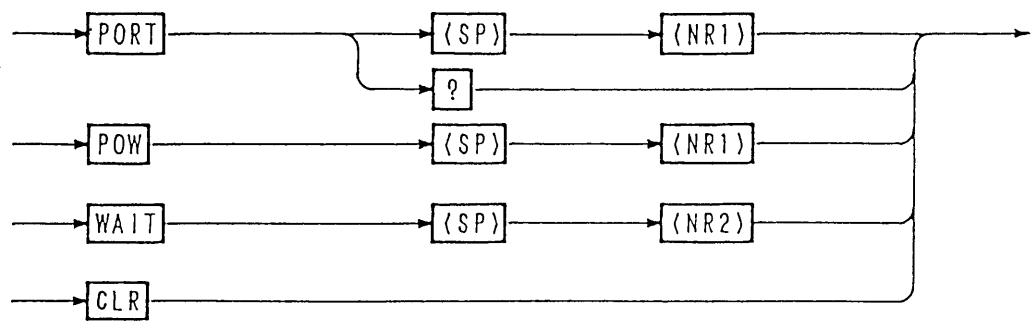
Header	Data	Action	Remarks
PORT	1 (ON)	Turn ON (closed) between digital common terminal and option terminal of J2 connector on rear panel	
	0 (OFF)	Turn OFF (open) between digital common terminal and option terminal of J2 connector on rear panel	
PORT?		Return 0 or 1	
POW	0 (OFF)	Turn OFF the AC POWER switch of the power supply	
WAIT	1-5	Wait for the <specified> period doing nothing	
CLR		Clear the buffer, etc.	

NOTE • *The option terminal that is ON/OFF-controlled by the* PORT *command provides an open collector output of Ic=50mA (VCE(SAT)=0.5V) (equivalent to Toshiba 2SC1815).*

[9] Commands for MCB only
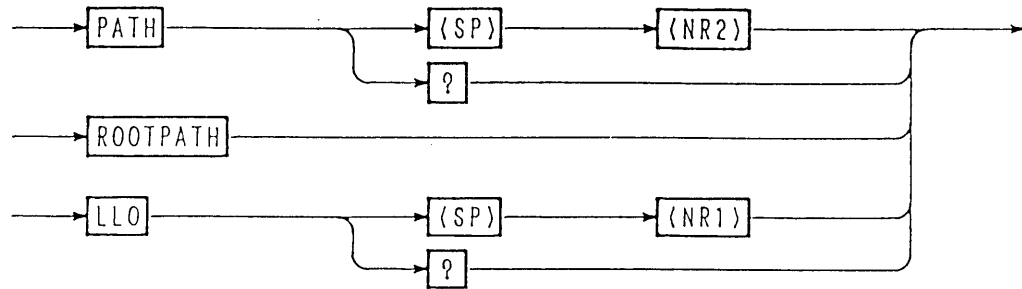
Header	Data	Action	Remarks
PATH	Address (0-15, 16)	Set the MCB path address (path address 16: for all addresses)	
PATH?		Return the MCB path address	
ROOTPATH		Set the path address to 0	
LLO	1 (ON)	Set to local lockout	
	0 (OFF)	Release from local lockout	
LL0?		Return 0 or 1	

(Caution)

- *For the MCB path address, specify an address which actually exists. When you have specified an address which does not actually exist, send <DCL> to GPIB. The path address will be set to 0 (master).*
- *For answer to the query message on path address 16, data of path address 0 (master) will be returned.*

(NOTE)

- *For the operation procedures, refer to Section 4.7 "Examples of Remote Programming," [6] "Example of MCB path address designation and simultaneous operation."*

[10] Commands and control codes for RS-232C only
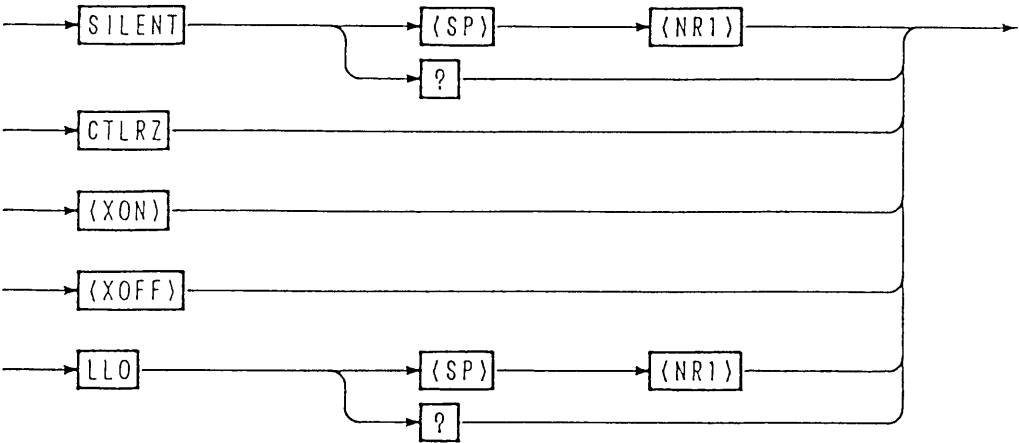
Header	Data	Action	Remarks
SILENT	1 (ON)	Do not return the acknowledge message	
	0 (OFF)	Return the acknowledge message	
SILENT?		Return 0 or 1	
CTRLZ		Return the code (1Ah)	
<XON> (11h)		Resume transmission from RS-11 (Refer to Section "Flow Control.")	
<XOFF> (13h)		Stop transmission from RS-11 (Refer to Section "Flow Control.")	
LLO	1 (ON)	Set to local lockout	
	0 (OFF)	Release from local lockout	
LL0?		Return 0 or 1	

[11] System commands
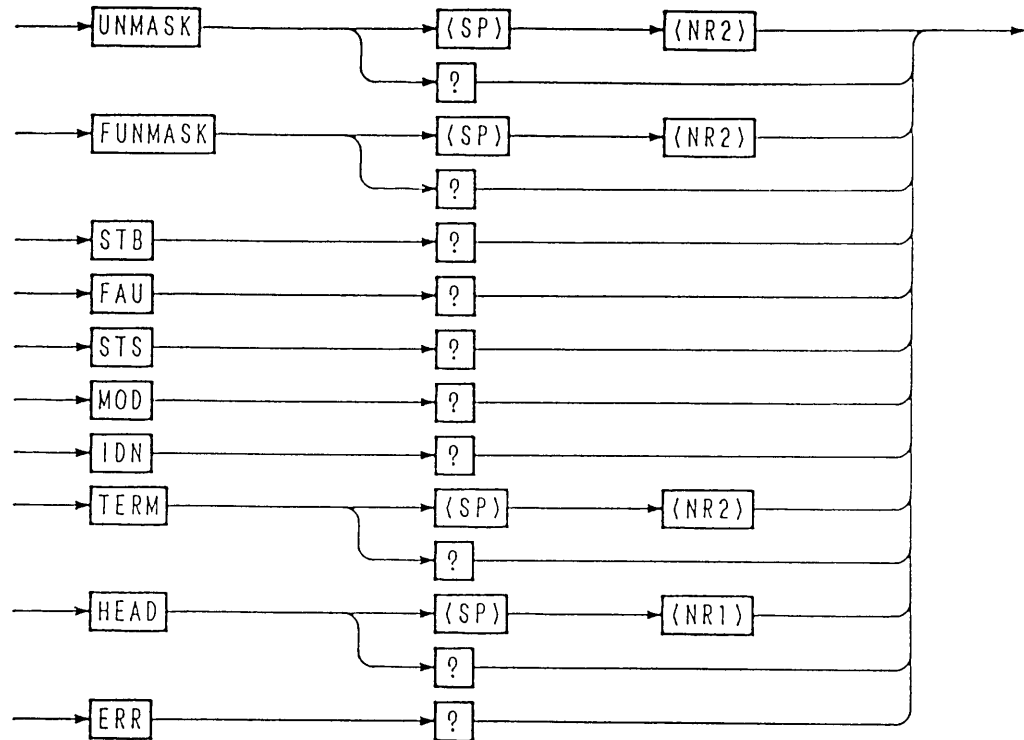
Header	Data	Action	Remarks
UNMASK	0-255	Set the unmask register	
UNMASK?		Return the UNMASK value in decimal	
FUNMASK	0-255	Set the fault unmask register	
FUNMASK?		Return the FUNMASK value in decimal	
STB?		Return the status byte register value in decimal	
FAU?		Return the fault register value in decimal	
STS?		Return the status register value in decimal	
MOD?		Return the mode register value in decimal	
IDN?		Return the model and ROM version number	
TERM	0	Set the response terminator to [CRLF]	
	1	Set the response terminator to [CR]	
	2	Set the response terminator to [LF]	
	3	Set the response terminator to [EOI]	
TERM?		Return 0, 1, 2 or 3	
HEAD	1 (ON)	Add a query header to the query message	
	0 (OFF)	Add no query header to the query message	
HEAD?		Return 0 or 1	
ERR?		Return error code (Refer to 4.6 "Table of Error Codes.")	

(NOTE)
- For bit assignment of each of the registers, refer to Section 4.4 "Bit Assignment of Registers."
- For the operation procedures, refer to Section 4.7 "Examples of Remote Programming," [5] "Examples of setting, call out, and SRQ operation of registers."

[12] Commands and special codes for GPIB only

Multiline message <DCL>: To set the MCB path address to 0. To clear the error message.

Multiline message <SDC>: The same as above.

Multiline message <GET>: The same as the $\boxed{\text{TRG}}$ command.

"@" (40h):   The "@" code (40h) suffixed to a program command is for hold off until exe-
                            cution of the message ends. However, in the event of a command message
                            terminator with only EOI, use "@@".

Example

```
call Tx("VSET 5.0V")                 'Get message into the input buffer
                                     'and then proceed to the next

call Tx("VSET 5.0V@")                'Execute "VSET 5.0V" and then
                                     'proceed to the next
```

4.4 Bit Assignment of Registers

[1] Status byte register

MSB   LSB

7	6	5	4	3	2	1	0
X	RQS	X	MCB	ERR	SE	PON	FAU

Bit 0 [FAU]   : Means that one of the fault register bits is "true."
Bit 1 [PON]   : Means the power-on status.
Bit 2 [SE   ]   : Means that the sequence is over.
Bit 3 [ERR]   : Means that a syntax error or the like has occurred.
Bit 4 [MCB]   : Means that an SRQ is received from MCB.
Bit 5 [X   ]   : Undefined
Bit 6 [RQS]   : Means that a service request is originated.
Bit 7 [X   ]   : Undefined

(NOTE)
- *Bit 1 [PON] and bit 6 [RQS] are effective for the IB11 interface board only.*
- *Bit 3 [ERR] can be reset with the* ERR? *query,* CLR *command, <DCL> or <SDC>.*
- *Bit 6 [RQS] can be reset by serial polling of GPIB.*
- *Bit 1 [PON] and bit 2 [SE] are undefined for the* STB? *query.*

[2] Unmask register

MSB   LSB

7	6	5	4	3	2	1	0
0	0	0	MCB	ERR	SE	0	FAU

Bit 0 [FAU]   : To originate an SRQ when one of the register bits is "true."
Bit 1 [0   ]   : Not used
Bit 2 [SE   ]   : To originate a service request when the sequence is over.
Bit 3 [ERR]   : To originate a service request when a syntax error or the like has occurred.
Bit 4 [MCB]   : To originate a service request as requested by MCB.
Bit 5 [0   ]   : Not used
Bit 6 [0   ]   : Not used
Bit 7 [0   ]   : Not used

(NOTE)
- *For the bits which are not used, set [0].*

[3] Fault register

MSB   LSB

7	6	5	4	3	2	1	0
X	LIM	X	X	X	OHP	DLIM	OVP

Bit 0 [OVP]   : OVP action
Bit 1 [DLIM]   : Delayed limit action
Bit 2 [OHP]   : OHP action
Bit 3 [X]   : Undefined
Bit 4 [X]   : Undefined
Bit 5 [X]   : Undefined
Bit 6 [LIM]   : Limit action
Bit 7 [X]   : Undefined

NOTE   • *Each of the fault resistor bits has a latch function. It is held in the set state until it is read by the* FAU? *query.*

[4] Fault unmask register

MSB   LSB

7	6	5	4	3	2	1	0
0	LIM	0	0	0	OHP	DLIM	OVP

Bit 0 [OVP]   : Enable the OVP bit of fault resistor
Bit 1 [DLIM]   : Enable the DLIM bit of fault resistor
Bit 2 [OHP]   : Enable the OHP bit of fault resistor
Bit 3 [0]   : Not used
Bit 4 [0]   : Not used
Bit 5 [0]   : Not used
Bit 6 [LIM]   : Enable the LIM bit of fault resistor
Bit 7 [0]   : Not used

NOTE   • *For the bits that are not used, set [0].*

[5] Status register

MSB   LSB

7	6	5	4	3	2	1	0
X	LIM	X	X	X	OHP	DLIM	OVP

Bit 0 [OVP]   : OVP action
Bit 1 [DLIM]   : Delayed limit action
Bit 2 [OHP]   : OHP action
Bit 3 [X]   : Undefined
Bit 4 [X]   : Undefined
Bit 5 [X]   : Undefined
Bit 6 [LIM]   : Limit action
Bit 7 [X]   : Undefined

[6] Mode register

MSB LSB

7	6	5	4	3	2	1	0
ERL1	ERL0	X	X	CV	EOFF	CRW	FST

Bit 0 [FST]   : [1] for C.V fast mode or C.C dynamic mode;
                   [0] for C.V normal mode or C.C static mode.
Bit 1 [CRW]   : [1] when crowbar option is set.
Bit 2 [EOFF]   : [1] when the output ON/OFF control signal applied via analog remote control connector J2 on rear panel is set to OFF (short).
Bit 3 [CV]   : [1] for C.V mode; [0] for C.C mode
Bit 4 [X]   : Undefined
Bit 5 [X]   : Undefined
Bit 6 [ERL0]   : External remote status code 0   * 1
Bit 7 [ERL1]   : External remote status code 1   * 1

* 1: Table of external remote status codes

	ERL1	ERL0
<Local>	0	0
<From J2>	0	1
<From BNC>	1	1
<From J2 & BNC>	1	0

4.5 Relationships Among SRQ, Status Bytes, and Registers

The power supply has registers which are used to notify to the controller the events occurred in the power supply. This section explains these registers.

Relationships among SRQ, status bytes, and registers
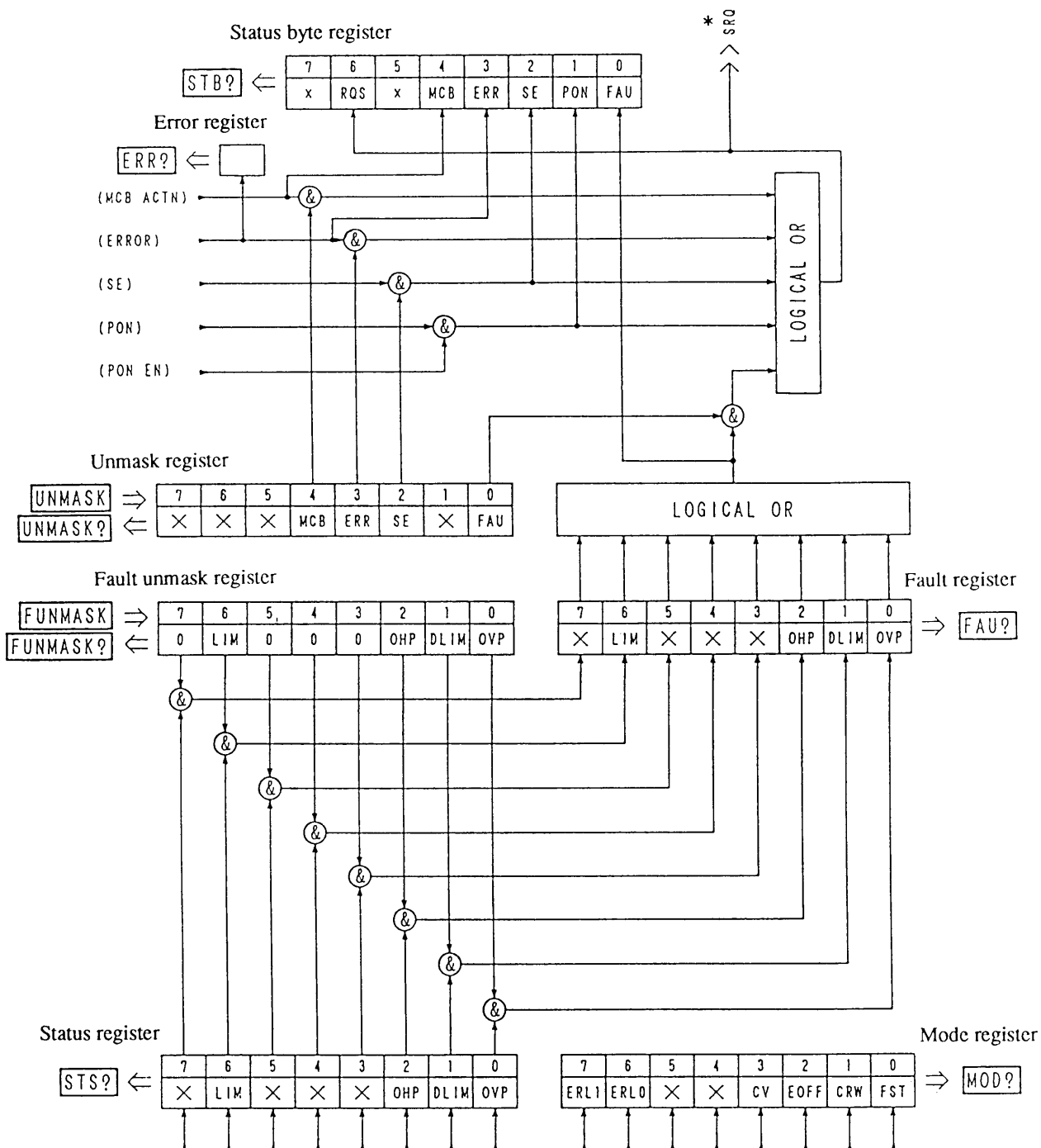
∗ : SRQ is for GPIB only.

4.6 Table of Error Codes

Error code	Panel display
1	I／F Syntax Error.
2	I／F Argument Error.
24	No Use EXT SIG IN.
27	Can't Recall SETUP.
35	Invalid Sequence.
51	Parity Error.
52	Framing Error.
53	RX Buff Overflow.
54	TX Buff Overflow.
60	I／F Invalid Data.
61	I／F Can't Execute.
62	I／F No Answer.
63	I／F Warning Data.
79	Data Clip.
80	Prediction V Limit.
81	Prediction I Limit.

(NOTE)

* *Each time an error occurs. it is written onto the error register. Thus, the error code returned in response to the* ERR? *query is of the error which occurred latest. The error register is cleared by the* ERR? *query,* CLR *command, <DCL>, or <SDC>.*
* *For details of errors, refer to Appendix 1 "Table of Error Messages."*

4.7 Examples of Remote Programming

4.7.1 Initializing the Interface Board

Before starting remote programming, initialize the interface board. The items to be set are as shown below. For the setting procedure, refer to Section 3.5.1 "Configuration."

GPIB interface board (IB11)
- GPIB device address
- Power-on service request

RS-232C interface board (RS11)
- Data transmission rate
- Data bit length
- Stop bit length
- Parity bit

MCB slave interface board (MC11S)
- MCB device address

4.7.2 Examples of Application Programs

Sample code (Visual Basic 6.0)

The sample program to be described later assumes Microsoft Visual Basic 6.0 for the development platform and VISA library (VISA COM) for the I/O library.

You can use the following either VISA libraries.

• Kikusui Corp.: KI-VISA

(VER.3.0.x or later, Downloadable from http://www.kikusui.co.jp/download/)

• National Instruments: NI-VISA

(VER.3.0 or later, Windows 2000 and Windows XP: VER.3.2 or later)

• Agilent Technologies: Agilent VISA

(Agilent IO Libraries M01.00 or later)

VISA Session Acquisition and Communication Setup

The codes listed below are common to all of the sample programs to be described later. They should be executed before holding a communication with this product.

The syntax of the VISA resource string to be substituted for variable strVisaAddress varies depending on GPIB and RS232C.

With GPIB, the use of device address 1 is supposed.

With RS232C, the communication parameters are supposed to be the factory-shipped parameters.

• Communication rate: 9600 bps
• Data length: 8 bits
• Stop bit: 1 bit
• Parity: NONE
• Flow control: XFlow
• Communication port: COM 1
• Terminator: CR+LF

The communication parameter setups of the program are described using the above values. Therefore, if the product condition is different from the factory-shipped condition, it is required to reset the product to the factory-shipped condition.

See "[4] Initialization" in section "3.3.3 Setup Function".

Common Modules

1. Communication IO open/close module

The GPIB or RS232C IC open/close module is a basic operation for communication and should be included in the standard module. After calling the comm_open function at the start of the program, be sure to call the comm_close function to close the communication port before the end of the program.

2. Setting/inquiry command send/receive module [Function Tx(send_data As String)]

After sending of a command that contains "?" in the command string, the reception operation is executed and the received data is saved in global variable [g_strRxd].

<<Include the following in the standard module>>

```
Option Explicit
Public Declare Sub Sleep Lib "kernel32" (ByVal dwMilliseconds As Long)    'sleep function for use with the API wait time.
'The following variables are required for control of VISA COM.
Public rm As VisaComLib.IResourceManager
Public io As VisaComLib.IMessage
Public serial As VisaComLib.ISerial
Public g_strRxd As String                               'Global variable for receive data save
Public m_session_INTFC As VisaComLib.IGpibIntfc         'Library for use with GPIB interface commands
Public Const trg_on = "1"                               'Sequence step trigger ON
Public Const trg_off = "0"                              'Sequence step trigger OFF


'-------------------------------------------------------------------------------------------------------
Function comm_open()
    '****************************************************
    '*   Communication IO open module
    '*   The communication port is fixed as follows.
    '*   GPIB address: 1
    '*   RS232C port: COM1
    '*
    '*   GPIB and RS232C are switched according to the string substituted for strVisaAddress.
    '*   This module sets READ to OFF after opening the communication port.
    '****************************************************
    Dim strVisaAddress As String             'Specifies VISA address in the strVisaAddress variable.
    'strVisaAddress = "ASRL1::INSTR"          'RS232C port setting  * When RS232C is enabled, GPIB should be a comment.
    strVisaAddress = "GPIB0::1::INSTR"        'GPIB address setting  *When GPIB is enabled, RS232C should be a comment.

    'Create a Resource Manager object.
    '(Begin creation using the VISA Global Resource Manager; If this fails, try creation using the Agilent Resource Manager.)

    On Error Resume Next
    Set rm = CreateObject("VISA.GlobalRM")
    If rm Is Nothing Then
        Set rm = CreateObject("AgilentRM.SRMCls")
    End If
    On Error GoTo 0

    'Open a VISA session.
    Set io = rm.Open(strVisaAddress, NO_LOCK)

    'Set RS232C-specific communication parameters.
```

```
    If io.HardwareInterfaceType = INTF_ASRL Then      'When IO resource is RS232C, execute following settings.
        Set serial = io                               'RS232C
        serial.BaudRate = 9600                        'Baud rate 9600 bps
        serial.DataBits = 8                           'Data length 8 bits
        serial.StopBits = ASRL_STOP_ONE               'Sets stop bit to 1 bit.
        serial.Parity = ASRL_PAR_NONE                 'Sets parity bit to NONE.
        serial.FlowControl = ASRL_FLOW_XON_XOFF       'Sets flow control Xon/off.
        serial.Timeout = 5000                         'Sets timeout to 5 sec. (The default without this setting is 2 sec.)

    ElseIf io.HardwareInterfaceType = INTF_GPIB Then  'Only when GPIB is used.
        Set m_session_INTFC = rm.Open("GPIB0::INTFC") 'Enables interface message.
    End If

    Call Tx("HEAD OFF")                               'Sets HEAD OFF.
End Function


'-------------------------------------------------------------------------------------------------------
Function comm_close()
    '****************************************************
    '*   Communication IO close module
    '*   Close communication port and INTFC (multi-line message, etc.).
    '****************************************************

    'Close the VISA session
    If rm Is Nothing Then Exit Function
    io.Close
    If m_session_INTFC Is Nothing Then Exit Function
    m_session_INTFC.Close
End Function


'-------------------------------------------------------------------------------------------------------
Function Tx(send_data As String)
    '****************************************************
    '* Send/receive module
    '* Send method: call ("ascii code string")+CR+LF
    '* With this module, terminator CR+LF is added after the string.
    '*
    '* Receive operation is executed with a query command that contains (?).
    '* Receive data is saved in global variable g_strRxd.
    '****************************************************
    On Error Resume Next
    io.WriteString send_data + vbCrLf                 'Sends command+CR+LF

    If InStr(send_data, "?") Then                     'Identifies a query command.
        g_strRxd = io.ReadString(256)                 'Receive data is substituted for global variable q_strRxd.
    End If
End Function
```

Sample Program

To use the following sample program, create a form, provide an optimum command button and use function call.

• Example:

```
Private Sub Command1_Click()
    Call comm_open                          'Opens communication port.
    Call example001                         'Executes sample program 001.
    Call comm_close                         'Closes communication port.
End Sub
```

[1] Example of voltage setup and monitor read-back (C.V operation)

```
Sub example001()
    'Sample program 1
    '[1] Example of voltage setup and monitor read-back (C.V operation)
    'Data format (The unit is omitted, and v, index, mV and KV can be used.)
    'Set voltage query value is substituted for global variable g_strRxd.
    '<<VSET,VSET?,VOUT?>>
    Dim dVoltMeasure As Double              'Measured voltage variable: Double type
    Call Tx("VSET 5.00")                    'Sets voltage to 5.00 V.
    Call Tx("OUT ON")                       'Output ON
    dVoltMeasure = Meas_vout                'Set voltage query/output voltage query

    Call Tx("VSET 0.00V")                   'Sets voltage to 0.00 V.
    dVoltMeasure = Meas_vout                'Set voltage query/output voltage query

    Call Tx("VSET 4.75E+0")                 'Sets voltage to 4.75 V.
    dVoltMeasure = Meas_vout                'Set voltage query/output voltage query

    Call Tx("VSET 5250mV")                  'Sets voltage to 5.25 V.
    dVoltMeasure = Meas_vout                'Set voltage query/output voltage query

    Call Tx("VSET 0.005KV")                 'Sets voltage to 5.00 V.
    dVoltMeasure = Meas_vout                'Set voltage query/output voltage query

    Call Tx("OUT OFF")                      'Output OFF
End Sub

'-------------------------------------------------------------------------------------------
Function Meas_vout() As Double
    'Set voltage query/output voltage query function
    Dim dVoltMeasure As Double              'Measured voltage variable: Double type
    Sleep (1000)                            'Sets rise delay time to 1 sec.
    Call Tx("VOUT?")                        'Saves output voltage query value in q_strRxd.
    dVoltMeasure = Val(g_strRxd)            'Converts character data into Double type numerical data.
    Meas_vout = dVoltMeasure
    Call Tx("VSET?")                        'Set voltage query
End Function
```

[2] Example of protection operation

```
Sub example002()
    'Sample program 2
    '[2] Example of protection operation
    'Query value is substituted for global variable g_strRxd.
    '<<Protection>>
    '------------Settings------------
    Call Tx("VLIMOVP 1")                       'Sets limit operation.
    Call Tx("PVLIMSET 20.0;MVLIMSET -20.0")    'Sets + and - voltage limits.
    Call Tx("PILIMSET 2.00;MILIMSET -2.00")    'Sets + and - current limits.
    Call Tx("LIMACTN 1;LIMDLY 2.5S")           'Action 1 in case of limiting: OUT OFF   2: PWR OFF
                                               'Sets limit delay time (0.05-9.9 sec.)

    '------------Query value save variable------------
    Dim dPV_LimData As Double                  '+ voltage limit data save variable
    Dim dMV_LimData As Double                  '- voltage limit data save variable
    Dim dPI_LimData As Double                  '+ current limit data save variable
    Dim dMI_LimData As Double                  '- current limit data save variable
    Dim d_LimDlyData As Double                 'Limit delay data save variable
    Dim iLimAction As Integer                  'Limit action data save variable
    Dim dHPV_LimData As Double                 'Hardware + voltage limit data save variable
    Dim dHMV_LimData As Double                 'Hardware - voltage limit data save variable
    Dim dHPI_LimData As Double                 'Hardware + current limit data save variable
    Dim dHMI_LimData As Double                 'Hardware - current limit data save variable

    '------------Query------------
    dPV_LimData = Tx("PVLIMSET?")              '+ voltage limit value query
    dMV_LimData = Tx("MVLIMSET?")              '- voltage limit value query

    dPI_LimData = Tx("PILIMSET?")              '+ current limit value query
    dMI_LimData = Tx("MILIMSET?")              '- current limit value query

    d_LimDlyData = Tx("LIMDLY?")               'Limit delay value query
    iLimAction = Tx("LIMACTN?")                'Limit action query

    dHPV_LimData = Tx("HPVLIM?")               'Hardware + voltage limit value query
    dHMV_LimData = Tx("HMVLIM?")               'Hardware - voltage limit value query

    dHPI_LimData = Tx("HPILIM?")               'Hardware + current limit value query
    dHMI_LimData = Tx("HMILIM?")               'Hardware - current limit value query

End Sub
```

[3] Example of fine adjustment setting

```
Sub example003(d_setvoltage As Double)
    'Sample program 3
    '[3] Example of find adjustment setting: call example003(12.000V)
    'This sample fine adjusts the output voltage to ±1 mV of the set value.
    'To reach the set value quickly, the previously calculated fine setting value is sent and then subjected to fine adjustment.
    'Software Auto Fine function
    'FINE setting range: -128 to 127
    'Command syntax: VFINE <set value>
    '<<Fine>>

    Dim d_fine_dif_val As Double                'Variable of the difference between set and output values.
    Dim volt_fine As Integer                    'FINE set value variable
    volt_fine = 0
    Call Tx("VSET" & Str$(d_setvoltage))
    Call Tx("OUT ON")                           'Output ON

    d_fine_dif_val = d_setvoltage - Wait_ReadBack  'Calculates the difference between set and output values.
    volt_fine = d_fine_dif_val / 0.0006         'Calculates expected FINE set value (calculation for reducing processing time).
                                                '(Constant, which is 0.0006 in this example, varies depending on product.)

    If volt_fine <= -128 Then                   'If FINE set value is below negative limit:
        volt_fine = -128                        'Sets FINE set value to -128.
        MsgBox "The - setting limit of FINE is exceeded."  'Message
    ElseIf volt_fine >= 127 Then                'If FINE set value is above positive limit:
        volt_fine = 127                         'Sets FINE set value to 127.
        MsgBox "The + setting limit of FINE is exceeded."  'Message
    End If

    Call Tx("VFINE " & Format(volt_fine))       'Sets coarse FINE value.

    Do                                          'Sets FINE value fine adjustment.
        DoEvents
        d_fine_dif_val = d_setvoltage - Wait_ReadBack  'Calculates the difference between set and output values.

        If Abs(d_fine_dif_val) > 0.0011 Then    'Executes FINE operation if the difference between set and output values is 1.1 mV or more.
            If d_fine_dif_val < 0 Then          'If output voltage is higher than set value --> FINE-.
                'FINE_minus prosess
                If volt_fine < -128 Then Exit Do 'Exits if FINE_minus is lower than minimum value.
                Call Tx("VFINE " & Format(volt_fine))  'Sets FINE.
                volt_fine = volt_fine - 1
            Else                                'If output voltage is lower than set value --> FINE+.
                'FINE_plus prosess
                volt_fine = volt_fine + 1
                If volt_fine > 127 Then Exit Do 'Exits if FINE_plus is larger than maximum value.
                Call Tx("VFINE " & Format(volt_fine))  'Sets FINE.
            End If
        Else
            Exit Do
        End If
    Loop
End Sub


'-----------------------------------------------------------------------------------------------------

Function Wait_ReadBack() As Double
    Sleep (1000)                                'Sets rise delay time to 1 sec.
    Call Tx("VOUT?")                            'Saves output voltage query value in g_strRxd.
    Wait_ReadBack = Val(g_strRxd)               'Converts character data into Double type numerical data.
End Function
```

[4] Example of use of memory function

```
Sub example004()
    'Sample program 4
    '[4]  Example of use of memory function
    'Frequently used settings can be stored in memory (A, B, C and D).
    'Settings stored in memory can be recalled later.
    'The voltage and FINE set values are stored together.

    'This sample program stores the 4.750 V FINE setting in memory A.
    'This sample program stores the 5.000 V FINE setting in memory B.
    'This sample program stores the 5.250 V FINE setting in memory C.
    'This sample program stores the 0.000 V FINE setting in memory D.
    'Memories A, B, C and D are read in 1 sec. after storage. The recall interval is set to 1 sec.
    'STORE command syntax: MMSTO <1-4>
    'RECALL command syntax: MEM <1-4>
    '<<MEMORY STO/RCL>>

    Dim d_setvoltage As Double                    'Set voltage variable
    Dim icount As Integer                         'Counter variable

    d_setvoltage = 4.5                            'Initial voltage setting value

    For icount = 1 To 4                           '1:A 2:B 3:C 4:D

        If icount = 4 Then
            d_setvoltage = 0                      'Sets 0.000 if icount = 4(D).
        Else
            d_setvoltage = d_setvoltage + 0.25    'Voltage set value +0.25 V
        End If

        Call example003(d_setvoltage)             'Calls voltage FINE setting function.
        Call Tx("MEMSTO" + Str$(icount))          'Memory storage
    Next

    Call Tx("VSET 0.000")                         'Resets voltage setting to 0.00 V.
    MsgBox "Memory storage operation is completed."   'Debugging message

    For icount = 1 To 4
        DoEvents
        Call Tx("MEM" + Str$(icount))             'Memory recall (of memory A, B, C)
        Call Wait_ReadBack                        'Reads output voltage.
        Sleep (1000)                              'Waits for 1 sec.
    Next
    MsgBox "Memory recall operation is completed."    'Debugging message
End Sub
```

[5] Examples of register settings/recalling and SRQ operation

```
Sub example005()
    'Sample program 5 [Valid only in GPIB communication]
    '[5] Example of register settings/recalling and SRQ operation
    'This sample program activates the current limit and generates SRQ at the Delayed Limit bit of FAU register bit 1 [DLIM].
    'This sample program checks the operation of SRQ by means of serial polling.
    'Related registers:
    '    STS? (Status register): Read-only register
    '    FUNMASK (Fault unmask register): Read/write register
    '    FUN? (Fault register): Read-only register (which is cleared after being read.)
    '    UNMASK (Unmask register): Read/write register
    '    STB? (Status byte register): Read-only register (which is cleared after being read.)
    '    Serial poll register (Status byte register): Read-only register
    '    The RQS bit is cleared after readout. If the SRQ factor remains in the cause register, the factor is not cleared.

    'Service requests
        '<<SRQ>>
        On Error Resume Next
        Call Tx("UNMASK 1;FUNMASK 2")          'Sets unmask register and fault unmask register.
        Call Tx("VLIMOVP 1;PILIMSET 0.5")      'Sets current limit to 0.5 A.
        Call Tx("LIMACTN 1;LIMDLY 0.05")       'Operation 1 when limited: OUT OFF, Delay time 0.05 sec.
        Call Tx("VSET 5.0;OUT ON")             'Sets voltage to 5.0 V and turns output ON.
        Call Tx("CLR")                         'Clears registers.

        Dim retVal As Integer

        Call Tx("IOUT?")
        If Val(g_strRxd) < 1 Then
            MsgBox "Vary load to supply 0.5 A or more."
        End If
        Do
            DoEvents
            retVal = io.ReadSTB                 'Serial polling
            Sleep (100)                        'Delay 100 ms.
        Loop Until retVal <> 0                  'Loops until SRQ rises.

        Dim spoll_result As String
        spoll_result = SRQ_analyze(retVal)      'Calls service request analysis.
        MsgBox spoll_result + vbCrLf + vbCrLf + "generated."  'Displays analysis result.
        Call Tx("SETINI")                       'Restores settings to factory-shipped settings.

End Sub

'-------------------------------------------------------------------------------------------------------
Function SRQ_analyze(spoll_data As Integer) As String
    'Service request analysis
    'After serial polling, the contents of the status byte register are analyzed.
    'If summary bit is ON, the contents of the register corresponding to the summary bit is queried and analyzed.
    Dim i As Integer
    Dim STBreg(7) As Integer
    Dim FAUreg(7) As Integer
    Dim ERRreg(7) As Integer

    '---------Status byte register analysis-----
    For i = 7 To 0 Step -1                      'Decomposes query into 8 bits.
        If spoll_data - 2 ^ i < 0 Then          'Substitutes 0 and 1 for STBreq(0) to STBreq(7).
            STBreg(i) = 0
```

```
    Else
        spoll_data = spoll_data - 2 ^ I
        STBreg(i) = 1

    End If
Next
'--------Fault register analysis------------
If STBreg(0) = 1 Then                               'Fault register summary bit ON
    Call Tx("FAU?")                                 'Fault register query
    spoll_data = Val(g_strRxd)                      'Converts FAU? query into numerical data.

    For i = 7 To 0 Step -1                          'Decomposes query into 8 bits.
        If spoll_data - 2 ^ i < 0 Then              '0 and 1 are substituted for FAUreq(0) to FAUreq(7).
            FAUreg(i) = 0
        Else
            spoll_data = spoll_data - 2 ^ i
            FAUreg(i) = 1
        End If
    Next

    If FAUreg(0) = 1 Then SRQ_analyze = "OVP"        'If bit 0 is 1, OVP is returned.
    If FAUreg(1) = 1 Then SRQ_analyze = "DLIM"       'If bit 1 is 1, DLIM is returned.
    If FAUreg(2) = 1 Then SRQ_analyze = "OHP"        'If bit 2 is 1, OHP is returned.
    If FAUreg(6) = 1 Then SRQ_analyze = "LIM"        'If bit 6 is 1, LIM is returned.
End If

If STBreg(1) = 1 Then SRQ_analyze = "PON"            'If bit 1 of serial poll register is 1, PON is returned.
If STBreg(2) = 1 Then SRQ_analyze = "SE"             'If bit 2 of serial poll register is 1, SE is returned.
'------------Error register analysis-----------
If STBreg(3) = 1 Then                                'Error register summary bit ON
    Call Tx("ERR?")                                  'Fault register query
    spoll_data = Val(g_strRxd)

    Select Case spoll_data

        Case 0
            SRQ_analyze = "No error."
        Case 1
            SRQ_analyze = "I/F syntax error."
        Case 2
            SRQ_analyze = "I/F argument error."
        Case 24
            SRQ_analyze = "No Use EXT SIG IN."
        Case 27
            SRQ_analyze = "Can't Recall SETUP."
        Case 35
            SRQ_analyze = "Inverlid Sequens."
        Case 51
            SRQ_analyze = "Parity error."
        Case 52
            SRQ_analyze = "Franing error."
        Case 53
            SRQ_analyze = "RX Buff overflow."
        Case 54
            SRQ_analyze = "RX Buff overflow."
        Case 60
            SRQ_analyze = "I/F invalid data."
        Case 61
            SRQ_analyze = "I/F can't execute."
```

```
          Case 62
              SRQ_analyze = "I/F No answer."
          Case 63
              SRQ_analyze = "I/F worning data."
          Case 79
              SRQ_analyze = "Data clip."
          Case 80
              SRQ_analyze = "Prediction V Limit"
          Case 81
              SRQ_analyze = "Prediction V Limit"
          Case Else
              SRQ_analyze = "Other error."
      End Select
   End If

   If STBreg(4) = 1 Then SRQ_analyze = "MCB"          'MCB ATCM bit ON

End Function
```

[6] Example of MCB path address specification and simultaneous operations

```
Sub example006()
    'Sample program 6  [Common to GPIB/RS232C]
    '[6] Example of MCB bus address specification and simultaneous operations
    'This sample program controls multiple PBX units at the same timing. The second and later PBXs need option boards.
    'Set the slave device address of the MCB11S option board to one of 1 to 15 using the configuration function of the main body.
    'Set the trigger voltage to multiple PBXs to let them output voltages simultaneously according to the GET or TRG command.
    'MCB master address: Fixed at 0, MCB slave address: 1 to 15
    'Specifying MCB address to 16 selects all MCBs.
    'The GET interface message can be used only in GPIB communication. The TRG command should be used in RS232C communication.
    '<<MCB>>
    Call Tx("PATH 0")                       'Specifies master address.
    Call Tx("VSET 0;OUT ON;TRIGVSET 5@")    'Sets trigger voltage to 5 V.
    Call Tx("PATH 1")                       'Sets sleep address.
    Call Tx("VSET 0;OUT ON;TRIGVSET 12@")   'Sets trigger voltage to 12 V.
    Call GET_operation                      'Issues GET command (valid only with GPIB; TRG command is used with RS232C.)
    Sleep (5000)                            'Wait time of 5 sec.
    Call Tx("PATH 16;TRIGVSET 0@")          'Sets trigger voltages of all devices to 0 V.
    Call Tx("TRG")                          'Issues TRG command (both GPIB/RS232C).
End Sub

'---------------------------------------------------------------------------------------------------
Sub GET_operation()
    Dim buff_ary(5) As Byte
    Dim count As Long
    Dim retVal As Long
    Dim GPIB_ADDRESS As Integer

    GPIB_ADDRESS = 1
    buff_ary(0) = &H3F                      'UNL
    buff_ary(1) = &H40                      'TA
    buff_ary(2) = &H20 + GPIB_ADDRESS       'MLA1
    buff_ary(3) = &H8                       'GET
    count = 4                               'Sent byte count
    retVal = m_session_INTFC.Command(buff_ary, count)
End Sub
```

[7] Example 1 of sequence operation [C.V operation, NV mode]

```
Sub example007()
    'Set the short piece on rear panel to NORMAL.
    'Sample program 7 [Normal sequence registration]
    'This sample program registers a new sequence.
    '(1)Sequence mode setting
    'NEWSEQ [1:NV 2:NI],[1:TimeUnit ms 2:TimeUnit sec 3:TimeUnit minute 4:TimeUnit hour]
    'Mode query command: SEQMODE? query is answered in numerical data. [1:NV 2:NI]
    '
    '(2) Sequence setting
    'SEQUENCE <SEQ_No,PROG_No,LOOP_value,Chain_SEQ_No,End_prog_No>
    'SEQ_No <1-8>  PROG_No <1-8>
    'Sequence query command: SEQUENCE?, <1-8> query is answered, for example, as "1,1,100,0,0,0.0001".
    '
    '(3) PROGRAM number setting
    'PROGRAM <1-16>
    'Program number query command: PROGRAM? query is answered in 1-16.
    '
    '(4) Step setting [Maximum number of steps in NV and NI modes: 256 steps]
    'STEP <Step_No,Lamp_on_off,Set_value,TRG_on_off,Out_on_off,Pause_on_off,time>
    'Step_No <1-256>  Set_value <Voltage/current set values> TRG_on_off<1:ON 0:OFF>
    'Step query command: STEP?, <Step number> query is answered, for example, as "1,1,1,2,16".
    '
    '(5) Program final line specification
    'EOS <Step number>  If step number is omitted, data is written in the step of the last step number + 1.

    'Example 2 of sequence operation (CV operation, NV mode)
    '<<NORMAL SEQUENCE SAMPLE>>

    '------ Mode ----------
    Call Tx("EXECUTE 0")                        'Exits sequence execution mode.
    Call Tx("NEWSEQ 1,1")                       'Specifies normal sequence [NV] mode.
    '------ Sequence ----------
    Call Tx("SEQUENCE 1,1,1,2,16")
    Call Tx("SEQUENCE 2,2,2,3,16")
    Call Tx("SEQUENCE 3,3,1,0,16")
    '------ Program ----------
    Call Tx("PROGRAM 1")                        'Specifies PROGRAM 1.
    Call Tx("STEP 1,0,25.0,1,1,0,50ms")
    Call Tx("EOS")                              'Sends EOS.

    Call Tx("PROGRAM 2")                        'Specifies PROGRAM 2.
    Call Tx("STEP 1,0,0.00,1,1,0,10ms")
    Call Tx("STEP 2,1,15.0,0,1,0,20ms")
    Call Tx("STEP 3,0,15.0,0,1,0,30ms")
    Call Tx("STEP 4,0,10.0,0,1,0,40ms")
    Call Tx("STEP 5,1,-10.0,0,1,0,50ms")
    Call Tx("EOS")                              'Sends EOS

    Call Tx("PROGRAM 3")                        'Specifies PROGRAM 3.
    Call Tx("STEP 1,0,-10.0,0,1,0,30ms")
    'If STEP number is omitted, last step number + 1 is set.
    Call Tx("STEP  ,1,10.0,0,1,0,20ms")
    Call Tx("STEP  ,0,10.0,0,1,0,30ms")
    Call Tx("STEP  ,0,-10.0,0,1,0,30ms")
    Call Tx("EOS")                              'Sends EOS.

    Call Tx("PROGRAM 16")                       'Specifies PROGRAM 16.
```

```
    Call Tx("STEP 1,0,0.00,0,0,0,1ms")
    Call Tx("EOS")                                          'Sends EOS.


    '------ SAVE to EEPROM ----------
    Call Tx("FSAVE 0@")                                     'Saves file.
    Call Sequence_RUN                                       'Executes sequence.


End Sub
```

[8] Example 2 of sequence operation (C.V operation, FV mode)

```
Sub example008()
    'Set the short piece on rear panel to FAST.
    'Sample program 8 [Fast sequence registration]
    'This sample program registers a new sequence.
    '(1) Sequence mode setting
    'NEWSEQ <10|11> [10: FV  11:FI]
    'Mode query command: SEQMODE? query is answered in numerical data. [10: FV  11:FI]
    '
    '(2) Sequence setting
    'SEQUENCE <SEQ_No,PROG_No,LOOP_value,Chain_SEQ_No,End_prog_No,time>
    'SEQ_No <1-8>  PROG_No <1-8>
    'Sequence query command: SEQUENCE?, <1-8> query is answered, for example, as "1,1,100,0,0,0.0001".
    '
    '(3) PROGRAM number setting
    'PROGRAM <1-16>
    'Program number query command: PROGRAM? query is answered in 1-16.
    '
    '(4) Step setting [Maximum number of steps in FV and NI modes: 1024 steps]
    'STEP <Step_No,Set_value,TRG_on_off> TRG_on_off
    'Step_No <1-1024>  Set_value <Voltage/current set values> TRG_on_off<1:ON  0:OFF>
    'Step query command: STEP?, <Step number> query is answered, for example, as "1,0.00,0".
    '
    '(5) Program final line specification
    'EOS <Step number>  If step number is omitted, data is written in the step of the last step number + 1.
    '
    'This program takes about 2 minutes till the end of sequence write.
    'Example 2 of sequence operation (CV operation, FV mode)
    '<<Fast Speed SEQUENCE SAMPLE (Sine wave)>>
    Dim VA As Double
    Dim PI As Double
    Dim V As Double
    Dim i As Integer
    Dim loop_count As String
    Dim SEQ_NO As String
    Dim PROG_NO As String
    Dim END_PROG_NO As String
    Dim Chain_prog_NO As String
    Dim time_set As String

    SEQ_NO = "SEQUENCE 1"                                   'Specifies SEQUENCE number.
    PROG_NO = "1"                                           'Specifies PROGRAM number.
    loop_count = "100"                                      'Specifies LOOP count.
    Chain_prog_NO = "0"                                     'Specifies chain program.  0: No chain
    END_PROG_NO = "0"                                       '0: No end
    time_set = "100uS"                                      'Sets FV/FI mode execution time to 100 _s or more.
    VA = 20
    PI = 3.1415
    '------ Mode ----------
```

```
    Call Tx("EXECUTE 0")                                              'Exits sequence execution mode.
    Call Tx("NEWSEQ 10")                                             'Specifies fast sequence [FV] mode.
    '------ Sequence ----------
    Call Tx(SEQ_NO + "," + PROG_NO + "," + loop_count + "," + Chain_prog_NO + "," + END_PROG_NO + "," + time_set) '
    '------ Program ----------
    Call Tx("PROGRAM 1")                                             'Specifies PROGRAM 1.

    For i = 0 To 1023                                                'Writes 1024 steps of data.
        V = VA * (Sin(2 * PI * i / 1023))                           'Calculates sine curve voltage data.
        Call Tx("STEP" + Str$(i + 1) + "," + Str$(V) + "," + trg_off)   'Sends STEP data.
    Next
    Call Tx("EOS")                                                   'Sends EOS.
    Call Tx("FSAVE 0@")                                              'Saves file.
    Call Sequence_RUN                                                'Executes sequence.
End Sub
```

[9] Execution of sequence operation 3

```
Sub Sequence_RUN()
    'Sample program 9 [Sequence execution]
    'This sample program executes a sequence.
    '(1) Program number specification: PROGRAM <1-16>     * This can be omitted if the program number has been set immediately before.
    '
    '(2) Sequence execution mode setting
    'EXECUTE <1,0> [1:Execute mode   0:Edit mode]
    'Sequence execution mode query: EXECUTE? query is answered in 1 or 0.
    '
    '(3) Execution/stop/pause
    'RUN <Sequence number 1-8>
    'STOP
    'PAUSE <1,0> [1:ON  0:OFF]
    '
    'Sequence executing status query command: RUNNING?
    'Query is returned as "<STOP:1,RUN:2,PAUSE:3>,<SEQ.NO>,<PROG.NO>,<STEP.NO>".
    '<<Fast Speed SEQUENCE Execute>>

    Dim retVal As Integer
    Call Tx("PROGRAM 1")                                             'Specifies PROGRAM 1.
    Call Tx("UNMASK 4")                                              'Sets SE bit of unmask register.
    Call Tx("SEQMODE?")                                              'Sequence mode query
    If Val(g_strRxd) > 9 Then                                        'Fast sequence judgment
        Call Tx("OUT 1@")                                            'Sends output ON.
    End If
    '------ Execute----------
    Call Tx("EXECUTE 1")                                             'Sends sequence execution mode ON.
    Call Tx("RUN 1")                                                 'Sends sequence execution.
    '------ SEQUENCE STOP detection----
    Do
        DoEvents
        Call Tx("RUNNING?")                                         'Sequence execution status query
        retVal = io.ReadSTB                                          'Serial polling
        Sleep (100)                                                 'Delay
    Loop Until retVal <> 0                                           'Loops until SRQ rises.

    Dim spoll_result As String
    spoll_result = SRQ_analyze(retVal)                              'Calls service request analysis.
    MsgBox spoll_result + vbCrLf + vbCrLf + "SRQ is generated."     'Displays analysis result.
    Call Tx("EXECUTE 0")                                            'Sends sequence execution mode OFF.
End Sub
```

4.8 Table of Command Headers

A table of command headers is shown below. The index numbers shown in the table conform with those used in Section 4.3.2 "Structures of Commands."

Header Name	Index No.	Header Name	Index No.	Header Name	Index No.
AMPLSET	[5]	LLO	[9], [10]	SETRCL	[3]
CLR	[8]	MCBACTN	[4]	SETSTO	[3]
CTRLZ	[10]	MEASMODE	[5]	SILENT	[10]
EOS	[7]	MEM	[3]	STB	[11]
ERR	[11]	MEMSTO	[3]	STEP	[6]
EXECUTE	[7]	MILIMSET	[4]	STOP	[7]
FAU	[11]	MOD	[11]	STS	[11]
FLOAD	[7]	MVLIMSET	[4]	TERM	[11]
FSAVE	[7]	NEWSEQ	[6]	TEXTIDX	[7]
FUNMASK	[11]	OUT	[1]	TEXTPROG	[7]
HEAD	[11]	PATH	[9]	TEXTSEQ	[7]
HMILIM	[4]	PAUSE	[7]	TRG	[2]
HMVLIM	[4]	PILIMSET	[4]	TRIGISET	[2]
HPILIM	[4]	PORT	[8]	TRIGSTOP	[2]
HPVLIM	[4]	POW	[8]	TRIGVSET	[2]
IDN	[11]	PROGRAM	[7]	TRTF	[1]
IFINE	[1]	PVLIMSET	[4]	UNMASK	[11]
IMAX	[5]	RESET	[4]	VFINE	[1]
IMIN	[5]	ROOTPATH	[9]	VLIMOVP	[4]
IOUT	[1]	RUN	[7]	VMAX	[5]
ISET	[1]	RUNNING	[7]	VMIN	[5]
LIMACTN	[4]	SEQMODE	[7]	VOUT	[1]
LIMDLY	[4]	SEQUENCE	[6]	VSET	[1]
		SETINI	[3]	WAIT	[8]
				$<X_{OFF}>$	[10]
				$<X_{ON}>$	[10]

Chapter 5

PANEL DESCRIPTION

This chapter describes the functions of the switches, keys, indicators, and other panel items on the front and rear panels of the power supply.

Contents   Page

5.1 Front Panel
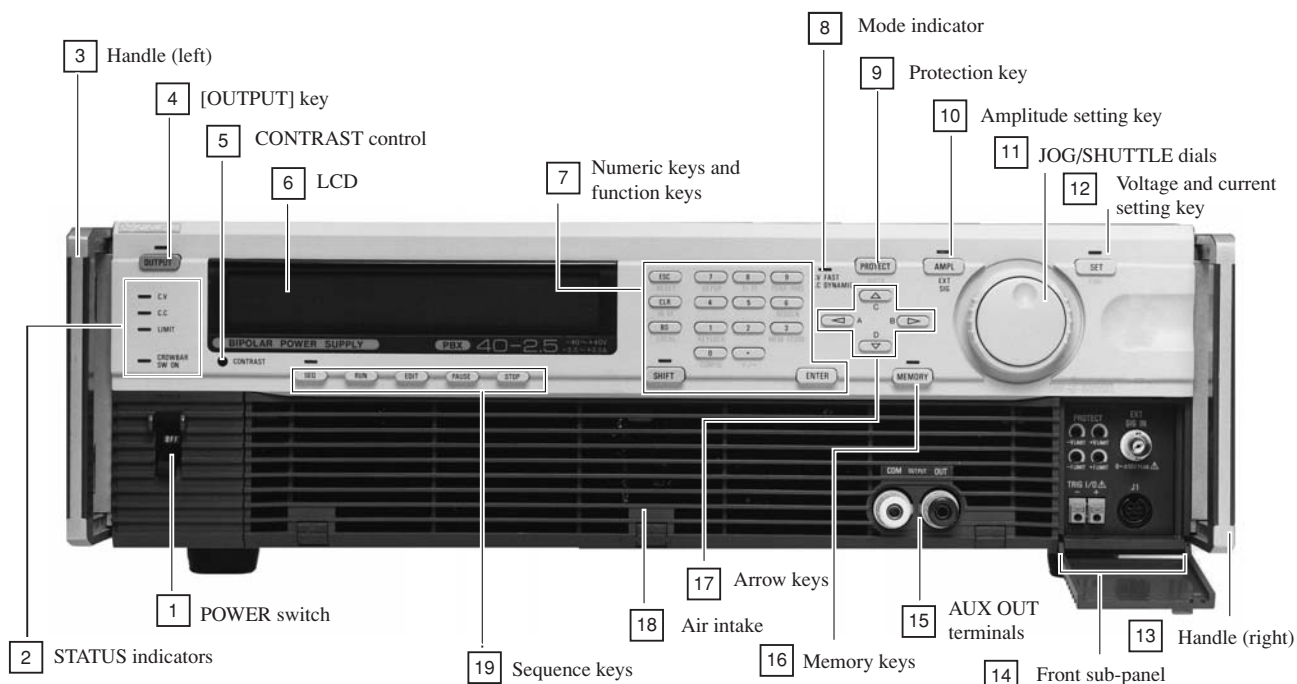
An example of Front Panel of PBX40-2.5

1 POWER switch

Turns ON/OFF the AC input power of the power supply.

For approximately 2 seconds after the POWER switch is turned ON, the power supply performs self test. During this power-on test period, other functions of the power supply are suppressed.

2 STATUS indicators

Indicate the statuses of the power supply.

C.V   Illuminates to indicate that the power supply is in the constant-voltage mode.

C.C   Illuminates to indicate that the power supply is in the constant-current mode.

LIMIT   Illuminates to indicate that one of the protectors (±V limiter, ±I limiter, power limiter, and OHP) has tripped.

CROWBAR SW ON

             Of a power supply which is incorporated with the crowbar option, this indicator illuminates to indicate that the OVP setting is [OV Crowbar ON].

3 Handle (left)

4 [OUTPUT] key

Each time as you press this key, the output is turned ON/OFF. When the output is ON, the LED illuminates. When the output is OFF, the output circuit exhibits a high impedance (several 1 kΩ).

5 CONTRAST control

Adjusts contrast of the LCD display.

6 LCD

A liquid crystal display which shows voltage and current settings, parameters, menus, messages, and other information and data.

7 Numeric keys and function keys

These keys are used to enter numeric data and to select menu items and functions.

[ESC]	To cancel the currently proceeding procedure and return to the preceding menu.
[CLR]	To clear the typed value.
[BS]	To clear only one letter that was typed latest.
[0] - [9]	To type a numeric value or to select a menu item.
[.]	To type a decimal point.
[SHIFT]	To be pressed to select the function marked with blue letters below a key. The <SHIFT> LED will illuminate when the shift is effected.
[ENTER]	To enter the typed value.

Table of blue-letter functions

RESET ([SHIFT]+[ESC])

> To reset from the error status or alarm status.

IBST ([SHIFT]+[CLR])

> To display the GPIB status.

LOCAL ([SHIFT]+[BS])

> To return to the LOCAL mode from the interfaced remote mode

Tr Tf ([SHIFT]+[8])

> To select rise/fall time for C.V or C.C mode. (Available only when in the C.V Fast mode or C.C dynamic mode.)

SETUP ([SHIFT]+[7])

> To display a setup file menu.

RESOLN ([SHIFT]+[6])

> To set a click resolution for [SET] (setting with JOG dial or [▲] [▼] keys).

> If selected when in C.V mode, the voltage [SET] resolution can be set; if selected when in C.C mode, the current [SET] resolution can be set. The range of resolution is from 0.001 to about one-half of the rated voltage or current.

MEM STORE ([SHIFT]+[3])

> To store the currently existing setup data (the voltage when in the C.V mode or the current when in the C.C mode) in memory area [A], [B], [C], or [D]. When modes are changed between C.V and C.C, the default value is assumed.

> Example: [SHIFT]+[3] MEM STORE +[A] keys are to store data in memory A.

KEYLOCK ([SHIFT]+[1])

> To lock the keys on the front panel. The locked keys can be released by pressing the [SHIFT]+[1] KEYLOCK keys again.

CONFIG ([SHIFT]+[0])

> To call out the configuration menu for setting the conditions the power supply should assume when its POWER switch is turned on.

8 Mode inindicator

Illuminates to indicate that the power supply is in the Fast C.V mode or Dynamic C.C mode.

9 Protection key

[PROTECT]   To set the software ±V limit or software ±I limit, or to select the actions to be taken when one of these limiters has tripped. Also to check the set limit value of the hardware ±V limiter or hardware ±I limiter.

AUTO ([SHIFT]+[PROTECT])

For automatic setting of software ±V limit or software ±I limit. The percentages are selectable on the configuration menu.

10 Amplitude setting key

[AMPL]   To set the amplitude value with reference to an external signal applied via the BNC terminal on the front sub-panel. The value can be set with the numeric keys or JOG/SHUTTLE dials.

11 JOG/SHUTTLE dials

To change numeric values or to scroll menus.

12 Voltage and current setting key

[SET]   To enable setting of the output (voltage when in the C.V mode or current when in the C.C mode). The value for the output can be set with the numeric keys, JOG/SHUTTLE dials, or [▲] [▼] keys.

FINE ([SHIFT]+[SET])

To enable fine setting of the output (voltage when in the C.V mode or current when in the C.C mode). The fine value for the output can be set with the JOG/SHUTTLE dials.

13 Handle (right)

14 Front sub-panel

Accommodates the following controls and connectors:

PROTECT

+V LIMIT	Potentiometer for hardware +V limit
-V LIMIT	Potentiometer for hardware -V limit
+I LIMIT	Potentiometer for hardware +I limit
-I LIMIT	Potentiometer for hardware -I limit
TRIG I/O	Terminal for trigger signal input/output
EXT SIG IN	Terminal of external signal input for analog remote control
J1	Terminal to hook up the dedicated-type remote controller (optional)

Caution

- *Before connecting wires to or disconnecting wires from the terminals, be certain that the AC input power of the power supply is OFF.*

15 AUX OUT terminals

The rated output current of the power supply is the sum of the current that is delivered through these output terminals plus that delivered through the output terminals on the rear panel.

NOTE

• *The performance specifications is not applicable to these auxiliary output terminals on the front panel.*

16 Memory keys

[MEMORY]   The voltage setting or current setting value can be recalled from the memory with the [A] , [B] , [C] or [D] key or with the JOG dial and [ENTER] key. When in the memory recall mode, the LED illuminates.

17 Arrow keys

To increment/decrement a numerical value or to scroll a menu.

18 Air intake

To intake cooling air.

Caution

• *Periodically clean the air filter.*

• *Pay attention so that the air intake is not blocked.*

19 Sequence keys

To edit sequence files and to control sequence actions.

[SEQ]   Selects the sequence mode. The LED illuminates to indicate the sequence mode.
[RUN]   Executes the selected sequence file.
[EDIT]   To edit the sequence file.
[PAUSE]   To pause the sequence file being executed or to resume the paused sequence.
[STOP]   To stop the sequence that is being executed or has been paused.

5.2 Rear Panel
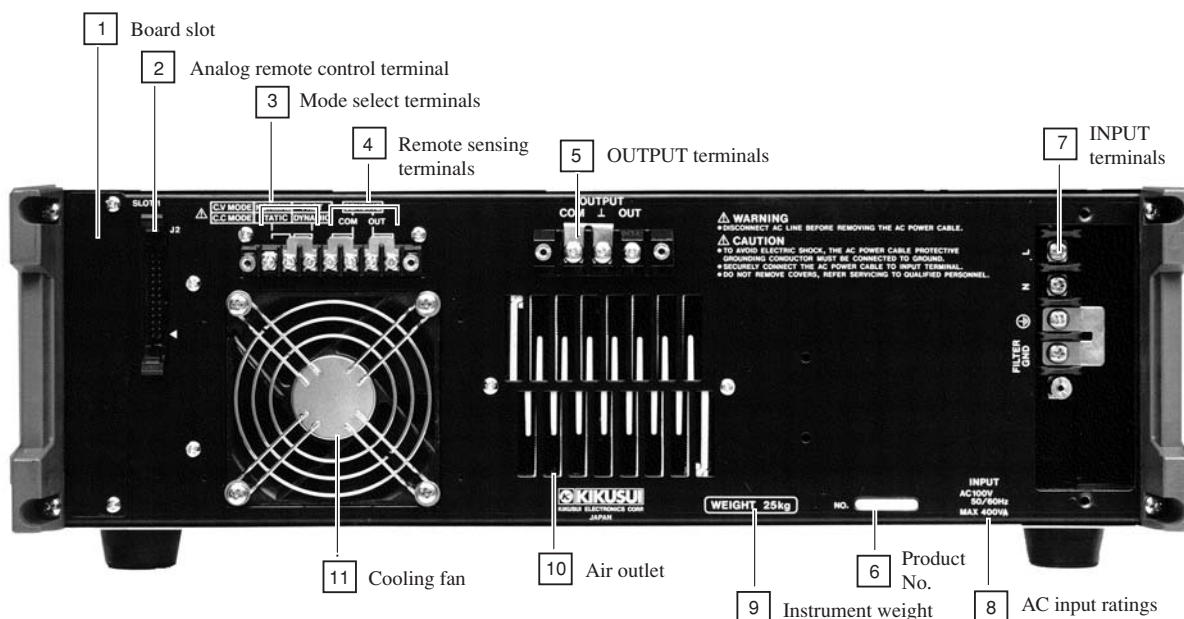
Note: Items 2, 3, 4, 5 and 7 are as they appear when their covers are removed.

An example of Front Panel of PBX40-2.5
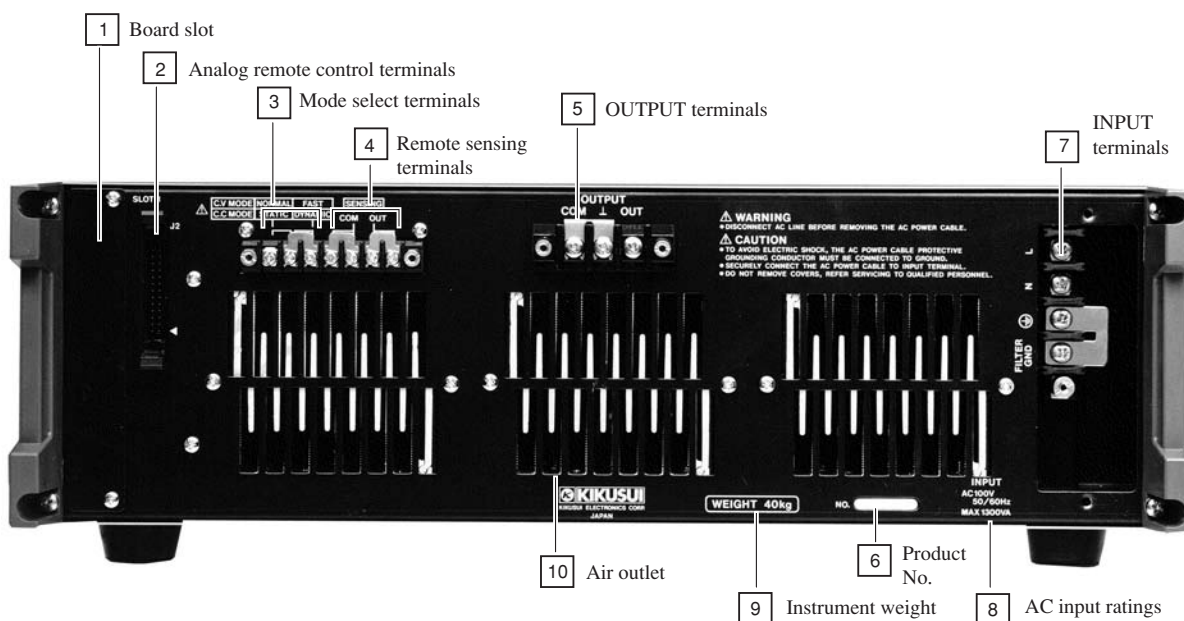
Note: Items 2, 3, 4, 5 and 7 are as they appear when their covers are removed.

An example of Front Panel of PBX40-10

1 Board slot

The board slot is to install one of the following three types of optional interface boards:

- IB11 (GPIB interface board)
- RS11 (RS-232C interface board)
- MC11S (MCB interface board)

Caution

- *Before inserting/removing an interface board or connecting/disconnecting the cables, be certain that the AC input power of the supply has been turned OFF.*

2 Analog remote control terminals

These terminals are for the analog remote control signals and monitor signals as follows:

- Voltage signal for output voltage control
- Resistance signal for output voltage control
- Voltage signal for Output current control
- Resistance signal for output current control
- Signal for output ON/OFFcontrol
- Signal for shut down of POWER switch
- C.V monitor signal
- C.C monitor signal
- Other output signals

Caution

- *Before connecting/disconnecting the connectors or cables, be certain that the POWER switch has been turned OFF.*

- *Be certain that the terminal cover has been put on. Do not operate the power supply with the terminal cover removed.*

3 Mode select terminals

To select an operation mode of the power supply by changing connection of the short piece.

Caution

- *Before changing connections of the short piece, be certain that the POWER switch has been turned OFF.*

- *Be certain that the terminal cover has been put on. Do not operate the power supply with the terminal cover removed.*

4 Remote sensing terminals

To connect the remote sensing wires. The remote sensing is to compensate for voltage drops that are caused by the load-connection wiring resistances and contact resistances.

Caution

- *Be sure to securely connect the sensing wires. Note that, if the sensing circuit is open, an abnormal voltage may develop and the power supply and its load may be damaged.*

- *Be certain that the terminal cover has been put on. Do not operate the power supply with the terminal cover removed.*

5 OUTPUT terminals

These terminals deliver the output of the power supply. Normally, connect the OUT or COM terminal to the chassis ground by using the short piece that accompanies the power supply. Note that, if none of them is grounded, the performance of the power supply may not meet the performance specifications.

WARNINGS

- *Be certain that the terminal cover has been put on. Do not operate the power supply with its terminal cover removed.*

6 Product No.

Indicates the serial number of the power supply.

7 INPUT terminals

The terminals of the AC input power circuit of the power supply.

L	Live
N	Neutral
GND	Ground
FILTER GND	Noise filter ground

WARNINGS

• *In order to prevent electric shock hazards, be sure to ground the GND terminal of the power supply by connecting to it the GND wire (green) of the AC input power cable which accompanies the power supply.*

• *Unless the power supply is grounded, electric shock hazards can result. Make it double sure that the power supply is securely grounded.*

• *Do not touch the AC power input terminals.*

• *The task of connecting the AC input power cable to the power supply and to a power distribution panel involves danger. The task must be undertaken only by qualified electronics personnel.*

• *Be certain that the terminal cover has been put on. Do not operate the power supply with its terminal cover removed.*

8 AC input ratings

9 Instrument weight

10 Air outlet

This is the cooling air outlet of the power supply. Note that hot exhaust air (room temperature + up to approximately 40°C) comes out of the outlet.

Caution

• *Do not touch the air outlet. Do not block the hot air that comes out of the outlet.*

• *The exhaust air temperature may become high (room temperature + up to approximately 40℃) depending on the load. Do not put behind the power supply any objects which are not heat resistant.*

11 Cooling fan

Chapter 6.
MAINTENANCE AND CALIBRATION

This chapter describes the maintenance, inspection, and calibration methods of the power supply.

Contents   Page

6.1 Maintenance and Inspection

It is most recommendable to render inspection, maintenance and calibration service for the power supply at certain scheduled intervals.

(WARNINGS) · *Before start servicing the power supply, be sure to disconnect its AC input power cable from its power source (AC line outlet or distribution panel).*

[A] Cleaning the front panel and dust filter

(a) Cleaning the front panel
To clean the front panel, wipe it lightly with a soft cloth moistened with thin neutral soapsuds.

(Caution) · *Do not use benzine, thinner, or other detergent. Detergent may cause discoloration of the panel surface, erasure of printed characters and marks, and clouding of the display screen.*

(b) Cleaning the dust filter
If the filter is clogged with dust, the cooling efficiency will be degraded and troubles may result or the life of the power supply may be shortened. It is most recommendable to clean the filter at certain scheduled intervals. To take out the filter to clean it, remove the louver as shown below.

■ Removing the louver
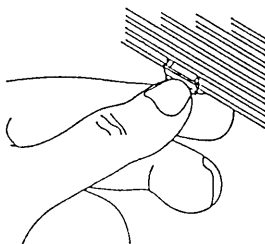
Push down the three nails.

■ Installing the louver
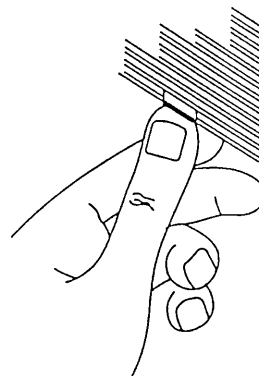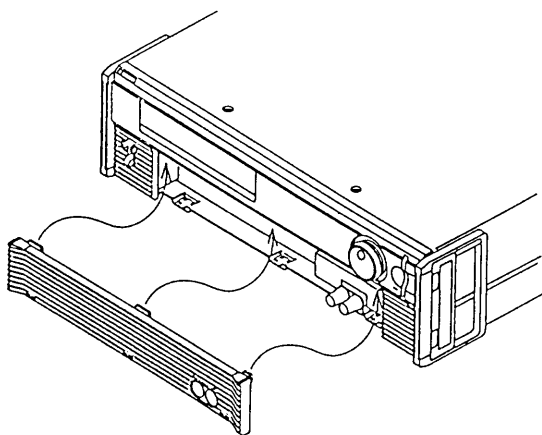
Put back the louver by mating its top protrusions into the indents of the power supply, and fix the louver by pushing up the three nails.

[B] Inspecting the AC input power cable

Inspect the AC input power cable for any signs of abnormality. Check that its sheath is not damaged, and that its plug is not cracked and has no loose screws.

[C] Order for overhaul

Certain internal components (such as electrolytic capacitors and cooling fan motor) of the power supply are wearable components and should be replaced when a certain period has elapsed. The period typically is 10,000 running hours, although it differs depending on the conditions of use of the power supply. You are recommended to order, when such period has elapsed, your Kikusui agent for overhaul of your power supply.

WARNINGS
- *Before cleaning or moving the power supply, be certain that its AC input power cable has been disconnected from its power source (AC line outlet or distribution panel).*
- *Never open the casing of the power supply.*

6.2 Calibration

The power supply is calibrated before shipment by the vendor warranting that it meets its performance specifications. Later, however, due to changes in environments and due to aging by a long run of use, the power supply may become unable to meet the specified setting accuracies of the output voltage, output current, V limit values, and I limit values. When this is the case, calibrate the power supply following the instructions given in this section.

6.2.1 Preparation

Before start calibrating the power supply, allow a stabilization period (warm up period with power switch ON) of 20 minutes or more. This will eliminate the calibration errors that could be caused by initial drifts.

Before start calibrating the power supply, turn the ±V limit and ±I limit potentiometers on the front sub-panel to their full clockwise positions. Return them to the required positions after the calibration is over.

6.2.2 Calibration Instruments

To calibrate the power supply, you need the following instruments:

- DC voltmeter (DVM), accuracy 0.02% or better
- Shunt resistor, accuracy 0.1% or better

6.2.3 Calibration Setups

The calibration setups differ between voltage calibration and current calibration as shown below.

(a) Voltage calibration
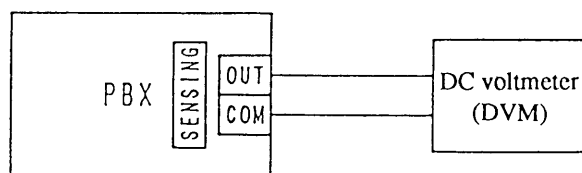
(b) Current calibration

The current can be known by measuring the voltage drop developed across the shunt resistor.
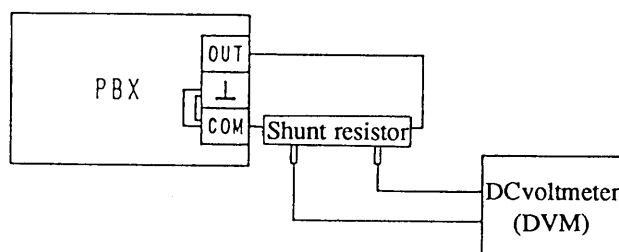
(Caution)　　　　• *For the calibration setup wiring, use wires of sufficiently large current ratings.*

6.2.4 Calibration Procedures

This section describes the calibration procedures, taking the PBX40-10 as an example.

(*Caution*) • *When calibrating your power supply, observe strictly the instructions given below.*
If you do not, your power supply may not meet the performance specifications.

[A] Voltage Calibration

The items which are subject to voltage calibration are as follows:

- Offset voltages
- Full scale voltages ("+" and "−")
- Software ±V limit offset voltages
- Software ±V limit full-scale voltages
- Hardware ±V limit offset voltages
- Hardware ±V limit full-scale voltages
- RMS display offset
- RMS display full-scale

Calibration of ±V limit values and RMS values are automatically done by using the calibration values of offset voltages and full-scale voltages. Thus, calibration of offset voltages and that of full-scale voltage only are needed for voltage calibration. For offset voltage calibration, adjust so that the output voltage becomes 0.000V. For full-scale voltage calibration, enter the readback value of the actual output voltage with the numeric keys.

■ Example of voltage calibration

① Press the 【SHIFT】 + 【0】 CONFIG keys and 【9】 key in this order to select [calibration].

```
>9 :  C a l i b r a t i o n
    I D  C o d e  ?      4 0 1 0
```

- Enter a calibration ID code of 4 digits with the numeric keys.
- For the calibration ID codes, refer to Appendix 6 "ID Codes for Calibration."

▼

```
>1 :  V o l t a g e
  2 :  C u r r e n t
```

- The display indicates the calibration mode.
- Check the connections when in this state.

② Press the 【1】 key to select the voltage calibration mode.

```
S t a r t  C a l i b r a t i o n
    R e a d y  ?
```

③ After checking the connections, press the 【ENTER】 key to start voltage calibration. With the JOG dial, adjust the DVM reading to 0V (zero volts) as accurately as possible.

```
Adjust  to  0 V
    Ready  ?
```

· The output voltage is 0V.

⑷ Press the 〔ENTER〕 key to terminate the offset voltage calibration.
Next, calibrate the full scale voltage.

```
Reading  Voltage  ?
                  V
```

· The output voltage is approximately 100% of the rated output voltage.

⑤ For "+" full-scale voltage calibration, enter the DVM reading with the numeric keys, For example, press the 〔3〕 , 〔9〕 , 〔.〕 , 〔6〕 , 〔9〕 , 〔2〕 and 〔ENTER〕 keys in this order.

```
Reading  Voltage  ?
       39.692V
```

⑥ For "−" full-scale voltage calibration, enter the DVM reading with the numeric keys, For example, press the 〔3〕 , 〔9〕 , 〔.〕 , 〔7〕 , 〔8〕 , 〔9〕 and 〔ENTER〕 keys in this order.

```
Reading  Voltage  ?
      −39.789V
```

· The [−] sign does no require key-entry.

▼

```
RMS  Calibrating
```

· Automatic execution of RMS display calibration

▼

```
V  Limit  Calibrating
```

· Automatic execution of software and hardware ±V limit calibration

▼ At about 2 seconds later

```
Save  Data
    Sure  ?
```

· The voltage calibration is over. The calibration values will be stored onto the non-volatile memory.
· The calibration values will not be stored if you press the 【ESC】 key.

⑦ Press the 【ENTER】 key to store the calibration values.

```
>1:  Voltage
  2:  Current
```

[B] Current Calibration

The items which are subject to current calibration are as follows:

- Offset current
- Full scale currents ("+" and "−")
- Software ±I limit offset currents
- Software ±I limit full-scale currents
- Hardware ±I limit offset currents
- Hardware ±I limit full-scale currents

Calibration of ±I limit values are automatically done by using the calibration values of offset currents and full-scale currents. Thus, calibration of offset currents and that of full-scale currents only are needed for current calibration.

For offset current calibration, adjust so that the output current becomes 0.000A. For full-scale current calibration, enter the readback value (value converted by calculation) of the actual output current with the numeric keys.

■ Example of current calibration

① Press the [SHIFT] + [0] CONFIG keys and [9] key in this order to select [calibration].

```
> 9 :   C a l i b r a t i o n
     I D   C o d e   ?       4 0 1 0
```

- Enter a calibration ID code of 4 digits with the numeric keys.
- For the ID codes, refer to Appendix 6 [ID Codes for Calibration.]

▼

```
> 1 :   V o l t a g e
  2 :   C u r r e n t
```

- If you are going to do a current calibration following a voltag calibration, start it with this state.
- Check the connections when in this state.

② Press the [2] key to select the current calibration mode.

```
S t a r t   C a l i b r a t i o n
     R e a d y   ?
```

③ After checking the connections, press the [ENTER] key to start current calibration. With the JOG dial, adjust the DVM reading to 0A (zero amperes) as accurately as possible.

```
A d j u s t   t o   0 A
     R e a d y   ?
```

- The output current is 0A.

④ Press the 【ENTER】 key to terminate the offset current calibration.
Next, calibrate the full scale current.

```
Reading  Current   ?
                    A
```

· The output current is approximately 100% of the rated output current.

⑤ Wait until the voltage detected by the shunt resistor is stabilized.
Then, enter the actual output current value (value converted by calculation from the DVM reading) with the numeric keys. For example, press the 【9】 , 【.】 , 【8】 , 【6】 , 【3】 and 【ENTER】 keys in this order.

```
Reading  Current   ?
             9.863A
```

· Conversion formula

$$\text{Actual current} = \text{DVM reading} \times \frac{\text{Rated curren of shunt resistor}}{\text{Rated voltage drop across shunt resistor}}$$

⑥ Enter the actual output current value (value converted by calculation from the DVM reading) with the numeric keys. For example, press the 【9】 , 【.】 , 【7】 , 【8】 , 【9】 and 【ENTER】 keys in this order.

```
Reading  Current   ?
           - 9.789A
```

· The [−] sign does no require key-entry.

▼

```
I  Limit  Calibrating
```

· Automatic execution of software ±I limit calibration

▼ At about 2 seconds later

```
Save  Data
   Sure  ?
```

· The current calibration is over. The calibration values will be stored onto the non-volatile memory.
· The calibration values will not be stored if you press the 【ESC】 key.

⑦ Press the 【ENTER】 key to store the calibration values.

```
>2:  Current
 1:  Voltage
```

⑧ Press the 【ESC】 key twice.

```
OUT      0.001V  -  0.01A
```

· The root display will resume.

Chapter 7.
SPECIFICATIONS

This chapter provides tables of electrical specifications, mechanical specifications, accessories, and optional items.

Contents

7.1 Electrical Specifications

(Caution)

- *Unless specified otherwise, the following conditions after warm-up for 30 minutes are assumed for the specifications:*
  1) *The loads are purely resistive.*
  2) *The remote sensing function is not employed.*
  3) *The COM output terminal is connected to the chassis ground terminal by using the short piece that accompanies the power supply.*
- *Polarity definitions for output voltage or current "+" (positive) and "−" (negative) are as follows:*
  1) *For voltage: "+" if the potential of the OUT terminal is higher than that of COM terminal, or "−" if the potential of the OUT terminal is lower than that of the COM terminal.*
  2) *For current: "+" if the current flows out of the OUT terminal, or "−" if it flows into the OUT terminal.*
- *The "rated load state" is such that the rated output current is flowing when the output voltage is at the rated voltage, or that the rated output voltage is developed when the output current is at the rated current.*
- *The "rated load" is a load that is connected to the power supply when it is in the rated load state.*
- *The "typ" values (typical values) are only for information. They are not included in the warranted electrical performance specifications of the power supply.*
- *The AUX OUT terminals do not meet the warranted electrical performance specifications of the power supply.*

Item			PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10	Unit
AC line requirements	Voltage and frequency		AC100V ±10%, 50/60Hz, 1 ϕ .			(110, 120, 200, 220, 240V are factory-modification options.)			
	Input current (at 100V, with rated load state)		3	6	10	3	5	9	A
	Inrush current *1		13						A
Output settings	Voltage setting	Setting range	0 - ±20.00			0 - ±40.00			V
		Resolution	1						mV
	Output voltage	Output accuracy *2	±20			±40			mV
		Temperature coefficient *3	100						ppm/℃
	Current setting	Setting range	0 - ±5.00	0 - ±10.00	0 - ±20.00	0 - ±2.50	0 - ±5.00	0 - ±10.00	A
		Resolution	1						mA
	Output current	Output accuracy *2	±20	±30	±60	±10	±20	±30	mA
		Temperature coefficient *3	100						ppm/℃
Display	DC	Voltage — Display accuracy *4	0.07% + 5			0.07% + 10			mV typ.
		Voltage — Temperature coefficient *5	100						ppm/℃ typ.
		Current — Display accuracy *4	0.3% + 20						mA typ.
		Current — Temperature coefficient *5	150						ppm/℃ typ.
	PEAK	Voltage display accuracy *6	±0.2			±0.4			V typ.
		Current display accuracy *6	±0.2	±0.3	±0.4	±0.2	±0.2	±0.3	A typ.
	RMS	Voltage display accuracy *7	±0.2			±0.4			V typ.
		Current display accuracy *7	±0.2	±0.3	±0.4	±0.2	±0.2	±0.3	A typ.

*1: Inrush current ≦ (Input voltage ×$\sqrt{2}$) ÷ 12 (Inrush current: The transient current that the power supply draws from the AC line within 2 seconds after its AC input power switch is turned on) AC line voltage = 110V

*2: Accuracy of the output voltage with respect to the setting, at a temperatures within ±5℃ (±9°F) of that when at calibration, excluding the measuring errors when at calibration and when at evaluation

*3: Rate of change of absolute value of output

*4: Accuracy of the displayed value with respect to the output, at a temperatures within ±5℃ (±9°F) of that when at calibration, expressed in terms of ±[(□□% of displayed absolute value) + □]

*5: Rate of change of absolute value of output display

*6: Accuracy of display when peaks of pulse width 1ms are detected at 500ms intervals

*7: Accuracy of display when DC output is measured in terms of RMS

Item				PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10	Unit
CV operation	Normal mode	Ripple	RMS *8	1						mV(RMS)
			P-P *9	10						mV(P-P)typ.
		Load effect *10		0.005% + 1						mV
		Line effect *11		0.005% + 1						mV
		Rise up *12		30						ms typ.
		Fall down *13		30						ms typ.
	Fast mode	Ripple	RSS *8	2						mV(RMS)
			P-P *9	10						mV(P-P)typ.
		Load effect *10		0.005% + 1						mV
		Line effect *11		0.005% + 1						mV
		Rise up *12	50 μs	50						μs typ.
			500 μs	500						μs typ.
			5ms	5						ms typ.
		Fall down *13	50 μs	50						μs typ.
			500 μs	500						μs typ.
			5ms	5						ms typ.
		Frequency response	Through *14	30						kHz typ.

* 8: 5Hz to 1MHz, (at output terminals)
* 9: DC to 20MHz, (at output terminals)
*10: Against 0 to 100% change of output current, at remote sensing terminals, expressed in terms of $\pm[(\square\square\%$ of absolute value of setting) + $\square]$
*11: Against $\pm10\%$ change of AC input voltage, at remote sensing terminals, expressed in terms of $\pm[(\square\square\%$ of absolute value of setting) + $\square]$
*12: Period the output voltage takes to rise up from 10% to 90% of the rated value when the output voltage setting is changed from zero to the rated value
*13: Period the output voltage takes to fall down from 90% to 10% of the rated value when the output voltage setting is changed from the rated value to zero
*14: Frequency at which the ratio of the output voltage amplitude with respect to the input control signal voltage amplitude becomes -3dB(at 100Hz, with reference to the point at which the peak output voltage becomes the rated output voltage, with rated load)

		Item		PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10	Unit
CC operation	Static mode	Ripple	*15	2	2	4	1	2	3	mA(RMS)
		Load effect	*16	0.01% + 1	0.01% + 1	0.01% + 2	0.01% + 1	0.01% + 1	0.01% + 1	mA
		Line effect	*17	0.01% + 1	0.01% + 1	0.01% + 2	0.01% + 1	0.01% + 1	0.01% + 1	mA
		Rise up	*18	50						ms typ.
		Fall down	*19	50						ms typ.
	Dynamic mode	Ripple	*20	2	2	3	1	2	3	mA(RMS)
		Load effect	*16	0.01% + 1	0.01% + 1	0.01% + 2	0.01% + 1	0.01% + 1	0.01% + 1	mA
		Line effect	*17	0.01% + 1	0.01% + 1	0.01% + 2	0.01% + 1	0.01% + 1	0.01% + 1	mA
		Rise up *18	100 μ s	100						μ s typ.
			500 μ s	500						μ s typ.
			5ms	5						ms typ.
		Fall down *19	100 μ s	100						μ s typ.
			500 μ s	500						μ s typ.
			5ms	5						ms typ.
		Frequency response	Through *21	10			5			kHz typ.

*15: 5Hz to 1MHz, (with the output voltage at rated voltage)

*16: Against output voltage change from 10% to 100% of the rated value, expressed in terms of $\pm$ [($\Box$$\Box$% of absolute value of setting) + $\Box$]

*17: Against $\pm$10% change of AC input voltage, expressed in terms of $\pm$ [($\Box$$\Box$% of absolute value of setting) + $\Box$], with the output voltage at 10% to 100% of the rated value

*18: Period the output current takes to rise up from 10% to 90% of the rated value when the output current setting is changed from zero to the rated value, with the rated load

*19: Period the output current takes to fall down from 90% to 10% of the rated value when the output current setting is changed from the rated value to zero, with the rated load

*20: 5Hz to 1MHz, with output voltage at 10% to 100% of the rated value

*21: Frequency at which the ratio of the output current amplitude with respect to the input control signal voltage amplitude becomes -3dB(at 100Hz, with reference to the point at which the peak output current becomes the rated output current, with rated load)

Item				PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10	Unit
Protective limiters	Voltage limiters (V limit)	Software	Setting ranges +V limit	2.0 - 22.0			4.0 - 44.0			V
			Setting ranges -V limit	-2.0 - -22.0			-4.0 - -44.0			V
			Trip accuracy *22	±0.2			±0.4			V typ.
			Temperature coefficient *23	±200						ppm/°C typ.
		Hardware	Effective setting ranges *24 +V limit	3.0 - 22.0			6.0 - 44.0			V
			Effective setting ranges -V limit	-3.0 - -22.0			-6.0 - -44.0			V
			Trip accuracy *22	±0.2			±0.4			V typ.
			Temperature coefficient *23	±300						ppm/°C typ.
	Current limiters (I limit)	Software	Setting ranges +I limit	0.5 - 5.5	1.0 - 11.0	2.0 - 22.0	0.5 - 2.8	0.5 - 5.5	1.0 - 11.0	A
			Setting ranges -I limit	-0.5 - -5.5	-1.0 - -11.0	-2.0 - -22.0	-0.5 - -2.8	-0.5 - -5.5	-1.0 - -11.0	A
			Trip accuracy *22	±0.2	±0.3	±0.6	±0.2	±0.2	±0.3	A typ.
			Temperature coefficient *23	±400						ppm/°C typ.
		Hardware	Effective setting ranges *24 +I limit	0.8 - 5.5	1.5 - 11.0	30. - 22.0	0.8 - 2.8	0.8 - 5.5	1.5 - 11.0	A
			Effective setting ranges -I limit	-0.8 - -5.5	-1.5 - -11.0	-3.0 - -22.0	-0.8 - -2.8	-0.8 - -5.5	-1.5 - -11.0	A
			Trip accuracy *22	±0.2	±0.3	±0.6	±0.2	±0.2	±0.3	A typ.
			Temperature coefficient *23	±500						ppm/°C typ.
	OVP		Setting ranges *25 +OVP	2.0 to 22.0 or approx. 24.0			4.0 to 44.0 or approx. 48.0			V
			Setting ranges -OVP	-2.0 to -22.0 or approx. -24.0			-4.0 to -44.0 or approx. -48.0			V
			Trip accuracy *26	±0.4			±0.8			V typ.
	Limit delay time		Setting ranges	0.05 to 9.99 (in 0.01-steps)						S
			Trip accuracy *22	±0.1						S typ.

*22: Accuracy of actual trip point of the limiter with respect to the set trip point, at a temperatures within ±5°C (±9°F) of that when at calibration, excluding the measuring errors when at calibration or when at evaluation

*23: Rate of change of the actual trip point value of the limiter with respect to the absolute value

*24: Among the operable ranges, the ranges which guarantee the performance specifications

*25: When the voltage limiters are selected for protection, the OVP trips at approximately ±24.0 (±48.0). When the OVP is selected for protection, the OVP trips at the set limit voltage.

*26: Accuracy of actual trip point of the protector with respect to the set trip point (±2.0 to ±22.0, or ±4.0 to ±44.0), at a temperatures within ±5°C (±9°F) of that when at calibration, excluding the measuring errors when at calibration or when at evaluation

		Item	PBX20-5	PBX20-10	PBX20-20	PBX40-2.5	PBX40-5	PBX40-10	Unit
Trigger	Input	Voltage	5 - 6V / 10mA						
		Pulse width	≧100ms						
	Output	Output impedance	apprpx. 15kΩ						
		Pulse	apprpx. 2.5V/10μs						
Ambient conditions	Insulation resistances	Input to chassis	≧ 30MΩ, with 500V DC						
		Output to chassis	≧ 20MΩ, with 500V DC						
	withstanding voltages	Input to chassis	1500V AC, for 60 sec.						
		Input to chassis	1500V AC, for 60 sec.						
	Operable temperature		0 - 40						℃
	Operable humidity *27		30 - 80						%
	Storage temperature		−20 - 70						℃
	Storage humidity *27		20 - 80						%

*27: There shall be no condensation

7.2 Dimensions and Weights
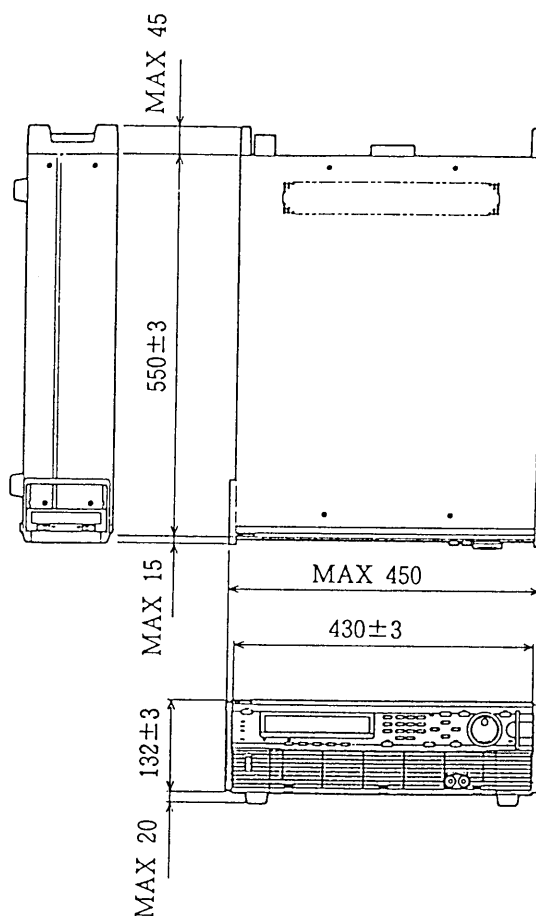
· PBX20-10   Approx. 30kg
· PBX20-20   Approx. 37kg
· PBX40-5   Approx. 30kg
· PBX40-10   Approx. 37kg

MAX 45

550±3

MAX 450

430±3

MAX 15

132±3

MAX 20
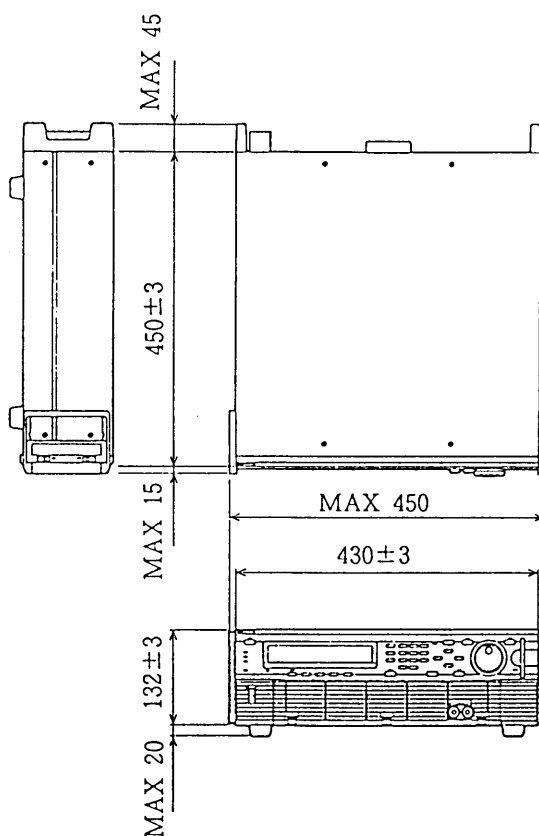
· PBX20-5   Approx. 22kg
· PBX40-2.5   Approx. 22kg
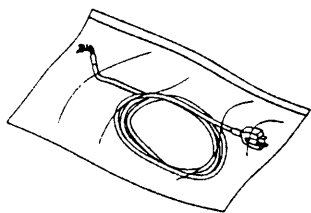
MAX 45

450±3

MAX 450

430±3

MAX 15

132±3

MAX 20

[UNIT:mm]

7.3 Accessories

• AC input power cable (1)
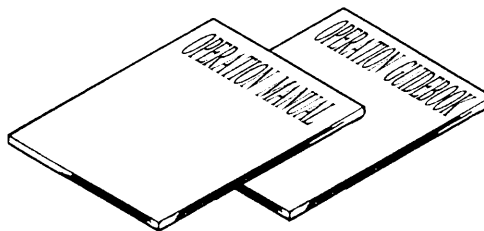
• Operation manual (1 copy)
• Sequence operation guidebook (1 copy)

• Terminals for analog
  remote control (20)
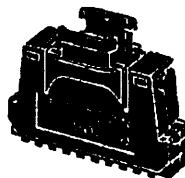
• Hood cover (1 set)

• Seals (2 sheets)

7.4 Optional Items

Exclusive Remote Controller
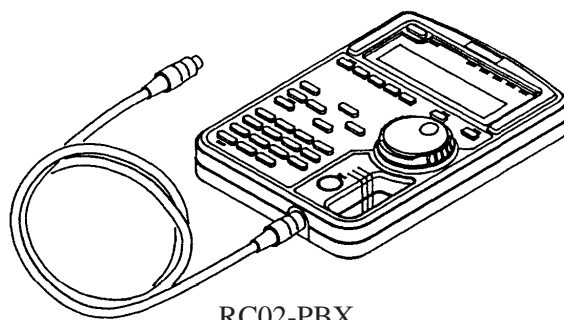
RC02-PBX

Interface Boards
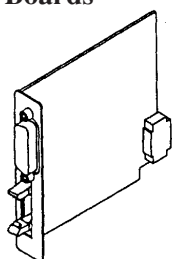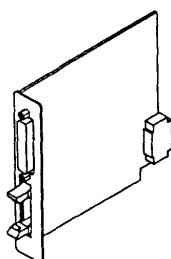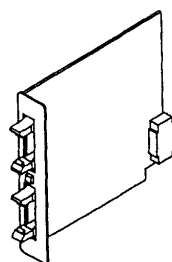
IB11	RS11	MC11S
(GPIB)	(RS-232C)	(MCB: Multichannel bus)

Rack Mount Brackets

KRB3
(for EIA racks)

KRB150
(for JIS racks)
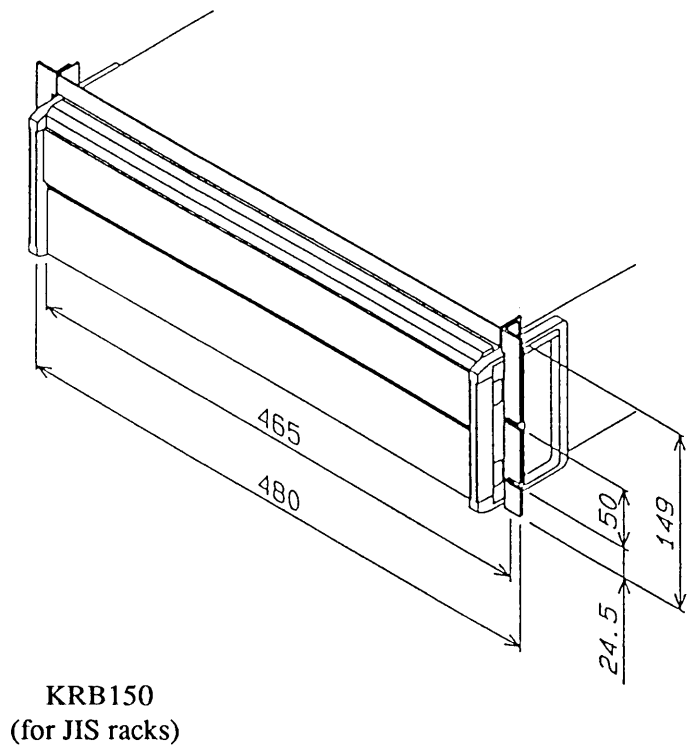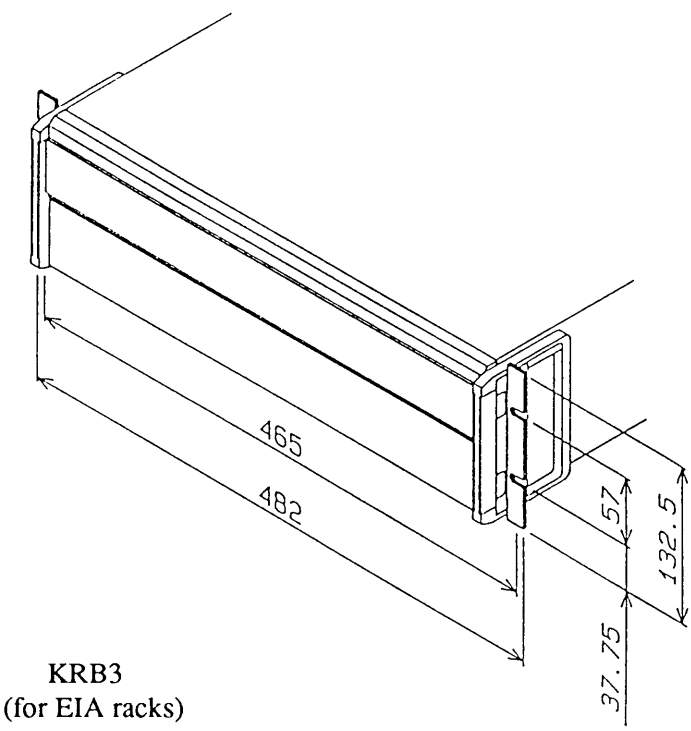
[UNIT:mm]

APPENDICES

The appendices on the following pages provide an error message table, a troubleshooting chart, a table of factory-defaults, a menu configuration chart, sequence coding sheets, and a table of ID codes for calibration.

Contents   Page

Appendix 1. Table of Error Messages

Error Message	Causes and Remedies
CC CAL Data Error.	Error in CC calibration data. Repeat calibration. If the same error persists, order your Kikusui agent for repair.
CONF Data Error.	Error in configuration data. Correct the configuration data.
CONF Data is broken.	Configuration data stored on the internal non-volatile memory is broken. Repeat configuration settings.
CV CAL Data Error.	Error in CV calibration data. Repeat calibration. If the same error persists, order you Kikusui agent for repair.
Can't Cal. Limit. Can't Cal. V Limit. Can't Cal. I Limit. Can't Cal. RMS.	Calibration is unsuccessful. Check the wiring and load impedance.
Can't Change L/R.	When the output is ON, you cannot change the modes between Remote and Local.
Can't Change Tr Tf.	When the output is ON, you cannot change Tr Tf.
Can't Delete.	You cannot delete sequence file [#0].
Can't Edit.	The steps required for editing a new program have not been secured.
Can't Recall SETUP	You cannot recall a setup file of a mode different from the currently running mode.
Can't Run.	You cannot run a sequence which has not been edited yet.
Data Clip.	The sequence data is greater than the rated output value and the amount of excess is clipped.
Different Meas Mod.	The meter function is invalid. For example, measurement of hardware limit value is attempted when the power supply is in the peak value measurement mode.
Does not Exist.	You have attempted to set a crowbar function while your power supply is not incorporated with the crowbar circuit.

Error Message	Causes and Remedies
EEP Data is broken.	Data stored on EEP ROM has been broken. (The EEP ROM stores default values.) It must be set again.
EEP ROM W Error. EEP ROM R Error.	Access to EEP ROM is unsuccessful. Order your Kikusui agent for repair.
ERROR Limit	The voltage or current limiter has tripped when at power-on. Order your Kikusui agent for repair.
ERROR OHP	The overheat protector has tripped when at power-on. Cool off the power supply and then re-start it.
ERROR OVP	The overvoltage protector has tripped when at power-on. Order your Kikusui agent for repair.
Framing Error.	A framing error has occurred. Check the settings.
I/F Argument Error.	An argument of the interface program is incorret. Check the argument of the program.
I/F Invalid Data.	An argument of the interface program is invalid. Check the argument of the program.
I/F Syntax Error.	There is a syntax error in a message from the interface.
I/F Warning Data.	An output clip or limit warning occurred when execution of sequence was attempted via the interface.
ICAL Data is broken.	The CC calibration data stored on the internal nonvolatile memory has been broken. Repeat calibration.
Invalid Sequence.	Sequence whose mode differs from the currently selected mode cannot be run.
Invalid Tr Tf.	You cannot specify Tr Tf when in the Normal C.V mode or Static C.C mode.
I/F Can't Execute	The command cannot be executed. For example, a RUN command is given when in the EXECUTE 0 status. Correct the mode of operation.

Error Message	Causes and Remedies
No Use EXT SIG IN.	The external analog signal input is not selected.
Parity Error.	A parity error has occurred. Check the settings.
Prediction V Limit.	A sequence data value is greater than the voltage limit value.
Prediction I Limit.	A sequence data value is greater than the current limit value.
RX Buff Overflow.	An overflow of the receive buffer occurred.
SEQ Data Error.	An error in sequence data occurred. Check the data of sequence file [#0].
SEQ Data is broken.	Sequence data stored on the internal nonvolatile memory is broken. The memory stores the default values. Repeat the settings.
SET Data Error.	An error in setup data occurred. Check the data of setup memory [#0].
SET Data is broken.	Setup data stored on the internal nonvolatile memory is broken. The memory stores the default values. Repeat the settings.
System Error.	The internal memory has failed. Order your Kikusui agent for repair.
TX Buff Overflow.	An overflow of the transmit buffer occurred.
VCAL Data is broken.	The CV calibration data stored on the internal nonvolatile memory has been broken. Repeat calibration.

Appendix 2. Troubleshooting Chart

This appendix is to provide you with very basic types of troubleshooting information. Before ordering repair, verify that the power supply has actually failed, by referring to the [Symptoms], [Check Items], an d [Causes] given below.

(Caution)   • *Provide a means to prevent the use of the failed power supply (for instance, put an "OUT OF ORDER" tag on the power supply).*

(WARNINGS)   • *Never open the casing of the power supply.*

[Symptoms]

Even when the AC input power switch of the power supply is turned on, the power supply does not operate and nothing appears on its display.

【Check Item 1】   Is the AC input power fed to the AC input terminal of the power supply?
【Cause】   Incorrect connection or open-circuiting of the AC input power cable

【Check Item 2】   Cases to which Check Item 1 does not apply.
【Cause】   Failure of the power supply

[Symptoms]

The AC input power switch cannot be turned ON.

【Check Item 1】   Is not pin ⑦ of the analog remote control terminal (J2) connected to common pin ③?
【Cause】   The external contact signal for Power-OFF control is in the ON state (made state).

【Check Item 2】   Is the circuit between pins ① and ② (alarm signal contact) of the analog remote control terminal (J2) closed (for about 60ms)?
【Cause】   The OVP has tripped. Check that no external overvoltage is applied to the output terminal.

【Check Item 3】   Cases to which Check Items 1 and 2 do not apply.
【Cause】   Failure of the power supply

[Symptoms]

The power supply does not deliver its output even when its OUTPUT key is pressed.

[Check Item 1] Check that the AC line voltage fed to the input terminal meets the specifica-
tions.

[Cause] Has been reset by trip of the input protector.
Check that the specified AC line requirements are met.

[Check Item 2] Cases to which Check Item 1 does not apply.
[Cause] Failure of the power supply

[Symptoms]

The output is unstable.

[Check Item 1] Is the remote sensing (if employed) correct?
[Cause] Wrong connections or open-circuiting of the remote sensing wiring

[Check Item 2] Is the analog remote control (if employed) correct?
[Cause] Unstable external control voltage or resistance signal, or incorrect wiring

[Check Item 3] Check that the AC line voltage fed to the input terminal meets the specifica-
tions.
[Cause] If the line voltage is low, ripple on the output will increase.

[Check Item 4] Cases to which Check Items 1 through 3 do not apply.
[Cause] Failure of the power supply

Appendix 3. Table of Factory Defaults

Mode Select Terminals

Fast/Normal (Dynamic/Static)	Fast (Dynamic)

Default Configuration

Mode of operation	C.V mode
Output	OFF
Local/Remote	Local
Keylock	OFF
Auto protection	110%
GPIB address	1
Power-on SRQ	Disabled
MCB slave address	1
RS-232C transfer rate	9600 bps
RS-232C data bit length	8 bit
RS-232C stop bit length	2 bit
RS-232C parity bit	None

Default sequence

Sequence data	Refer to the entry example of Appendix 5.
TRIG direction	Input
Auto-run	OFF

Default setup

SET		0.0V (C.V mode)
		0.0A (C.C mode)
FINE		0 (C.V mode)
		0 (C.C mode)
RESOLN (resolution)		0.1V (C.V mode)
		0.1A (C.C mode)
Software V Limit		±110% of rated output voltage
Software I Limit		±110% of rated output current
Limit protective action		Output OFF
Limit/OVP		Limit action
Limit delay time		2 sec
MCB protection		None
Tr Tf		50 μ s (C.V mode)
		100 μ s (C.C mode)
Output display mode		DC
Display time		1 sec
Amplitude setting		0%
MEM A	SET	0.0V (C.V mode)
MEM B		0.0A (C.C mode)
MEM C	FINE	0 (C.V mode)
MEM D		0 (C.C mode)

Hardware Protection

Hardware +V limit	Maximum
Hardware −V limit	Maximum
Hardware + I limit	Maximum
Hardware − I limit	Maximum

Appendix 4. Menu Charts

This appendix provides protection menu, setup menu, configuration menu, and sequence menu charts.

Protection Menu
[PROTECT]
Initial protection menu

──── 1: [V Limit Level]   : Voltage protection setting menu
       For setting of voltage limit levels

    ──── 1: [Software +V Limit]
         For setting of +V voltage limit level by software
         (Can be set also by [SHIFT] + [PROTECT] AUTO keys)

    ──── 2: [Software −V Limit]
         For setting of −V voltage limit level by software
         (Can be set also by [SHIFT] + [PROTECT] AUTO keys)

    ──── 3: [Hardware V Limit]
         For display of voltage limit value set by potentiometer on front sub-panel

──── 2: [I Limit Level]   : current protection setting menu
       For setting of current limit levels

    ──── 1: [Software +I Limit]
         For setting of +I current limit level by software
         (Can be set also by [SHIFT] + [PROTECT] AUTO keys)

    ──── 2: [Software −I Limit]
         For setting of −I current limit level by software
         (Can be set also by [SHIFT] + [PROTECT] AUTO keys)

    ──── 3: [Hardware I Limit]
         For display of current limit value set by potentiometer on front sub-panel

──── 3: [Limit Action]   : Protective action menu
       To select the actions to be taken when the output voltage or current has reached the limit value

    ──── 1: [Output OFF]
         To turn OFF the output

    ──── 2: [Power OFF]
         To turn OFF the output and also the AC input power switch

──── 4: [Limit Time Delay]
       To set a delay time (0.05 sec to 9.99 sec) to be allowed before the protective action is taken after the limiter has tripped.

──── 5: [V Limit/OVP]   : V Limit/OVP function select menu

    ──── 1: [V Limit]
         The V Limit function is selected for voltage protection. The protective action is as selected by [Limit Action].

    ──── 2: [OV Output OFF]
         The OVP function is selected for voltage protection. The protective action is Output OFF.

    ──── 3: [OV Power OFF]
         The OVP function is selected for voltage protection. The protective action is AC input power switch OFF.

    ──── 4: [OV Crowbar ON]
         The OVP function is selected for voltage protection. The protective action is crowbar ON.

──── 6: [MCB Protection]   : MCB protective action select menu

    ──── 1: [None]
         Do nothing.

    ──── 2: [Output OFF]
         When one of the protectors of the equipment connected to MCB has tripped, the power supply output is turned OFF.

Setup Menu

SETUP
(【SHIFT】 + 【7】)

Setup Menu

```
├──────── 1: [Recall]      : To recall the setup data from the specified setup memory.
├─────── 2: [Store]       : To store the operation setup data in the specified  setup memory.
├───────── 3: [Store to #0]  : To store the setup data in setup memory #0.
└─────── 4: [Initialize]    : To initialize the settings.
```

Items of setup

```
┌─────────────────────────────────────┐
│  V SET (I SET)                       │
│  V FINE (I FINE)                     │
│  V RESOLN (I RESOLN)                 │
│  Software V Limit level              │
│  Software I Limit level              │
│  Protective action                   │
│  V Limit/OVP                         │
│  Limit delay time                    │
│  MCB protection                      │
│  Tr Tf                               │
│  Output display mode                 │
│  Display time                        │
│  Amplitude setting                   │
│  Memory A                            │
│  Memory B                            │
│  Memory C                            │
│  Memory D                            │
└─────────────────────────────────────┘
```

The items enclosed in the parentheses are for C.C mode.

Sequence Menu

(【SEQ】)

Initial sequence menu

```
├── 1: [File]                    : File management menu

│      ├──────── 1: [List Files]      : To display the sequence file contents
│      ├──────── 2: [Load File]       : To load the sequence file onto the sequence operation memory
│      └──────── 3: [Save File]       : To save the data of sequence operation memory into sequence file

├── 2: [Edit]                    : Edit menu

│      ├──────── 1: [Edit Program]    : To add, edit, or delete programs of sequence operation memory
│      ├──────── 2: [Edit Sequence]   : To create or edit sequence parameters of sequence operation memory
│      └──────── 3: [New]             : To initialize sequence operation memory

├── 3: [Run]                     : menu
│                                : To run the contents of sequence operation memory
└── 4: [Configuration]           : Configuration menu

       ├──────── 1: [TRIG Direction]  : To define input/output direction of trigger
       └──────── 2: [Auto Run]        : To specify either the sequence is to be run or not when power is turned on
```

Configuration Menu

CONFIG
([SHIFT] + [0])

Configuration Menu

```
├── 1: [Local/Remote]          : To select the local control mode or the remote control mode of operation.

    ├── 1: [Local]             : The output voltage (or current) is controlled locally from the front panel.

    ├── 2: [From J2]           : The output voltage (or current) is controlled remotely with an external signal applied via
                                 terminal J2 on the rear panel.

    ├── 3: [From BNC]          : The output voltage (or current) is controlled remotely with an external signal applied via
                                 the EXT SIG IN terminal (BNC terminal) on the front sub-panel.

    └── 4: [From J2 & BNC]     : The output voltage (or current) is controlled remotely with an external signal applied via
                                 the J2 terminal and the BNC terminal.

├── 2: [Start Up]              : Start up menu

    ├── 1: [CV/CC]             : To select the mode the power supply should assume when at power-on.

        ├── 1: [CV]            : C.V mode
        └── 2: [CC]            : C.C mode

    ├── 2: [Output]            : To select the state of [OUTPUT] key when at power-on.

        ├── 1: [OFF]           : Output OFF
        └── 2: [ON]            : Output ON

    └── 3: [Key Lock]          : To select the locked or unlocked states for the keys when at power-on.

        ├── 1: [OFF]           : Unlocked
        └── 2: [ON]            : Locked

├── 3: NULL

├── 4: NULL

├── 5: [Auto Fine] :   Auto Fine menu

    ├── 1: [CV Auto Fine] :   ON/OFF setting of CV Auto Fine

        ├── 1: [OFF]
        └── 2: [ON]

    └── 2: [CC Auto Fine] :   ON/OFF setting of CC Auto Fine

        ├── 1: [OFF]
        └── 2: [ON]

├── 6: [Auto Protection] :   To select an auto-protection level for V Limit when in C.V mode or for I Limit when in
                             C.C mode.
    ├── 1: [110%]
    ├── 2: [120%]
    └── 3: [130%]
```

8: [Interface]   : Interface board setting menu

  1: [GPIB Address]   : For GPIB address setting

  2: [MCB Address]   : For MCB bus address setting

  3: [RS-232C Speed]   : For transfer rate selection

      1: [9600 bps]
      2: [4800 bps]
      3: [2400 bps]
      4: [1200 bps]

  4: [RS-232C Data bit]   : For data bit length selection

      1: [8 bit]
      2: [7 bit]

  5: [RS-232C Stop bit]   : For stop bit length selection

      1: [1 bit]
      2: [1.5 bit]
      3: [2 bit]

  6: [RS-232C Parity]   : For parity bit selection

      1: [None]
      2: [Odd]
      3: [Even]

  7: [Power-on SRQ]   : For power-on service request selection

      1: [Disable]
      2: [Enable]

9: [Calibration]   : Calibration setting menu
   (Setting for calibration is needed.)

  1: [Voltage]   : For voltage calibration

      Voltage offset calibration (manual)
      "+" voltage full-scale calibration (manual)
      "−" voltage full-scale calibration (manual)
      Software (hardware) V Limit offset calibration (auto)
      Software (hardware) V Limit full-scale calibration(auto)
      RMS display offset calibration (auto)
      RMS display full-scale calibration (auto)

  2: [Current]   : For current calibration

      Current offset calibration (manual)
      "+" current full-scale calibration (manual)
      "−" current full-scale calibration (manual)
      Software (hardware) I Limit offset calibration (auto)
      Software (hardware) I Limit full-scale calibration(auto)

Appendix 5. Sequence Coding Sheets

Coding Sheet (for Normal speed sequence)

Date:_____ Name:_____

Title:_____ Description:_____

Mode   : NV NI

Time unit: msec sec minute hour

Sequence

No.	Execute Program	Loop	Chain Sequence	End Program	Comments
S:1	P__	L____	C_	E__	
S:2	P	L	C	E	
S:3	P	L	C	E	
S:4	P	L	C	E	
S:5	P	L	C	E	
S:6	P	L	C	E	
S:7	P	L	C	E	
S:8	P	L	C	E	

Program

NO.	Step No.	S/R	C. V[V]	S/R	C. C [A]	Trig	Out	Pause	Time [ ]	Comments

Coding Sheet (for Fast speed sequence)

Date:_____ Name:_____

Title:_____ Description:_____

Mode   : FV FI

Sequence

No.	Execute Program	Loop	Chain Sequence	End Program	Time [msec]	Comments
S:1	P__	L____	C_	E__	____	
S:2	P	L	C	E		
S:3	P	L	C	E		
S:4	P	L	C	E		
S:5	P	L	C	E		
S:6	P	L	C	E		
S:7	P	L	C	E		
S:8	P	L	C	E		

Program

NO.	Step No.	C.V [V]	C.C [A]	Trig	Comments

Examples of Sheet Entry

Title: <u>SAMPLE SEQ.</u>

Date: <u>date</u> Name: <u>Kikusui</u>

Description: _____

Mode : (NV) NI

Time unit: (msec) sec minute hour

Sequence

No.	Execute Program	Loop	Chain Sequence	End Program	Comments
S:1	P 0 1	L 0001	C 2	E 16	START
S:2	P 0 2	L 0002	C 3	E 16	MAIN
S:3	P 0 3	L 0001	C *	E 16	END
S:4	P	L	C	E	
S:5	P	L	C	E	
S:6	P	L	C	E	
S:7	P	L	C	E	
S:8	P	L	C	E	

Program

NO.	Step No.	S/R	C. V[V]	S/R	C. C [A]	Trig	Out	Pause	Time [mS]	Comments
P01	001	S	0.00			•	0	•	50	START
	001	S	0.00			T	0	•	10	TEST 1
	002	R	15.00			•	0	•	20	
	003	S	15.00			•	0	•	30	
	004	S	10.00			•	0	•	40	
	005	R	−10.00			•	0	•	50	
P03	001	S	−10.00			•	0	•	30	TEST 2
	002	R	10.00			•	0	•	20	
	003	S	10.00			•	0	•	30	
	004	S	−10.00			•	0	•	30	
P16	001	S	0.00			•	•	•	1	OUTOFF

Appendix 6. ID Codes for Calibration

Model	ID code
P B X 2 0 − 5	2 0 0 5
P B X 2 0 − 1 0	2 0 1 0
P B X 2 0 − 2 0	2 0 2 0
P B X 4 0 − 2 . 5	4 0 2 5
P B X 4 0 − 5	4 0 0 5
P B X 4 0 − 1 0	4 0 1 0

Appendix

Index

Alphabetic order