◆NF

AC POWER SUPPLY

EPX4104
EPX4106
EPX4112

OPERATION MANUAL

P-STATI●N **EPX**

NF Corporation

EPX4104
EPX4106
EPX4112
AC POWER SUPPLY

Operation Manual

— Warranty —

This product is shipped after being fully tested and inspected by **NF CORPORATION**. If you note any failure(s) caused by insufficient manufacturing or by a transportation accident, please contact us or our sales agency.

The product purchased from us or our sales agency is warranted for one year from date of delivery against problems attributable to us such as failures of parts under correct use or caused by insufficient manufacturing.

This warranty promises repair services free of charge if you contact us or our sales agency within the warranty period.

The following services will be charged even during the warranty period.

* Failure caused by use or storage against the method of use and precautions described in the operation manual

* Failure or damage caused by drop or shock during transportation by customer

* Modification of product by customer

* Failure influenced by an abnormal external voltage or external devices connected to the product

* Failure or damage caused by forces majeures such as fire, earthquake, flood, stroke of lightning, civil commotion, act of war and other acts of God

* Replenishment of consumables such as magnetic tape

— Repair —

In case of a problem or the product is judged failing or if you have any inquiries, please contact us or our sales agency you purchased the product from.

When contacting us, please inform us of the type name (or product name), manufacturing number (SERIAL number) and detailed description of symptoms of the problem and condition of use.

We will do our best to shorten the repair period, however in the case of a product you purchased over 5 years ago, it may take a longer period of time because of stockout of repair parts, etc.

Please accept beforehand that we might reject repair in some cases due to discontinuation of manufacturing of spare parts or considerable damage or modification.

Foreword

Thank you very much for procuring the NF product EPX4104, EPX4106 or EPX4112. At the outset, please take a few minutes to read the Safety Precautions indicated in this manual in order to use this equipment safely and correctly.

- **Warning and Caution notices**

    The following Warning and Caution notices appear in this manual. These must be observed in order to protect both the user from physical harm and the equipment from damage.

! WARNING
Risk of serious and possibly fatal physical injury from electric shock or other cause.

⚠ CAUTION
Risk of damage to the equipment.

Safety Precautions

Observe the following warnings and cautions in order to use this equipment safely. No responsibility or warranty is assumed for damages arising from use in a manner contrary to these warnings and cautions.

This product belongs to Class I of insulation ratings by IEC standards (equipped with a protective grounding terminal).

- **Observe instructions in the manual**

  This manual has been compiled in order to enable safe operation and use of this equipment. Be sure to read this manual before using the equipment.

  Items designated by Warning advise of serious physical hazards. Be sure to observe these carefully.

- **Be sure to connect the protective earth terminal to the ground**

  Failure of grounding the protective earth terminal would cause electric shock because a line filter is used in the product.

  To prevent electric shock, securely connect the equipment to a ground providing a resistance to ground of 100 ohms or less.

- **Confirm power source voltage**

  The EPX4104/06/12 operates at a supply voltage described in "2.3 Power supply and grounding" in the operation manual.

  Before connecting this equipment, check that the proper voltage is being supplied to the wall power outlet.

- **Smoke, odor, noise**

  In event smoke, peculiar odor or noise is emitted, immediately disconnect the power source and avoid further operation.

  Whenever such an abnormality occurs, prevent the equipment from being used until it is completely repaired and immediately contact us or our sales agency.

- **Do not use in flammable gases.**

  Use of the product in flammable gases may cause explosion or other hazards.

- **Do not remove covers**

  Since the product contains a high voltage part inside, internal inspection should be performed only by educated service technicians who are familiar with hazard prevention.

- **Do not modify**

  Do not use parts other than specified by the manufacturer and by no means attempt to modify the equipment.

  There is risk of personnel hazard and damage to the equipment. The manufacturer reserves the option of refusing service in such cases.

- **Safety related symbols and indications**

  Following are general definitions of the symbols used in the manual and on the product.

  ⚠️ Operation manual reference symbol
      Advises of possible hazard to the user, as well as the need to consult this manual when using an operation or function.

  ! WARNING Warning symbol
      Appears in the manual and on the product to advise risk of fatal or otherwise serious physical injury.

  ⚠️ CAUTION Cautionary symbol
      Appears in the manual and on the product to advise risk of damage to the product.

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1. General Description

1.1 Outline

EPX4104, EPX4106 and EPX4112 consist of a linear power amplifier having an output of 410VA, 620VA and 1250VA respectively to electronic device loads and a digital direct-composing synthesizer.

The user can select one of four output ranges: rated voltage of 100V, 120V, 200V and 240V (effective value) with variable range of 0 to 120% of each rated value.

Further, the DC power supply voltage of the power amplifier is controlled to the optimal level according to the output voltage, which enables the user to obtain rated output current in the range of 20 to 120% of the rated output voltage without increasing the loss.

The unit provides a frequency rage of 40 to 500Hz, and the incorporated synthesizer allows the user to set the frequency in 0.001Hz increments. External AC signal sources may be used as well.

The unit can store four sets of frequency and amplitude in its preset memory, and stored sets can be retrieved easily.

The user can also use a personal computer or other adequate device to control frequency, output voltage and ON/OFF of output via optional GPIB interface.

The unit is operated by a power supply of 100V±15% AC, 48 to 62Hz.

1.2 Features

(1) Suitable for testing electronic devices having a capacitor input rectifier circuit

The unit can provide a peak current of up to 2.5 times the rated current (effective value) if the load is a capacitor input rectifier circuit, as commonly used in the power supply section of general equipment.

(2) High accuracy in frequency

The built-in synthesizer enables the user to set frequency of 40.000 to 500.000Hz in 1mHz increments, and the set frequency is always shown on the six digit numerical display.

(3) Presetting function

Four sets of frequency and amplitude can be preset in the internal storage.

(4) Digital display monitor for output voltage and current

The output voltage and current are displayed in digital indication by the internal monitor circuit. These values can be used in easy calculation of power consumption (VA) of the load.

(5) Stable output also for capacity load

A load of up to 10μF can be driven in stability.

(6) GPIB (optional)

This option enables frequency and voltage setting and ON/OFF of output to be controlled from your personal computer or other similar devices.

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(7) Wide range of output voltage

Output voltage can be varied from 0 to 120% of the rated value (or the nominal range value), and the rated output current can be supplied in the output voltage range of 20 to 120%.

(8) Protection circuits for automatic recovery

Protection circuits are provided against extreme output voltage, output current, input current and temperature.

(9) Distortion factor is low

The voltage waveform distortion factor is as low as 0.5% or less for rated load of pure resistance and rated output.

(10) Three-phase system is also available (optional)

Using one unit to which an optional three-phase function is added, together with two standard units, the user can easily generate three-phase system.

1.3   List of available functions

(1) Output frequency

Range of output frequency setting:	40.000 to 500.000Hz in 1mHz increments
Frequency indication:	six digit numerical LED
Preset frequency:	three points of 50, 60 and 400Hz

(2) Output voltage

Ranges of output voltage setting:	0 to 120.0V in 100V range
	0 to 144.0V in 120V range
	0 to 240.0V in 200V range
	0 to 288.0V in 240V range
Indication of output voltage:	set value or measurement on the four digit numerical display
	measurement shown in effective value of averaged demodulation

(3) Output current

Range of rated output current:

	EPX4104	EPX4106	EPX4112
100V range	0 to 3.30A	0 to 5.00A	0 to 10.00A
120V range	0 to 2.75A	0 to 4.17A	0 to 8.33A
200V range	0 to 1.65A	0 to 2.50A	0 to 5.00A
240V range	0 to 1.38A	0 to 2.03A	0 to 4.17A

Peak current: about 2.5 times the rated (effective) value for the full-wave rectifier circuit of capacitor input

Indication of output current: measurement on three-digit numerical display (four-digit for **EPX4112**)

effective value indication of effective value demodulation

(4) Output power

Maximum output power to loaded electronic equipment

EPX4104 410VA

EPX4106 620VA

EPX4112 1250VA

Rated output power to loaded resistance

EPX4104 330VA

EPX4106 500VA

EPX4112 1000VA

(5) On-panel setting functions

Change of settings: Use UP/DOWN modify dial.
Setting is available on desired digit on cursor position.

Preset memory: Four sets are ready for presetting of frequency, range and output amplitude.

Auto-level: Automatically controls the output voltage to reach the set voltage level.

Panel setting lock: Selection of LOCK disables setting in all switches.
To release LOCK, put the Shift button to ON then press LOCK.

Battery-supported settings: The system memory stores the settings on the power turning OFF moment, and they will be retrieved on the next power charging occasion as the startup settings except the output which is turned off whenever the unit is fresh powered.

(6) Amplification of external signal

Range of signal frequency: 40 to 500 Hz

Rated input voltage of signal: 1 Vrms (input voltage needed to get the rated output voltage)

(7) General matters

Power supply: single-phase 100V AC, ±15%, 48 to 62Hz

Mean power consumption:

EPX4104 about 1.0kVA

EPX4106 about 1.5kVA

EPX4112 about 3.2kVA

on rated load of pure resistance and rated output

External dimensions:

EPX4104 430 (W) × 148 (H) × 520 (D) mm

EPX4106 430 (W) × 198 (H) × 520 (D) mm

EPX4112 430 (W) × 248 (H) × 520 (D) mm

Mass:

EPX4104 about 31kg

EPX4106 about 38kg

EPX4112 about 53kg

(8) Optional items

GPIB: Externally controls the frequency, output voltage and ON/OFF of output.

Three-phase output: Use of three units enables generation of three-phase system. This three-phase output device will be supplied together with GPIB.

1.4 Principle of operation

(1) Outline

Figure 1-1 "Block Diagram" shows the circuit structure of this unit which broadly consists of the following four sections: a frequency synthesizer; a power amplifier; a DC power supply and a CPU.

(2) Frequency synthesizer

The unit uses a standard 4MHz clock driven by a crystal oscillator to produce 40 to 500Hz sine wave by means of LSI of our developed Directly-composed Digital Synthesizer (DDS).

After elimination of harmonics contained in the sine wave by a low-pass filter (LPF), the sine wave is regulated for its amplitude through the 12 bit multiplying D/A converter, then sent to the power amplifier as an input signal.

Similarly in the optional three-phase output device, a standard 4MHz clock generates a balanced three-phase sine wave of 40 to 500Hz using a Directly-composed Digital Synthesizer (DDS) LSI.

(3) Power amplifier

This amplifier uses an output transformer to increase the power of the synthesizer output signal or the signal applied to the external input terminal, which is then insulated and boosted by the output transformer and supplied to the load.

Further, it has a protective circuit to guard the power transistor against actions that go beyond the safe operation region by detecting the voltage and current of the power transistor at the output section.

(4) DC power supply

This DC power supply provides the DC power required for unit operation: ±5V, ±15V and ±Vcc (the power supplied to the power transistor at the output section).

The Vcc controller, according to the output voltage of the power amplifier, creates DC voltage needed by the power transistor through the choke input rectifier circuit by directly controlling the phase of the 100V AC input. As a result, the power transistor can operate at the lowest necessary voltage, reducing the loss of the power transistor.

(5) CPU

The CPU coordinates the control commands coming from the keyboard or GPIB (if added), and controls the synthesizer oscillation frequency, the amplitude and range of the output and output ON/OFF.

In addition, the output current is detected by current transformer (CT), and after effective value demodulation, it is AD-converted and sent to the CPU, and its value is shown on the CURRENT LED.

The output voltage, after isolation by the feedback transformer, undergoes mean value demodulation then AD conversion, and sent to the CPU, and its value is shown on the VOLTAGE LED.

If the auto-level function is selected, the CPU controls the output voltage so that it will be equal to the set voltage level.
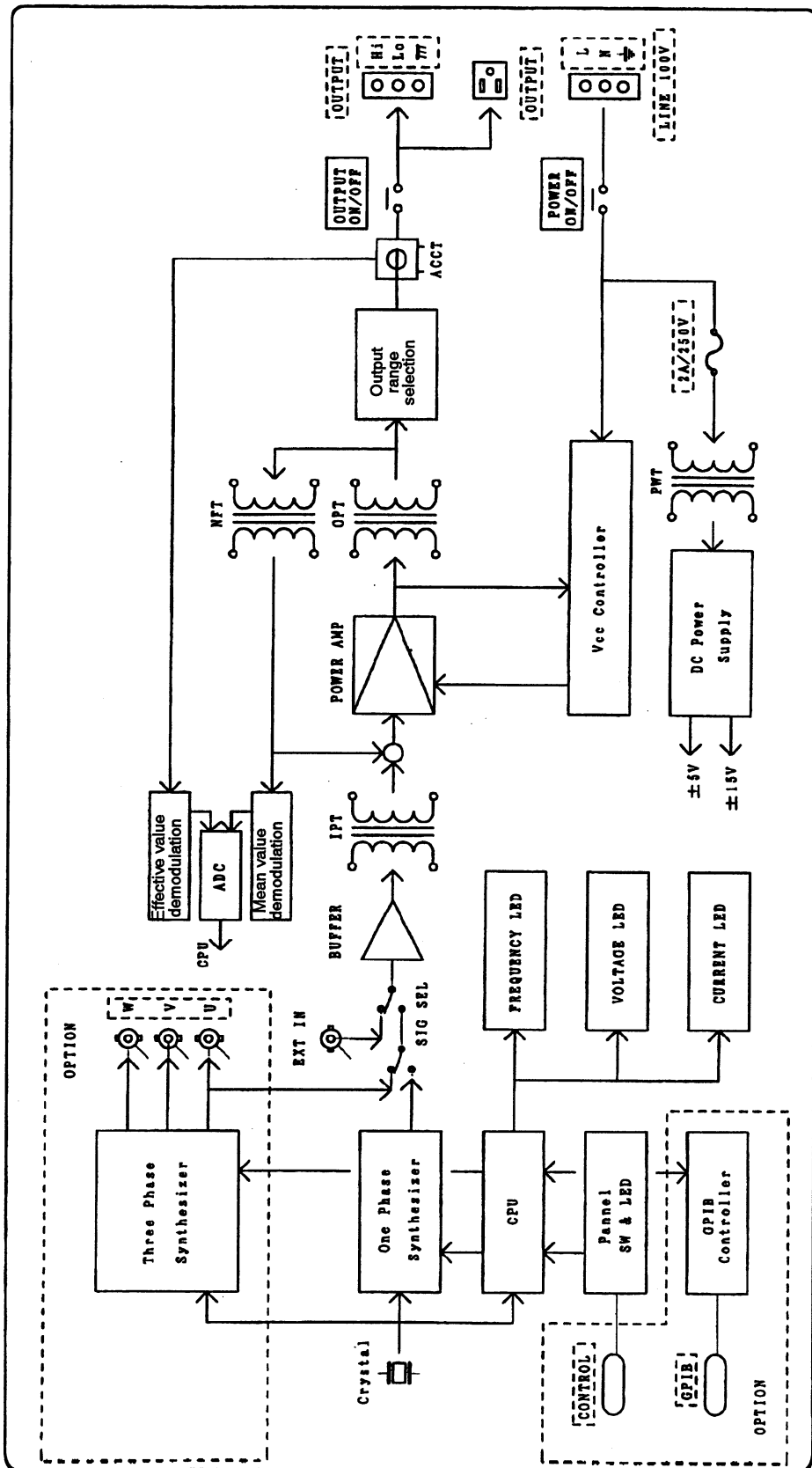
Figure 1-1   Block Diagram

2. Preparation before Use

2.1 Checking the appearance and accessories

Take out the contents in the package and identify each item supplied.

Should there be any abnormal scars on the unit appearance, or lack of accessories, please inform us or our sales agency.

Any anomaly (scars or dents) on the package should be immediately informed as well.

- **Appearance check**

Confirm that there is no damage or dents on the panel surface, controls, connector and others.

- **Accessories check**

This product is supplied with accessories as listed in Table 2-1 "Accessories". Confirm that no shortage in quantity or damage is found.

Table 2-1   Accessories

- One Instruction Manual (this document)
- One 3-meter tough-rubber sheath cable (or cabtyre cable) for output and power supply

  2.0mm^2 for **EPX4104**

  3.5mm^2 for **EPX4106**

  5.5mm^2 for **EPX4112**
- Two fuse pieces (fusible type, 2A/250V, ϕ5.2 × 20mm)

2.2 Location for installation

Since this unit is provided with a fan-forced cooling system, keep 30cm or more distance between the walls and the unit front, back and lateral sides where air suction or exhaust ports are located to ensure proper ventilation.

Ambient temperature and humidity for this unit must be maintained in the allowable range as follows:

0 to 40°C and 10 to 90%RH for operation

−10 to +50°C and 10 to 80%RH for storage

Select an adequate location for unit placement which meets the above temperature and humidity requirements, and is free from dust, vibration or direct sunshine.

Avoid places, as much as practicable, adjacent to equipment that emits pulsating noises, strong magnetic fields, strong electric fields or the like, which may affect this unit.

2.3 Power supply and grounding

The unit has no transformer in the power supply circuit of the power amplifier section. However, the power input is isolated from both the signal input and the output terminal by the signal transformer.

For prevention of hazards and external disturbances, the protective earth terminal must be connected to the ground. The earth terminal is located on the rightmost position of the power supply input and output terminals.

The power supply required by the unit is specified as follows:

*   Power supply voltage: single-phase AC of 100Vrms ±15% or less

*   Power supply frequency: 48 to 62Hz

*   Maximum current consumption on rated output

    1.3kVA for **EPX4104**
    1.9kVA for **EPX4106**
    3.8kVA for **EPX4112**

*   Power supply cable

    If other cables than supplied ones are used for power cable, they must have a nominal cross section or greater as described below:

    2.0mm^2 for **EPX4104**
    3.5mm^2 for **EPX4106**
    5.5mm^2 for **EPX4112**

For power cable connection, see Figure 2-1 "Power Cable Connection Diagram" below.
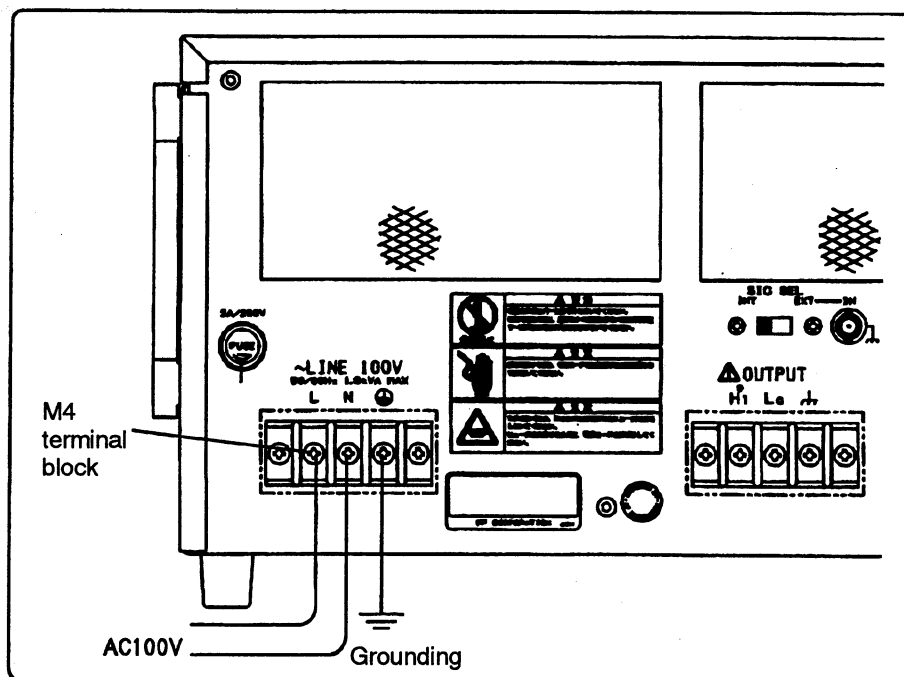
Figure 2-1   Power Cable Connection Diagram

2.4 Rack mounting

This unit can be also mounted on meter system rack or inch system rack using rack mount attachments.

To mount the unit on a rack using the attachments, follow the procedure below:

1. Using a sharp flat-blade screwdriver or the like, remove two caps on the handle attached to the sides of the unit. Then remove the exposed two screws and take off the handle.

   The taken handles are not used in rack mounting; they should be stored with care for possible future use when the unit is dismounted from the rack.

2. Using flat countersunk head screws supplied with the rack mount adapter, fix the rack mount attachments as shown in Figure 2-2 "Fixing the Rack Mount Attachments".

   For proper dimensions, see Figure 2-3 "Rack Mounting Dimensions for **EPX4104**", Figure 2-4 "Rack Mounting Dimensions for **EPX4106**" or Figure 2-5 "Rack Mounting Dimensions for **EPX4112**".

3. Insert the unit in the rack frame which has a rail to support the bottom of the unit.

4. Fix the unit to the rack frame from the front using screws together with flat washers and bent washers.

   Note: The whole weight of the unit can not be supported by the rack mount attachments. Be sure to use the rail to support the entire weight of the unit on the bottom.
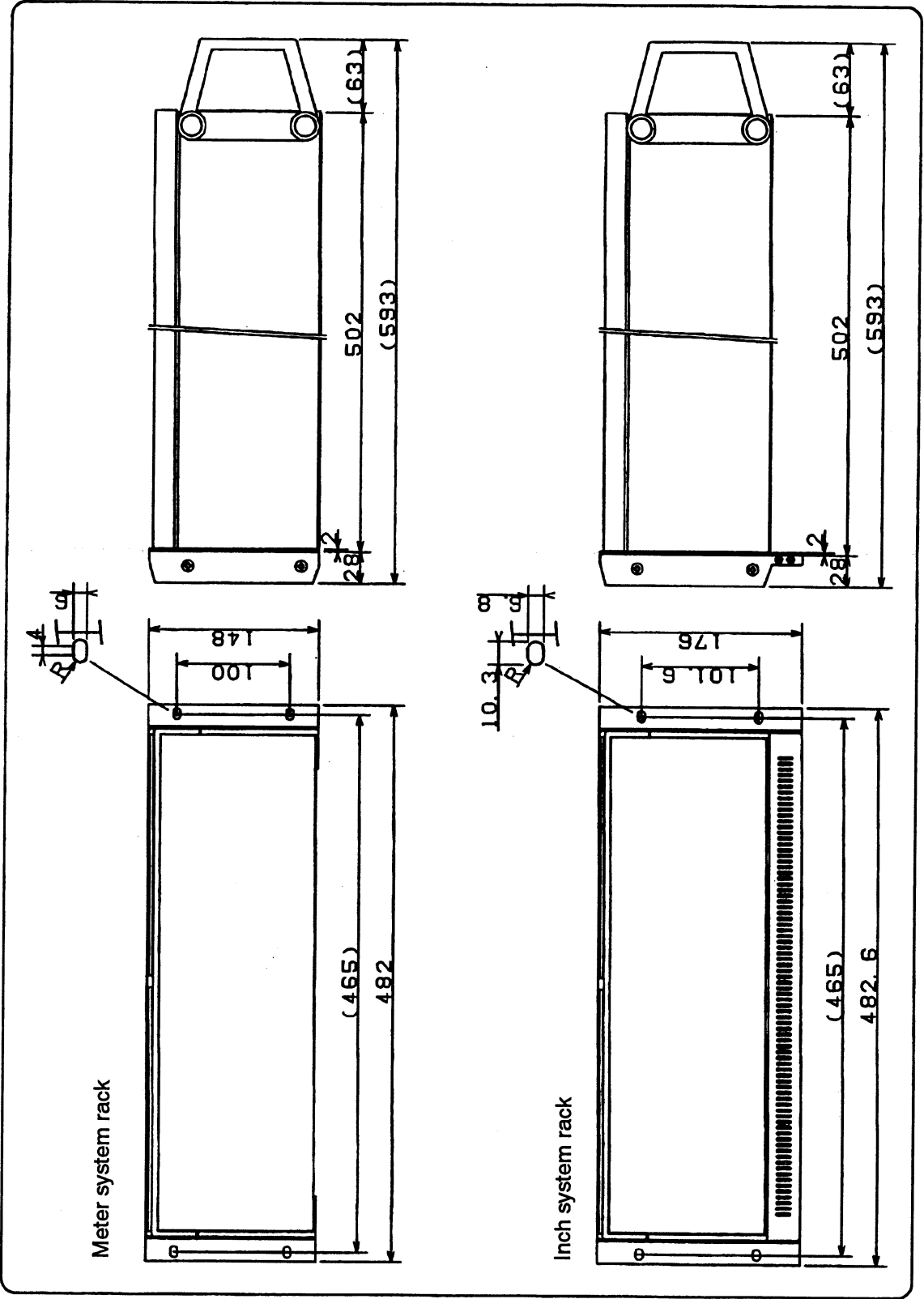
Meter system rack

Remove this handle.

Inch system rack

Remove this handle.

Figure 2-2   Fixing the Rack Mount Attachments

Figure 2-3   Rack Mounting Dimensions for EPX4104
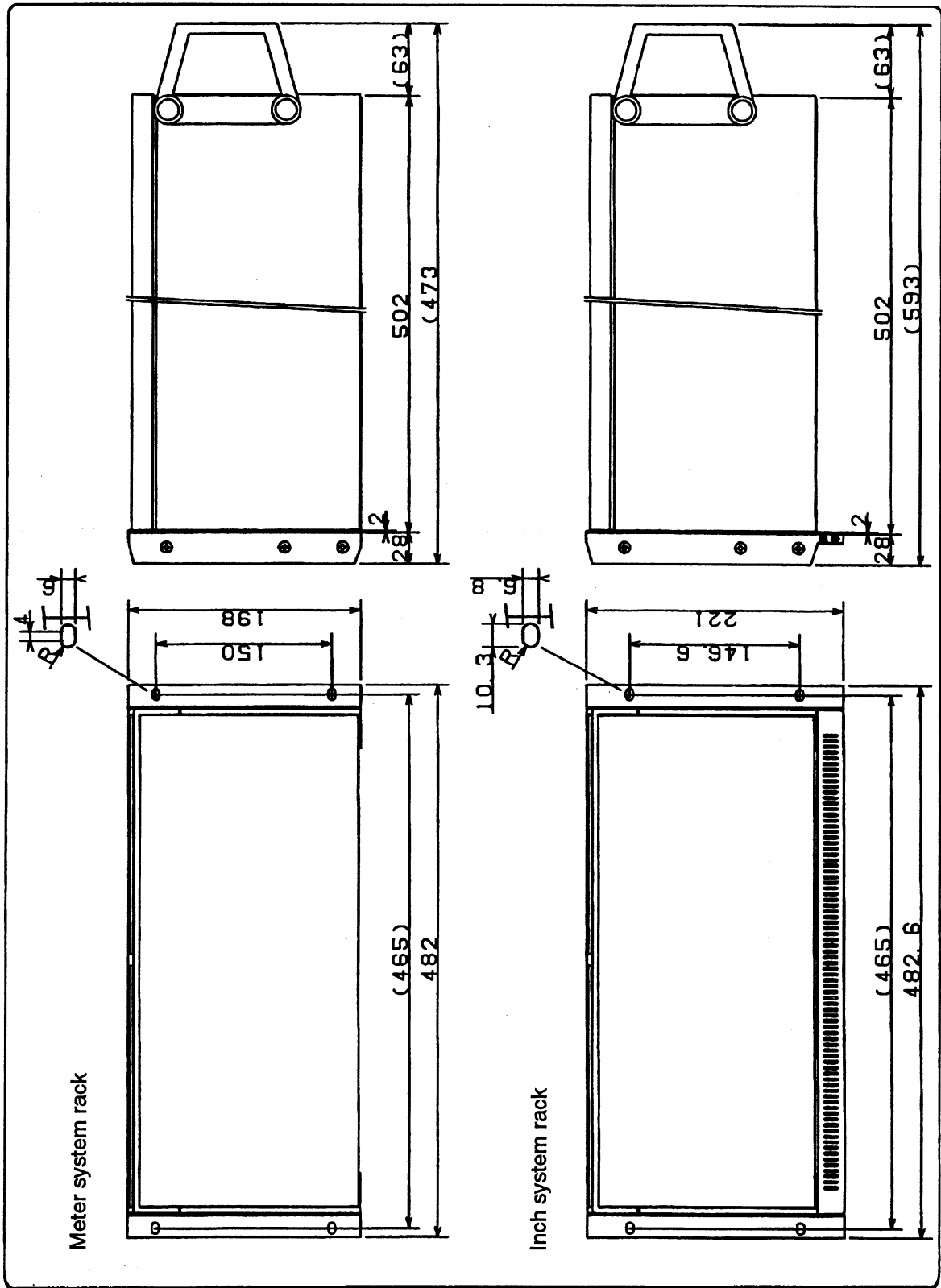
Figure 2-4   Rack Mounting Dimensions for EPX4106
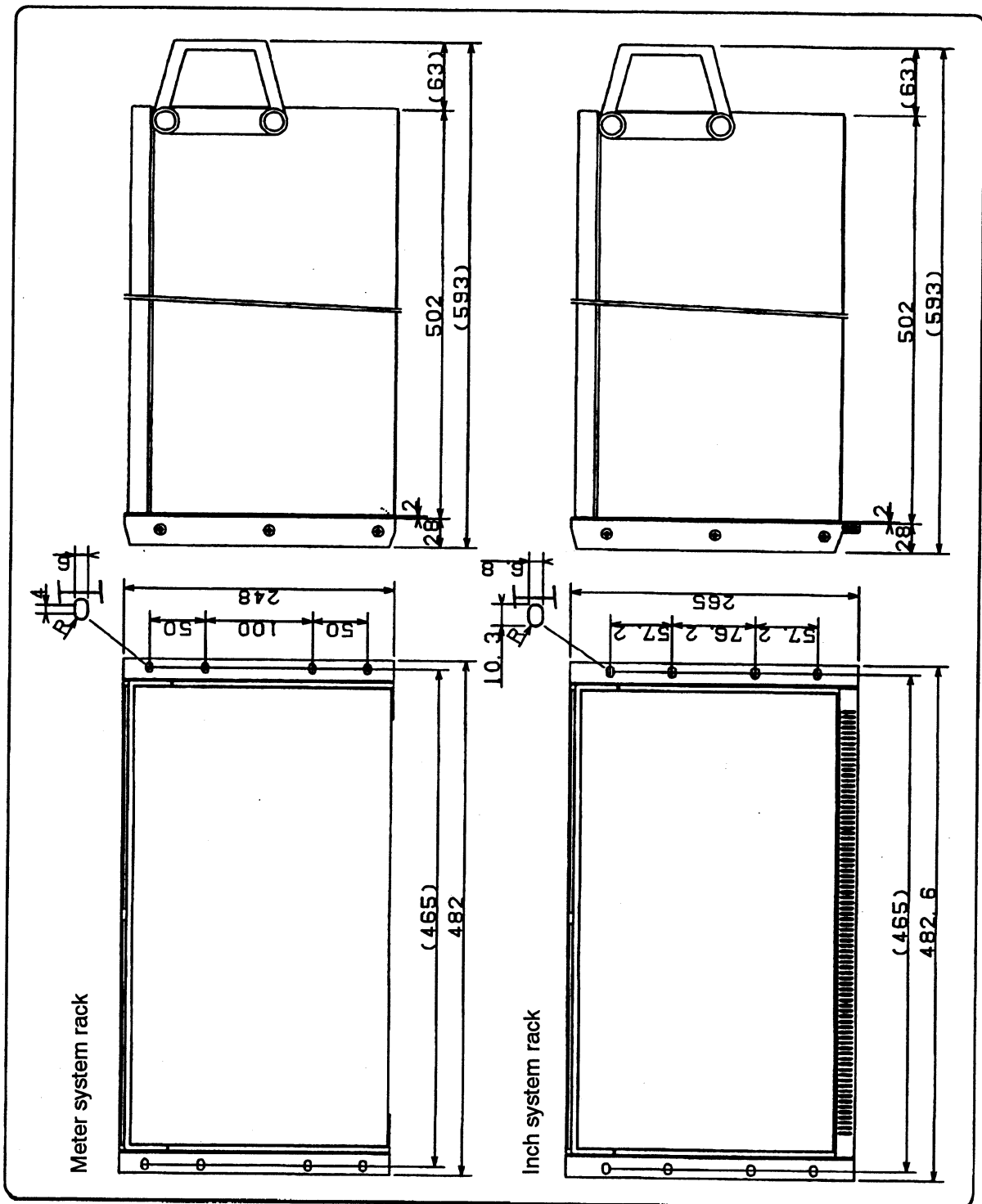
Figure 2-5   Rack Mounting Dimensions for EPX4112

2.4 Rack mounting

3. Description of Panel Controls and Basic Operation

3.1 Name and function of parts on the panel

See Figure 3-1 "EPX4104 Front and Back Panels", Figure 3-2 "EPX4106 Front and Back Panels" and Figure 3-3 "EPX4112 Front and Back Panels".

3.1.1 Front panel

① **Air intake**

This port is used to take in necessary air for the forced cooling fan. Place the unit so that the air flow will not be obstructed.

② **Frequency**

This six digit numerical display shows the output frequency, with the minimum resolution being 1mHz.

To set the frequency, press the ⑪ "SET" button then use the ⑲ MODIFY dial.

If EXT has been selected in ㉕ "SIG SEL", the internal synthesizer is not used, and the indication will be "-----".

③ **100V, 120V, 200V, and 240V**

These indicators show the output voltage range.

Every press on the ⑫ "RANGE" button changes the voltage range in the order of 100V, 120V, 200V and 240V, and then further back to 100V.

When the output voltage range is changed, the voltage value that has been set will be cleared to 0V for the safety reasons..

④ **VOLTAGE**

This display shows the output voltage. It indicates the set value when ⑭ "MEAS" indicator is not lighting, and indicates the measurement when it is lighting.

⑤ **CURRENT**

This display shows the measurement of output current, indicating the effective value of the effective value demodulation.

⑥ **SHIFT**

When any of the ⑯, ⑰ and ⑳ buttons is used to activate the function that is labeled below the button, first press this button then press that intended button.

When the lamp of this button is lighting, the control is in the "SHIFTED" state, enabling the lower function of each button.

⑦ **OVERLOAD**

This lamp lights up when the maximum output current of this unit is exceeded.

If you notice this lamp lighting, promptly shut off the output.

If this lamp continues lighting for ten seconds or longer, the output will be automatically turned off.

⑧ OUTPUT

This button, equipped with a lamp, turns ON/OFF the output voltage. Every press on this button toggles the ON/OFF of the output. As long as the output is ON, the lamp on the left keeps lighting.

⑨ POWER

This is the power supply switch. Put the switch to the upper (I) position to charge the power to the unit.

The switch, also working as a non-fuse breaker, will be shut off when an extraordinary current flows in the power line. Further, it will also be shut off when too much heat is accumulated in the unit or if an unusual voltage takes place.

⑩ 50Hz, 60Hz and 400Hz

These buttons are used to select the preset frequency by a single finger press.

Pressing the button selects the labeled frequency.

⑪ SET

This button should be pressed when changing the frequency with the ⑲ MODIFY dial.

When this button is pressed, the ② "FREQUENCY" display blinks at the digit of 1Hz. In this condition, turn the ⑲ MODIFY dial to alter the frequency in 1Hz increments.

To move the digit of frequency for alteration, press the ⑱ "MODIFY ← →" button to move the blinking position to the desired digit.

⑫ RANGE

This button is used to change the output voltage range.

Every press on the button changes the voltage range in the order of 100V, 120V, 200V and 240V, and then further back to 100V.

When the output voltage range is changed, the voltage value that has been set will be cleared to 0V for the safety reasons..

⑬ AUTO LEVEL

This button is used to automatically fine-tune the output voltage to the set voltage level.

When the button is pressed and the button lamp is lighting, the output voltage will be automatically fine-tuned to the set level.

⑭ MEAS

This button toggles the indication of output voltage between the set value and the measurement.

When the button is pressed and the button lamp is lighting, the value in ④ VOLTAGE indicates the measurement of output voltage, and when the lamp is not lighting, it indicates the set voltage.

⑮ SET

This button is used to set the output voltage.

When this button is pressed, the ④ "VOLTAGE" display blinks at the digit of 1V. In this condition, turn the ⑲ MODIFY dial to alter the output voltage setting in 1V increments.

To move the digit of voltage for alteration, press the ⑱ "MODIFY ← → " button to move the blinking position to the desired digit.

⑯ GPIB LOCAL (ADRS)

This is a "Return to Local" button of GPIB. When this unit is controlled via a GPIB from a personal computer or other devices, the unit is put in a remote state, and the lamp of this button is turned off. In this condition, (i.e., remote condition), operation on the panel is disabled.

When in a remote condition, press this button and the lamp will light up and the control is put in the local condition, enabling the user to operate on the panel.

However, if a local lockout command has been sent from the computer, pressing this button can not bring the control back to the local condition.

If this button is pressed when the ⑥ SHIFT button has been pressed with the SHIFT lamp lighting, the ② "FREQUENCY" display shows the GPIB address and delimiter setting status.

The left side of the decimal point indicates the GPIB address and the right side the delimiter setting status of the data sent by this unit.

The delimiter setting status is indicated as follows:

  0:   meaning CR + LF

  1:   meaning CR

  2:   meaning LF

The delimiter setting can be changed by using the ⑲ MODIFY dial.

⑰ LOCK (OFF)

This button is used to prohibit operation on the panel.

Pressing this button, when the ⑥ "SHIFT" lamp is not lighting, disables operation on the panel, turning on the lamp of this button at the same time.

When the LOCK button is lighting with panel operation being disabled, pressing this LOCK button, after pressing ⑥ "SHIFT" to light up the SHIFT lamp, enables panel operation, turning off the lamp.

⑱ MODIFY ← →

These buttons move the digit for alteration when the set value is to be modified.

⑲ UP DOWN

This is the MODIFY dial used to change settings. Clockwise turn increases the value and counterclockwise turn decreases the value.

㉒ PROGRAM

These buttons are used to store or retrieve settings. Up to four sets of settings can be stored.

Specify a desired value for setting on the panel, then press the ⑥ "SHIFT" button to light the button lamp. In this condition, press one of these ㉒ "PROGRAM" buttons which carries the relevant memory number above to store the specified values.

To retrieve any set of stored values, press one of the ㉒ "PROGRAM" buttons which carries the relevant memory number above, when the ⑥ "SHIFT" button is not lighting, and the stored values will be put in the setting.

When calling a set value, if the output voltage range for the stored value is different from the currently used range, then ⑧ "OUTPUT" will be turned OFF.

㉑ OUTPUT

This receptacle is used to take out the AC output from this unit.

The receptacle is rated as 10A at 250V. To take out a heavy current, use the output terminal block on the back panel because the use of this receptacle would cause a voltage drop or other disadvantages.

A black dot "•" marked on the right end indicates that the end has the same electric potential as that at the end of the output terminal block on the back panel which has also a black dot.

3.1.2 Back panel

㉒ 2A/250V

This fuse holder is used for protection of the power supply to the CPU and the synthesizer.

Fit a 2A/250V fuse of commonly used fusible type with the size of ϕ5.2 × 20mm.

㉓ LINE 100V, L, N and ⏚

This terminal block is used to accept power supply input.

Provide this unit with power supply of 100V±15% AC.

⚠ **WARNING**

Connection of power supply should be: L to the Live line and N to the Neutral line.

The terminal labeled with a "⏚" mark should be used for protective earth. Be sure to connect the terminal to the ground.

㉔ OUTPUT, Hi, Lo and ⏚

This terminal block is used to provide the output of this unit.

The black dot "•" indicates that the end below the mark has the same electric potential as that at the end of the AC receptacle on the front panel which has also a black dot.

㉕ SIG SEL

This switch selects which to drive this unit by, by the internal synthesizer or by the external signals.

Selection of "INT" starts the internal synthesizer while selection of "EXT" allows the unit to be driven by the signal applied to the BNC connector on the right.

External signals must be a sine wave of 40Hz to 500Hz. Application of 1Vrms produces a full nominal voltage for the relevant range, where the input impedance is about 10kΩ.

⚠ **CAUTION**

Never apply DC voltage to the external signal terminal.

㉖ Blank panel for optional devices

Optional GPIB or three-phase output devices can be installed via connector or others fit in this space.

㉗ Exhaust vent

This is an air outlet for the forced cooling fan. The vent should be placed 30cm or more away from wall or other surfaces to ensure necessary air flow.

3.2 Startup

To start up the unit, follows the procedure below:

1. Place this unit in a stable place to secure proper air flow through the air intake on the front and the exhaust vent on the back.

2. Confirm that the ⑨ power supply switch of this unit is put to the bottom (O) position, indicating the power is turned off.

3. Confirm that "INT" is selected on the input selector switch, ㉕ "SIG SEL", on the back.

4. Connect the supplied power cable to "L" and "N" of the power input terminal on the back and tighten the clamp screws.

5. Connect the other end of the power cable to an adequate power supply that has a capacity equal to or greater than the value shown below. Also connect the protective earth terminal (⏚) of the power input to the ground for hazard prevention.

    15A for **EPX4104**

    20A for **EPX4106**

    40A for **EPX4112**

6. Confirm that no unnecessary matters are connected to the output terminal.

7. Put the power supply switch to the upper position to energize the unit. All segment of the numerical display turns on first, then the display on the right shows the version number of the stored software for one second or so.

    The display then shows "SEt UP 10" and countdown starts. In about ten seconds, the control retrieves the settings which were stored on the last power turn-off occasion. The output, however, starts with a turned off condition for the safety reasons.

8. The table below lists up errors that may appear on power charging moment.

Indication	Buzzer	Details of error
ro Er1	for nearly 1 sec.	An error was detected, on power charging, in the ROM which contains the program.
r Er2	for nearly 1 sec.	An error was detected, on power charging, in the RAM used by the program.
bc Er1	for nearly 1 sec.	An error was detected, on power charging, in the memory storing the panel settings.
Er 01	for several msec.	A difference was detected, on power charging, between the setting switches on the last power-off occasion and those on this power charging moment.

3.3 Frequency setting

Frequency can be set in the range of 40.000 to 500.000Hz with 1mHz resolution in setting, and the accuracy being ±50ppm or less.

When the power to the unit is turned on, the control retrieves the frequency value which was stored on the last power-off occasion, and uses it as the initial setting. Hereafter, frequency should be selected in the following procedure.

1. To select any of 50, 60 or 400Hz, press the relevant one of the ⑩ buttons which has your desired frequency on the top. This will change the frequency to the specified value at once.

    When the frequency is changed, the same phase is maintained; the output wave is changed with the continuous phase.

2. To select any arbitrary value between 40.000 and 500.000Hz, first press the ⑪ "SET" button located below the frequency display.

    The 1Hz digit of the frequency display blinks.

    Use the ⑱ "MODIFY" buttons to move the blinking position to the desired digit.

    Use the ⑲ "UP/DOWN" modifying dial to select your desired frequency for setting.

3. To quick-change the frequency in the range of 40.000 to 500.000Hz, the ⑳ "PROGRAM" buttons can be used.

☞ **For details, see the section of program setting.**

3.4   Setting output voltage

Four output voltage ranges (rated or nominal voltage levels) can be selected, with the variable range depending on the range as follows:

100V range, variable range of 0 to 120.0V, setting resolution being 0.1V

120V range, variable range of 0 to 144.0V, setting resolution being 0.1V

200V range, variable range of 0 to 240.0V, setting resolution being 0.1V

240V range, variable range of 0 to 288.0V, setting resolution being 0.1V

For the output frequency of 40 to 45Hz, however, the highest level of the output voltage is restricted to 110% of the nominal voltage

When the power to the unit is turned on, the control retrieves the voltage value which was stored on the last power-off occasion, and uses it as the initial setting. Hereafter, voltage should be selected in the following procedure.

1. Note that the ④ "VOLTAGE" display of this unit can show output voltage of the set value or the measured value, whichever is desired, by user's selection so that the user may alter the output voltage while observing the set value or the measured value.

    Although measured values come from the measurement by the mean value demodulation system, the same value as the effective value can be obtained because the output waveform is a low-distortion sine wave.

    To change indication, press the ⑭ "MEAS" button located below the output voltage display. When the lamp of the display is not lighting, the set value is shown and when it is lighting, a measured value is shown.

2. Confirm that the lamp of the ⑬ "AUTO LEVEL" button is not lighting. If it is lighting, then press the button to turn off the lamp.

3. Press the ⑪ "SET" button located below the output voltage display.

    The output voltage display blinks at the digit of 1V.

    Use the ⑱ "MODIFY" buttons to move the blinking position to the desired digit.

    Turn the ⑲ "UP/DOWN" modifying dial to select your desired output voltage for setting.

4. To quick-change the output voltage, use ⑦ "PROGRAM" buttons.

☞ **For details, see the section of program setting.**

3.5 Monitoring the output current

Although the output voltage of this unit has a waveform of low-distortion sine wave, the output current has various types of waveform depending on the conditions of the load. Therefore, the current monitor of this unit measures and shows the effective value.

At any time, the output current is shown on the ⑤ "CURRENT" display.

The user can determined the power consumption (VA) value of the load by multiplying the value shown on ④ "VOLTAGE" by the value shown on ⑤ "CURRENT".

The rated output of this unit is shown in the table below.

	Linear load power factor of resistance etc. of 0.85 or higher	For a rectifier circuit of capacitor input type with peak factor of 2
EPX4104	330VA	410VA
EPX4106	500VA	620VA
EPX4112	1000VA	1250VA

Therefore, the rated output current for each range are as shown below.

☞ **For linear load power factor of resistance etc. of 0.85 or higher (0.85 or lower), see Section 3.6 "Restrictions on output current due to load power factor ".**

	EPX4104	EPX4106	EPX4112
100V range	3.30Arms	5.00Arms	10.00Arms
120V range	2.75Arms	4.17Arms	8.33Arms
200V range	1.65Arms	2.50Arms	5.00Arms
240V range	1.38Arms	2.08Arms	4.17Arms

For a rectifier circuit of capacitor input type with peak factor of 2:

	EPX4104	EPX4106	EPX4112
100V range	4.10Arms	6.20Arms	12.50Arms
120V range	3.42Arms	5.17Arms	10.42Arms
200V range	2.05Arms	3.10Arms	6.25Arms
240V range	1.71Arms	2.58Arms	5.21Arms

Further, the maximum output current for each range is restricted to the value shown in Figure 3-4 "Output Voltage and Allowable Output Current" depending on the output voltage.

If the output voltage is 0 to 10% of the nominal voltage value for the range, then 25% or less of the rated output current.

If the output voltage is 10 to 20% of the nominal voltage value for the range, then 50% or less of the rated output current.

If the output voltage is 20 to 100% of the nominal voltage value for the range, then 100% or less of the rated output current.

If the output voltage is 100 to 120% of the nominal voltage value for the range, then 80% or less of the rated output current.
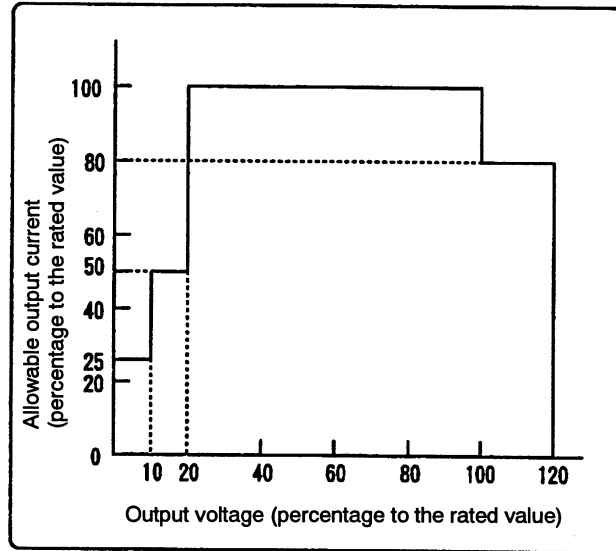
Figure 3-4   Output Voltage and Allowable Output Current

If the unit is used beyond the maximum current, the ⑦ OVERLOAD lamp will light up for warning.

When the overload lamp is noticed lighting, promptly turn off the output because the load is exceeding the capacity of this unit.

If the overload lamp continues lighting for ten seconds or longer, the output will be automatically shut off.

3.6   Restrictions on output current due to load power factor

Since this unit uses a linear power amplifier, its maximum output is limited by the output frequency, output voltage, load power factor and so on.

If the load power factor is 0.85 or higher, the relationship between the output voltage and the allowable output current is as shown in Figure 3-4. If it is 0.85 or lower, the maximum output current Io is restricted by the output voltage Vo and load power factor (cos φ) as follows:

Maximum output current = The rated output current × The load power factor

Load power factor = The power / (The voltage × The current)

3.7 Using AUTO LEVEL

This unit allows the user to set values within the following tolerance:

Within ±1% of the nominal range value for the range of 45 to 65Hz.

Within ±3% of the nominal range value for the range of 40 to 500Hz excluding the above range.

In addition, a difference of maximum ±0.5% may takes place at no load condition and at rated load condition due to load regulation.

On the other hand, the measurement of the output voltage will be obtained in the following accuracy:

Within ±0.5% of the nominal range value for the range of 40 to 500Hz.

Therefore, if control is carried out so that the result of the output voltage measurement will be equal to the set value, the accuracy of the output voltage can be improved.

The AUTO LEVEL function provides this form of control via the incorporated CPU.

Press the ⑬ "AUTO LEVEL" button and the "AUTO LEVEL" function will be enabled, with the lamp lighting up.

When the lamp of the ⑬ "AUTO LEVEL" button is lighting, press the button again and the "AUTO LEVEL" function will be disabled, with the lamp turning off.

3.8 Using PROGRAM

The unit has a memory device to store four sets of settings made on the panel. These sets can be retrieved or stored by operation of the ⑳ "PROGRAM" buttons.

Any set of three items, consisting of output frequency, output set voltage, and output range, can be stored. Output ON/OFF, AUTO LEVEL or other items are not stored.

To store settings, first specify desired values on the panel displays, then press the ⑥ "SHIFT" button and press a relevant one of ⑳ "PROGRAM" buttons which carries the number to which you want to store the items while the lamp of ⑥ "SHIFT" is lighting.

To call any set of stored values, press the relevant one of the ⑳ "PROGRAM" buttons which carries the number in which the set is stored while the ⑥ "SHIFT" lamp is not lighting.

If a set is called which contains the same output voltage range as the currently selected one when the output is turned ON, the output keeps to be ON. If a set is called containing a different output voltage range from the currently selected one, then the output will be turned OFF.

The changing time needed to read out the memory is about 0.2 second.

Use of this program function allows the user to perform test or other measurements of subject test piece at the highest, regular, and lowest supply voltage just with a single touch on the button.

3.9 Connecting an external oscillator

This unit can be operated not only by the incorporated synthesizer, but also by external signals from an outside oscillator or other devices. If external signals are used, this unit works as a power amplifier, and the stability of the output frequency and output voltage will be dependent on the external signals.

⚠ CAUTION

Never supply DC voltage to the external signal terminal. External signals must be AC of 40 to 500Hz.

Operation of this unit by external signals should follow the procedure below:

1. Put ㉕ "SIG SEL" to the "EXT" position on the back panel. This erases the indication of frequency and amplitude on the front panel, indicating the change of signal source.

2. Confirm that the ⑧ "OUTPUT" lamp is not lighting on the front panel, turning off the output.

3. Fully turn down the external signal level, and connect it to the ㉖ BNC connector on the back panel.

4. Gradually raise the output level of the external signal, and set the output voltage.
   A sine wave or 1Vrms will produce the rated output voltage.

3.10 Operation of protective circuits

This unit is provided with protective circuits consisting of a heat sink temperature detection circuit, a power transistor operation region limiting circuit, a line input overcurrent detection circuit, an excessive output current detection circuit and an internal power supply overvoltage detection circuit.

(1) Heat sink temperature detection circuit

The heat sink temperature detection circuit is intended to detect the heat sink temperature exceeding the specified level due to the fault of the forced air cooling fan, overload or other causes. If any is detected, the circuit zeros the output of the power amplifier, lighting the overload lamp, in order to decrease the heat sink temperature. When the temperature lowers to the specified level, the output is automatically recovered. However, a cycle of output zeroing and recovery will be repeated if the cause for the temperature rise is not removed.

(2) Power transistor operation region limiting circuit

The power transistor operation region limiting circuit restricts the voltage and current so that the power transistor will be operated within the safe operation region at all times against those stresses including an overload, a low-power-factored load, and a rush current. If any is detected, this circuit will light up the overload lamp.

When the operation region limiting circuit is excited caused by a rush current or back electromotive force from the load, distortion will be noticed in the output waveform. The deformation of waveform depends on the phase on the load jointing or the magnitude of the rush current. An example is shown in Figure 3-5 "Typical Voltage Waveform on Protective Circuit Activation".
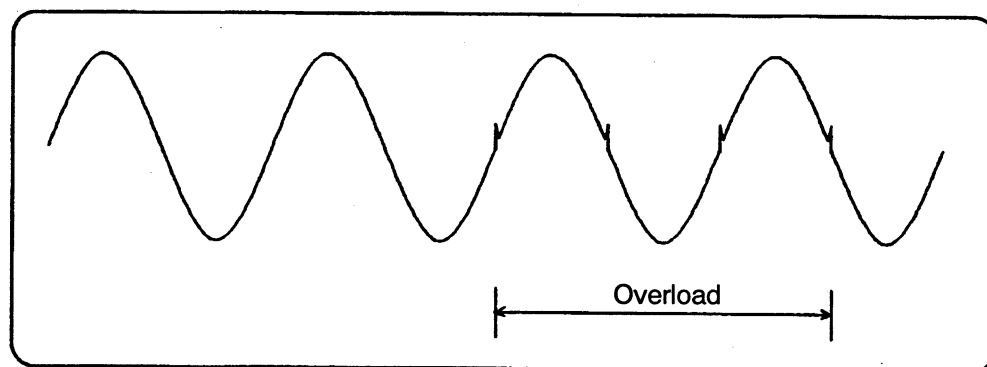
Figure 3-5   Typical Voltage Waveform on Protective Circuit Activation

(3) Line input overcurrent detection circuit

The line input overcurrent detection circuit tries to detect an excessive input current due to overload, failure or other causes and when any is detected, it turns off the power supply switch to shut off the line input. Turn on the switch for recovery after elimination of the cause.

(4) Excessive output current detection circuit

When the output current exceeds the rated value, the excessive output current detection circuit detects it to light up the overload lamp. If this condition continues for ten seconds or longer, this device turns off the power supply switch to shut off the line input. Turn on the switch for recovery after elimination of the cause.

(5) Internal power supply overvoltage detection circuit

When the DC power voltage supplied to the power transistor exceeds the specified level, the internal power supply overvoltage detection circuit turns off the switch to shut off the input in order to protect the power transistor. Turn on the switch for recovery after elimination of the cause.

The above protective circuits, as incorporated in the unit, light up the overload lamps or shut off the switches when the applicable one of the following conditions is met.

(a) Overload lamp will be lit up if:

Heat sink temperature rises to an extraordinary level,
Safe operation region for the power transistor is violated, or
Excessive output current flows.

(b) POWER switch will be turned on if:

Excessive line input current flows,
Excessive output current flows for ten seconds or longer, or
The voltage of internal DC power supply increases too high.

3.11 Allowable output

Since this unit uses a linear power amplifier, the allowable output changes with the output frequency, output voltage, load power factor and other conditions.

If the load power factor is 0.85 or higher, the allowable output current of this unit is as shown in Figure 3-4 "Output Voltage and Allowable Output Current".

If it is 0.85 or lower, the allowable output current Io (Arms) of this unit is expressed in a function of the output voltage Vo (Vrsm) and load power factor, cos ϕ, as follows:

Output voltage range	Allowable output current (for sine wave current)
$0.2Vr \le Vo \le Vr$	$Io = Ir\ COS\ \phi$
$Vr < Vo$ [Note]	$Io = \dfrac{Pr}{Vo}\ COS\ \phi$

Note: The maximum output voltage is 1.1Vr for 40 to 45Hz, and 1.2Vr for 45 to 500Hz.

where,

cos ϕ < 0.85

Io is the allowable output current (Arms),

Ir is the rated output current (Arms),

Vo is the output voltage (Vrms),

Vr is the rated output voltage (Vrms) and

Pr is the rated output power (VA).

If the current takes the form of distorted wave, the allowable peak output current value could be as shown in Figure 7-2 "Specification of Output Current Waveform", if it is an applicable case. The current waveform should be maintained within the operation limits of the protective circuit. Be careful to ensure the output power is at the rated power level or lower, not to mention.

Further, if the output current continues to be at the rated level or hither for about ten seconds, the overcurrent protection circuit will be excited to turn off the "⑨ POWER" switch, causing shutoff of the line input. If this occurs, reduce the load so that the output current will become lower than the rated level and then turn on the "⑨ POWER" switch again.

3.12 Considerations for various types of loads

Before connecting any load to this unit, proper considerations should be taken according to the nature of the load including the power consumption of the load, power factor, starting current and maximum current. It is essential to understand the load characteristics so that operation will be conducted within the allowable output of this unit.

The following sections describe typical types of loads that need specific considerations.

(1) Load of low power factor

For those loads of which power factor is low, such as inductive loads and capacitive loads, the allowable output of this unit becomes lower than the case of pure resistance. For the relationship between the power factor of the load and the allowable output, see the table in Section 3.12 "Allowable output".

If the overload lamp tends to light up or the output waveform would become distorted although the output current of the unit stays within the rated range and your loads consist of motors, transformers, fluorescent lamps, or the like, then check the power factor of the loads, and confirm that the output is within the allowable output range for that power factor.

(2) Loads requiring high starting current

If your loads consist of motors, slide regulators, transformers, incandescent lamps or the like, it may happen that the starting current rises up to several times the steady-state current at the moment when power is turned on. On startup, with any of these types of loads connected to the unit, the output may go beyond the rated power, triggering the protection circuit to restrict the output within the safe operation region, and eventually the unit fails to be started. Figure 3-6 "Starting Characteristics of an Induction Motor" shows an example of starting characteristics of an induction motor.

Waveform of
current, 20A/div

Waveform of
voltage, 100V/div,
50Hz
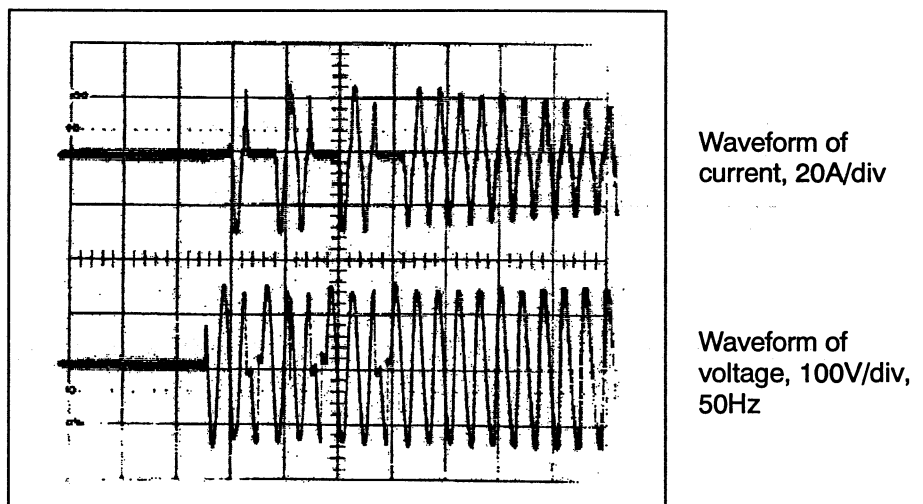
Figure 3-6   Starting Characteristics of an Induction Motor

(3) Load with high peak current

For switching regulators, full-wave rectifier circuits of capacitor input type and other similar devices, the peak current may soar up to several times of the effective-value current. Such peak current would be also subjected to restriction of protection level by this unit. For the protection level against the current value of this unit, see Figure 7-2 "Specification of Output Current Waveform". As shown in the figure, the protection level is 2.5 times the rated current (effective value) at 90° or 270° in voltage waveform when the output voltage is at the rated level. If this protection level is exceeded, even in a moment, the protection circuit is excited to restrict the output voltage. Figure 3-7 "Characteristics of a Full-wave Rectifier Circuit of Capacitor Input Type Being Connected" shows an example of characteristics when the unit is connected to a full wave rectifier circuit of capacitor input type.
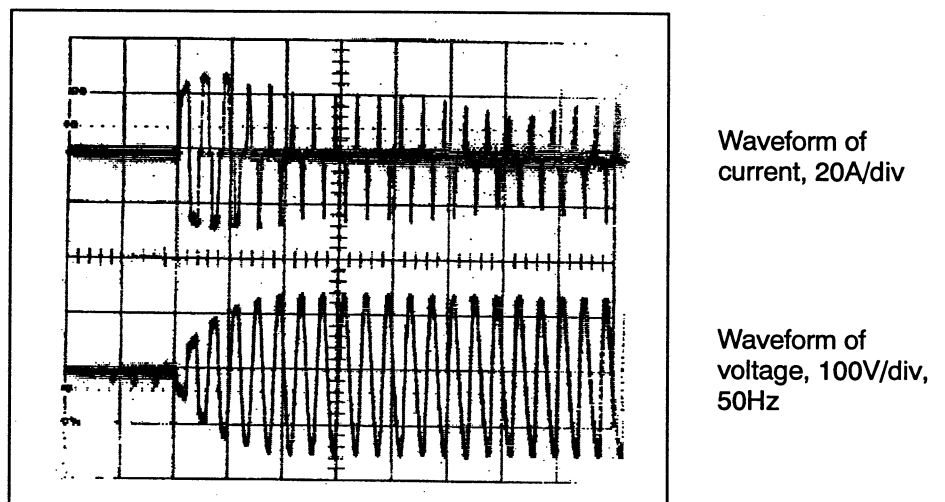
Waveform of
current, 20A/div

Waveform of
voltage, 100V/div,
50Hz

**Figure 3-7   Characteristics of a Full-wave Rectifier Circuit
of Capacitor Input Type Being Connected**

(4) Load of positive/negative unbalanced current

If the output current is unbalanced in its positive and negative sides, as observed when a half-wave rectifier circuit, for example, is connected as the load, this unit suffers overload even if the output current is lower than the rated level. This is because the unbalance current component brings the output transformer of this unit into magnetic saturation. The lower the output frequency is and the higher the output voltage is, the more likely this condition is to occur.

It is recommended that this unit should be used in a condition of the output current being as equal in the positive and negative sides as practicable.

(5) Stability against capacitive load

The upper limit of capacitive load that allows stable operation is about $10 \mu F$ for all four ranges.

3.13 Three-phase output (optional)

Use of three units, with an optional three-phase output device attached to one of three, designated as the master unit, can compose a power supply of balanced three-phase output.

Figure 3-8 "Three-phase Output System Connection Diagram" shows a connection diagram to create a three-phase output system.

The EPX unit in which the three-phase output device is added is used as the master unit, and the other two units will be assigned as slave units. The master unit is used for U-phase output while the slave units are used for V-phase and W-phase output.

Put the "SIG SEL" switch located on the back to the "INT" position for the master, and to the "EXT" position for the slaves.

Connect the three-phase signal output, V and W, of the master unit to the external signal input of each slave unit.

To set the output voltage in line-to-line voltage, put No. 4 DIP switch to "ON" on the internal panel display board of the mater unit.

In the three-phase output configuration, "AUTO-LEVEL" can not be used.

When the power is turned on, the master unit shows the frequency and output voltage on its displays. However, slave units show only a series of dashes, "– – – – – –", on the frequency and output voltage displays.

Select the same output range on all three units.

Setting of frequency and output voltage should be conducted on the master unit, and output ON/OFF should be made on every unit.

Simultaneous ON/OFF of output can be made if a control panel is attached by special order.
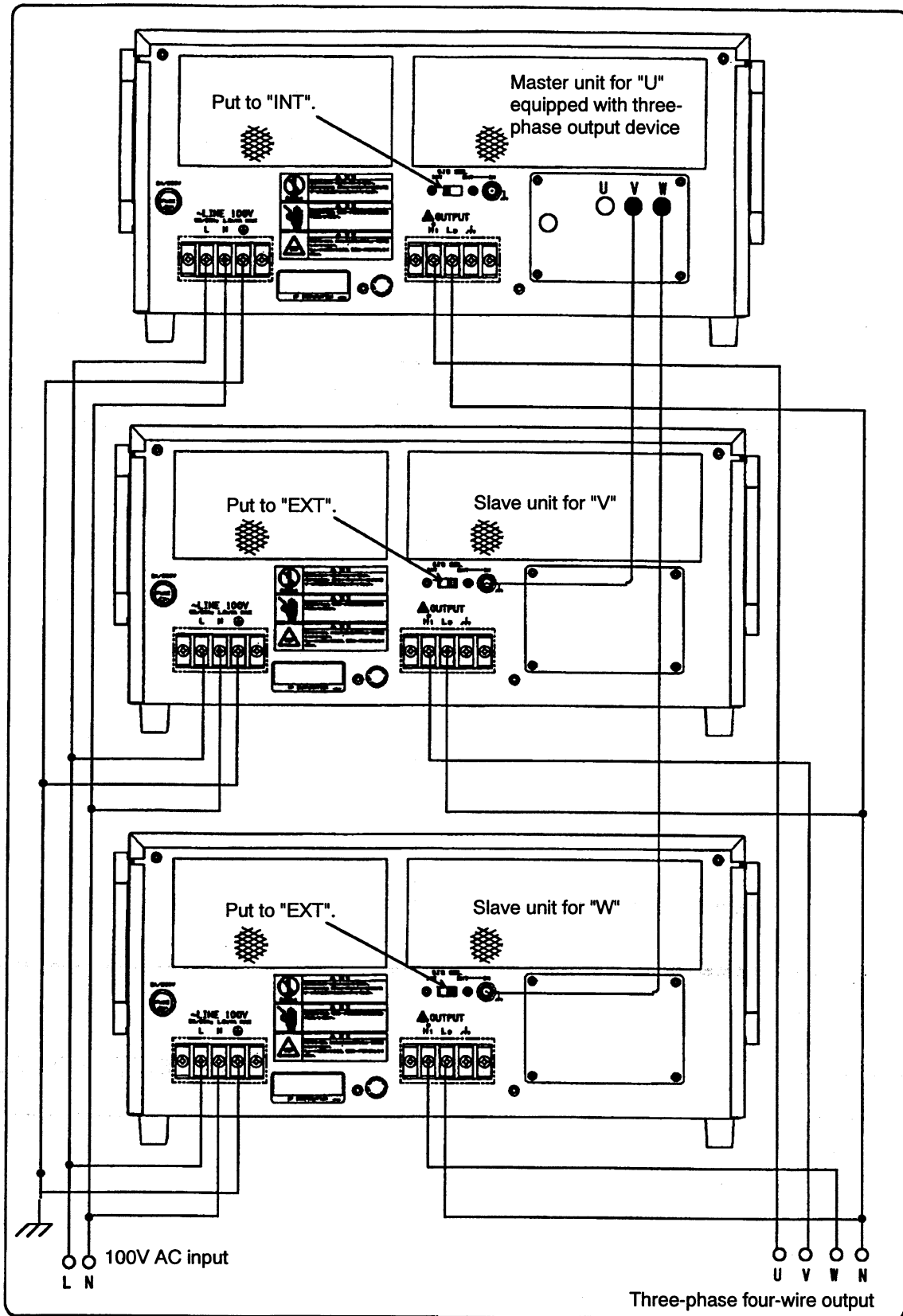
Figure 3-8   Three-phase Output System Connection Diagram (for EXP4106 units)
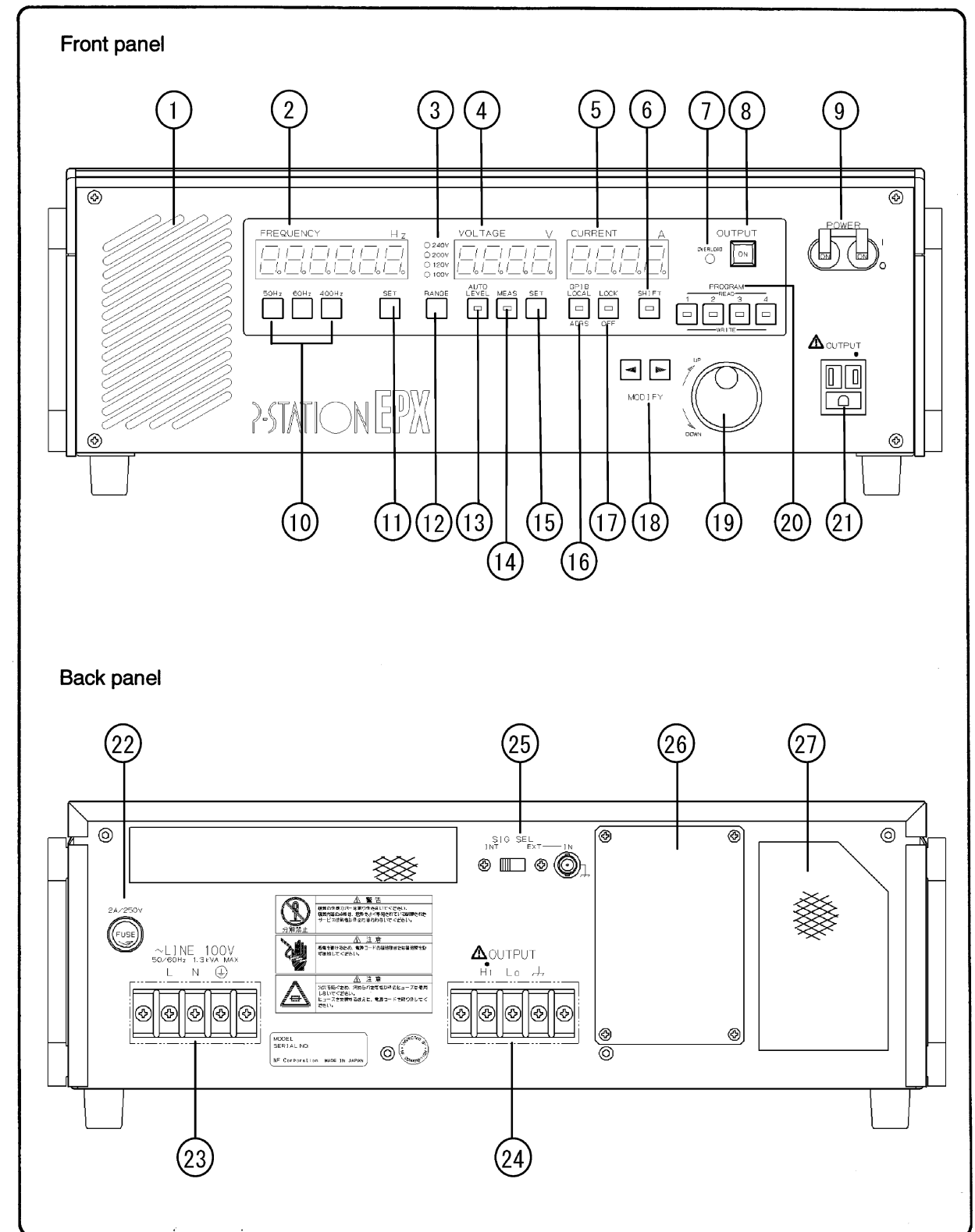
Figure 3-1   Front and Back Panels of EPX4104

Front panel
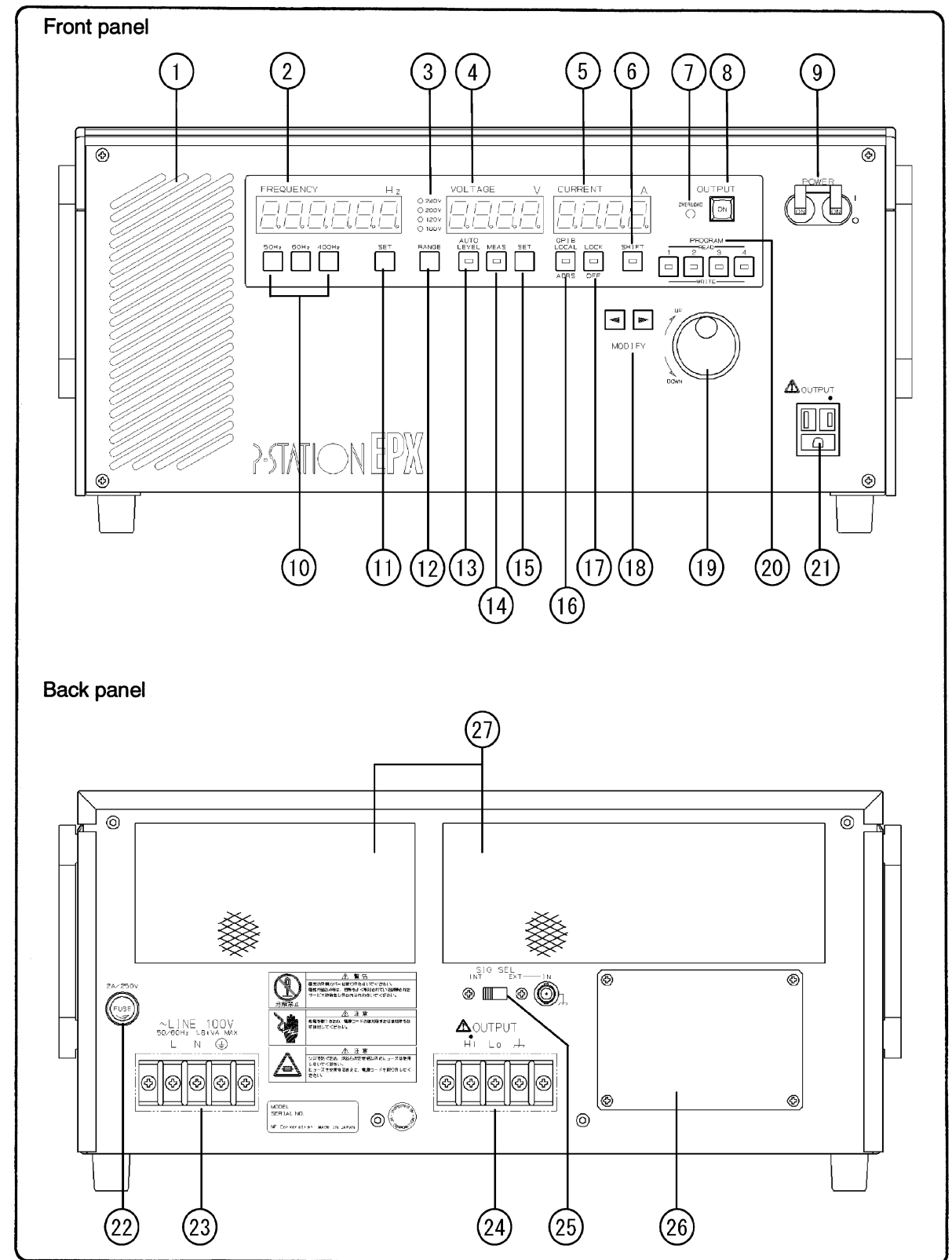
Back panel

Figure 3-2   Front and Back Panels of EPX4106
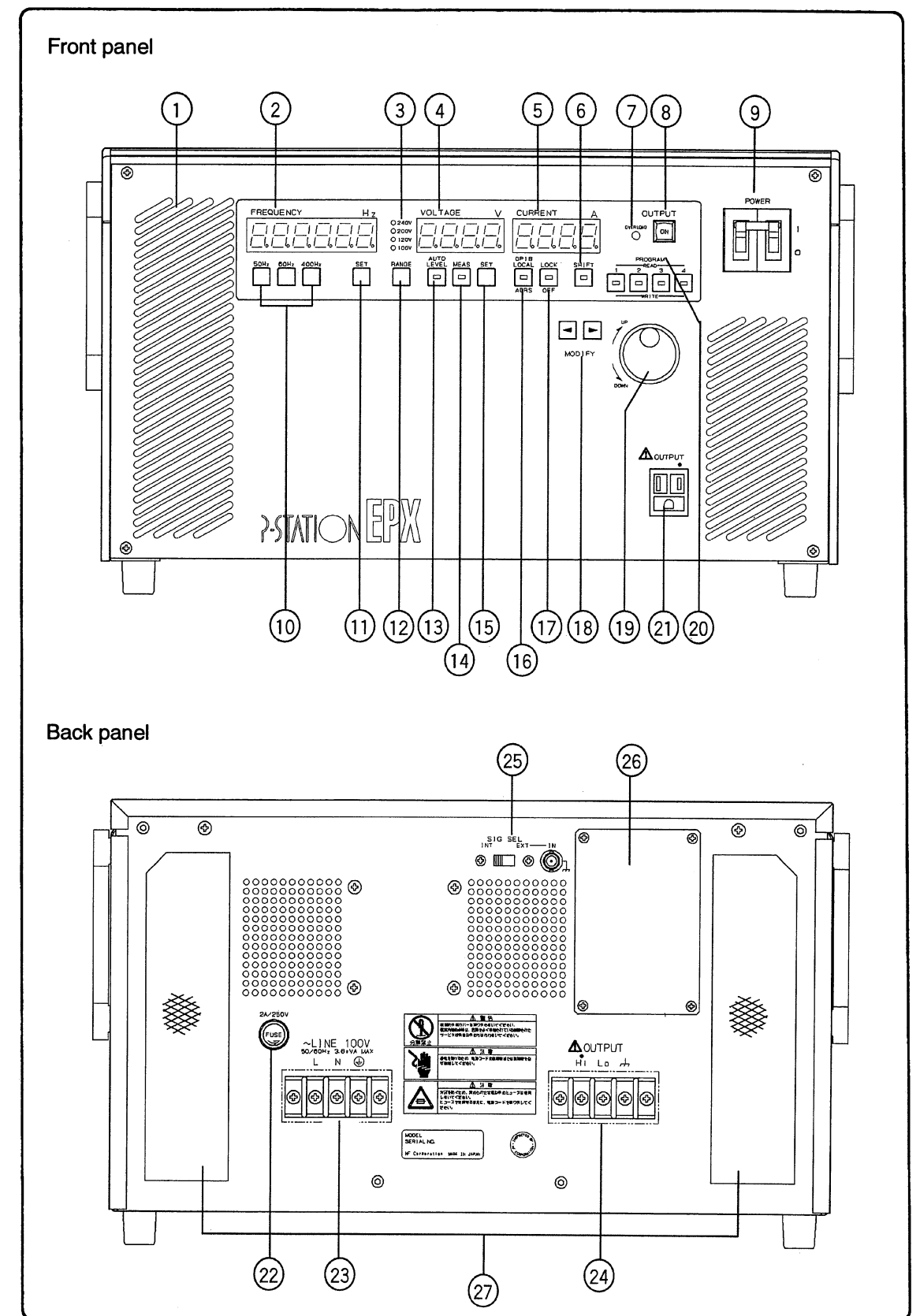
Figure 3-3　Front and Back Panels of EPX4112

4. GPIB Interface (Optional)

4.1 Instructions before use

The GPIB interface, compatible to this unit, is an optional item. If your system requires a GPIB interface, contact our sales agency or Sales Department.

- **Setting the address**

Press the "SHIFT" button to light up the LED of the button, then press the "ADRS" button and the "FREQUENCY" display shows the GPIB address and terminator setting status.

The address is on the left part to the decimal point. The user can use the MODIFY dial to set a value ranging 0 to 30.

Normally use 1 to 30 values for setting because "0" is used by the controller. Take care so that the same address number will not be used as that of other devices connected to one cable.

- **Setting the terminator**

Press the "SHIFT" button to light up the LED of the button, then press the "ADRS" button, and the "FREQUENCY" display shows the GPIB address and terminator setting status.

The terminator setting status is on the right part to the decimal point. The user can use the MODIFY dial to set a value ranging 0 to 2, which denote as follows:

   0, means CR + LF,

   1, means CR, and

   2, means LF.

- **Releasing the remote condition**

Devices controlled by GPIB have two conditions: a "Local" condition that enables on-panel operation; and a "Remote" condition that disables on-panel operation.

If this unit is in a local condition, the green LED located inside the "GPIB LOCAL" button keeps lighting.

If the unit is controlled by the controller, the unit is brought in a remote condition from the local condition and the panel operation is disabled, with the "GPIB LOCAL" LED turned off.

To return the unit back into the local condition when the controller has finished its control, press the "GPIB LOCAL" button to light up the LED.

Selection of remote/local can be achieved also from the controller. When the controller sends a local lockout (LLO) command, the "GPIB LOCAL" button on this unit is disabled; pressing the button will not return to the local condition. Only the controller can control the operation.

```
┌─────────────────┤ ⚠ CAUTION ├──────────────────┐
```

- Plugging and unplugging of the GPIB connector must be conducted when power to any device connected to the bus is turned off.

- When the GPIB is to be used, turn on the power to all devices connected to the bus.

- The number of devices to be connected to the GPIB should be 15 or less within one system, including the controller.

- The cable length is subject to the following restrictions:
  The total length of the cables is "the number of devices" times 2m or 20m, whichever is shorter.
  The length of any cable must be 4m or shorter.

- Before assigning the address on the GPIB, check enough for possible duplication. If there is the same talk address for different devices in a single system, equipment damage may be caused.

- Pay attention to terminators. If they are not unified in a system, unexpected trouble may be caused.

- The GPIB is prepared for use in relatively good environment. Refrain from use as much as practicable in environment which suffers from power supply fluctuation or which is exposed to much noise.

4.2 Terminators

Terminators will be responded as follows:

- **As a listener**

Reception of any of a CR, LF or EOI signal, or any combination thereof, will be determined to be the end of the data.

Terminator setting is effective when this unit sends out data, but not effective when it receives data.

- **As a talker**

Based on the setting on the front panel, a terminator will be sent following the data. In addition, an EOI signal will be sent simultaneously with the last byte of the terminator.

4.3 Response to interface messages

IFC	Initializes the GPIB interface. Releases the status of set talker or listener.
DCL, SDC	Clears the input buffer and aborts interpretation/execution of the commands. Clears the response message buffer and clears the MAV bit of the status byte. If SRQ is being transmitted, then releases it and clears the RQS bit of the status byte.
LLO	Disables the local buttons on the front panel.
GTL	Puts the control into a local condition.

4.4 Service request and status structure

If the load goes beyond the rated level to cause an overload condition, or if the GPIB program code contains an error and brings anomaly in this unit, then the system creates a service request (SRQ) of GPIB to interrupt the controller.

On such occasions, a status byte expresses the factor of the SRQ.

The status byte is structured as shown in Figure 4-1 "Structure of a Status Byte". It consists of four status bytes and two queues and one status byte that indicates their status.

Transmission of an SRQ can be masked by the service request enable register, and it can be also used by selecting only the factor that is required by the program. In addition, an SRQ is transmitted even it is in a local condition.

Figure 4-1   Structure of a Status Byte

- **Status byte**

The logic of each bit of status bytes, OSB, ESB, WSB and FLS, defines "1" for occurrence of one or more of these factors, and "0" for no occurrence.

For status bytes, a clearing condition is defined for each bit. Therefore, status bytes are cleared all together only on the occasion of program booting.

Table 4-1   Status Bytes

Bit	Designation	What is indicated
7	OSB	**Operation status register summary bit** This is set to "1" if any one of the operation status register bits is "1", and cleared to "0" if all of them are "0".
6	RQS/MSS	**Request service bit/Master summary bit** RQS/MSS bit is set to "1" if a SRQ request takes place, and cleared to "0" at the serial poll. However, it is not cleared by a "Read status byte" command.
5	ESB	**Standard event status register summary bit** This is set to "1" if any one of the standard event status register bits is "1", and cleared to "0" if all of them are "0".
4	MAV	**Response message output availability bit** This is set to "1" if a response message becomes ready for inquiry, and cleared to "0" if it is read.
3		Not used.
2	EAV	**Error occurrence bit** This is set to "1" if any error takes place, and cleared to "0" if the message is read.
1	WSB	**Warning event status register summary bit** This is set to "1" if any one of the warning event status register bits is "1", and cleared to "0" if all of them are "0".
0	FLS	**Anomaly detection status register summary bit** This byte is set to "1" if any one of the anomaly detection status register bits is "1", and cleared to "0" if all of them are "0".

- **Operation status register**

The operation status register can be read out by ?OSC. Every bit of this register is cleared to "0" when the register is read.

For each factor of the operation status register, the bit which has set "1" to the operation status enable register will be valid.

Table 4-2   Operation Status Register

Bit	Designation	What is indicated
7 to 1		Not used
0	SET	"1" is set here when the setup processing has completed immediately after power charging. Setting of frequency, range, output voltage and other items is disabled until this bit becomes "1".

- **Standard event status register**

The standard event status register can be read out by ?ESR. Every bit of this register is cleared to "0" when the register is read.

For each factor of the standard event status register, the bit which has set "1" to the standard event status enable register will be valid.

Table 4-3   Standard Event Status Register

Bit	Designation	What is indicated
7	PON	Power charging bit
6		Not used.
5	CME	**Command error bit** This is set if an syntax error is detected in the program codes.
4	EXE	**Execution error bit** This is set if the parameter is outside the allowed setting range, or if contradiction is detected in the setting.
3		Not used.
2	QYE	**Inquiry error bit** This is set if a inquiry message queue that has no data was read, or if inquiry is made beyond the upper limit of response message queue.
1		Not used.
0		Not used.

• **Warning event status register**

The warning event status register can be read out by ?WSC. Every bit of this register is cleared to "0" when the register is read.

For each factor of the warning event status register, the bit which has set "1" to the warning event status enable register will be valid.

Table 4-4   Warning Event Status Register

Bit	Designation	What is indicated
7 to 3		Not used.
2	SYN	This is set to "1" when the synchronization setting is changed.
1	SIE	This is set to "1" when the external input signal selection is changed.
0	ENG	This is set to "1" when the range is changed.

• **Anomaly detection status register**

The anomaly detection status register can be read out by ?FSC. Every bit of this register is cleared to "0" when the register is read.

For each factor of the anomaly detection status register, the bit which has set "1" to the anomaly detection status enable register will be valid.

Table 4-5   Anomaly Detection Status Register

Bit	Designation	What is indicated
7 to 3		Not used.
2	ALC	This is set to "1" if the correction range is violated during "AUTO LEVEL" operation.
1	CUR	This is set to "1" when current overload occurs.
0	VLT	This is set to "1" when voltage overload occurs.

4.5 Program codes

Program code are first stored in the reception buffer, then interpreted and executed on the first-in first-out basis when a terminator is received. When they are executed, the reception buffer is cleared in order to be ready for the next reception.

The reception buffer has a capacity of 256 bytes to store received commands. NULL (00H) and terminator are not stored in the input buffer. Only 256 characters are executed and the overflowed (if any) will be cleared, causing an error.

Program codes are divided into two groups as follows:

- Setting messages: conduct settings or operation directives.

- Inquiry messages: read setting data and status values.

Inquiry messages, also called query messages, are featured with a question mark "?" added to the top of the header of a setting message.

Program codes indicate the type of data, and consist of a header made up of alphabets and a parameter showing a number.

Program codes may be sent successively if they are within the limit for the input buffer characters. In addition, spaces or semicolons can be inserted between program codes for better legibility when sending program codes in a row.

Figure 4-2 shows a basic syntax of program codes
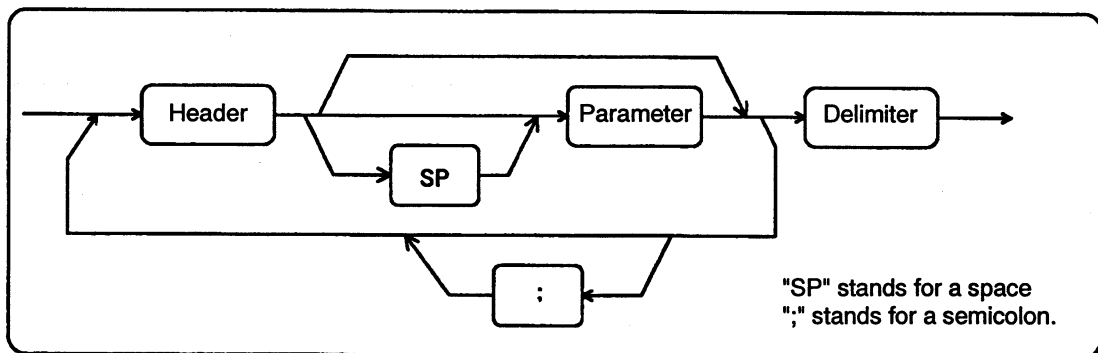
Figure 4-2   Basic Syntax of Program Codes

Three types of numerical formats are provided for parameters as follows:

- NR1 (integer format type)   Example: 99   066   −1234   +24

- NR2 (floating-point format type)   Example: 1.2   .001   −160.5   +0003.82

- NR3 (exponential format type)   Example: 12E3   9.8E+02   +0.4E−6   −0.07E+09

Any of the above formats can be used for parameters if the value stays within the allowable setting range.

4.5 Program codes

Table 4-6   List of Program Codes for Basic Functions

Function name	Header	Setting range and operation	Inquiry	Example
Output frequency	FRQ	40.000 to 500.000 (in Hz)	Yes	FRQ50
Output voltage	VLT	0.0 to 288.0 (in Vrms) 0.0 to 498.8 for line-to-line voltage	Yes	VLT123.4
Voltage indication	DSP	0 for setting, 1 for measurement	Yes	DSP1
Voltage measurement	MVL	0.0 to 500.0 (in Vrms)	Only inquiry	?MVL
Current measurement	MCU	0.00 to 20.00 (in Arms)	Only inquiry	?MCU
Voltage range	RNG	0 for 100V, 1 for 120V, 2 for 200V, 3 for 240V	Yes	RNG1
Output ON/OFF	OUT	0 for OFF, 1 for ON	Yes	OUT1
AUTO LEVEL	ALC	0 for OFF, 1 for ON	Yes	ALC0
Oscillator	SIE	0 for internal oscillator, 1 for external oscillator	Only inquiry	?SIE
Program writing	STO	1 to 4 Writes frequency and voltage range in the memory having the setting number.	No	STO3
Program reading	RCL	1 to 4 Reads frequency and voltage range in the memory having the setting number.	No	STO3
Model name	IDX	Model name: **4104, 4106** or **4112** Reply with the relevant model name.	Only inquiry	?IDX
Version	VER	ROM version in the form of "X.XX".	Only inquiry	?VER

Table 4-7   List of Program Codes for Optional Functions

Function name	Header	Setting range and operation	Inquiry	Example
Synchronization setting	SYN	0 for internal oscillator, 1 for line synchronization, 2 for external synchronization	Yes	SYN0
Three-phase output	PMD	0 for single-phase, 1 for three-phase output	Only inquiry	?PMD
Line-to-line mode	VMD	0 for phase voltage, 1 for line-to-line voltage	Yes	VMD0

Table 4-8   List of Program Codes for GPIB Interface Functions

Function name	Header	Setting range and operation	Inquiry	Example
Header	HDR	**Presence of header for data output from this unit** 0 for w/o header, 1 for w/ header	Yes	HDR1
Buzzer	BEE	0 for buzzer OFF, 1 for buzzer ON Valid only for buzzer control to GPIB command error.	Yes	BEE0
Status byte	STR	**Inquiry for status byte** Replies within 0-255 characters with weight totaled for every bit.	Only inquiry	?STR
SRQ enable register	SRE	**Mask of SRQ transmission** SRQ transmission allowed if every bit is "1". Replies within 0-255 characters with weight totaled for every bit.	Yes	SRE7
Operation status register	OSC	**Inquiry for operation status register** Replies within 0-255 characters with weight totaled for every bit.	Yes	?OSC
Operation status enable register	OSE	**Operation status register** Mask of factor for SRQ transmission SRQ transmission allowed if every bit is "1". Replies within 0-255 characters with weight totaled for every bit.	Yes	OSE1
Standard event status register	ESR	**Inquiry for standard event status register** Replies within 0-255 characters with weight totaled for every bit.	Yes	?ESR
Standard event status enable register	ESE	**Standard event status register** Mask of factor for SRQ transmission SRQ transmission allowed if every bit is "1". Replies within 0-255 characters with weight totaled for every bit.	Yes	ESE5
Warning event status register	WSC	**Inquiry for warning event status register** Replies within 0-255 characters with weight totaled for every bit.	Only inquiry	?WSC
Warning event status enable register	WSE	**Warning event status register** Mask of factor for SRQ transmission SRQ transmission allowed if every bit is "1". Replies within 0-255 characters with weight totaled for every bit.	Yes	WSE5
Anomaly detection status register	FSC	**Inquiry for anomaly detection status register** Replies within 0-255 characters with weight totaled for every bit.	Only inquiry	?FSC
Anomaly detection status enable register	FSC	**Warning event status register** Mask of factor for SRQ transmission SRQ transmission allowed if every bit is "1". Replies within 0-255 characters with weight totaled for every bit.	Yes	FSE5
Error code	ERR	Inquiry for error code	Only inquiry	?ERR

4.6 Error message

If an error occurs during GPIB control, a short buzzer sounds for warning, and an error message is created and stored in the error queue. The message stored in the queue is read by the "?ERR" command.

The error queue stores only the last one error.

If GPIB interface is in the standard mode, the EAV bit of the status byte is set to "1" when an error message is put in the error queue. When the error message stored in the error queue is read, the EAV bit is automatically cleared to "0".

In addition, the setting bit of the standard event status register is set to "1" depending on the nature of the error.

Table 4-9   List of GPIB Error Messages

Error No.	Error message	Description
0	No Error	No error is detected.
-101	Invalid character	An invalid character is detected in the received strings.
-102	Syntax error	A incorrect syntax is detected in the received strings.
-103	Invalid separator	An invalid separator is detected in the received strings.
-109	Missing parameter	A necessary parameter is missing.
-113	Undefined Header	An invalid header is detected in the received strings.
-120	Numeric data error	An error of numerical data
-121	Invalid character in number	An invalid character is detected in a parameter in the received strings.
-222	Data out of range	The parameter is out of the allowable setting range.
-314	Save/recall memory lost	Setting can not be retrieved because of collapse of setting storage memory.
-316	Backup memory lost	The battery-supported memory has been destroyed.
-420	Query unterminated	Response message is not found in the response message queue after talker setting.
-430	Query deadlocked	Response data is not found in the response message butter after reception of inquiry command (max. 256 characters).
-530	Input Buffer overflow	Program codes exceeded the input buffer capacity (256 characters).
-810	State has not been stored	The on-panel setting program memory specified by recall has not been stored.
-820	Not ready for setting command	The setting command can not be accepted because the control is under setup procedure.

4.7 Sample program

4.7.1 National Instruments' GPIB board + Visual Basic

The chart below shows the form and codes of the sample program prepared by Visual Basic using a GPIB board manufactured by National Instruments.

OUTPUT ON command button [cmdOutPutOn]

Voltage setting text box [txtSetV]
(Use the Return key to enter the voltage value.)

GPIB Notify control [GpibNotifyRQS]
(gpibNotify OLE control *)

Measured voltage indication label [lblMeasV]

Overload shape control [shpOverLoad]

Clear command button [cmdClrOvr]
(Clears overload indication)

* gpibNotify OLE control is an additional component, which can be used by selection of "gpibNotify OLE control module".

Figure 4-3   Form of Sample Program (NI board + Visual Basic)

4.7 Sample program

Codes of sample program (NI board + Visual Basic)

```
' EPX series Sample Program
'                   [uses a GPIB board by National Instruments]
Dim Dev As Integer
Const adr As Integer = 2                 ' GPIB address: 2


' Initialization process (executed on program starting)
Private Sub Form_Load()
      ibdev 0, adr, 0, T300ms, 1, 0, Dev    ' Device opens
      If (Dev < 0) Then                     ' Open error
         End
      End If
      ibclr Dev                             ' Interface clear
      ibwrt Dev, "SRE 01; FSE 03"           ' Enable bit setting for SRQ creation
      ibwrt Dev, "HDR 0"                    ' Setting of header off
                                            ' GPIB Notify RQS event notification starts
      Status% = GpibNotifyRQS.SetupNotify(Dev, RQS)
End Sub


' Ending process (executed on program ending)
Private Sub Form_Unload(Cancel As Integer)
      ibloc Dev                             ' Go to Local
      ibonl Dev, 0                          ' Device off line setting
End Sub
zz
' Output ON process (executed when the "OUTPUT ON command button" is pressed)
Private Sub cmdOutPutOn_Click()
      ibwrt Dev, "OUT 1"                    ' Output ON setting
End Sub


' Output voltage setting/measured voltage inquiry process (executed each time when a character is entered in
"Voltage setting text box")
Private Sub txtSetV_KeyPress(KeyAscii As Integer)
      Dim rdbuf As String
      If KeyAscii = vbkeyReturn Then        ' When the return key is pressed

         ibwrt Dev, "VLT" + txtSetV         ' Setting of voltage
         ibwrt Dev, "?MVL"                  ' Inquiry of measured voltage
         rdbuf = Space$(16)
         ibrd Dev, rdbuf                    ' Reception of measured voltage
         lblMeasV = Left$(rdbuf, ibcnt1)    ' Indication of measured voltage

         KeyAscii = 0
      End If
End Sub
```

```
' SRQ creation (factor being overload) check process
'     "GPIB Notify control" callback routine (executed on SRQ creation)
Private Sub GpibNotifyRQS_Notify(ByVal LocalUd As Long, ByVal LocalIbsta As Long, ByVal LocalIberr As Long,
ByVal LocalIbcnt1 As Long, RearmMask As Long)
    Dim StByte As Integer
    Dim FLSByte As Integer
    Dim rdbuf As String

    If (LocalIbsta And RQS) Then            ' Confirmation of RQS creation

        ibrsp Dev, StByte                   ' Serial poll
                                            ' RQS creation factor check
        If (StByte And &H1) Then            '     FLS bit of status byte is ON

            ibwrt Dev, "?FSC"               '     Inquiry of anomaly detection status
            rdbuf = Space$(16)
            ibrd Dev, rdbuf                 '     Reception of anomaly detection status byte
            FLSByte = Val(Left&(rdbuf, ibcnt1))
            If (FLSByte And &H3) Then        '     When VLT (bit0) or CUR(bit1) is ON
                shpOverLoad.FillColor = &HFF '        Overload detection; "Overload shape control" lights up
            End If

        End If

        RearmMask =RQS                      ' Resetting of GPIB Notify RQS event notification
    End If
End Sub

' Overload clearing process (executed when "clear command button" is pressed)
Private Sub cmdClrOvr_Click()
    shpOverLoad.FillColor = &HO            ' "Overload shape control" goes out
End Sub
```

4.7.2   KEITHLEY's GPIB board + Visual Basic

The chart below shows the form and codes of the sample program prepared by Visual Basic using a GPIB board manufactured by KEITHLEY.

OUTPUT ON command button [cmdOutPutOn]

Voltage setting text box [txtSetV]
(Use the Return key to enter the voltage value.)

Timer control [Timer1]

Measured voltage indication label [lblMeasV]

Overload shape control [shpOverLoad]

Clear command button [cmdClrOvr]
(Clears overload indication)
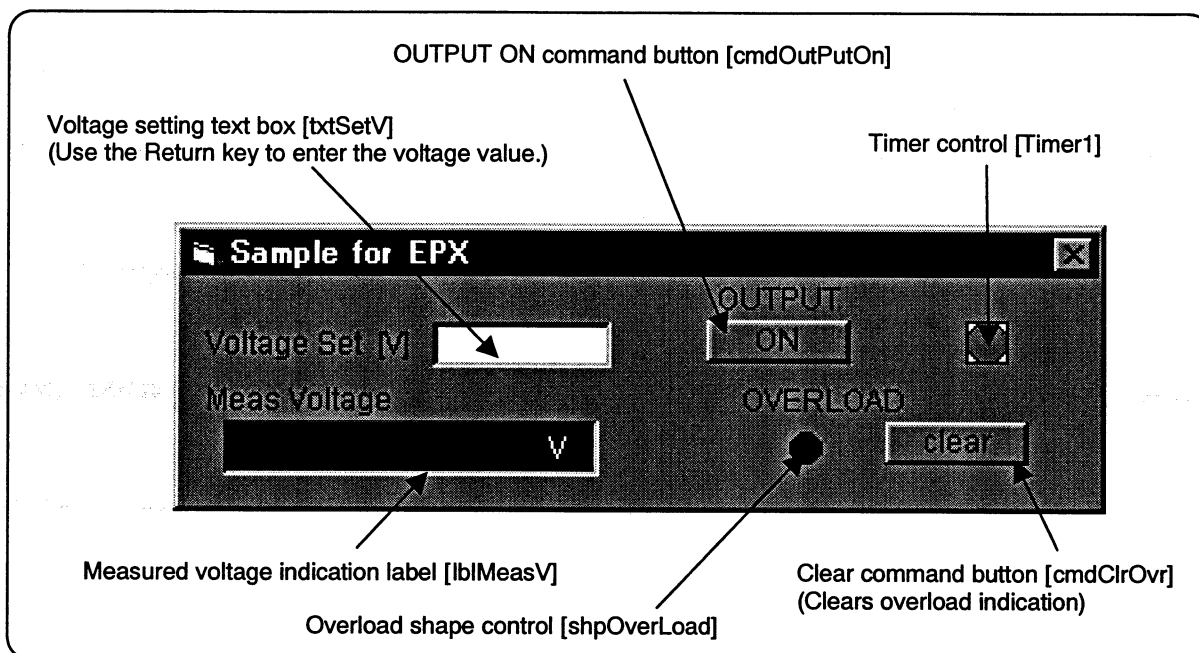
Figure 4-4   Form of Sample Program (KI board + Visual Basic)

Codes of sample program (KI board + Visual Basic)

```
' EPX series Sample Program
'                [uses a GPIB board by KEITHLEY]
Const adr As Integer = 2              ' GPIB address: 2


' Initialization process (executed on program starting)
Private Sub Form_Load()
    Dim status As Interger
    initialize 21, 0                  ' GPIB initialization
    '                                     (Controller-side GPIB address = 21)
    send adr, "SRE 1; FSE 3", status  ' SRQ creation enable bit setting
    send adr, "HDR 0", status         ' Header off setting
    Timer1.Enabled = True             ' RQS creation check timer ON
    Timer1.Interval = 500             '     (Timer interval = 500ms)
End Sub


' Ending process (executed on program ending)
Private Sub Form_Unload(Cancel As Integer)
    Dim status As Integer
    Transmit "GTL", status            ' Go to Local
End Sub
```

```
' Output ON process (executed when the "OUTPUT ON command button" is pressed)
Private Sub cmdOutPutOn_Click()
      Dim status As Integer
      send adr, "OUT 1", status            ' Output ON setting
End Sub


' Output voltage setting/measured voltage inquiry process (executed each time when a character is entered in
"Voltage setting text box")
Private Sub txtSetV_KeyPress(KeyAscii As Integer)
      Dim rdbuf As String
      If KeyAscii = vbKeyReturn Then       ' When the return key is pressed


            ibwrt Dev, "VLT" + txtSetV     ' Setting of voltage
            ibwrt Dev, "?MVL"              ' Inquiry of measured voltage
            rdbuf = Space$(16)
            ibrd Dev, rdbuf                ' Reception of measured voltage
            lblMeasV = Left$(rdbuf, ibcntl) ' Indication of measured voltage


            KeyAscii = 0
      End If
End Sub


' SRQ creation (factor being overload) check process
'     "GPIB Notify control" callback routine (executed on SRQ creation)
Private Sub GpibNotifyRQS_Notify(ByVal LocalUD As Long, ByVal Locallbsta As Long, ByVal Locallberr As Long,
ByVal Locallbcntl As Long, RearmMask As Long)
      Dim StByte As Integer
      Dim FLSByte As Integer
      Dim rdbuf As String


      If (Locallbsta And RQS) Then         ' Confirmation of RQS creation


            ibrsp Dev, StByte              ' Serial poll
                                           ' RQS creation factor check
            If (StByte And &H1) Then       '    FLS bit of status byte is ON


                  ibwrt Dev, "?FSC"        ' Inquiry of anomaly detection status
                  rdbuf =Space$(16)
                  ibrd Dev, rdbuf          ' Reception of anomaly detection status byte
                  FLSByte = Val(Left&(rdbuf, ibcnt1))
                  If (FLSByte And &H3) Then '   When VLT (bit0) or CUR(bit1) is ON
                      shpOverLoad.FillColor = &HFF '    Overload detection; "Overload shape control" lights up
                  End If


            End If


            RearmMask =RQS                 ' Resetting of GPIB Notify RQS event notification
      End If
End Sub


' Overload clearing process (executed when "clear command button" is pressed)
Private Sub cmdClrOvr_Click()
      shpOverLoad.FillColor = &H0          ' "Overload shape control" goes out
End Sub
```

4.7 Sample program

```
' Output voltage setting/measured voltage inquiry process (executed each time when a character is entered in
"Voltage setting text box")
Private Sub txtSetV_KeyPress(KeyAscii As Integer)
        Dim status As Integer
        Dim In As Integer
        Dim rdbuf As String
        If KeyAscii =vbKeyReturn Then              ' When the return key is pressed

                send adr, "VLT" + txt SetV, status      ' Setting of voltage
                send adr, "?MVL", status                ' Inquiry of measured voltage
                enter rdbuf, 16, In adr, status         ' Reception of measured voltage
                lblMeansV = rdbuf                       ' Indication of measured voltage

                KeyAscii = 0
        End If
End Sub


' RQS creation (factor being overload) check process (executed each time when a timer event occurs)
Private Sub Timer1_Timer()
        Dim StByte As Integer
        Dim FSCByte As Integer
        Dim In As Integer
        Dim status As Integer
        Dim rdbuf As String

        transmit "SPE", status              ' Serial poll
        spoll adr, StByte, status           '    (If KEITHLEY's GPIB board is used,
        transmit "SPD", status              '    SPE and SPD commands are essential before and after spoll.)

                                            ' Confirmation of RQS creation
        If StByte And &H40 Then             '    RQS bit of status bit ON

                                            ' RQS creation factor check
                If(StByte And &H1) Then         '    FLS bit of status byte is ON
                        send adr, "?FSC", status        '    Inquiry of anomaly detection status
                        enter rdbuf, 16, In, adr, status '   Reception of anomaly detection status
                        FSCByte =Val(rdbuf)
                        If (FSCByte And &H3) Then       '    When VLT (bit0) or CUR(bit1) is ON
                           shpOverLoad.FillColor = &HFF  '   Overload detection; "Overload shape control" lights up
                        End If
                End If

        End If
End Sub


' Overload clearing process (executed when "clear command button" is pressed)
Private Sub cmdClrOvr_Click()
        shpOverLoad.FillColor = &H0         ' "Overload shape control" goes out
End Sub
```

4.7.3 Test Point15

The chart below shows the definition of panel and objects of a sample which uses KEITHLEY's comprehensive measurement control package software "TestPoint".

Voltage setting Data-Entry object [Voltage Set[V]]   OUTPUT ON Pushbutton object [ON]

Measured voltage indication Display object   Overload Indicator object   Clear Pushbutton object
[Meas Voltage [V]]   [OVERLOAD]   [clear]

Objects that are not shown on the panel:

Device GPIB object
[Device]

Bit judgment Condition object
[CheckBits]

Initial setting Task object
[Initialize]

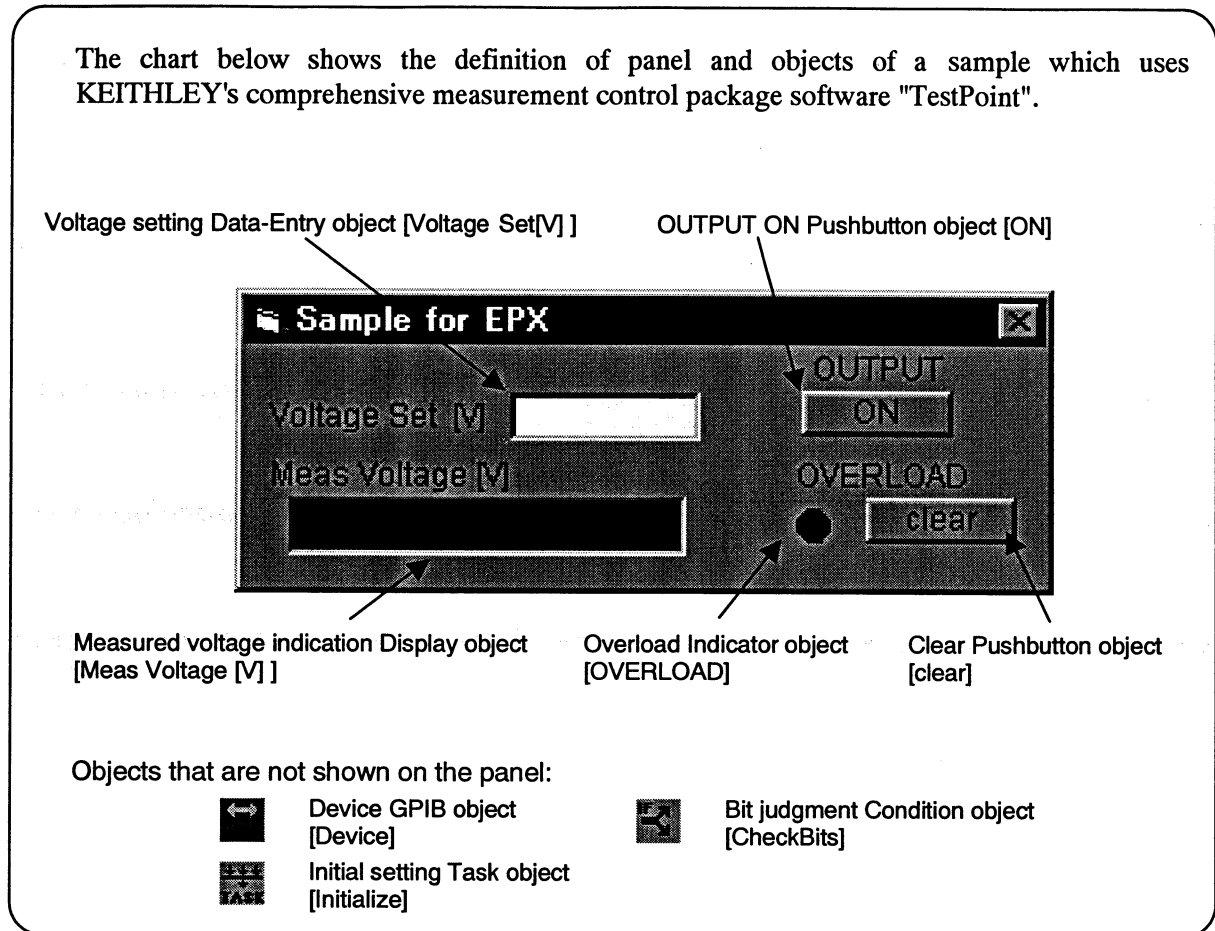**Figure 4-5   Panel and Objects Structure of Sample Program (Test Point)**

Definition of Objects of Sample Program (TestPoint)

Definition of initial setting Task object
- This sets "Execute action list" of Settings to "at initialization" (on program stating).

Action list

1) Output to	Device	with "SRE 01; FSE 03", term. =LF send EOI?=1
		' SRQ creation enable bit setting
2) Output to	Device	with "HDR 0", term.=LF send EOI?=1
		' Header off setting

Definition of OUTPUT ON Pushbutton object
Action list

1) Output to	Device	with "OUT 1; term =LF send EOI?=1
		' Output ON setting

Definition of Output voltage setting Data-Entry object
Action list

1) Output to	Device	with "VLT" , Voltage Set [V], term. =LF send EOI?=1
		' Setting of voltage
2) Output to	Device	with "?MVL", term.=LF send EOI?=1
		' Inquiry of measured voltage
3) Enter from	Device	up to 256 bytes, stop on EOS=LF or EOI
		' Reception of measured voltage
4) Set	Meas Voltage[V]	to Device
		' Indication of measured voltage

Definition of device GPIB object
- This sets "GPIB Address" of Setting to 2.
- This sets "Spoll on SRQ" of Setting to 1 (automatically executes serial poll on SRQ creation).
- On creation of SRQ, serial poll is executed automatically, and if the RQS bit of status byte of this device (GPIB Address = 2) is ON, then Action list will be executed.
- The result (status byte) of serial poll conducted on SRQ creation is stored in the "Device" data.

Action list

1) If/Then	CheckBits	with STAT=Device VALUE=1
		' FLS bit of status byte is ON
2) Output to	Device	with "?FSC", term.=LF send EOI?=1
		' Inquiry of anomaly detection status
3) Enter from	Device	up to 256 bytes, stop on EOS=LF or EOI
		' Reception of anomaly detection status
4) If/Then	CheckBits	with STAT =Devive VALUE=3
		' VLT(bit) or CUR(bit1) of anomaly detection status is ON
5) Set	OVERLOAD	to 1 ' Overload detection "OVERLOAD"
		' Overload Indicator object lights up
6) End If	CheckBits	
7) End If	CheckBits	

Definition of Clear Pushbutton object
Action list

1) Clear	OVERLOAD	' Overload Indicator object goes out

Definition of bit judgment Condition object
- Conditional branching (Then/Else) according to the result of AND of two values.
- "STAT and VALUE" is set to "Expression" of Settings.

4.8   Specifications of GPIB

The table below lists the interface function of this device.

Table 4-10   GPIB Interface Functions

Function	Subset	Explanation
Source handshake	SH1	All send handshake functions are available.
Acceptor handshake	AH1	All reception handshake functions are available.
Talker	T6	Basic talker function, serial poll, talker disabler with MLA Talk-only mode is not available.
Listener	L4	Basic listener function, listener disabler with MTA Listen-only mode is not available.
Service request	SR1	All service request functions are available.
Remote/local	RL1	All remote/local functions are available.
Parallel poll	PP0	No parallel polling functions are available.
Device clear	DC1	All device clear functions are available.
Device trigger	DT0	No device trigger functions are available.
Controller	C0	No controller functions are available.

Table 4-11 Multi-line Interface Messages

b4	b3	b2	b1	Column Low	0 (000)	MSG ①	1 (001)	MSG	2 (010)	MSG	3 (011)	MSG	4 (100)	MSG	5 (101)	MSG	6 (110)	MSG	7 (111)	MSG
0	0	0	0	0	NUL		DLE		SP	↑	0	↑	@	↑	P	↑	`	↑	p	↑
0	0	0	1	1	SOH	GTL	DC1	LLO	!		1		A		Q		a		q	
0	0	1	0	2	STX		DC2		"		2		B		R		b		r	
0	0	1	1	3	ETX		DC3		#		3		C		S		c		s	
0	1	0	0	4	EOT	SDC	DC4	DCL	$		4		D		T		d		t	
0	1	0	1	5	ENQ	PPC ③	NAK	PPU	%		5		E		U		e		u	
0	1	1	0	6	ACK		SYN		&		6		F		V		f		v	
0	1	1	1	7	BEL		ETB		'		7		G		W		g		w	
1	0	0	0	8	BS	GET	CAN	SPE	(		8		H		X		h		x	
1	0	0	1	9	HT	TCT	EM	SPD	)		9		I		Y		i		y	
1	0	1	0	10	LF		SUB		*		:		J		Z		j		z	
1	0	1	1	11	VT		ESC		+		;		K		[		k		{	
1	1	0	0	12	FF		FS		,		<		L		\ ④		l		|	
1	1	0	1	13	CR		GS		-		=		M		]		m		}	
1	1	1	0	14	SO		RS		.		>		N		^		n		~	
1	1	1	1	15	SI		US		/	↓	?	UNL	O	↓	_	UNT	o	↓	DEL	↓

MSG columns annotations: "The listener addresses that are designated to each device" (LAG); "The talker addresses that are designated to each device" (TAG); "The meanings are defined by PCG" (SCG).

Address Command Group (ACG) | Universal Command Group (UCG) | Listener Address Group (LAG) | Talker Address Group (TAG)

Primary Command Group (PCG)

Secondary Command Group (SCG)

Note:
① MSG is an interface message.
② b1=DI01 ...... b7=DI07, DI08 are not used.
③ It carries the secondary command.
④ Backslash (\) is used in IEC standard and yen mark (¥) is used in JIS standard.
GTL .... Go to Local
SDC ... Selected Device Clear
PPC.... Parallel Poll Configure
GET.... Group Execute Trigger

TCT .... Take Control
LLO .... Local Lockout
DCL.... Device Clear
PPU ... Parallel Poll Unconfigure
SPE.... Serial Poll Enable
SPD ... Serial Poll Disable
UNL.... Unlisten
UNT ... Untalk

5. Troubleshooting

5.1 Error messages

The table below lists the errors that may appear on power charging and during GPIB control.

ro Er1	for nearly 1 sec.	An error was detected, on power charging, in the ROM which contains the program.
r Er2	for nearly 1 sec.	An error was detected, on power charging, in the RAM used by the program.
bc Er1	for nearly 1 sec.	An error was detected, on power charging, in the memory storing the panel settings.
Er 01	for several msec.	A difference was detected, on power charging, between the setting switches on the last power-off occasion and those on this power charging moment.
r Er	for several msec.	Output ran beyond the correction range during AUTO LEVEL operation.
No indication	for several msec.	An error was detected in the program code received via GPIB.

Any of these error messages continues to appear for two to three seconds until it disappears automatically after a due time.

The buzzer issues warning sound only for several milliseconds except for critical errors that may occur on power charging.

Buzzer ON/OFF by GPIB commands is effective only for those errors that may occur in a GPIB remote condition. Buzzer can not be turned off for errors occurring in a local condition.

5.2 If fault is suspected

- **The unit can not be powered**

Check the power supply terminal for the connection and the voltage.

Commercial power supply of 100V AC should be connected to the "L" and "N" power supply terminals of "LINE 100V" on the back panel.

The terminal labeled with "⏚" is for protective grounding. This terminal must be connected to the ground for safety purpose.

- **Frequency and voltage not displayed**

Check the external signal selector switch.

When this unit is operated by external signals, the LED shows "– – – –" for frequency and output voltage. To use the internal oscillator, put the "SIG SEL" switch on the back panel to the "INT" position.

This unit allows the user to synchronize the output frequency with the external signal at option. If external synchronization has been selected, the frequency LED shows "-E-". Press the "50Hz", "60Hz" or "400Hz" setting button when the "SHIFT" button lamp is not lighting, and internal synthesizer operation will be enabled, and the frequency of the pressed button will be outputted and shown.

5.2 If fault is suspected

- **Can not carry out setting on the panel**

Check the "LOCK" LED on the panel for lighting.

If it is lighting, press "LOCK" in the "SHIFT" condition to release the locked-panel condition.

Check the "GPIB LOCAL" LED on the panel for lighting.

If it is not lighting, press "GPIB LOCAL" to bring the system into a local condition.

Check the internal DIP switches.

If No. 7 DIP switch is ON with no optional GPIB board installed, panel operation is disabled. Either install a GPIB board or put No. 7 DIP switch to the OFF position.

- **Overload lamp tends to light up**

Check the capacity of the load and the wiring of the output cable.

This unit provides different levels of maximum output current depending on the output voltage.

☞ For further information, see Section 7.4 "Output characteristics".

- **"OUTPUT" is turned OFF by itself.**

Check the overload lamp.

Note that the output is forced to be OFF when the unit experiences overload for ten seconds or longer.

- **Power supply switch tends to turn off by itself.**

Check the overload lamp and ambient temperature.

Note that the power supply ON/OFF switch of this unit also works as a circuit breaker for prevention of overcurrent, and the switch will be turned OFF forcibly if the internal temperature rises to an extraordinary level.

If the power supply switch turns OFF with no load applied, a system failure is supposed. Contact us or our sales agency.

6. Maintenance

6.1 Introduction

This chapter contains the following items:

- Instructions on and the method of storage when the unit is to be left unused for an extended period.

- Instructions on transport of the unit and repackaging.

- Performance test which helps promote preventive maintenance, and which is also required on acceptance inspection or performance confirmation after repair and other occasions.

If operation check or performance test is not successful, contact us for calibration or repair.

6.2 Daily servicing

- **External cleaning**

Use soft cloth to clean dust and dirt on the panel and housing. To wipe extreme dirt, use a piece of cloth soaked in neutral detergent and well wrung.

Never use thinner, benzene or other volatile solvents, or chemical dusters for wiping. This may result in surface deterioration or paint peeling.

- **Backup battery**

The values set on the panel are maintained by the internal NiCd battery even while the unit is not powered.

This battery, if fully charged, ensures memory storage for about sixty days. However, this period varies with the ambient temperature as well as individual conditions.

When the battery becomes degraded, the memory storage period is shortened accordingly. If the battery is becomes weak for practical functioning, contact us or our sales agency for replacement at cost.

It is recommended to energize the unit occasionally because leaving the unit for six months or longer without power charging would shorten the battery life.

6.3 Storage, repackaging and transport

- **Storage for an extended period**

Unplug the power supply cord and output cord from the unit body, and place the unit on a shelf or rack or other adequate location free of falling matters or dust. If the unit is, or may be, exposed to dust, put a cover made of cloth, polyethylene or other appropriate web.

The environment of storage must be between −10°C and +50°C and between 10% and 80% RH. However, the unit should be stored preferably at the room temperature as much as practicable; avoid places of extreme temperature change or places subject to direct sunbeam.

- **Repackaging and transport**

To repackage the unit for transport or other purposes, it is critical to consider the weight of the unit. Use the carton that was used on delivery. If it is not available, first wrap the unit with polyethylene bags or other plastic webs, then put it in a corrugated cardboard box with enough space and strength. Stuff the remaining space with packing that has enough rigidity against the mass of the unit.

If consignment is used, give the forwarding agency instructions saying that the unit is a precision instrument.

6.4 Identifying the version number

To check the version number of the incorporated software, turn on the power to the unit, and all displays and indicators light up for indication check, and then the version number will appear on the "CURRENT" display.

6.5 Performance test

- Performance test is carried out as part of preventive maintenance, and thus to prevent performance of the unit from deterioration. In addition, performance test is also conducted to check the performance of the unit on acceptance inspection or regular inspection and after repair.

  If performance test reveals that the specified performance is not achieved, then calibration or repair is required.

- **Use the following measuring instruments for performance test.**

Slide regulator	2kVA for **EPX-4104**, 3kVA for **EPX-4106** and 5kVA for **EPX-4112**; used to adjust the voltage of commercial power supply.		
Oscilloscope	Band of 10MHz or greater; used to observe the output waveform.		
AC voltmeter/ammeter	within ±0.5% of nominal range; used to measure the commercial power supply voltage and current. #2013 by Yokogawa Electric Corporation etc.		
Digital multimeter	40 to 500Hz within ±0.1%; used to measure the output voltage. HP34401A etc.		
Frequency counter	within ±10ppm; measures the output frequency. TR5822 by Advantest, etc.		
Harmonic distortion factor meter	Within 0.1% of normal range value; measure output waveform distortion. E-2001B by NF Corporation, etc.		
Load resistor	**EPX4104**	**EPX4106**	**EPX4112**
100V range	30.3Ω 1kW	20.0Ω 1.5kW	10.0Ω 3kW
120V range	43.6Ω 1kW	28.8Ω 1.5kW	14.4Ω 3kW
200V range	121Ω 1kW	80.0Ω 1.5kW	40.0Ω 3kW
240V range	175Ω 1kW	115Ω 1.5kW	57.6Ω 3kW

- **Before starting performance test, ensure the following items:**

Power supply voltage is within the range of 85 to 115V AC.

Ambient temperature is 15 to 35°C and humidity is 25 to 75%RH.

No condensation is observed.

Thirty minutes or longer time has passed after power charging.

- **Basic connection for performance test**

Figure 6-1 "Basic Connection for Performance Test" shows the basic connection diagram for performance test.

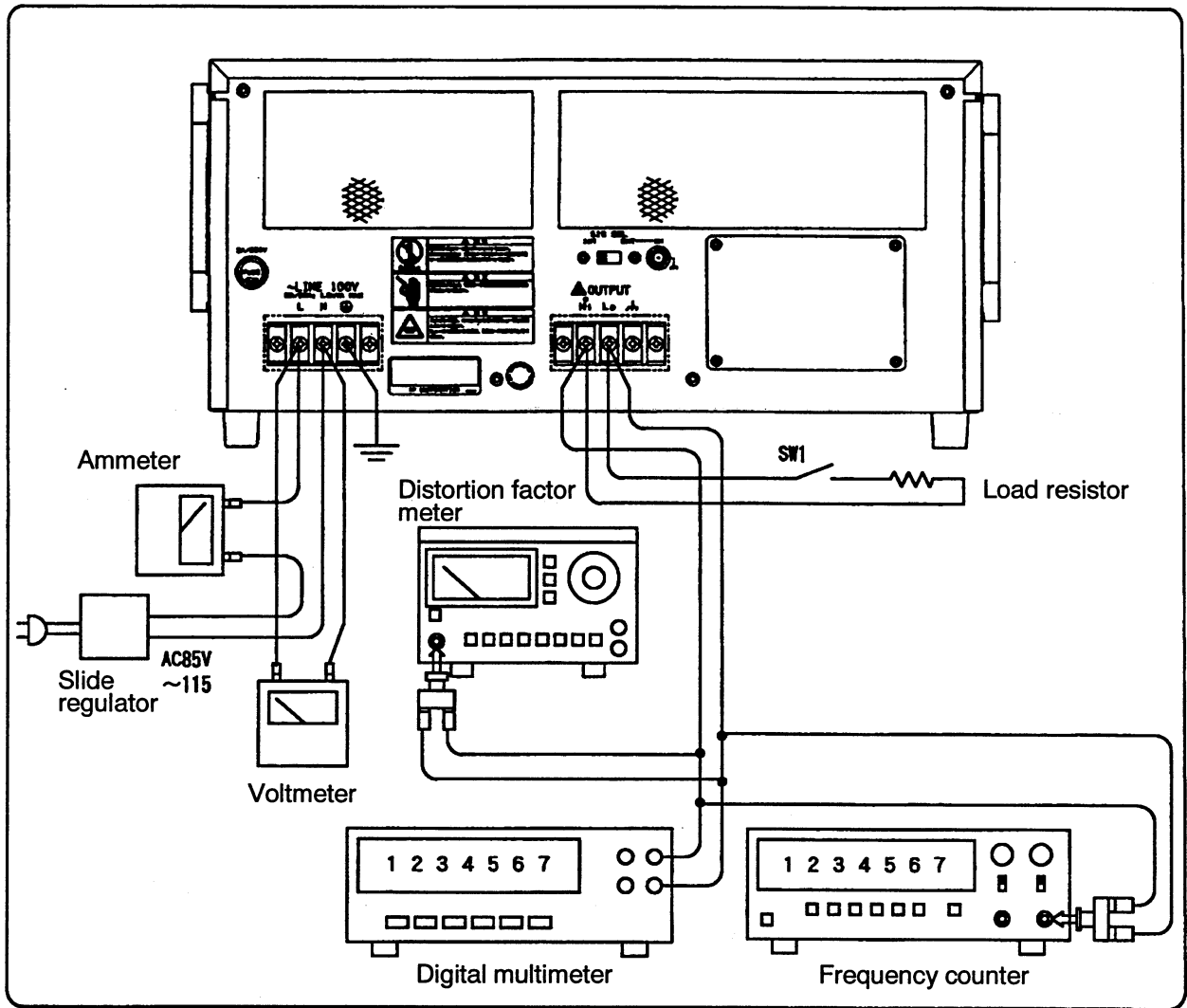| ⚠ WARNING |
|---|
| Ensure that grounding has been connected for safety purpose.
Further, pay extreme attention to prevention of burn or other accidents because the load resistor becomes very hot. |

Figure 6-1   Basic Connection for Performance Test

(1) Performance test of output voltage

Confirm that the connection is correct and the power supply voltage is 100V.
Turn off SW1 to carry out no-load test.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Put MEAS to OFF (LED goes out).
Turn down the output setting voltage to 0V.
Put OUTPUT to ON (LED light up).
Press the VOLTAGE SET button and clockwise turn the MODIFY dial slowly, and confirm that the set voltage and the value measured by the digital multimeter are within ±1% of the nominal range value.
Similarly, carry out the test for 120V, 200V and 240V as well.

(2) Performance test of measured voltage

Confirm that the connection is correct and the power supply voltage is 100V.
Turn off SW1 to carry out no-load test.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Turn down the output setting voltage to 0V.
Put MEAS to ON (LED light up).
Put OUTPUT to ON (LED light up).
Press the VOLTAGE SET button and clockwise turn the MODIFY dial slowly, and confirm that the measured voltage and the value measured by the digital multimeter are within ±0.5% of the nominal range value.
Similarly, carry out the test for 120V, 200V and 240V as well.

(3) Performance test of output voltage – frequency characteristics

Confirm that the connection is correct and the power supply voltage is 100V.
Turn off SW1 to carry out no-load test.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put MEAS to OFF (LED goes out).
Put OUTPUT to ON (LED light up).
Press the FREQUENCY SET button and turn the MODIFY dial slowly to change the output frequency from 40Hz to 500Hz, and confirm that the variation in measurement of the digital multimeter stays within ±3% of the nominal range value.
Similarly, carry out the test for 120V, 200V and 240V as well.

(4) Performance test of output frequency

Confirm that the connection is correct and the power supply voltage is 100V.
Turn off SW1 to carry out no-load test.
Turn on the power supply switch of this unit.
Set the output frequency to 55Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put MEAS to OFF (LED goes out).
Put OUTPUT to ON (LED light up).
Set the gate time of the frequency counter to the maximum and measure the output frequency to confirm that it is within ±50ppm (or 0.005%) of the set value of 55Hz (i.e., 54.99725 to 55.00275Hz).

(5) Performance test of rated output

Confirm that the connection is correct and the power supply voltage is 100V.
Connect a load resistor of the output range for testing, then turn on SW1.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Put MEAS to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put OUTPUT to ON (LED light up).
Press the FREQUENCY SET button and turn the MODIFY dial slowly to change the output frequency from 40Hz to 500Hz, and confirm that the variation in measurement of the digital multimeter stays within ±3.5% of the nominal range value with the overload lamp keeping unlit.
Similarly, carry out the test for 120V, 200V and 240V by changing the load resistor.

(6) Performance test of load regulation

Confirm that the connection is correct and the power supply voltage is 100V.
Connect a load resistor of the output range for testing, then turn on SW1.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Put MEAS to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put OUTPUT to ON (LED light up).
Turn on SW1 and confirm that the variation in measurement of digital multimeter stays within ±0.5% of the nominal range value.
Similarly, carry out the test for 120V, 200V and 240V by changing the load resistor.

(7) Performance test of line regulation

Confirm that the connection is correct and the power supply voltage is 100V.
Connect a load resistor of the output range for testing, then turn on SW1.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Put MEAS to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put OUTPUT to ON (LED light up).
Turn the slide regulator to change the power supply voltage from 85V to 115V, and confirm that the variation in multimeter measurement stays within ±0.1% of the nominal range value.
Similarly, carry out the test for 120V, 200V and 240V by changing the load resistor.

(8) Performance test of output waveform distortion

Confirm that the connection is correct and the power supply voltage is 100V.
Connect a load resistor of the output range for testing, then turn on SW1.
Turn on the power supply switch of this unit.
Set the output frequency to 50 or 60Hz.
Select 100V of the output voltage range.
Put AUTO LEVEL to OFF (LED goes out).
Put MEAS to OFF (LED goes out).
Turn the output setting voltage to 100V.
Put OUTPUT to ON (LED light up).
Operate the distortion factor meter to confirm that the output waveform distortion is 0.5% or less.
Similarly, carry out the test for 120V, 200V and 240V by changing the load resistor.
Note that the maximum input voltage of **E-2001B** is 140Vrms. If it goes over 140Vrms, use an external resistive divider with care so that the input voltage of **E-2001B** will not violate the limit level of 140Vrms.

6.5   Performance test

7. Specification

7.1 Internal oscillator

Range of frequency:

40.000 to 500.000Hz, with 1mHz resolution

Indication of frequency:

six-digit numerical display

Frequency modes:

50, 60 and 400Hz fixed, and variable

Accuracy in frequency:

within ±50ppm

Output voltage setting:

100V range   0 to 120.0V

120V range   0 to 144.0V

200V range   0 to 240.0V

240V range   0 to 288.0V

Accuracy of output voltage setting (at no-load):

within ±1% of nominal range value for the range of 45 to 65Hz [note 1]

within ±3% of nominal range value for the range of 40 to 500Hz excluding the above range [note 1]

Note 1: These items are effective when the ambient temperature is within 25°C±10°C.

7.2 Indication

Indication of output voltage:

set value or measurement on four-digit numerical display

measurement indicated in effective value of mean value demodulation

Accuracy of output voltage measurement:

within ±0.5% of nominal range value for the range of 40 to 500Hz [note 1]

Indication of output current:

	EPX4104	EPX4106	EPX4112
100V range	0 to 3.30A	0 to 5.00A	0 to 10.00A
120V range	0 to 2.75A	0 to 4.17A	0 to 8.33A
200V range	0 to 1.65A	0 to 2.50A	0 to 5.00A
240V range	0 to 1.38A	0 to 2.03A	0 to 4.17A

indicated in effective value of effective value demodulation

Accuracy of output current measurement:

within (±1% of nominal value) + (±3 count) for the range of 40 to 500Hz [note 1]

Note 1: These items are effective when the ambient temperature is within 25°C±10°C.

7.3 External signal input

Range of frequency:

40 to 500Hz

Rated input voltage:

1Vrms; the input voltage necessary to obtain the rated output voltage

Input impedance:

about 10kΩ (unbalanced)

Input terminal:

BNC receptacle (on the back panel)

7.4 Output characteristics

Maximum output power to loaded electronic equipment:

EPX4104	410VA
EPX4106	620VA
EPX4112	1250VA

provided that the peak factor (Ipeak/Irms) is two (2) for the rectifying circuit of capacitor input type.

Rated output voltage:

EPX4104	330VA
EPX4106	500VA
EPX4112	1000VA

for rated load of power factor being 0.85 or higher

Maximum output power:

1.1 × rated output power (for load of pure resistance)

Range of output voltage:

100V range	0 to 120.0V
120V range	0 to 144.0V
200V range	0 to 240.0V
240V range	0 to 288.0V

Rated output current:

	EPX4104	**EPX4106**	**EPX4112**
100V range	0 to 3.30A	0 to 5.00A	0 to 10.00A
120V range	0 to 2.75A	0 to 4.17A	0 to 8.33A
200V range	0 to 1.65A	0 to 2.50A	0 to 5.00A
240V range	0 to 1.38A	0 to 2.03A	0 to 4.17A

EPX4104/06/12

Allowable output current:

25% or less of rated output current for 0 to 10% of nominal output voltage

50% or less of rated output current for 10 to 20% of nominal output voltage

100% or less of rated output current for 20 to 100% of nominal output voltage

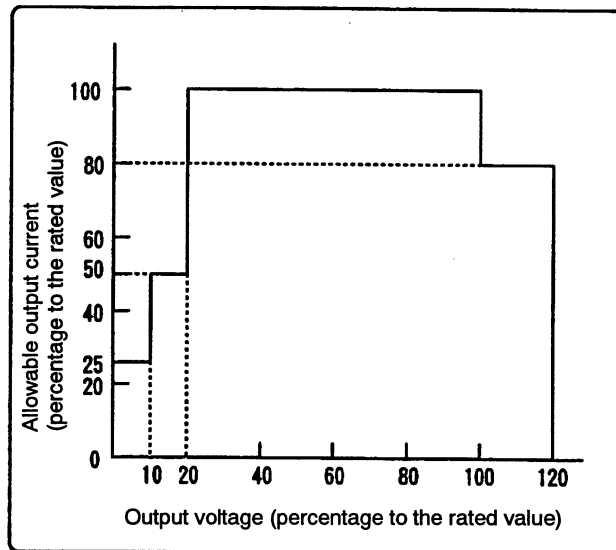80% or less of rated output current for 100 to 120% of nominal output voltage

Figure 7-1   Output Voltage and Allowable Output Current

Rated load:

Linear load with the power factor of 0.85 or higher that passes rated output current at the rated output voltage.

	EPX4104	EPX4106	EPX4112
100V range	30.3Ω	20.0Ω	10.0Ω
120V range	43.6Ω	28.8Ω	14.4Ω
200V range	121Ω	80.0Ω	40.0Ω
240V range	175Ω	115Ω	57.6Ω

Allowable load capacity:

10μF or less (a value that keeps output voltage waveform from abnormal oscillation or other fault)

Peak current:

about 2.5 times the rated value (effective value)

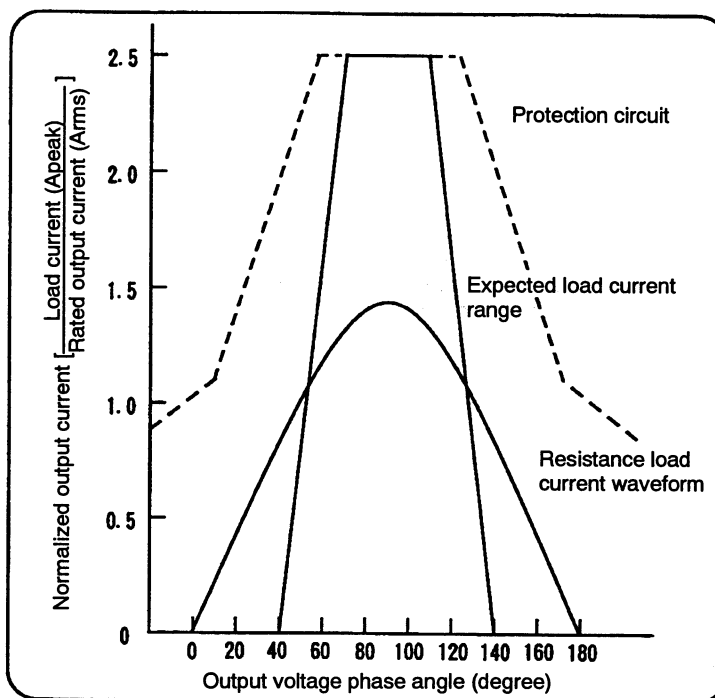for a full-wave rectifying circuit of capacitor input type

Figure 7-2   Specification of Output Current Waveform

Output voltage stability:

±100ppm/°C typ

±100ppm/8h

With the rated load and at the rated output.

Line regulation:

±0.1% or less

With the rated load and at the rated output, and with the power supply voltage being changed in the range of 100V ±15%.

Load regulation:

±0.5% or less

With the rated output voltage, and the load being changed from no-load to the rated load (for 45Hz to 65Hz)

Recovery time:

50μs (TYP value)

The time for the instantaneous value of output voltage to converge to ±1% or less of the rated value when the unit experiences a change from no-load to the rate load, with the output voltage being at the rated level.

Rate of voltage waveform distortion:

0.5% or less

With the pure resistance rated load and at the rated output

Characteristics of output voltage frequency:

±0.2dB or less for 40 to 500Hz, 150Hz standard

With the pure resistance rated load and at the rated output

Output format:

Single-phase, balanced output, either of two conductors available for grounding

Output connector:

4mm terminal block

7.5 Others

Preset memory:

Four sets of frequency, range and output amplitude can be stored.

AUTO LEVEL:

ON/OFF

ON of AUTO LEVEL activates automatic adjustment to control the output voltage to the set value.

Change of settings:

Achieved by turning the UP/DOWN modify dial.

Setting available on desired digit on cursor.

Panel setting lock:

Selection of LOCK disables setting in all switches.

To release LOCK, put the Shift button to ON then press LOCK.

Battery-supported settings:

The system memory stores the settings on the power turning OFF moment. So they will be retrieved on the next power charging occasion as the startup settings except the output which is turned off whenever the unit is fresh powered.

7.6   General matters

Power supply:

Single-phase 100V±15% AC, 48 to 62Hz

Maximum power consumption:

EPX4104   about 1.3kVA

EPX4106   about 1.9kVA

EPX4112   about 3.8kVA

on rated load of pure resistance and rated output

Mean power consumption:

EPX4104   about 1.0kVA

EPX4106   about 1.5kVA

EPX4112   about 3.2kVA

on rated load of pure resistance and rated output

Withstand voltage:

$20M\Omega$ or greater at 500V DC

1500V AC for one minute

between power supply input and output/chassis altogether, and

between output and power supply input/chassis altogether

Range of ambient temperature/humidity:

0 to 40°C and 10 to 90% RH for operation

−10 to 50°C and 10 to 80% RH for storage

External dimensions:

EPX4104   440 (W) × 148 (H) × 530 (D) mm   excluding projections

EPX4106   440 (W) × 198 (H) × 530 (D) mm   excluding projections

EPX4112   440 (W) × 248 (H) × 530 (D) mm   excluding projections

Mass:

EPX4104   about 31kg

EPX4106   about 38kg

EPX4112   about 53kg

EPX4104/06/12

7.7 Optional items

GPIB:

This provides external control of frequency, output voltage and output ON/OFF/

Three-phase output:

Use of three units can configure a three-phase power supply system.

This optional device also includes GPIB.

7.8 Components

This unit is composed as shown in Table 7-1 "List of Components".

Table 7-1   List of Components

One unit of main equipment

One copy of instruction manual

Accessories including:

One piece of cable for power supply input

EPX4104 2.0mm^2 cabtyre cable for EPX-4104

EPX4106 3.5mm^2 cabtyre cable for EPX-4106

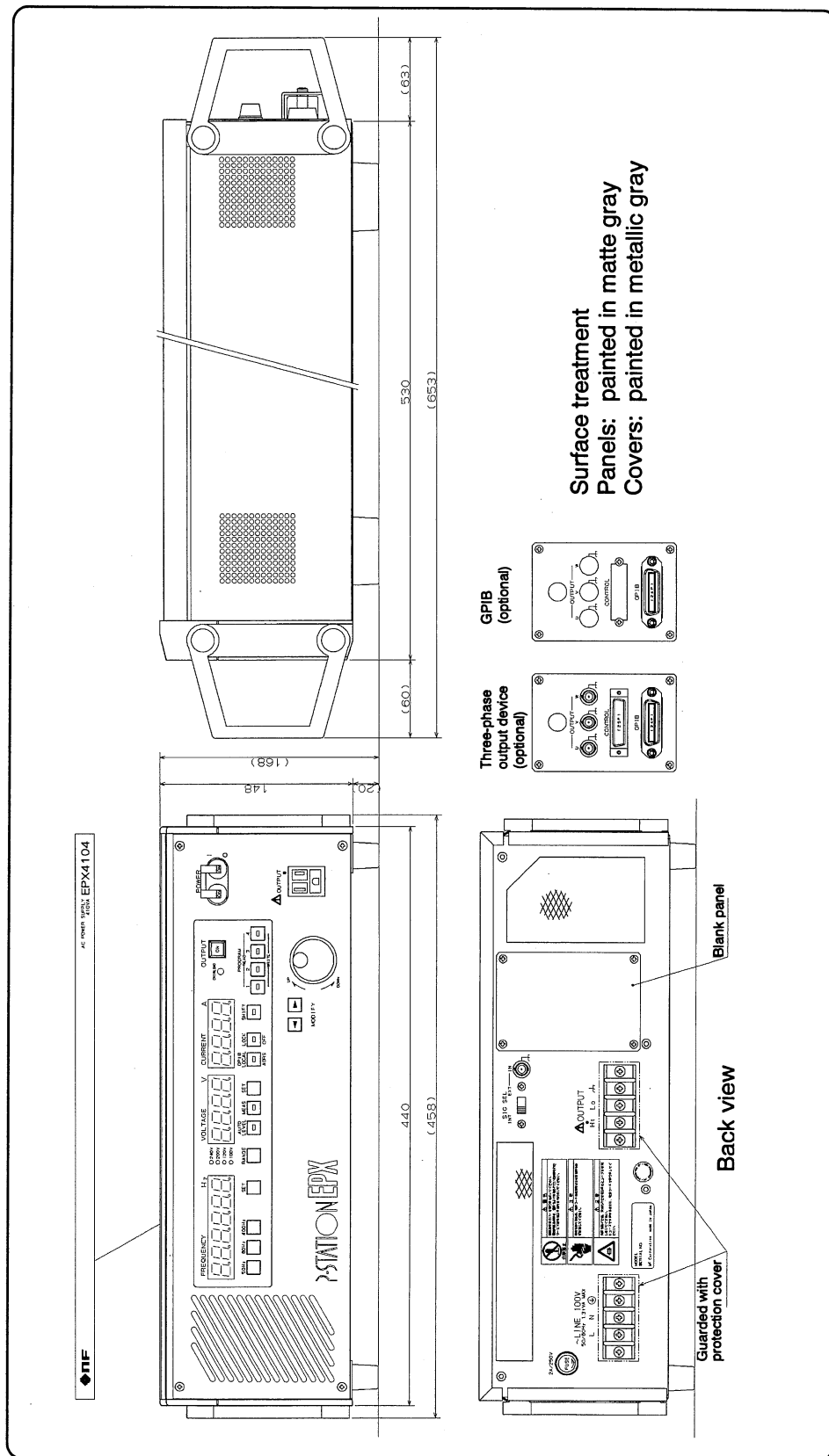**EPX4112** 5.5mm^2 cabtyre cable for EPX-4112

Two pieces of 2A fuse

Figure 7-3   External Dimensions of EPX4104

Surface treatment
Panels: painted in matte gray
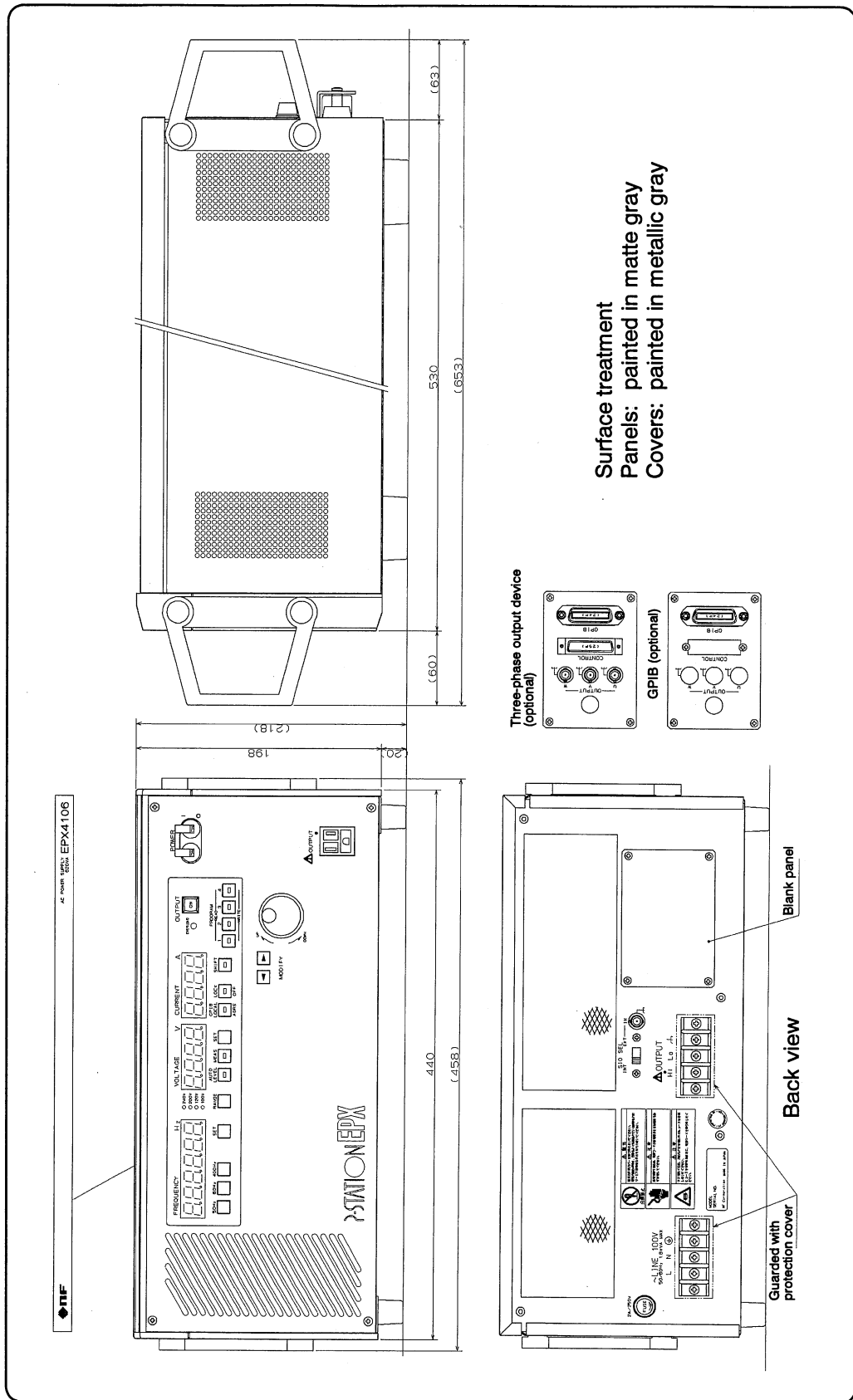Covers: painted in metallic gray

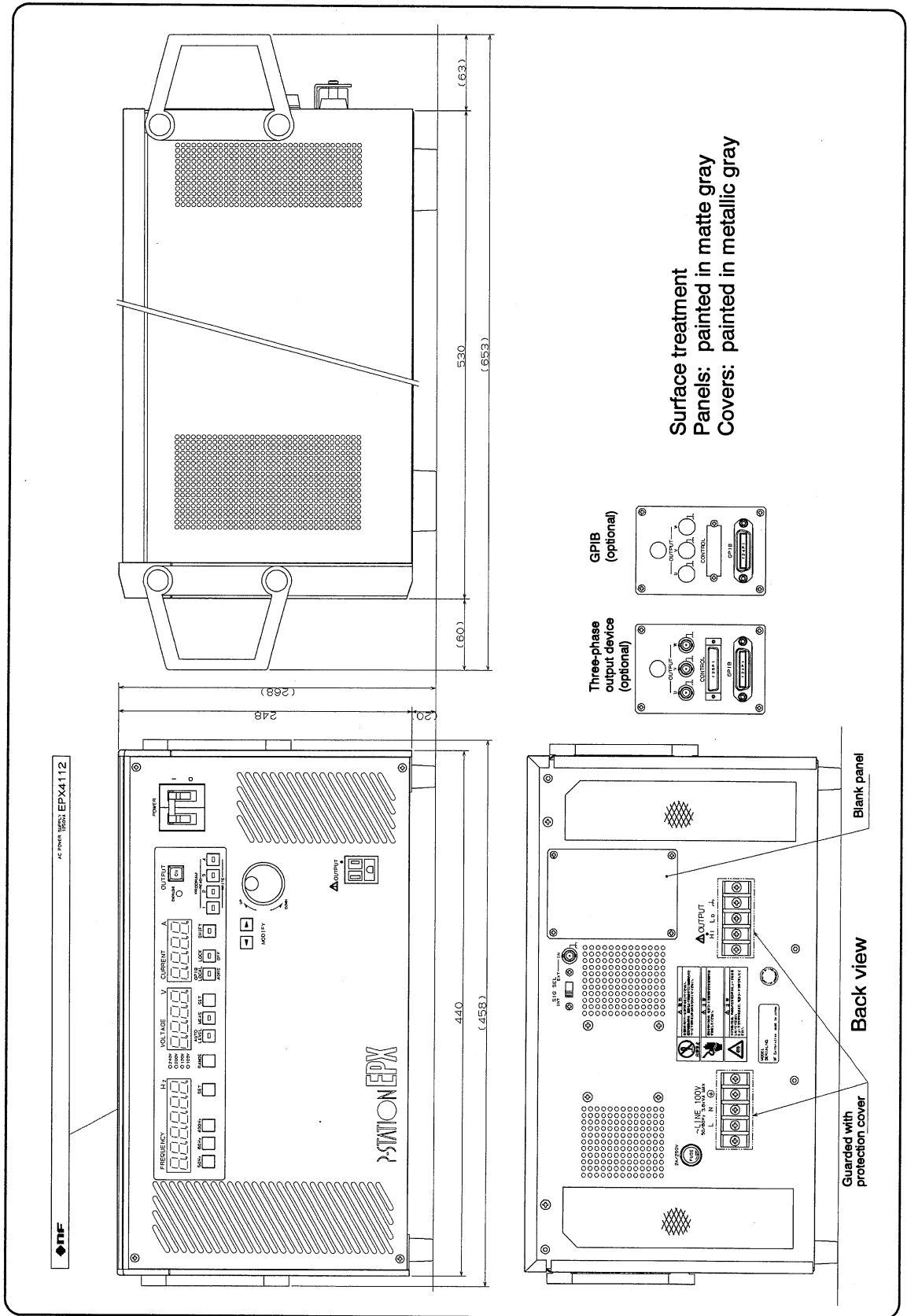**Figure 7-4   External Dimensions of EPX4106**

Figure 7-5   External Dimensions of EPX4112

EPX 4104/06/12 Operation Manual

If there are any misplaced or missing pages, we will replace the manual. Contact the sales representative.

⬗NF