PRECISION POWER AMPLIFIER
POWER BOOSTER

4502／4505／4510／4520A
4521A

INSTRUCTION MANUAL

NF Corporation

DA00011520-001

4502 / 4505
4510 / 4520A
4521A

PRECISION POWER AMPLIFIER
POWER BOOSTER

【 INSTRUCTION MANUAL 】

Notes

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2. The contents of this manual may be changed without notice.

3. ***NF CORPORATION*** carefully checked for accuracy in the preparation of this manual. If, however, you find ambiguities, errors, or other deficiencies in this manual, please let us know about them.

*** DANGER! ***

1. For safety, turn off the power switch of this unit and the switch of the power-board, when you connect an input/output cable.

2. In the constant current (CC) mode, never open-circuit the output of this unit. Doing so will result in high voltage (450Vp-p max.) generation.

3. Maintenance

   For safety, turn off the power switch before performing internal check of this unit. Touching internal chassis or electric circuits when the power is turned on, may cause an electric shock. (See "5 MAINTENANCE").

4. Remote sensing

   If you use the wrong polarity for sensing, or if you short the sensing terminals, the internal resistors in this unit will be destroyed. The connection must be as shown in Fig. 3-4 or Fig. 3-11.

CAUTION

Powerful high frequency generation may not comply with local radio regulations. If necessary, please obtain permission before beginning operation.

About the 4520A and 4521A models

Consequent to the discontinuation of the production of booster cable connectors for the 4520 and 4521, the 4520A and 4521A are new model numbers indicating the inclusion of new connectors in these models.

As a result, although the 4520A and 4521A are equivalent to the 4520 and 4521 in terms of electrical performance, please be aware of the fact that the 4520A cannot be connected to the 4521, and similarly, that the 4520 cannot be connected to the 4521A.

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1. GENERAL DESCRIPTION

1.1 Introduction

Model 4500 Series Precision Power Amplifier is a DC amplifier featuring ultra wide frequency range and high voltage output.

The frequency range is from DC to 20kHz. The maximum output voltage is ±200V (141Vrms for sine wave).

Four selectable output modes are provided: DC constant voltage and constant current, and AC constant voltage and constant current.

This series contains four Models 4502, 4505, 4510, and 4520A with rated output power of 250VA, 500VA, 1kVA, and 2kVA, respectively.

For all the four models, if the outputs of two units are connected in series, output voltage of ±400V max can be obtained.

If combined with appropriate peripheral devices, this series can easily configured as a variable frequency AC power supply, fixed frequency AC power supply, multi-phase AC power supply, flicker power supply, instantaneous power failure simulator, bipolar power supply, etc.

The series features a mode for automatically controlling the DC power supply voltage (Vcc) of the power amplifier unit, in accordance with the output voltage. In this mode, the rated output current can be obtained even when output voltage is lower than the rated voltage.

1.2 Features

1. Wide band
   0 to 20kHz : Covers DC to entire audio band
2. High output voltage
   ±200V max. ±400V if two units are connected in series.
3. Output mode selectable
4. Input/output isolation
   Two units can be connected in series, since the output is electrically floating from the frame.
5. Increase of output power (4520A only)
   Up to four MODEL 4521A Power Boosters (10kVA max.) can be connected in parallel with one 4520A. In this case, if the series operation is employed, the output power can be boosted up to 20kVA max.

6. Excelent load regulation
   ≦0.1% in CV mode. (DC to 1kHz)
7. Low distortion factor
   ≦0.05% in CV mode. (10Hz to 1kHz)
8. High stability
   Gain stability : ± 100ppm / °C (typ.) DC to 1kHz CV, DC mode

9. Remote sensing
   The voltage drop across the output cable can be compensated for in the frequency range DC to 1kHz, in CV, DC mode

1.3 Specifications

1.3.1 Input

Frequency range	DC to 20kHz
Allowable maximum input voltage	±50V (AC+DC)
Gain	CV : 100V/V

CC :

	4502	4505	4510	4520A
A/V	1.5	3.0	6.0	12.0

Gain adjustment	Approx. ±10%, By the trimmer resistor (GAIN) on the panel.
Gain stability	±100ppm / °C (typ.) ┐ ±100ppm /8h (typ.) ┘ DC to 1kHz, CV mode
Input impedance	100kΩ unbalanced
Input terminal	Binding post (rear panel)

1.3.2 Output

		4502	4505	4510	4520A
Rated output power	DC output (W)	320	640	1.27k	2.55k
	AC output *1 (Load power-factor ≧ 0.7) (VA)	250	500	1k	2k
Max. output power *2 for electronic devices (VA)		313	625	1.25k	2.5k
Rated output current	DC output (A)	±1.9	±3.8	±7.5	±15.0
	AC output *1 *3 (Arms)	2.1	4.2	8.3	16.7
Peak current *2		Approx. 2.5 times the rated value (rms value)			

*1 45Hz to 20kHz

*2 For capacitor input type rectifier circuit, peak factor ($\frac{Ipeak}{Irms}$) = 2, 45 to 450Hz in CV mode.

*3 rms value of the sine wave current (at the rated output voltage, when Vcc is at 90% or in AUTO mode.

Rated output voltage ±170V (DC output), 120Vrms (AC output, sine wave)

Max. output voltage ±200V (DC output), 141Vrms (AC output, sine wave)
When the output voltage exceeds the rated value, maximum allowable output current I=P/V.
(where P = Rated output power, V = Output voltage)

Output offset voltage / current Adjustable to zero (in DC mode) by the trimmer resistor (ZERO) on the panel.

Output offset voltage drift (CV mode)

DC mode ±3mV/℃ (Reference value)

AC mode ±20μV/℃ (Reference value)

Load regulation (DC mode) At rated output voltage and current with reted pure resistance load.

CV mode ≦±0.1% (DC to 1kHz)
≦±2% (1kHz to 20kHz)
(Sensing: Local)

CC mode ≦±2% (DC to 1kHz)
≦±20% (1kHz to 20kHz)

Line regulation (DC mode)	For ±10% change of power source voltage, at the rated output power to the rated pure resistance load.
CV mode	≦±0.1% (DC to 1kHz)
	≦±1% (1kHz to 20kHz)
CC mode	≦±0.2% (DC to 1kHz)
	≦±2% (1kHz to 20kHz)
Output voltage/current distortion factor (DC mode)	At the rated output power to the rated pure resistance load.
CV mode	≦0.05% (10Hz to 1kHz)
	≦1% 10kHz
	≦2.5% 20kHz
CC mode	≦0.5% (10Hz to 1kHz)
	≦2.5% 20kHz
Frequency vs. output voltage / current characteristics	Reference level at 400Hz (both for CV, CC) at the rated output power, to the rated pure resistance load in AC mode.
DC (45Hz) to 5kHz	−0.5 to +0.2dB
5kHz to 20kHz	−3 to +0dB
Output noise level	≦20mVrms in CV mode, Vcc at 100%
Remote sensing	Remote sensing possible in CV and DC modes. (DC to 1kHz) Output cable shall be 10m or less in length, for a voltage drop across the output cable of 2Vrms or less (for sine wave).
Output system	Balanced, (may be operated floating or with either side grounded.)
Output mode	Constant voltage (CV) / constant current (CC) DC/AC Selectable by the switch on the rear panal.
Output indicater	
Voltmeter	450V full scale
Ammeter	140% full scale Rms responding, rms calibrated Class 2.5 For the ammeter, AC rated current = 100%.

Internal DC power supply (Vcc) control mode

1. FIXED ····· Vcc fixed. 10 levels for Vcc can be set from 10% to 100%.
2. AUTO ····· Automatically controlled to the optimum Vcc level for the output voltage

Can be set by the semi-fixed switch on the panel or by the external control signal (RMT).

The setting of control mode is indicated by the LEDs on the front panel.

LED indication

The following items are indicated by LEDs.

1. Output voltage peak value (10 indicators for 10% to 100%.
2. Overload
3. DC/AC mode
4. CV/CC mode
5. Vcc setting

1.3.3 Protection Functions

Object of protection	Protection measure	
	Output limiting	Power shut-off
Output over current	○	△
Power transistor loss	○	
Deviation from power transistor area of safe operation (ASO)	○	
Power transistor temperature rise		○
DC power (Vcc) over voltage		○
Power input over current		○

△ depends on overload conditions

1.3.4 General Specifications

Power requirements

	4502	4505	4510	4520A
Voltage (Vrms)	100±10%		200±10%	
Frequency (Hz)	48 to 62			
Power consumption (W)	600	1.1k	2k	4k
Apparent power (VA)	1.1k	2k	4k	8k

At the rated output power to the rated pure resistance load.

Note : Operation on 120V (4502, 4505 only), 220V or 240 Vrms power input is available on request.

Insulation resistance ≧10MΩ 500VDC,

Withstanding voltage 1500VAC, 1 min.

The above figures are measured between the power input and the output / chassis, and between the output and the power input /chassis.

Ambient temperature / humidity

Operating : 0 to 40°C, 10 to 90%RH

Storage : −20 to 60°C, 10 to 80%RH

Dimensions, weight

	Dimensions (exclusive of protrusion) W×D×H (mm)	Weight (kg) *4
4502	430×598×176	approx. 27
4505	430×598×265	approx. 40
4510	430×600×353.5	approx. 70
4520A	430×600×442.5	approx. 93
4521A	430×600×442.5	approx. 92

*4 : Not including output transformer (optional)

1.3.5 Specifications when the Model 4521A power booster is additionally used

The ratings, when the 4521A is additionally coupled with the 4520A, are given below.
As to the rating not specified here refer to those for the 4520A.

(1) Gain

CV : 100V/V (the same as that for a single unit 4520A)

CC :

The number of the 4521A's used	1Unit	2Units	3Units	4Units
Gain (A/V)	24	36	48	60

(2) Output

Number of the 4521A's used		1Unit	2Units	3Units	4Units
Rated output power	DC output (kW)	5.10	7.65	10.2	12.8
	AC output *1 (kVA) (Load power factor 0.7)	4	6	8	10
Max. output power for electronic device (kVA) *2		5	7.5	10	12.5
Rated output current	DC output (A)	±30	±45	±60	±75
	AC output (Arms) *1 *3	33	50	67	83

*1 : ≧45Hz (The upper limit frequency is specified in the table of frequency characteristics below.

*2 : For capacitor input type rectifier circuit, peak factor $\left(\frac{\text{Ipeak}}{\text{Irms}}\right) = 2$, 45 to 450Hz in CV mode.

*3 : rms value of the sine wave current (at the rated output voltage, when Vcc is at 90% or in AUTO mode.

Load regulation (DC mode)

CV mode ≦ ±0.1%
CC mode ≦ ±2%
} DC to 1kHz

Line regulation

CV mode ≦ ±0.1%
CC mode ≦ ±0.2%
} DC to 1kHz

Output voltage/current distortion factor (DC mode)

CV mode ≦ 0.05%
CC mode ≦ 0.5%
} 10Hz to 1kHz

Frequency vs. output voltage/current characteristics

Number of 4521A's used	1Unit	2Units	3Units	4Units
Frequency characteristics range	DC to 10kHz	DC to 7kHz	DC to 5kHz	DC to 4kHz

In AC mode, ≧45Hz

Within −1.0 to +0.2dB in the above frequency ranges (referenced to 400Hz)

(3) General specifications

Power requirements (single unit of the4521A)

Voltage	200V±10% (220V or 240V±10% is also available on request.)
Frequency	48 to 62Hz
Power consumption	4kW
Apparant power	8kVA
Power on /off operation	The 4521A can be turned on and off using power switch of the 4520A, in addition to its own switch.
Dimensions, weight	430 (W) × 600 (D) × 442.5(H) mm Approx. 92kg

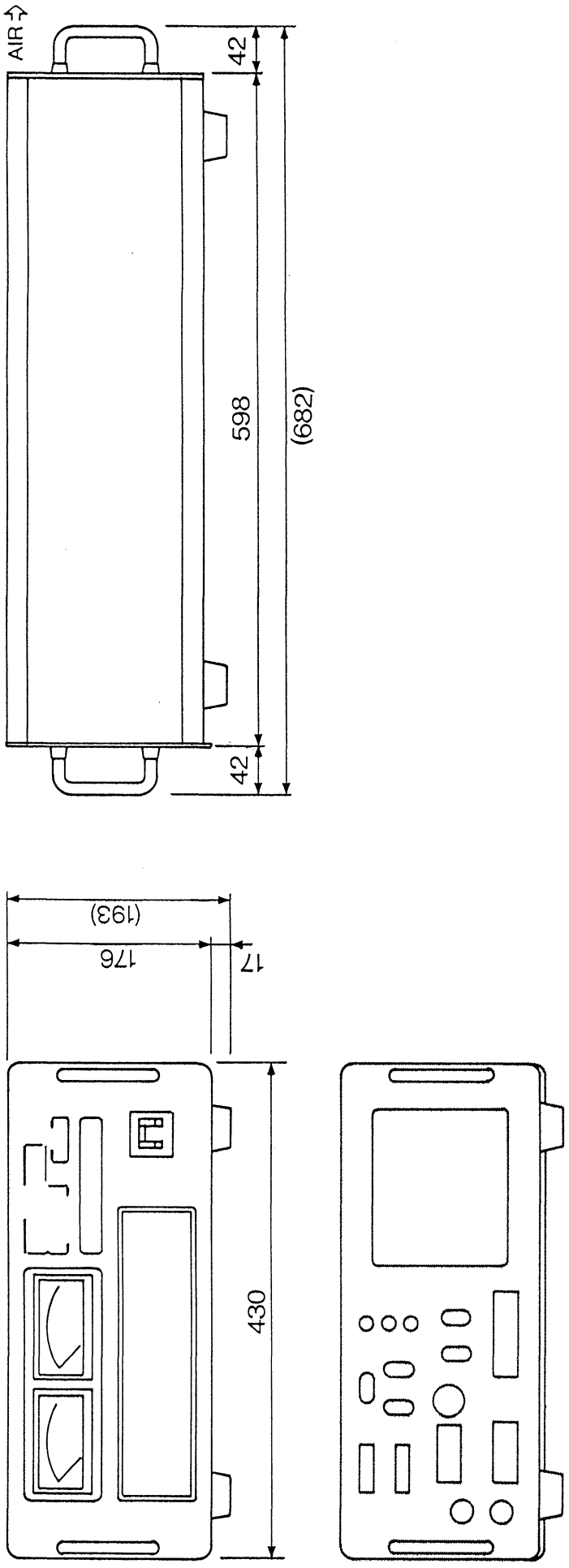


Fig. 1-1 External view of the 4502 and dimensions

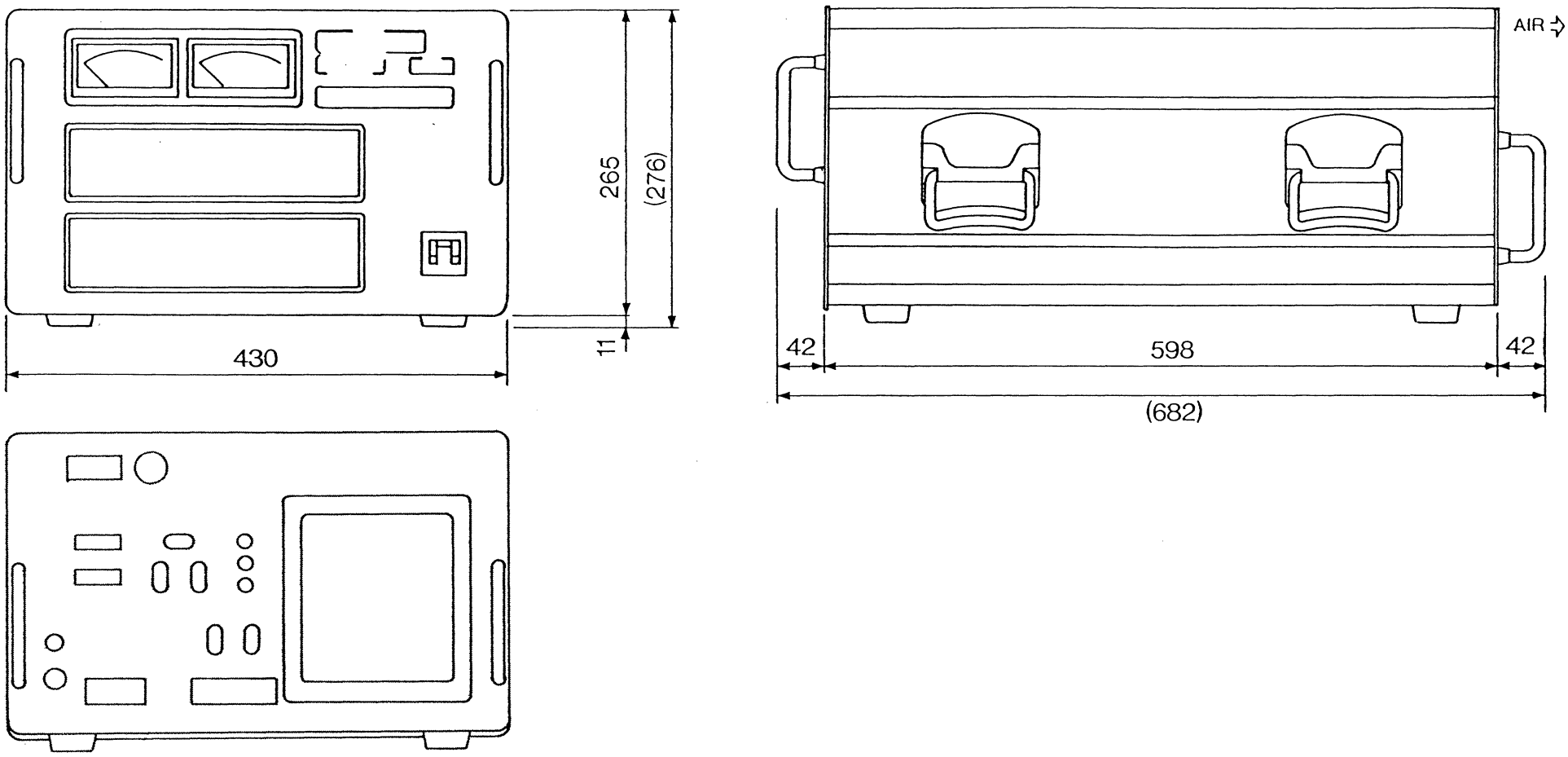


Fig. 1-2 External view of the 4505 and dimensions

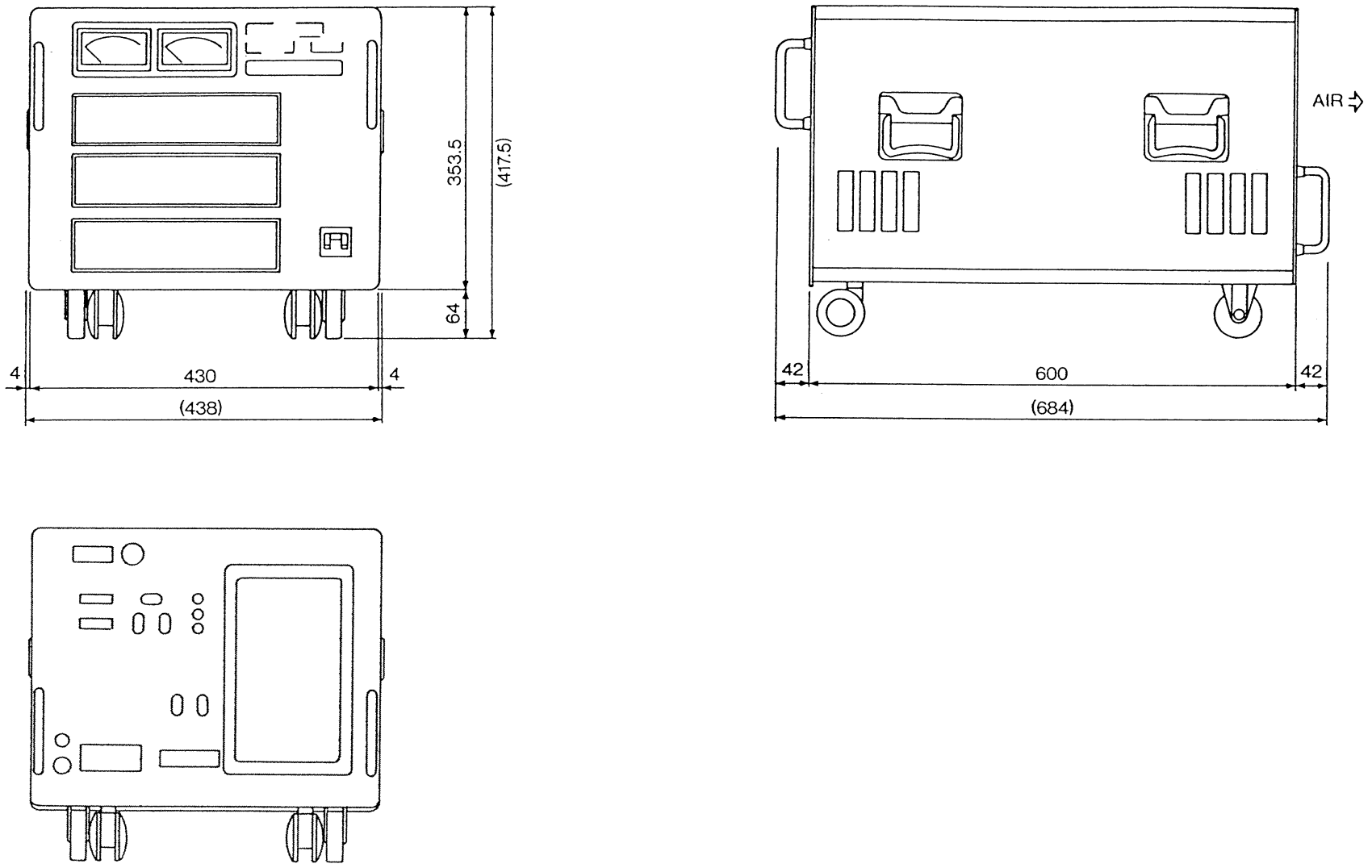


Fig. 1-3 External view of the 4510 and dimensions

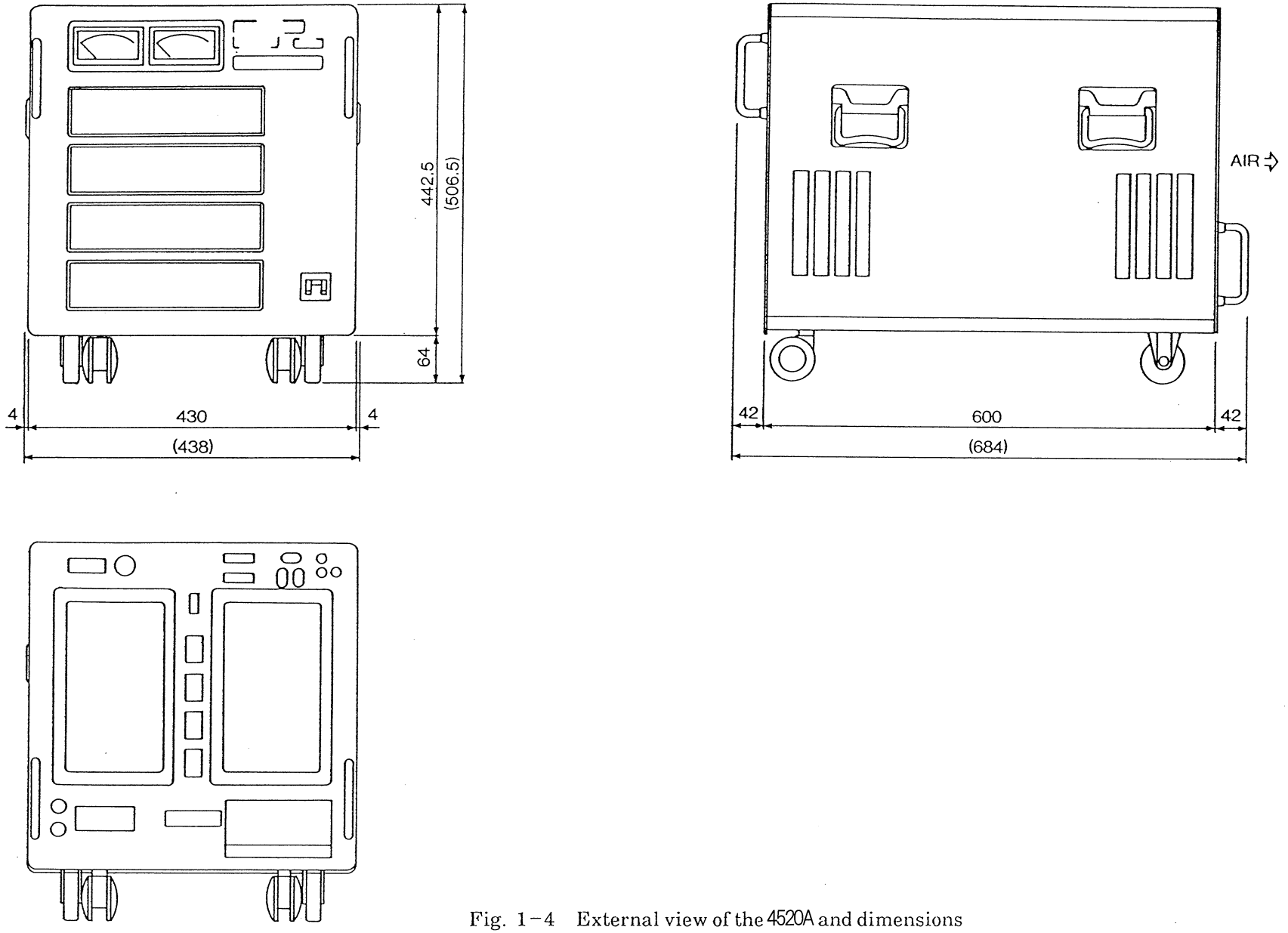


Fig. 1-4 External view of the 4520A and dimensions

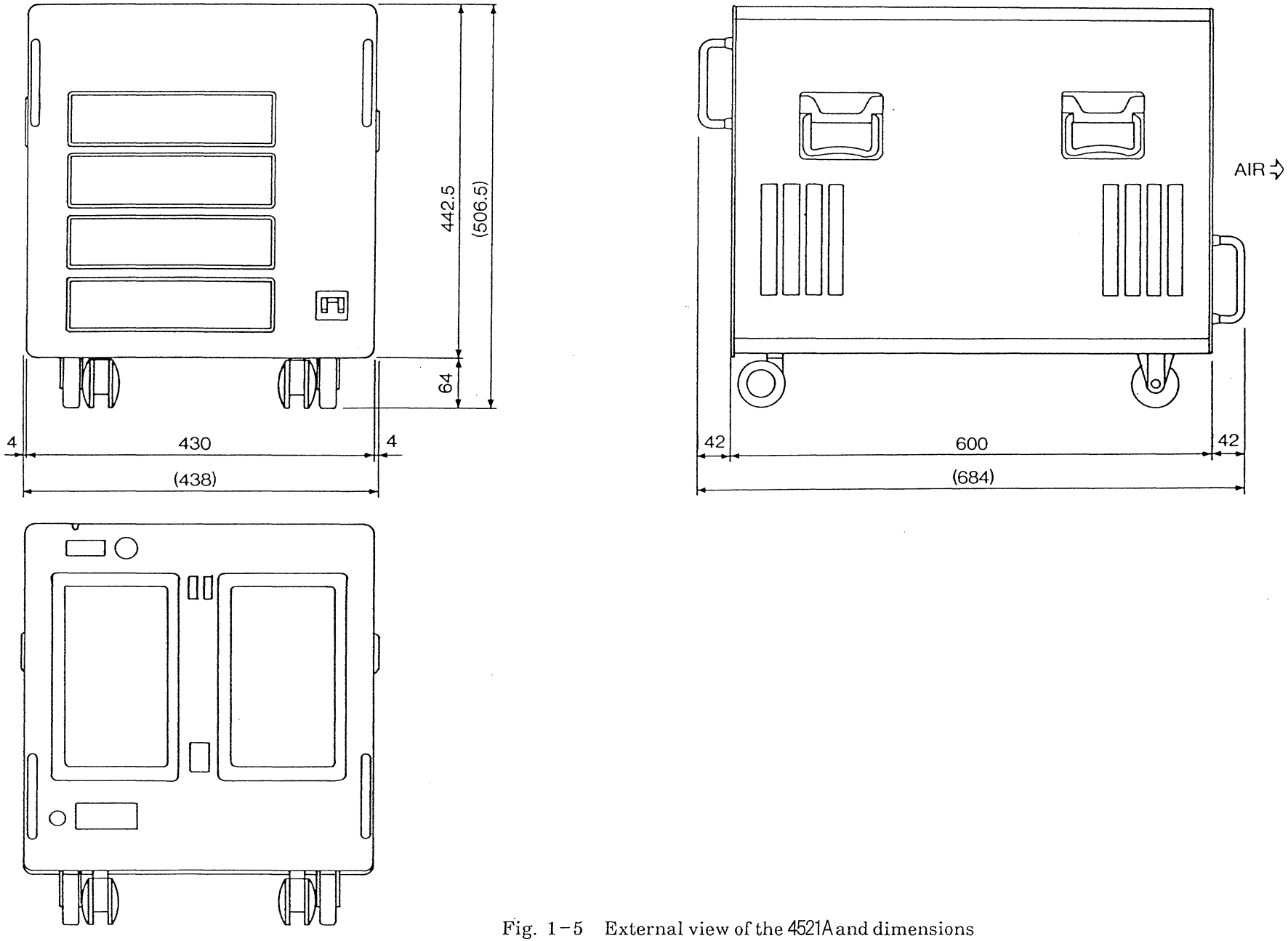


Fig. 1-5 External view of the 4521A and dimensions

2. PREPARATION FOR USE

2.1 Introduction

Install the unit with sufficient care. Improper installation will adversely affect the life, reliability, and safety of this unit.

2.2 Unpacking and Repacking

(1) Unpacking

After unpacking, check to see if there is any damage due to transportation.

Also check the accessories, referring to section 2.3 "Configuration".

(2) Repacking

When repacking this unit for transportation or other purposes, the weight of this unit must be taken into consideration.

When packing the 4502 and 4505, use a cardboard box of sufficient volume and strength.

Fill the spaces with packing material that is strong enough to support the unit.

The 4510, 4520A and the 4521A cannot be packed in a cardboard box, because of their weights. Instead, pack them in a wood frame case which can bear the weight.

2.3 Configuration

The composition of this unit is as given below.

Table 2-1 Configuration List

Main unit	1
Instruction manual (except Model 4521A)	1
Accessories	
Power cable (3m)	1
4502 : $2mm^2$ 4520A : $8mm^2$	
4505 : $3.5mm^2$ 4521A : $8mm^2$	
4510 : $3.5mm^2$	
Fuse (Small glass cartridge, ordinary type, 2A)	2
Control cable (only the 4521A)	1
Booster cable (only the 4521A)	1

2.4 Installation

This unit is forcibly air-cooled by a fan. Air is taken from the front and exhausted from the rear.

Place this unit away from the walls by at least 30cm as measured from the front, rear and the sides to secure the air flow, The allowable temperature /humidity ranges of this unit are :

Operating : 0 to 40 °C, 10 to 90%RH

Storage : −20 to 60 °C, 10 to 80%RH

Install this unit in a place which satisfies the above temperature and humidity figures, and is free from dust and vibration, and not exposed to direct sunlight. Do not place objects on top of the unit. Care should be taken not to drop objects on the unit.

2.5 Power Supply and Grounding

The power input section of this unit includes a line filter. To allow the line filter to operate with satisfactory performance and to prevent electrical hazard, the ground terminal of this unit must be connected to ground. The specified leakage current of the line filter of this unit at 250V, 60Hz is 2mA max. for the 4520A and the 4521A, and 1mA max. for the other units. The ground terminal is the center terminal of the power input terminal board on the rear (See Fig. 2−1).

The requirements for the power supply are listed below.

	4502	4505	4510	4520A	4521A
Power voltage (Vrms)	100±10%		200±10%		
Frequency (Hz)	48~62				
Current capacity (Arms)	11	20	20	40	40
Power cable cross section area (mm^2)	2	3.5	3.5	8	8

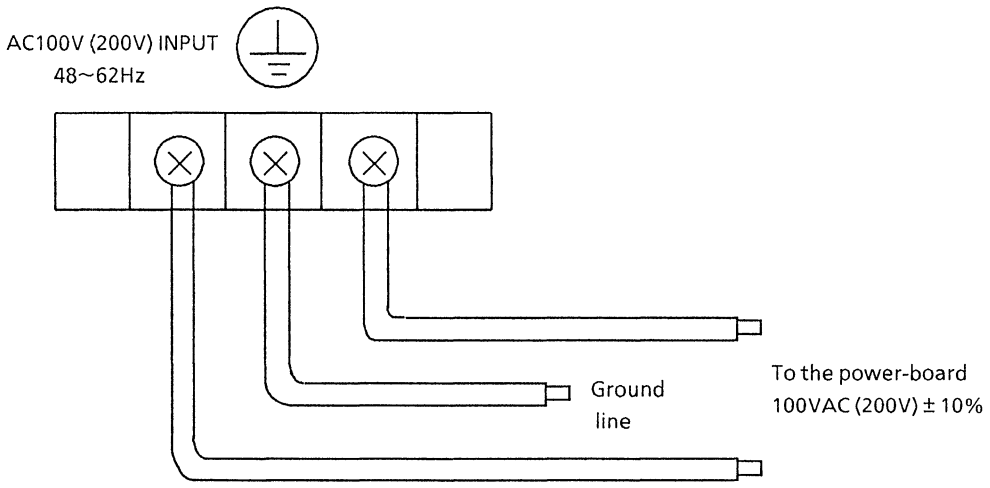


Fig. 2−1 Power input terminal

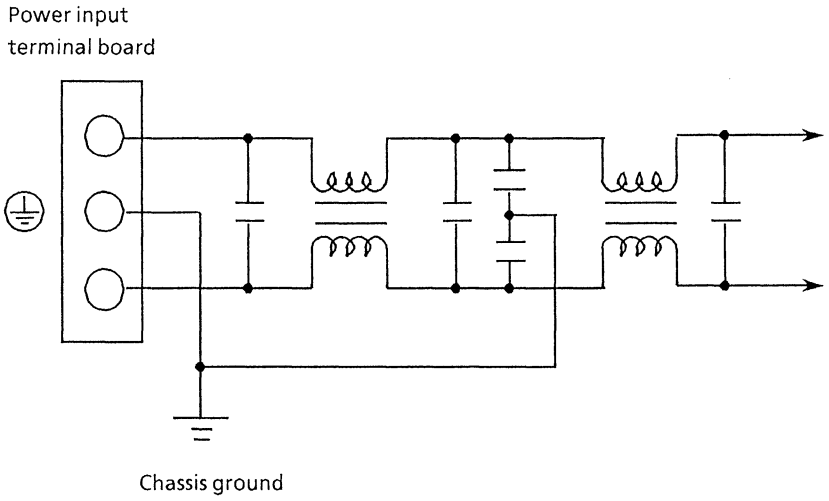


Fig. 2-2 Line filter

2.6 Rack mount

This unit can be mounted on a rack by using rackmount adapators (optional). Two types of rackmounts, the British system, and the metric system, are available.

The procedure for mounting the unit on the rack will be described.

(1) Remove the two (or three) screws on the sides panels closest the front.
(2) Install the rackmount adaptor with flat-head screws (M4×14) as shown in Fig 2-3.
(3) Remove the casters or rubber feet.
(4) Insert this unit into the rack frame using rails to support the bottom of the unit.
(5) Screw the unit to the rack frame through the adaptors, using flat and angle washers.

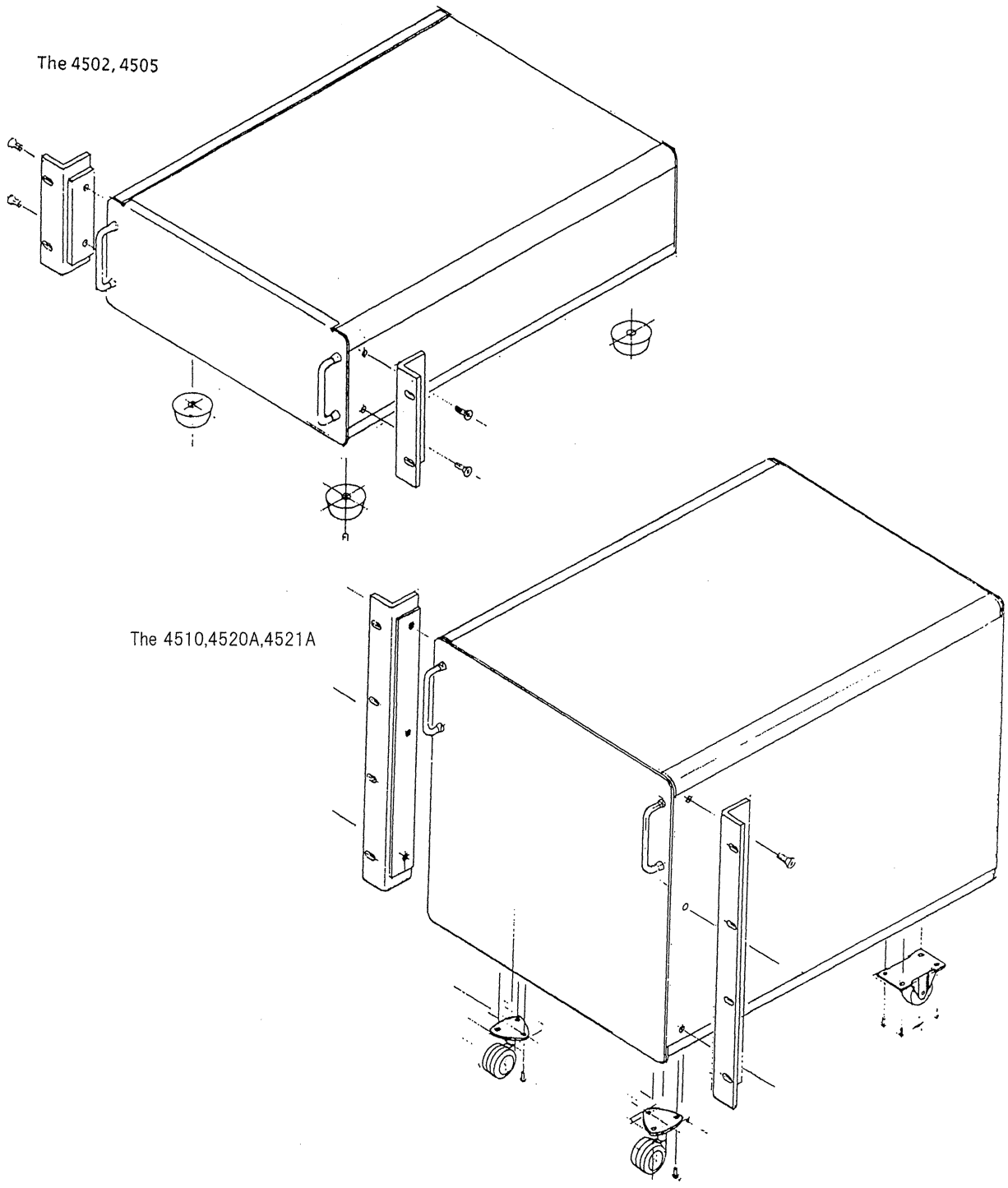


Fig. 2-3 Installation of rack mount adaptors

3. OPERATION

3.1 Controls and Operation

Control and display features of the 4500 Series will be described using the reference numbers from Figs. 3-14, 3-15, 3-16, 3-17, and 3-18.

3.1.1 Front Panel

① VOLTAGE

Voltmeter of class 2.5 for indicating the output voltage. Since it is rms responding, the correct rms value can be obtained even for a distorted wave, when a DC voltage is indicated, its polarity is shown by the ② polarity indication lamp.

② Output voltage polarity indication lamps

(−) or (+) lamp will be lit, depending on the polarity of the output voltage. The indicated polarity is the polarity of the Hi terminal voltage (with respect to the Lo terminal voltage) on the ⑧ output terminal board. When the output voltage is AC and the frequency is about 50Hz or more, it looks as if both lamps (−) and (+) are simultaneously lit.

③ CURRENT

Ammeter of class 2.5 for indicating the output current in percentage. Since it is rms responding, the correct rms value can be obtained even for distorted wave. When it indicates DC current, the polarity is shown by the ④ polarity indication lamp. 100% corresponds to 2.1A for the 4502, 4.2A for the 4505, 8.3A for the 4510, and 16.7A for the 4520A (rms value of the sine wave current).

④ Output current polarity indication lamps

(−) or (+) lamp will be lit, depending on the polarity of the output current.

The polarity of positive (+) implies the current which flows out of the Hi terminal on the 20 output terminal board. If the output current is AC and the frequency is about 50Hz or more, it looks as if both lamps (−) and (+) are simultaneously lit.

⑤ Vcc STATUS Lamps indicating setting of the internal DC power supply (Vcc), and the setting switch

FIXED (10% to 100%)..... Indicates that Vcc is fixed to one of ten points from 10% to 100%.

AUTO..... Indicates that Vcc is automatically set depending on the output voltage.

RMT..... Indicates that the setting of Vcc is done by the external signal. When RMT is lit, SELECT switch is disabled.

SELECT..... Vcc setting switch. Set it to FIXED (10% to 100%) or AUTO.

⑥ GAIN Gain adjustor

15-turn gain adjustor, which can vary gain by approx. ±10%. Gain increases when it is turned clockwise

⑦ ZERO Zero adjustor

15-turn zero adjustor for setting the DC offset. Effective only in the DC mode.

⑧ MODE Output mode indication lamps

DC-AC ⑯ Indicates the mode selected by the DC /AC select switch.

CV-CC ⑰ Indicates the mode selected by the CV/CC select switch.

⑨ OVERLOAD Overload indication lamp

Indicates operation of the overload protection circuit. The lamp is lit when any one of the protection circuits for the output current, power transistor loss, or ASO, operates. If the overload condition is removed, the protection circuit is automatically restored to the normal state, and the lamp goes out.

⑩ OUT VOLT (PEAK) (10% to 100%) · Output voltage (peak value) indication lamp (bar graph)

Indicates the peak value of the output voltage in 10% steps. To set Vcc to FIXED, set OUT VOLT (PEAK) so that the set Vcc percentage will be equal to the peak value percentage of the output voltage.

⑪ POWER Power switch

Power switch of this unit. This switch includes a non-fuse breaker for protection purposes. When abnormality occurs, it shuts off the power supply.

⑫ Air intake

Air intake for forced-air cooling fan. Maintain a space of at least 30cm from any obstructions.

3.1.2 Rear Panel

⑬ INPUT A Connector for dedicated signal generator.

When using the dedicated signal generator, connect it via this connector. The signal generator supplies an oscillator output signal and a Vcc control signal. The connector also transmits signals for Vcc setting, output mode (AC/DC, CV/CC), unit type code, output voltage monitor, output current monitor, and the overload condition.

⑭ Space for spare connector mounting

⑮ SIG SELECT Input signal select switch

This switch selects the input signal between taht of ⑬ INPUT A (the dedicated signal generator), or ⑱ INPUT B.

⑯ DC/AC, DC/AC mode select switch

This switch selects the coupling mode for the signal input. To use this unit as a DC amplifier, set it to DC. To use as an AC amplifier, set it to AC. In the AC mode, the signal input unit is AC coupled, and the cutoff frequency is about 1.6Hz. Since a 100% negative feedback is applied for the DC component in the AC mode, DC offset is better than that in the DC mode. For the application where the DC component of the output is should be minimized, use the AC mode.

⑰ CV/CC, CV/CC mode select switch

This switch selects the CV (constant voltage) mode or the CC (constant current) mode. In the CV mode, the output voltage is proportional to the input voltage. In the CC mode, the output current is proportional to the input signal voltage.

⑱ INPUT B Signal input terminal

Terminal for inputting the output signal of an external signal source. The signal is input across the Hi and Lo terminals. Normally, the Lo terminal is connected to the GND (⊥) terminal with the attached short bar. If hum is induced due to the ground current flowing between this unit and the frame of the signal source, remove the short bar. Input impedance is 100kΩ. The max. input voltage allowed for normal operation is ±2V. The allowable max. input voltage is ±50V. If a higher voltage is applied, this unit might be damaged.

⑲ Outlet

Outlet for the forced-air cooling fan. Maintain a space of at least 30cm, from any obstructions, to ensure proper air flow.

⑳ OUTPUT Output terminal board

Lo, Hi (4520A only)

S-Lo, Lo, ⊥, Hi, S-Hi (the 4502, 4505, 4510)

The output is taken out from the Lo terminal and Hi terminal. S-Lo and S-Hi terminals are remote sensing terminals. When remote sensing is not performed, connect S-Lo to Lo, and S-Hi to Hi, respectively with attached short bars. To perform the remote sensing, remove the short bars. Connect S-Lo and S-Hi terminal respectively to the Lo and Hi terminals of the load. If the load is connected to S-Lo and S-Hi terminals when the output cable is disconnected, the internal resistor will be damaged.

⊥ is the GND terminal. When grounding one of the paired outputs, connect this terminal to the Lo or Hi terminal.

㉑ REMOTE SENSING Remote sensing terminal board (4520A only)

On the 4520A, due to the structure of the ⑳ output terminal board, a remote sensing terminal is provided separately. For use, see 3.1.2 ⑳. Never take the output power from the REMOTE SENSING terminal board, because these terminals have very low current capacity. For the 4520A, remote sensing is also possible in the AC mode.

㉒ AC 200V/100V INPUT Power input terminal board
48 to 62Hz

Terminal board for power input. The power voltage is 200VAC for the 4510, 4520A and 4521A, and 100VAC for the 4502 and 4505. Allowable voltage range is ±10%. Connect the AC source to this terminal board by the attached cable. See section "2.5 Power Supply and Grounding" for details.

㉓ AC OUTLET Power output connector

Power output connector for the dedicated signal generator. The power input voltage of the 4500 Series unit is directly output. A current of up to 1A can be output from this connector. The pin connection of the connector is shown in Fig. 3-1.

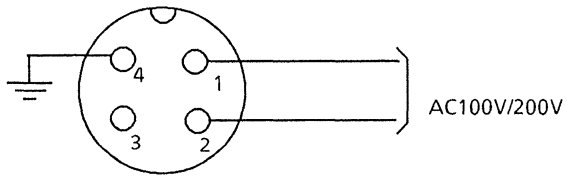


Fig. 3-1 AC OUTLET pin connection

㉔ 2A fuse holder

Holder a fuse to protect the low power sections of this unit. Use a small glass-cartridge, ordinary fusible type, 2A. When replacing, do not fasten the fuse holder cap too tightly, or the holder might be damaged.

㉕ BOOSTER I/O Booster input/output connector (4520A only)

Connector for the 4521A booster. It supplies the output of the 4521A to the 4520A, and transmits the power on signal from the 4520A to the 4521A.

㉖ CONTROL I/O Input/output connector for booster control (4520A only)

Connector for the 4521A power booster for transmission of control signals.

㉗ POWER Power indication lamp (4521A only)

Pilot lamp for indicating that the power is turned on.

3.2 Input /Output Connection

(1) Signal Connection

Input the output signal of the signal generator (an oscillator, for example) to the ⑱ INPUT B terminal on the rear. Set the ⑮ SIG SELECT switch to INPUT B.

> Caution
>
> Max. input voltage allowed for normal operation is ±2V. Do not input higher voltage than this.

To use the dedicated signal generator, connect the generator to the ⑬ INPUT A connector via the cable attached to the signal generator. Set SIG SELECT switch to INPUT A.

(2) Power connection (See 2.5.)

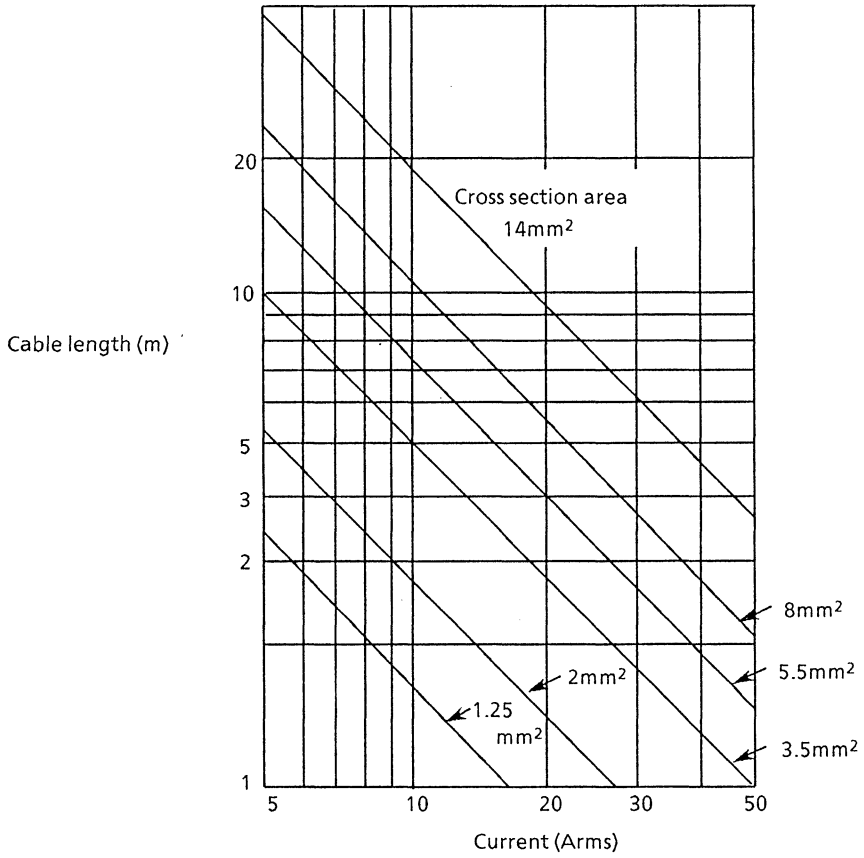
Confirm first that the POWER switch is off. Then, connect the ㉒ power input terminal on the rear panel to a power-source (100V or 200V) with the attached power cable. Tighten the screws securely, for a loose screw can cause an accident. As a protection measure, be sure to connect the ground terminal to ground. The power capacities are as follows.

4502	4505	4510	4520A
100V·11A	100V·20A	200V·20A	200V·40A

(3) Load connection (See section 3.1.2 ⑳.)

Confirm first that the ⑪ POWER switch is off. Then, connect the load to the Hi and Lo terminals of the ⑳ output terminal board. If the inductance of the output cable is high, the voltage drop at high frequency becomes large, worsening the load regulation. To keep the inductance of the output cable low, twist the two Hi and Lo cables.

Select an appropriate nominal cross sectional area of the output cable, referring to Fig. 3-2.



Note : Voltage drop , 0.5V
JIS C 3316 KIV cable

Fig. 3-2 Relation Between Current and Cable Length

Danger

Before connecting the load to this unit, be sure to turn off the ⑪ POWER

3.3 Output Mode Setting (See Section 3.1.2 ⑯, ⑰.)

Set up the required mode by the ⑯ DC/AC switch and the ⑰ CV/CC switch on the rear panel, according to the situation. To use this unit as an AC amplifier, set to AC mode. To use it as a DC amplifier, set to DC mode. When constant voltage output is required, set to CV mode. When constant current output is required, set to CC mode.

Danger

Do not open the output in CC mode, as high voltage will result.

3.4 Startup

Following input /output connection and output mode set-up according to sections 3.2 and 3.3, start up the unit in the procedural steps below.

(1) Set the output voltage of the signal generator to minimum.

(2) Turn on the ⑪ POWER switch of the unit.

Under this condition, the ② and ④ output polarity indication lamps, a ⑤ Vcc STATUS lamp, two ⑧ output mode lamps (DC/AC, CV/CC) and ⑩ OUT VOLT lamps will be lit, to indicate that the unit has entered the operating state.

(3) Set Vcc by the Vcc SELECT switch.

Set Vcc to AUTO, except for the application where output voltage or output current is quickly changed. In the application where the output is quickly changed, set Vcc to a fixed level (10% to 100%). Here, set it to 100% for convenience (See 3.4 (5).)

(4) Set the output voltage or the output current of the 4500 Series unit to a desired value via the output voltage adjustor of the signal generator.

The output voltage and the output current are indicated by the front panel ① voltmeter and the ③ ammeter respectively.

(5) Set Vcc to a fixed value (10% to 100%), if the output is quick changed.

First set the output of this unit to the expected maximum to which the level may quickly change. Then, set Vcc to the percentage value indicated by the ⑩ OUT VOLT indication bar graph. For example, if the OUT VOLT indicates 80%, set Vcc to 80% (See Fig. 3-3).

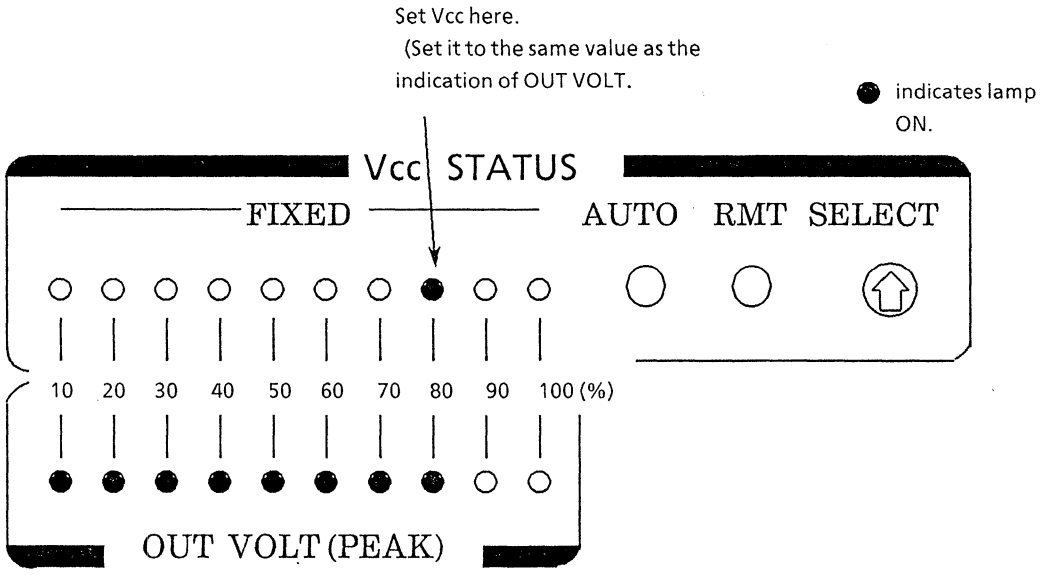


Fig. 3-3 Vcc Setting

3.5 Fine Adjustment of the Gain

The gain of this unit is fixed at 100V/V in the CV mode, but varies in the CC mode according to the type of unit used, as shown below. Output level adjustment is made by adjusting the input signal level. The gain can be fine-tuned by the ⑥ GAIN adjustor on the panel, in the range of about ±10%. This GAIN adjustor is of a 15-turn type, so very fine adjustment can be performed.

4502	4505	4510	4520A
1.5A/V	3A/V	6A/V	12A/V

3.6 DC Offset Adjustment

When a 4500 Series unit is used in DC mode, the output DC offset voltage (in the CV mode) or the output DC offset current (in the CC mode) can be adjusted to zero.

For this, set the ⑮ SIG SELECT switch on the rear panel to the ⑮ INPUT B. Then, short Hi and Lo terminals of INPUT B. Adjust the front panel ⑦ ZERO control so as to eliminate any output DC offset voltage (or current).

3.7 Output Voltage Peak Indication

The output voltage of this unit is indicated by the ① voltmeter as an rms value, and also indicated by the ⑩ OUT VOLT (PEAK) bar graph as the peak value.

In the bar graph, the maximum output voltage 200Vpeak is set to 100%. The bar graph has 10 divisions, and displays the output voltage in 10%-steps.

The rated output voltage of this unit is 120Vrms for a sine wave, whose peak voltage is 169.7($=120\times\sqrt{2}$)V, so it corresponds to about 85% of 200V, and the bar graph indicates 90%.

If the load of this unit is relatively light, there occurs a case in which the peak output voltage is indicated as a value larger than the fixed Vcc% value. This is because the actual Vcc is larger than the set value, due to the load regulation of the Vcc power supply.

Note

There occurs a case in which the peak output voltage indication exceeds the Vcc set value. This does not indicate abnormality.

3.8 Remote Sensing

This unit is provided with a remote sensing function. It can compensate for the voltage drop of the output cable, thus improving the load regulation (in the CV mode).

The remote sensing is effective in the frequency range of DC to 1kHz.

The 4502, 4505, and 4510 can perform remote sensing only in the DC mode. The 4520A can perform it in both DC and AC modes.

When an output transformer is used outside this unit, remote sensing must be done at the primary terminal of the transformer. If you sense the secondary terminal, the unit will be damaged.

To perform remote sensing, remove the short bars which respectively connect the sensing terminals S-Lo and S-Hi of the ⑳ output terminal panel or of the ㉑ sensing terminal panel (4520 only) and output terminals Lo and Hi. Then, connect terminals S-Lo and S-Hi to Lo and Hi terminals of the load, respectively. When the remote sensing is on, if the output cable is disconnected, the internal resistors of the unit will be damaged.

When you use an external swich for output on /off, sense the terminal of this switch near the 4500 Series unit (see Fig. 3-4). When you do not perform remote sensing, short terminals S-Lo and Lo, and terminals S-Hi and Hi.

Caution

If you use the wrong polarities for sensing, or if the sensing terminals are shorted, the internal resistors of this unit will be damaged.

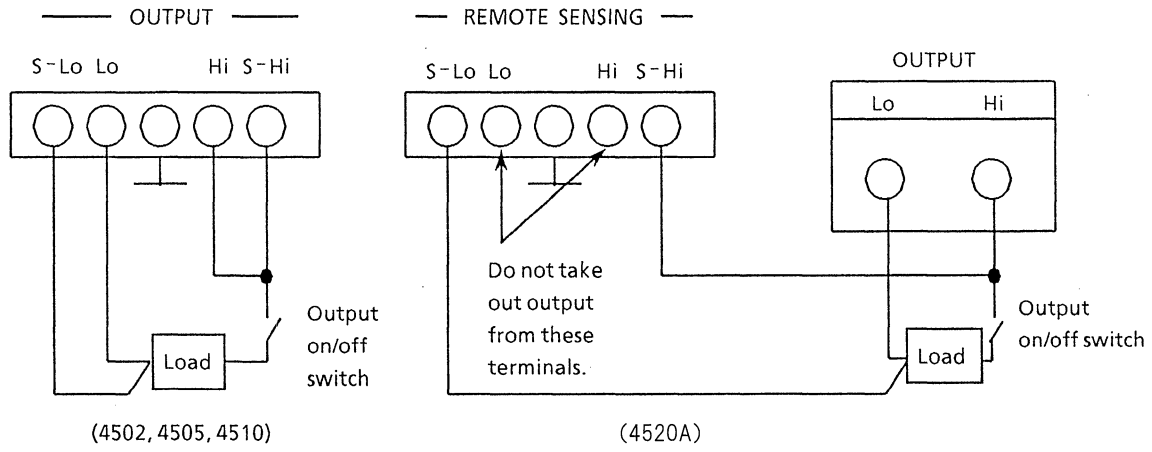


Fig. 3-4 Remote Sensing Connection

3.9 Fan Control

The 4510 and 4520A employ a forced-air cooling fan having two speeds to be selected depending on the load condition. For a light load, the low speed is used, offering low noise. For a heavy load, the high speed is used, thus increasing the cooling ability. Because of this feature, there might occur a case in which the fan speed changes to and from high and low at a certain period, depending on the load condition, but this does not indicate abnormality.

3.10 Output Polarity Indication Lamp

The polarity of the output voltage and the output current are indicated by the ② and ④ polarity indication lamps respectively. Note that if the output voltage/current is very low, that is, 1% of the rated values or less, the incorrect polarity might be indicated by the polarity decision circuit. When you perform a precise measurement in the low level, use an oscilloscope and the like.

3.11 External Control of Vcc and Status Information Transmission

The Vcc setting of this unit can also be performed by an external signal. Also, the internal status signals can be output. For the input /output of these signals, the ⑬ INPUT A connector is used. Fig. 3-5 shows the pin connection of the INPUT A connector.

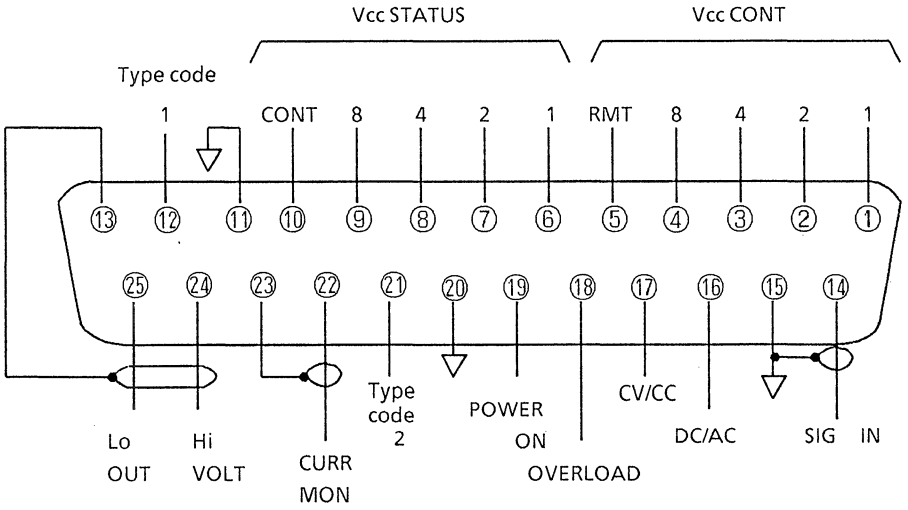


Fig. 3-5 INPUT A Connector Pin

(1) External control of Vcc

For external control of Vcc, set the RMT bit in Fig. 3-5 to "L" level. Set the Vcc value by the combination of control bits 1, 2, 4, and 8. Active low TTL logic is used. The input circuit for external Vcc control is shown in Fig. 3-6.

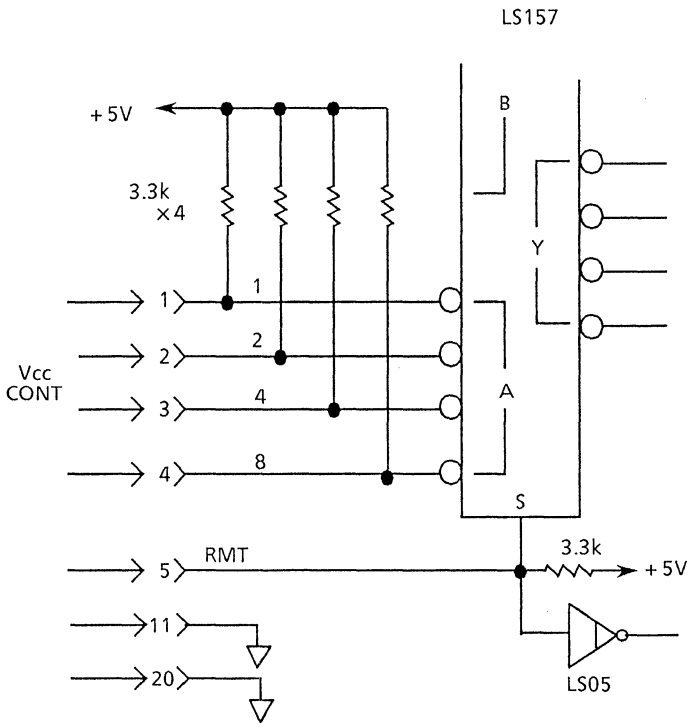


Fig. 3-6 The Input Circuit for External Vcc Control

Vcc	Vcc CONTROL				
	RMT	8	4	2	1
AUTO	L	H	H	H	H
10%	L	H	H	H	L
20	L	H	H	L	H
30	L	H	H	L	L
40	L	H	L	H	H
50	L	H	L	H	L
60	L	H	L	L	H
70	L	H	L	L	L
80	L	L	H	H	H
90	L	L	H	H	L
100	L	L	H	L	H
AUTO	L	L	H	L	L
〃	L	L	L	H	H
〃	L	L	L	H	L
〃	L	L	L	L	H
〃	L	L	L	L	L
LOCAL※	H	–	–	–	–

* LOCAL is set by the Vcc SEL switch on the front panel.

(2) Status output

To output the status of the unit, set the CONT bit in Fig. 3-5 to a low level. There are four types of status outputs, Vcc set value, output mode, overload and power on.

The Vcc set value is output in the combination of Vcc status bit 1, 2, 4, 8. Active low TTL logic is employed. Each bit corresponds to that of the Vcc external control.

Two bits are used for each output mode, DC /$\overline{\text{AC}}$ and CV/$\overline{\text{CC}}$. These bits go low corresponding to the AC and CC modes.

The overload (OVLD) bit goes low when the unit is put in a overload state.

The power on bit goes high level when the power of the unit is turned on.

The status output circuit uses a TTL 3-state buffer (LS244), so that each status output assumes high impedance when the CONT bit is at a high level (or open).

The output circuit is shown in Fig. 3-7.

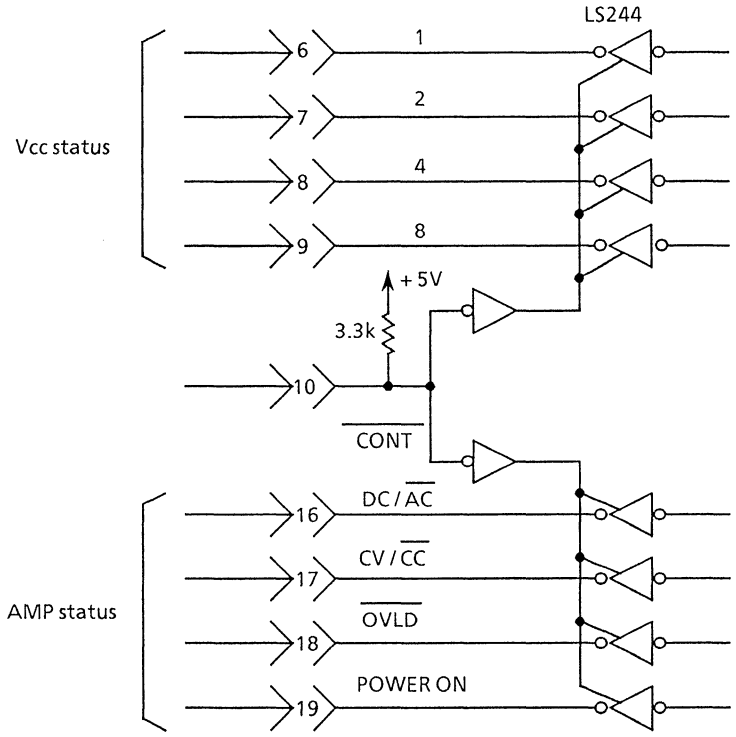


Fig. 3-7 Status Output Circuit

(3) Type code output

The 4500 Series amplifiers have the following unit codes.

The unit can be identified by reading this code.

	Type code bit	
	2	1
4502	O	O
4505	O	G
4510	G	O
4520A	G	G

O : OPEN
G : GND

(4) Voltage / current monitor outputs

The voltage/current monitor outputs are at different potentials from those of the input signal system and the chassis. When high voltage is applied to the output system of the unit, as viewed from the chassis side, high voltage is also applied to the monitor output. Therefore, when you connect a measuring instrument to the monitor output, the entire measuring system must be insulated from the chassis of the unit.

The voltage monitor output is the voltage of the output terminal of the unit itself, so max. voltage is ±200V (when the output transformer is built in, ±400V). The current monitor output is a voltage which is proportional to the output current. The ratio of the output current to the monitor output voltage is as follows.

4502	1.25A/V
4505	2.5A/V
4510	5.0A/V
4520A	10A/V*

* When the boosters of the 4521A are connected to the 4520A, this ratio increases as the number of boosters are increased. When a single booster is used, it is 20 A/V, and when four boosters are connected, it is 50 A/V.

3.12 Protection Circuit Operation

The protection circuit of the unit is classified as an output overcurrent protection circuit, power transistor loss protection circuit, power transistor area-of-safety-operation area protection circuit, power transistor temperature rise protection circuit, Vcc overvoltage protection circuit, and power input overcurrent protection circuit.

(1) Output current protection circuit

This circuit is made up of two systems of instantaneous current protection, and average current protection.

The instantaneous current protection circuit controls the drive signals of the power transistors, so that the instantaneous value of the output current does not exceed the specified value.

The average current protection circuit restricts the input signal, and limits the output current when the mean value of the output current exceeds the rated value. If the output current cannot be controlled to be low due to the output offset voltage and the like, this protection circuit turns off the ⑪ POWER switch, to disconnect the power source.

Either circuit causes the overload lamp to light when it is restricting the current.

(2) Power transistor loss (Pc) protection circuit

The power transistor loss protection circuit controls Pc by decreasing Vcc, when the power loss of the power transistor (Pc) exceeds a specified value. When it is restricting Pc, the overload lamp lights.

(3) Power transistor area-of-safe-operation (ASO) protection circuit

When the operating point of the power transistors would exceeds the ASO due to overload, a load with low power factor, or rush current, this circuit controls the input signal so that the transistors operate within the ASO at all times. At this time, the overload lamp lights.

When the ASO protection circuit operates, the output voltage/current might fluctuate (hunting phenomenon), but this does not indicate abnormality.

(4) Power transistor temperature rise protection circuit

This circuit turns off the ⑪ POWER switch to disconnect the power source when the temperature of the power transistors exceeds a specified value due to the failure of the forced cooling fan or overload.

(5) Vcc over-voltage protection circuit

This circuit turns off the ⑪ POWER switch to disconnect the power source, thus protecting the power transistors, when the DC power voltage Vcc supplied to the power transistors exceeds a specified value.

(6) Power input over-current protection circuit

The power input overcurrent protection circuit turns off the ⑪ POWER switch to disconnect the power source, when the power source input current increases too greatly due to overload or failure.

The 4500 Series includes the above protection circuits. The following is the summary of the causes of overload lamp lighting and power source shut-off.

Lighting of overload lamp

- Output current is excessive.
- Power transistor loss is excessive.
- Power transistor operates out of the ASO.

Power supply shut-off

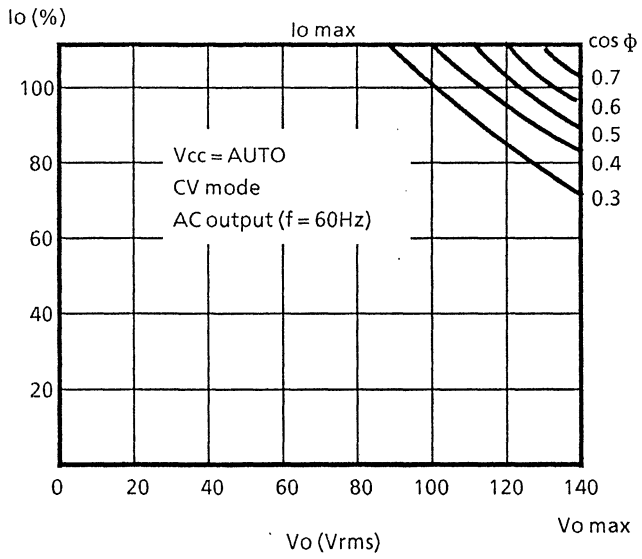
- Abnormal increase of the power transistor temperature.
- Vcc over-voltage.
- Output over-current.
- Power source input over-current.

3.13 Maximum Allowable Output

The maximum allowable output of this unit varies, depending on Vcc voltage, output voltage, load power factor, and so on, since it is a linear power amplifier.

Typical examples of the allowable output when Vcc is in AUTO mode, and fixed at 100%, are shown in Figs. 3-8 and 3-9, respectively.

(a) AC output



(b) DC output

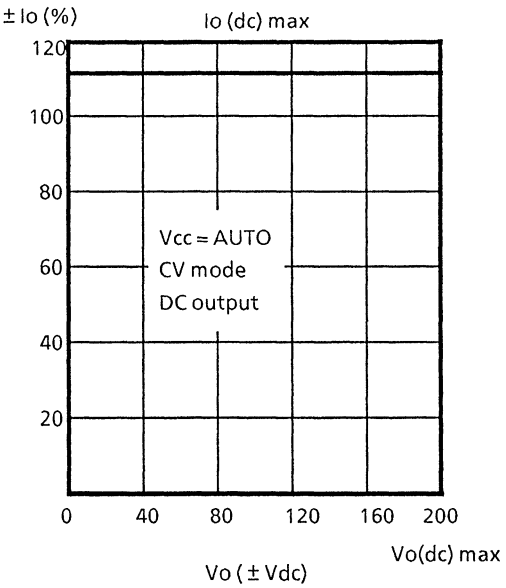
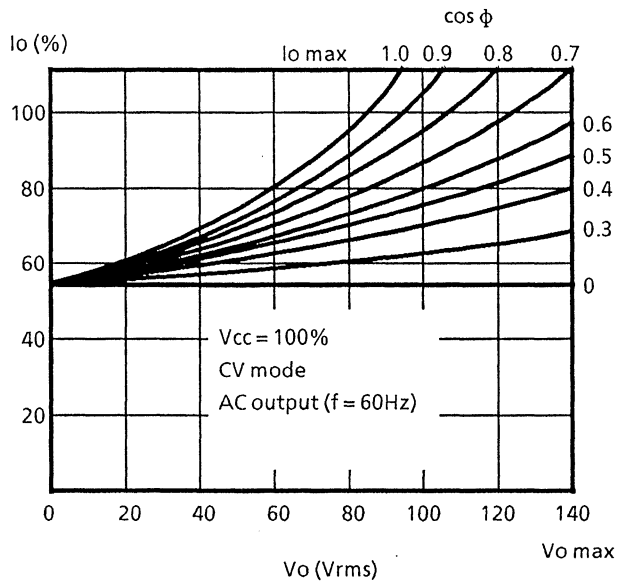


Fig. 3-8 Typical Example of Allowable Output with Vcc = AUTO

(a) AC output



(b) DC output

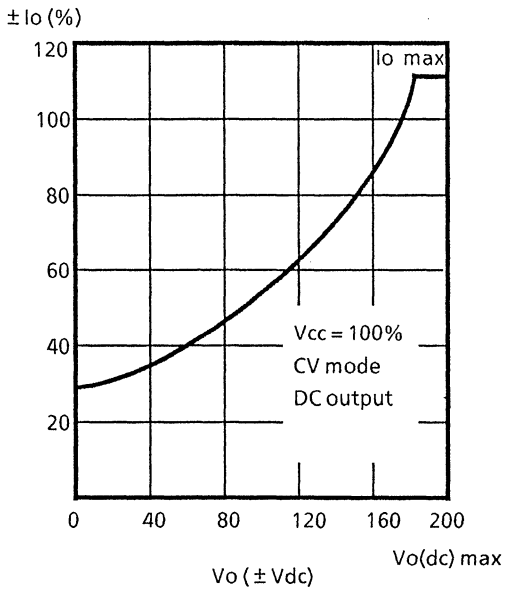


Fig. 3-9 Typical Example of Allowable Output with Vcc = 100%

3.14 Series Operation

A double output voltage can be obtained, by using two units of this series and connecting the outputs in series. In this case, the maximum output voltage is ±400V. Note that the series operation is allowed only in CV mode.

When the two units include built-in transformers, do not set the output range above 200V/unit, as the output voltage may exceed the withstanding voltage.

The connection for the series operation is shown in Fig. 3-10.

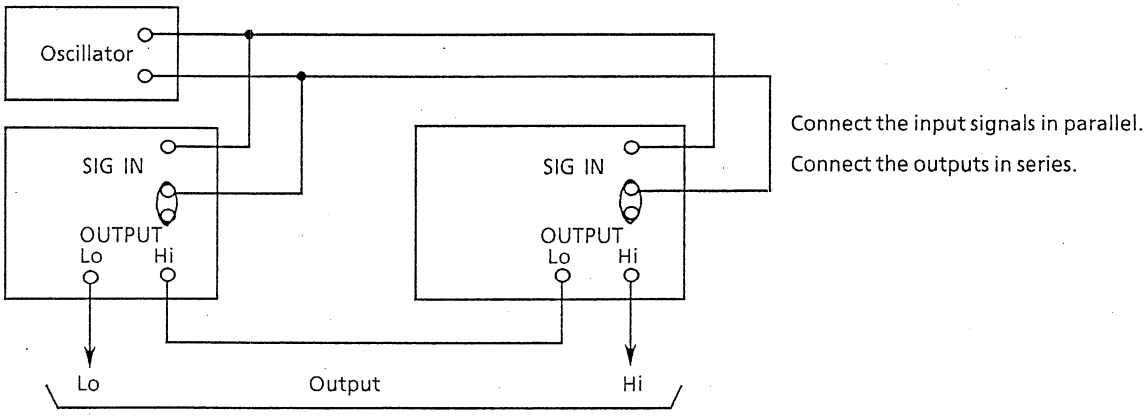
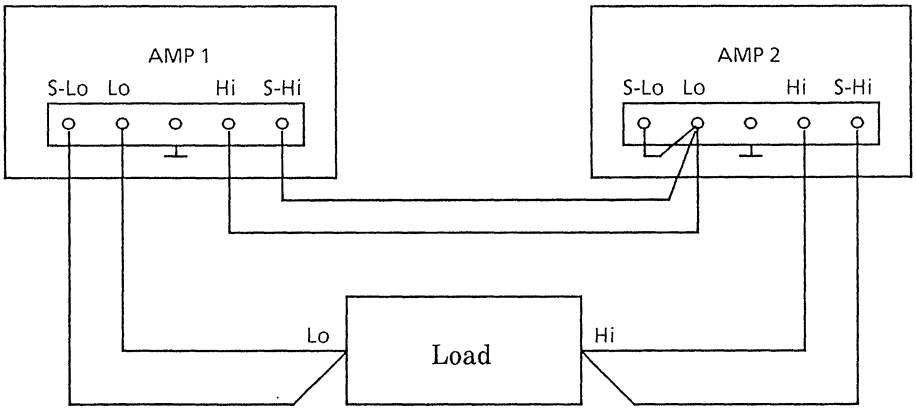


Fig. 3-10 Connection for Series Operation

Fig. 3-11 diagramatically explains how to perform remote sensing in the series operation. For general information on remote sensing, see section 3.8.



S-Lo terminal of AMP1 to Lo terminal of the load,
S-Hi terminal of AMP1 to Lo terminal of AMP2,
S-Lo terminal of AMP2 to Lo terminal of AMP2,
S-Hi terminal of AMP2 to Hi terminal of the load.

Fig. 3-11 Remote Sensing in Series Operation

Note

The series operation is allowed only in the CV mode. When the units include output transformers, do not set the voltage range above 200V/unit.

3.15 Power Enhancement by the 4521A Booster

For the 4520A, the output power can be enhanced by mounting the 4521A dedicated Power Booster.

The 4521A is a booster with an output power of 2kVA. Up to 4 units of the 4521A can be mounted to a single 4520A. With this feature, a power amplifier of 10kVA maximum output power can be realized.

The series operation is possible even when the 4521A is mounted. At this time, the maximum output will be 20kVA.

Note that the 4521A is a booster, and cannot be used alone.

(1) Connection of 4520A and 4521A

Connect the 4520A to 4521A with an attached cable, as shown in Fig. 3-12.

Power is supplied to each individual power input terminal board.

The output is taken out from the output terminal of the 4520A. The maximum output current is 83 Arms, so be careful in choosing the output cable with proper cross sectional area. See Fig. 3-2 of section 3.2 (3).

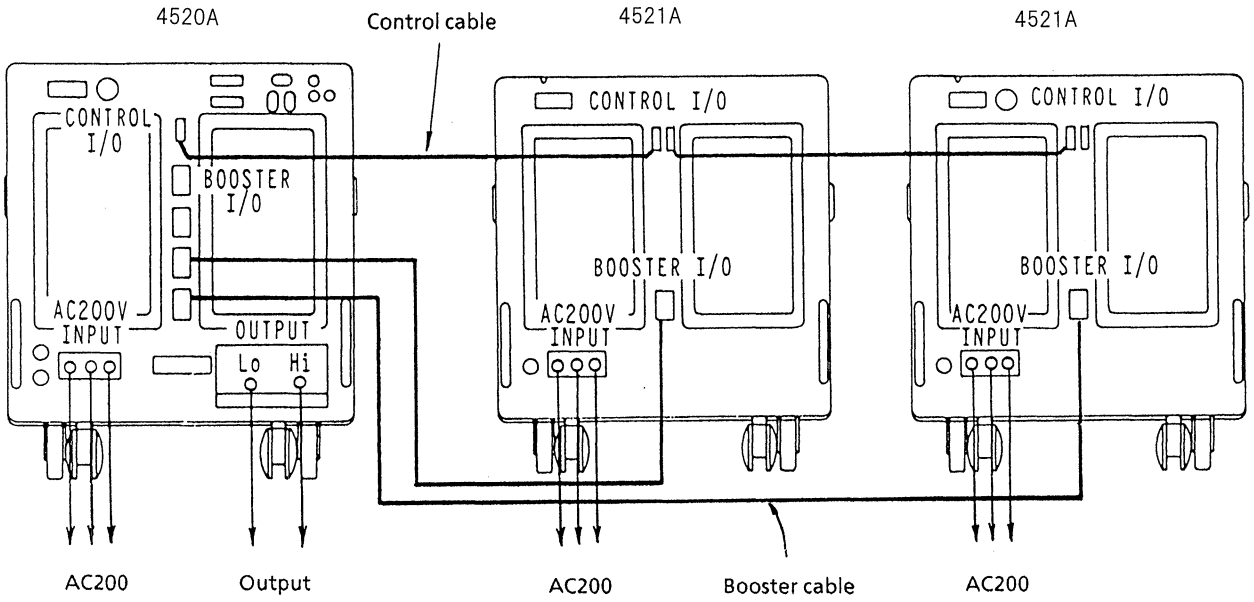


Fig. 3-12 Connection of 4520A and 4521A

(2) Operation

When the POWER switches of the 4521A's are left on, all of the power supplies can be turned on and off via the POWER switch of the 4520A. When the POWER switch of some 4521A is turned off, the output of that 4521A will be disconnected.

So, for a light load, the power consumption can be decreased by turning off the unnecessary 4521A's.

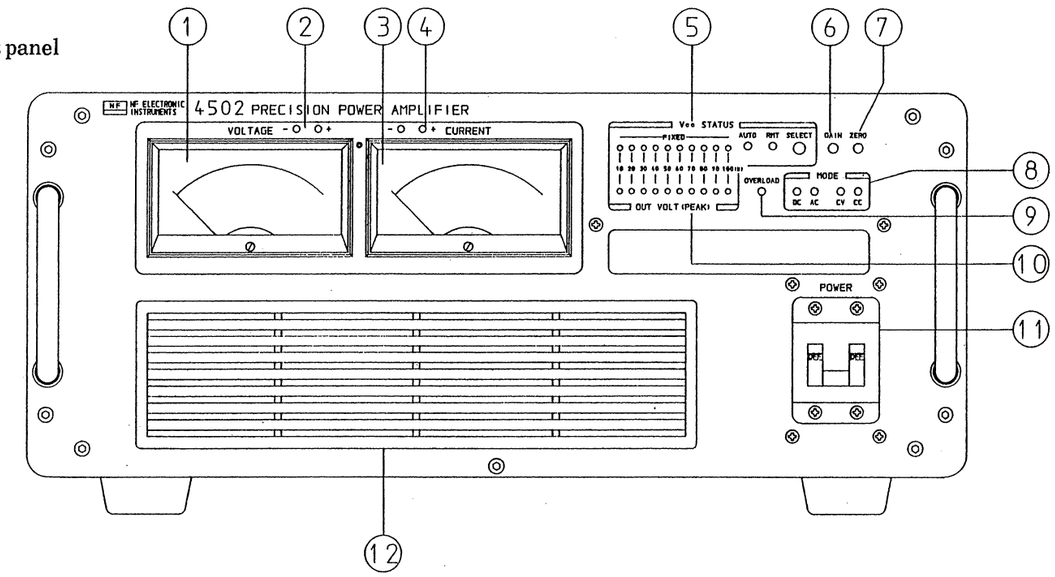
When you turn on and off the power switch of the 4521A, be sure to turn off the power switch of the 4520A first.

The other items of the operation instruction are the same as those for a single unit of the 4520A.

Note

When the 4521A's are used, the frequency range narrows inversely proportional to the increase of the rated output power. The decrease of the frequency band will be apparent in the form of decrease of the maximum output voltage in the high frequency band.

Front panel



Rear panel

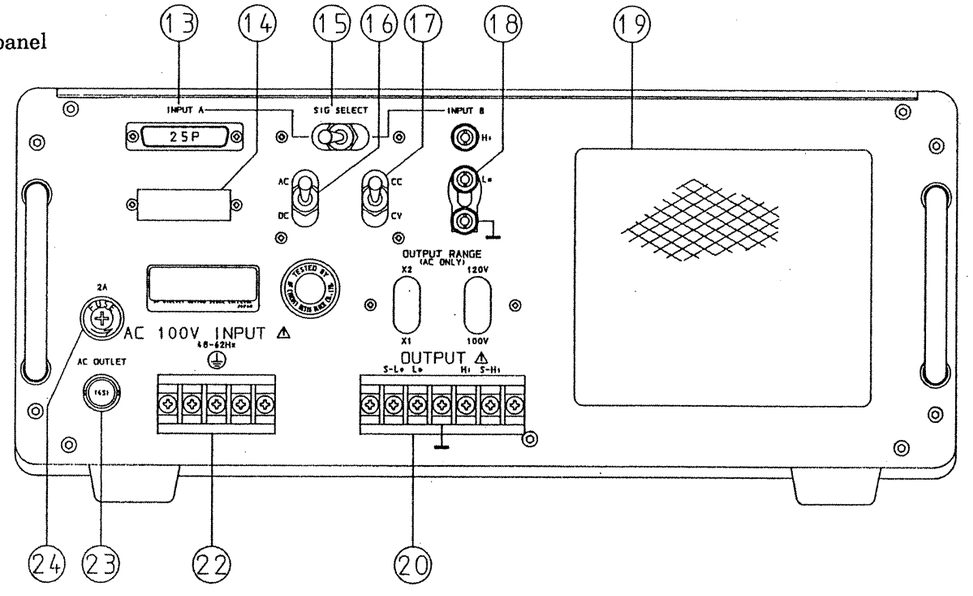
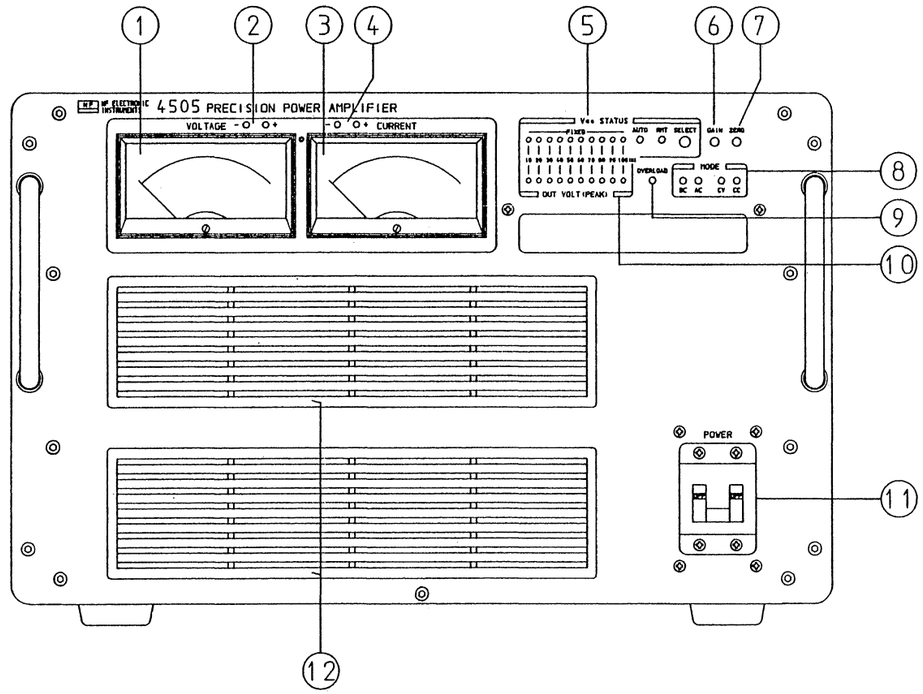


Fig. 3-13 4502 Front/Rear views

Front panel



Rear panel

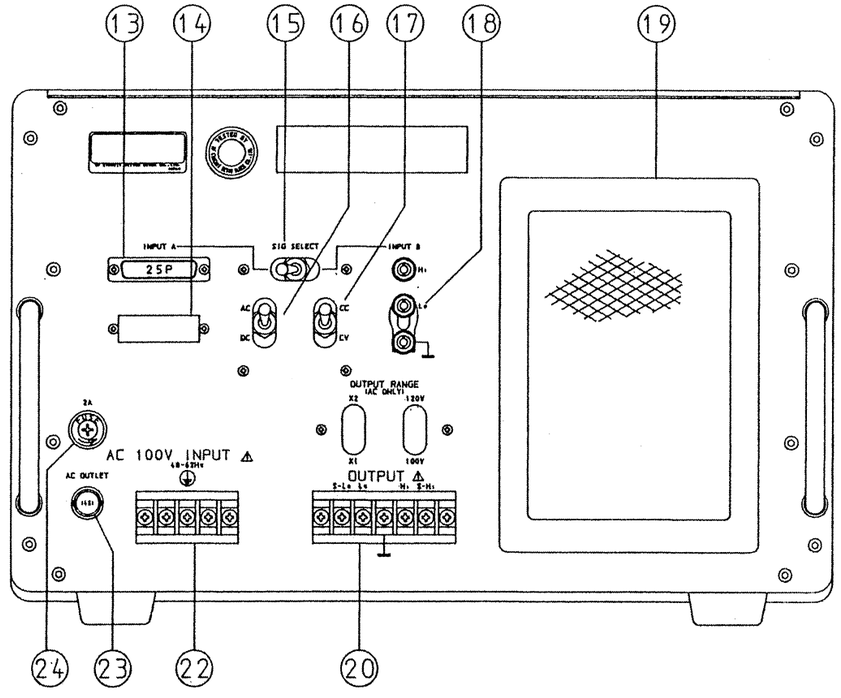
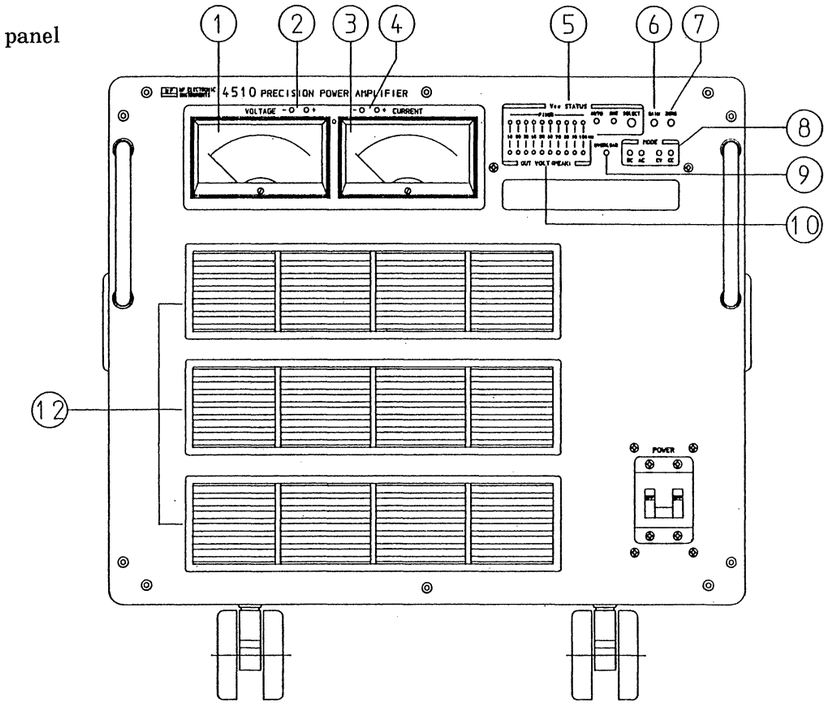


Fig. 3-14 4505 Front /Rear views

Front panel



Rear panel

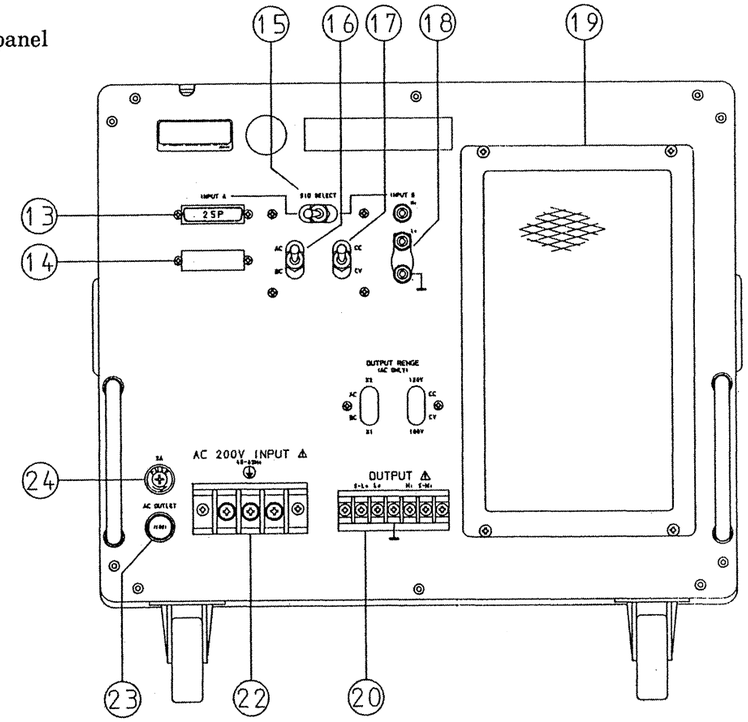
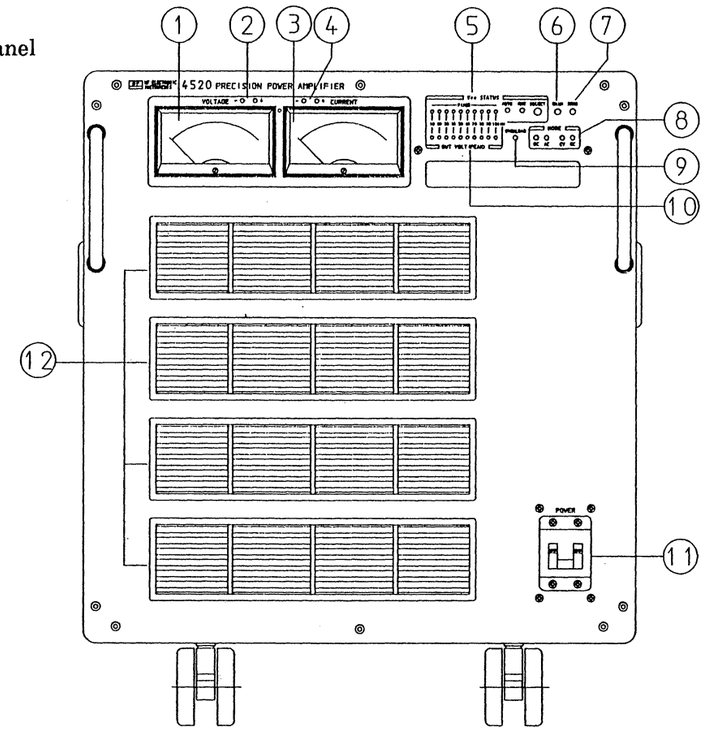


Fig. 3-15 4510 Front /Rear views

Front panel



Rear panel

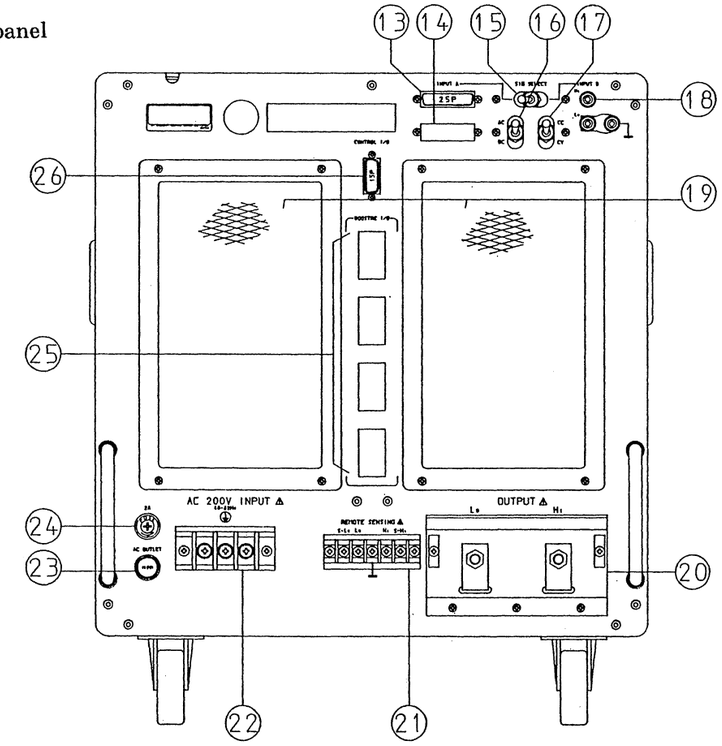
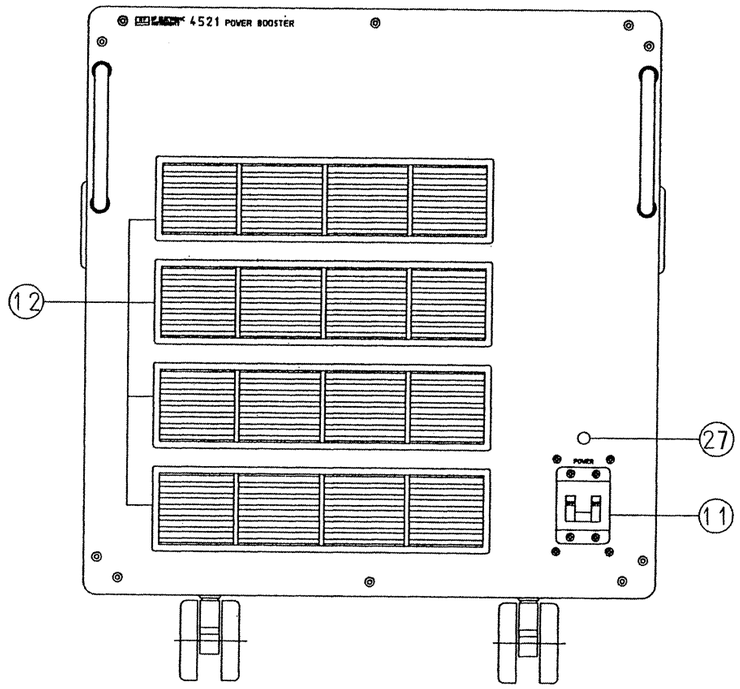


Fig. 3-16 4520A Front/Rear views

Front panel



Rear panel

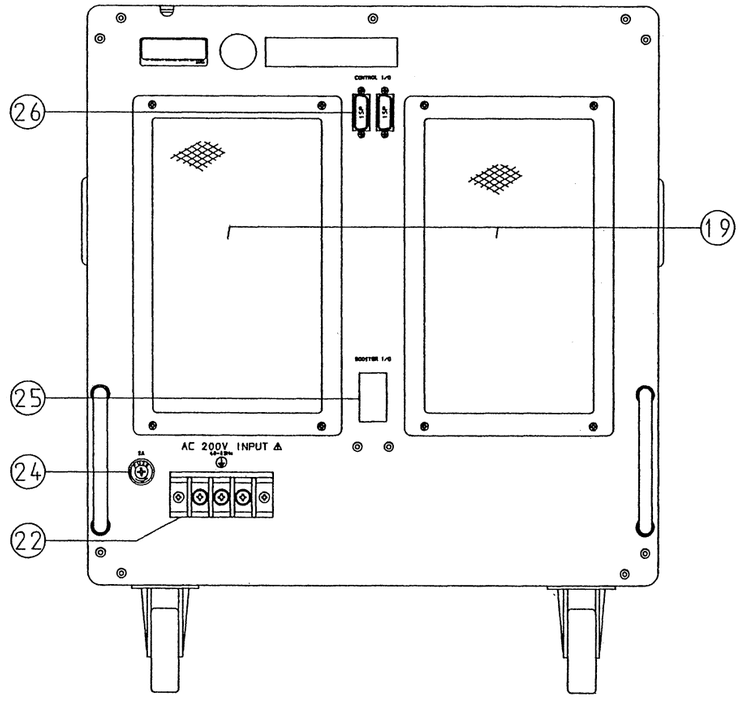


Fig. 3-17 4521A Front/Rear views

4. OPERATING PRINCIPLE

4.1 Introduction

The circuit configuration of this unit is shown in the block diagram of Fig. 4-1. Functionally, this unit can be categorized into :

(1) Isolation amplifier
(2) Power amplifier
(3) Control circuit
(4) DC power supply

4.2 Section by Section Description

(1) Isolation amplifier

Since the output of this unit is of the balanced type, an isolation amplifier is used to isolate the input circuit and the output circuit.

The isolation is based on a modulation / demodulation method using a pulse transformer.

The carrier is pulse-width modulated by the input signal. The modulated signal is isolated by the transformer and then demodulated, to obtain the original input signal waveform.

(2) Power amplifier

The 4500 Series amplify the input signal which is passed through the isolation amplifier, and supplies the amplified signal to the load.

The power amplifier is electrically floating from the chassis to obtain either a balanced or single ended type output.

The power amplifier includes protection circuits for overcurrent, power transistor loss (Pc), ASO, and temperature rise.

(3) Control circuit

The control circuit performs the setting and display of Vcc, amplifier status output, mode display, overload display, and output peak voltage display.

(4) DC power supply

This circuit supplies DC power necessary for the operation of the unit. It supplies $\pm$15V, $\pm$B (power for the voltage amplifier stage), and $\pm$Vcc to each section. In the Vcc controller, the conduction of thyristers is controled to obtain DC voltage necessary for the power transistors.

When Vcc is set to AUTO, it controls the Vcc value in accordance with the output voltage of the power amplifier. When Vcc is set to FIXED, it sets Vcc to a fixed value.

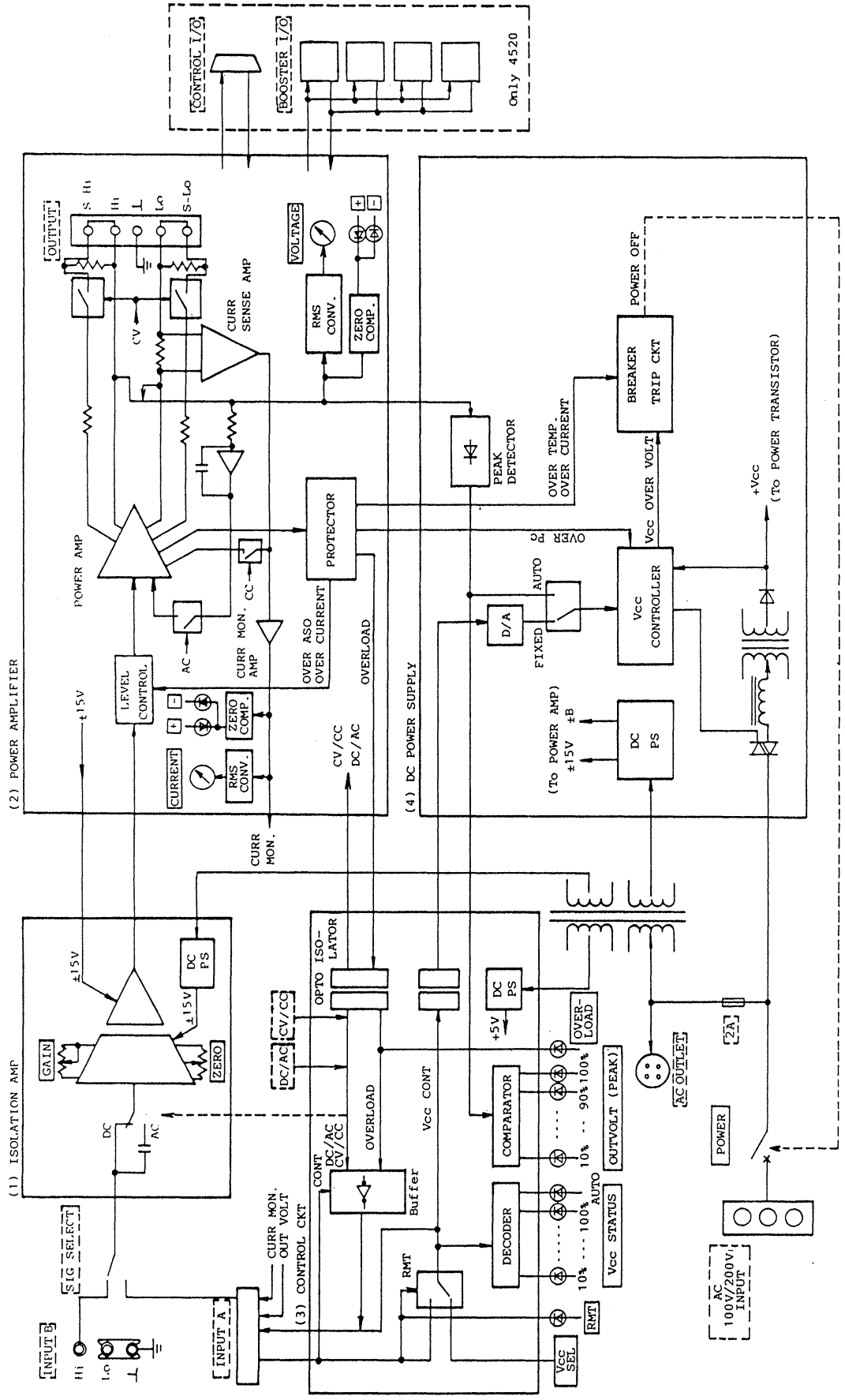


Fig. 4-1 Block Diagram

5. MAINTENANCE

5.1 Introduction

To maintain proper operation over a long period of time, the following maintenance is required.

> **Caution**
>
> The power amplifier circuit, heat sinks for the power transistors, and the internal chassis are electrically floating from the frame. Especially when one of the output lines is connected to the frame, a voltage (due to the output voltage) appears between the frame and these internal parts. Therefore, if you check the internal circuits with the power on, electric shock and other accidents may result.
>
> To prevent hazard, turn off the power switch before any internal check.

a. Operation check
   Check if this unit is operating normally, and if the specifications are satisfied.
b. Adjustment and calibration
   Adjust the specified component if the rated value is exceeded.
c. Troubleshooting
   If abnormality still exists, search for the cause for the trouble or faulty locations.
d. Repair

If abnormality appears be due to some malfunction of the unit, please contact us immediately.

This instruction manual describes only the checks that can be done easily. For calibration and repair, contact us through our representatives.

5.2 Operation Check

This section describes the check method of such an extent that can be made solely through the operation from the front panels and rear panels. Except where otherwise specified, the setting should be as follows :

Power voltage	100 or 200Vrms
Output voltage	120Vrms (in the CV mode)
Output current	Rated current (in the CC mode)
Vcc setting	AUTO
DC/AC setting	AC
Sensing	Local

If this unit includes a built-in output transformer, set the voltage range to 120V. When using a 4520A with the 4521A, turn off the 4521A and first check the operation of the 4520A alone.

(1) No load check (output open in the CV mode, output shorted in the CC mode)

a. DC offset check

In the DC mode, and when the signal input terminals are shorted, confirm that the output voltage (CV mode) or the output current (CC mode) changes from positive to negative and vice versa by turning the ⑦ ZERO adjustor on the panel.

b. Gain check

Input signal 400Hz, 1Vrms

Confirm that the output voltage changes about ±10% with respect to 100Vrms in the CV mode, and about ±10% with respect to the current below in the CC mode.

4502	4505	4510	4520A
1.5Arms	3.0Arms	6.0Arms	12.0Arms

(Output current for input of 1Vrms)

(2) Check with rated resistive load (For the load resistance, use one of as low inductance as possible.)

a. Rated output check

Set the input signal voltage to have the rated output voltage or current (in the CV mode, 120Vrms, in the CC mode, the current given below). Then, change the frequency from 45Hz to 20kHz, and confirm that the overload lamp does not light.

	4502	4505	4510	4520A
Rated output current	2.1Arms	4.2Arms	8.3Arms	16.7Arms

b. Output voltage/current frequency characteristics check

First set the input signal to 400Hz and 1.2Vrms.

Then change the frequency from 45Hz to 20kHz while keeping the input voltage constant. Confirm that the variation in the output voltage (CV mode), or the output current (CC mode) is within the ranges below.

45Hz to 5kHz +0.2 to −0.5dB

5kHz to 20kHz +0 to −3dB

c. Load regulation check

Set the input signal to the 1.2Vrms and set the unit to DC mode, and confirm that the variation in the output voltage (CV mode) or current (CC mode) when the load is turned on and off, fall within the the following ranges. The output voltage is measured at the output terminals (Lo and Hi) on the rear panel.

CV mode	45Hz to 1kHz	±0.1%
	1kHz to 20kHz	±2%
CC mode	45Hz to 1kHz	±2%
	1kHz to 20kHz	±20%

d. Distortion factor check

In the DC mode, set the input signal voltage to obtain an output voltage of 120Vrms. Change the frequency from 10Hz to 20kHz, and check that the distortion factor of the output voltage waveform is within the figures given below.

CV mode	10Hz to 1kHz	0.05%
	10kHz	1%
	20kHz	2.5%
CC mode	10Hz to 1kHz	0.5%
	20kHz	2.5%

e. Check of the 4521A

The check when using the 4521A, is the same as that in items "a" through "d" above. However, the decision criteria should comply with section 1.3.6 "Specifications when the 4521A booster is additionally used".

WARRANTY

NF CORPORATION certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory.

ALL ***NF*** products are warranted against defects in materials and workmanship. Obligations under this warranty are limited to replacing, or repairing of any instrument returned to our factory for that purpose within one year of delivery to the original purchaser. No other warranty is expressed or implied. ***NF*** does not assume liability for installation or for incidental or consequential damages.

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4500 SERIES INSTRUCTION MANUAL

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