



For your reference:

Please note that this product is no longer available and is provided as a reference technical document.

HIGH SPEED BIPOLAR AMPLIFIER

HSA4101

OPERATION MANUAL

D : 509648

HSA4101
HIGH SPEED BIPOLAR AMPLIFIER
Operation Manual



NF ELECTRONIC INSTRUMENTS

Foreword

Thank you very much for procuring HSA4101 HIGH SPEED BIPOLAR POWER AMPLIFIER. At the outset, please take a few minutes to read the Safety Precautions indicated in this manual in order to use HSA4101 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.

- **Manual composition**

Please read Section 1 before using the equipment for the first time.

Section 1 Overview

Describes an outline, features, applications, functions and an outline of the principle of operation.

Section 2 Preparation

Required preparatory work before installing and operating the equipment. Be sure to read this section.

Section 3 Description of Panel and Basic Operations

Describes the functions, operations and basic operations of the dials on the panel. Read while operating the equipment.

Section 4 Applications

Expanded operations are described.

Section 5 Maintenance

Describes the methods of storage, repacking, transportation and corrective measures when abnormalities occur.

Section 6 Specifications

Equipment specifications (functions and performance) are described.

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.

HSA4101 belongs to Class I of insulation ratings by IEC standards (equipped with a protective grounding terminal).

- **Observe text instructions**

This manual has been compiled in order to enable safe operation and use of HSA4101. 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 ground**

This product uses a line filter. Failing to ground the product can result in electric shock.

To prevent electric shock, securely connect the equipment to a ground.

Be sure to properly connect the ground. By connecting the 3 conductor power cable to a grounded 3-terminal wall socket, HSA4101 is automatically grounded.

- **Confirm power source voltage**

The HSA4101 operates at a supply voltage described in "2.4 Power Supply and Grounding".

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

- **Observe the fuse rating**

Danger of fire, etc. Use the rated fuse specified in "2.4 Power Supply and Grounding."

When replacing the fuse, be sure to pull out the power cord from the receptacle.

- **Whenever you feel any abnormality, stop operating the equipment**

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.

- **Flammable gas**

Do not use this equipment in an inflammable gas. There is danger of fire and explosion.

- **Do not remove covers**

HSA4101 contains dangerously high voltages. Do not remove external covers.

No persons other than trained service technicians who are familiar with danger prevention should perform inspection of the interior of the HSA4101.

- **Do not modify**

Do not replace or modify the HSA4101 in a way other than that specified by NF Electronic Instruments under any circumstances.

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

- **Prevention of electric shock by output voltage of HSA4101**

The maximum output of the HSA4101 is 50 Vrms (± 71 V)/1 Arms. Be careful to avoid electric shock.

Directly touching the output or changing the cord connection while the output is ON may cause electric shock.

- **Caution on use of high frequency signal**



Note that use of devices producing electromagnetic waves in a radio frequency band is restricted by laws and regulations in some countries.

- **Safety related symbols and indications**

Following are general definitions of the symbols and indications used in the text and on HSA4101.



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 symbol

Appears in the text and on the product to advise risk of fatal or otherwise serious physical injury.



Cautionary symbol

Appears in the text and on the product to advise risk of damage to the product.

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1. Overview

1.1 Overview

The "HSA4101 HIGH SPEED BIPOLAR POWER AMPLIFIER" is a high-speed, wideband power amplifier with a frequency ranging from DC to 10 MHz and maximum output of 50 VA.

The frequency characteristic is almost flat in the range of DC to 10 MHz with little overshoot or sag of step response waveforms. Its ability to amplify from a direct current allows not only waveforms asymmetric between positive and negative polarities but also waveforms with a direct current superimposed to be transmitted correctly.

Implementing balanced output using two HSA4101s makes it possible to configure a high-speed, wideband power amplifier with a maximum output voltage of 300 Vp-p and maximum output of 100 VA.

The "HSA4000" series high-speed power amplifier/bipolar power supplies are available in the following models including the HSA4101:

HSA4101	DC to 10 MHz	50 Vrms	1 Arms	50 VA
HSA4011	DC to 1 MHz	50 Vrms	1 Arms	50 VA
HSA4012	DC to 1 MHz	50 Vrms	2 Arms	100 VA
HSA4014	DC to 1 MHz	50 Vrms	4 Arms	200 VA
HSA4051	DC to 500 kHz	100 Vrms	1 Arms	100 VA
HSA4052	DC to 500 kHz	100 Vrms	2 Arms	200 VA

1.2 Features

Ultra-wideband, high speed and high output

DC to 10 MHz

The ability to pass even a DC allows not only positive/negative asymmetric waveforms but also waveforms with a DC superimposed to be transmitted correctly.

±71 VDC

50 V_{rms} (40 Hz to 100 kHz)

46 V_{rms} (100 kHz to 1 MHz)

35 V_{rms} (1 MHz to 10 MHz)

5000 V/μs through rate

Optimal waveform response

Low output impedance

1.5Ω + 0.5μH typ

Little waveform distortion or harmonic spurious

Distortion rate at frequency 1 kHz is 0.1%, harmonic spurious with respect to 10 MHz fundamental is -25 dBc.

DC bias

Can be arbitrarily set in the range of ±70 V.

Phase between input and output

Allows in-phase/inverse phase setting.

AC mode

Provides AC mode that reduces the DC component to zero when connecting load, such as inductance and transformer, whose DC voltage should be removed.

Connection of high balanced output

Use of two units with balanced output allows a configuration of a wide band power amplifier of a maximum output voltage of 280 V_{p-p} and maximum power of 100 VA with floating 100Ω load.

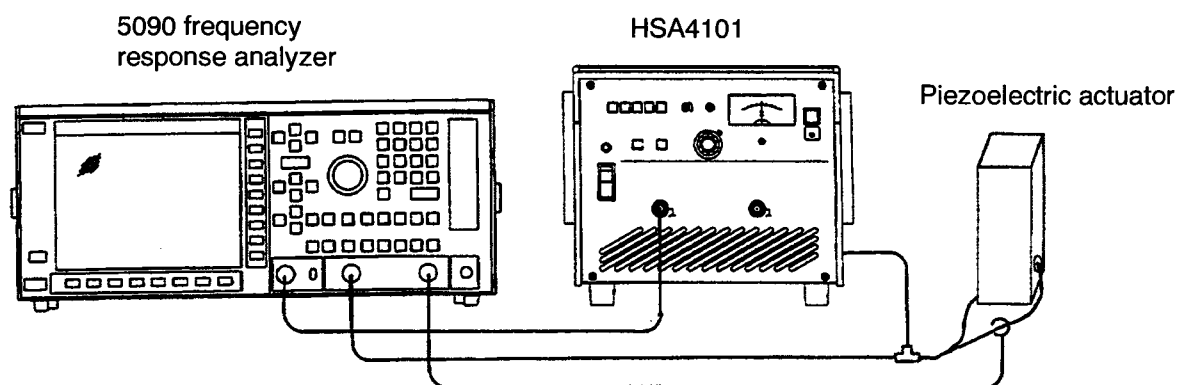
With protective circuit and overload display

The HSA4101 incorporates an auto-recovery type output current restriction type protective circuit that protects the output stage when it is overloaded.

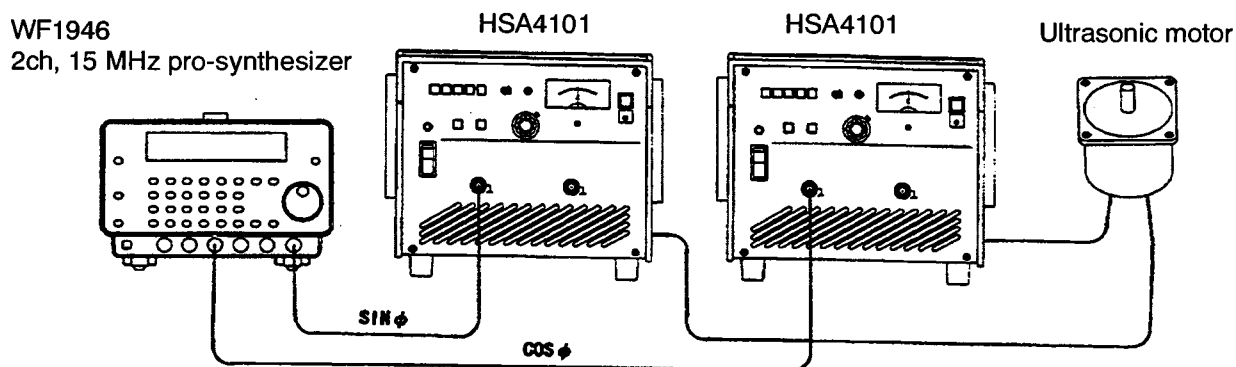
With output voltage monitor connector

1.3 Applications

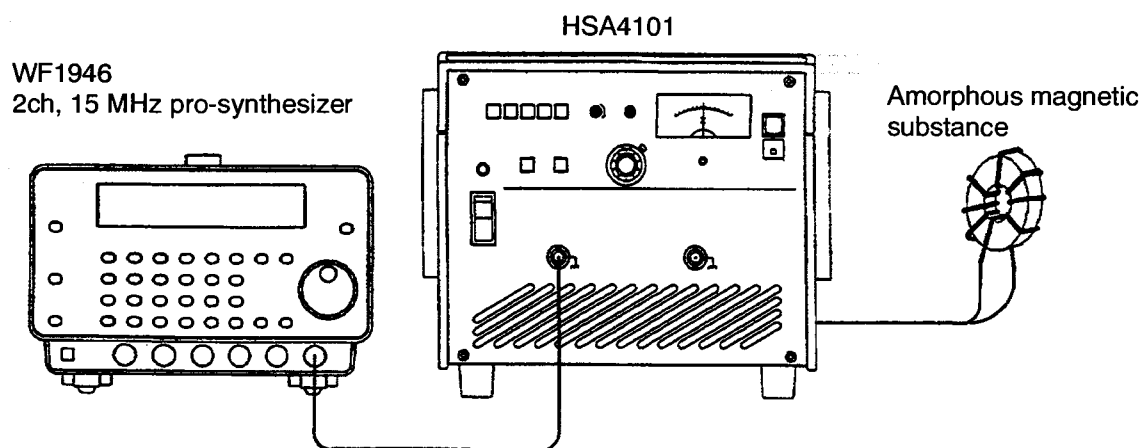
Piezoelectric actuator drive



Ultrasonic motor drive

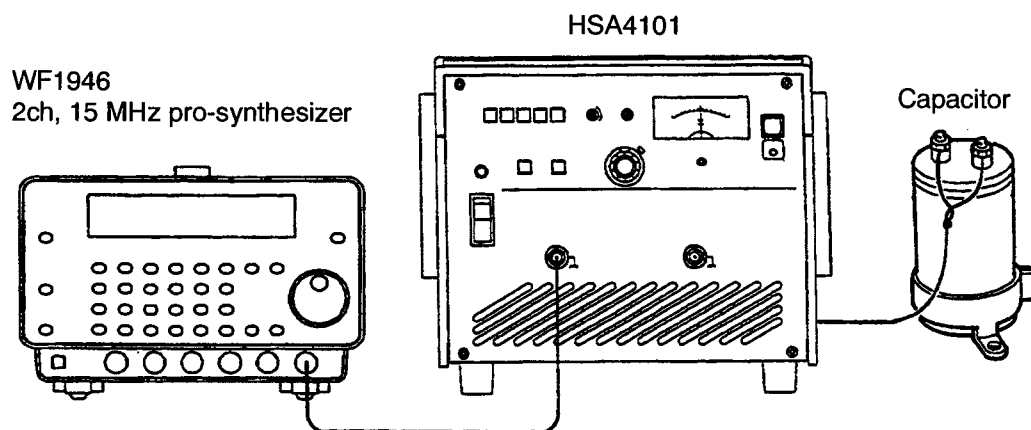


Amorphous magnetic substance test



1.4 Function List

Capacitor ripple test



1.4 Function List

The HSA4101 has the following main functions:

Output: ON/OFF switching

Input: Input gain switching: Fixed $\times 10$, $\times 20$, $\times 50$, $\times 100$
Continuously variable $\times 0.4$ to $\times 1$

Input coupling: DC/AC switching

Polarity switching: In-phase/inverse phase

Bias addition: ON/OFF setting
Continuously variable: ± 70 V, 10 turns

Offset fine adjustment: Continuously variable: ± 1 V or more (DC mode)
 ± 10 mV or more (AC mode)

Display: Output meter: DC bias monitor: FS: 75 V

Overload lamp

1.5 Principle of Operation

The HSA4101 consists of a preamp, power amp and DC power supply.

"Figure 1-1 Block Diagram" shows a block diagram of the HSA4101.

The preamp consists of an attenuator and wideband operational amplifier and has functions like gain setting, DC bias addition and phase switching, etc.

Since DC bias addition is performed after gain setting, it does not depend on the gain (but influences phase switching).

The power amp is a wideband power amplifier using a high-speed bipolar transistor in the output stage and has a power gain of approximately 50 times. This output stage is protected from overload by the current restriction type protective circuit.

Voltage addition for offset adjustment is performed by the preamp section in DC mode, and by the power amp section in AC mode, and is added to a high precision correction circuit to control the DC component of the output voltage to zero and adjusted.

In AC mode, the DC bias addition voltage is separated from the preamp and in this way enhances the DC stability.

For the DC power supply, a high efficiency, low noise type switching regulator circuit is used, which supplies necessary power to the preamp section and power amp section, etc.

The HSA4101 is internally subjected to forcible air-cooling by a small fan and whenever an internal temperature rise due to drop in the rotation speed or stop is detected, the power switch is turned to protect the system.

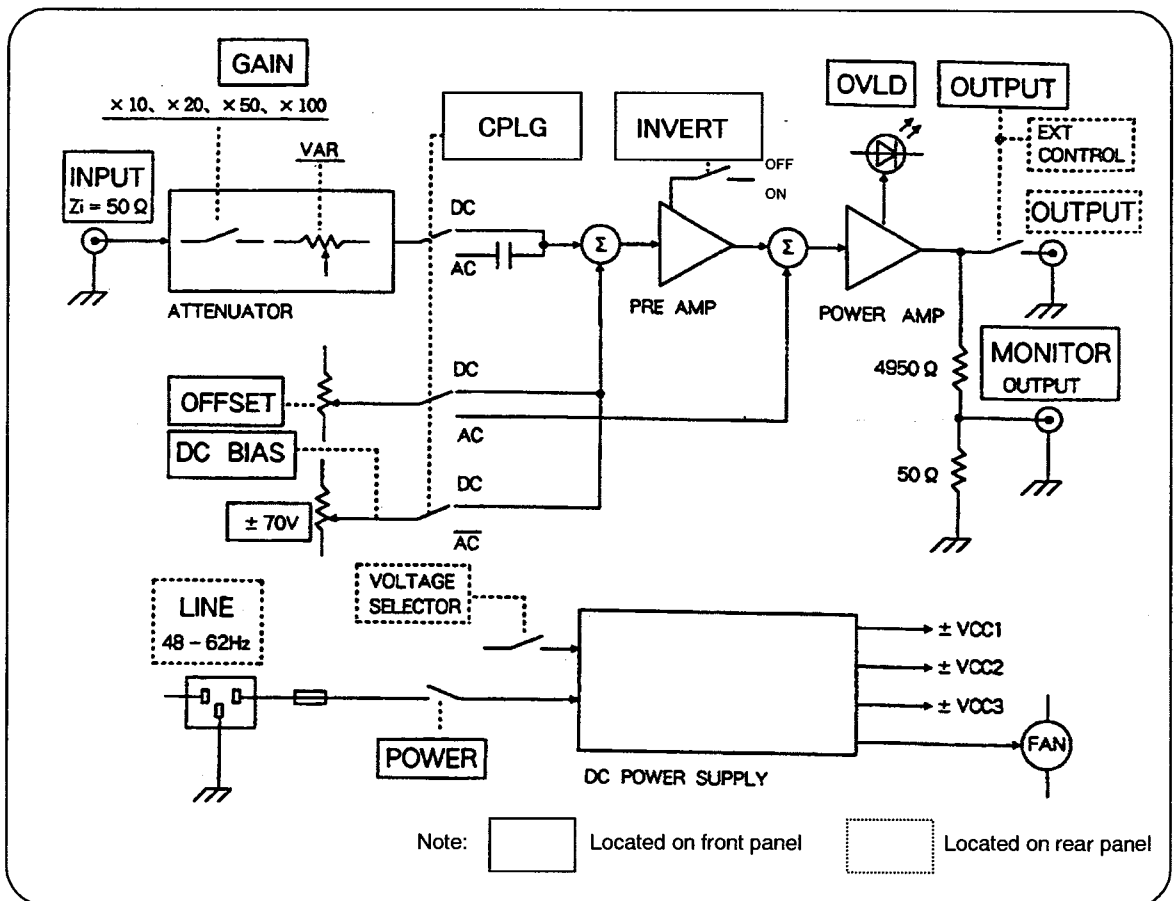


Figure 1-1 Block Diagram

2. Preparation

Before using the HSA4101, please read "Safety Precautions" again.

2.1 Appearance and Accessory Check

1. If there is any abnormality (damage or dent, etc.) in appearance of the cardboard box, immediately contact us or our sales agency.
2. Take the HSA4101 and accessories, etc. out of the cardboard box and check them. If any accessory is missing, contact us or our sales agency.
 - HSA4101 appearance check
Make sure there is no damage or dent on the panel surface, knobs and connectors, etc.
 - HSA4101 accessory check
Check that all accessories described in "Table 2-1 Configuration Table" are included.

2.2 Configuration

The HSA4101 has the following configuration. Check the number of pieces of each accessory.

Table 2-1 Configuration Table

HSA4101, main unit.....	1
Operation Manual.....	1
Accessories	
Power cord	1
Time lag fuse ($\phi 5.2 \times 20$ mm) 5 A	2
Fuse ($\phi 5.2 \times 20$ mm) 10 A.....	2
(One is incorporated in inlet)	
Signal cord (BNC - BNC 1 m).....	2

2.3 Assembly and Installation

Installation location

Do not place the HSA4101 on its back or side on the floor or a desk.
Place the HSA4101 in such a way that the four rubber legs at the bottom are supported on a level surface such as a desk.

Rack mount

The HSA4101 can be mounted on a standard millimeter or inch rack using auxiliary brackets.
Contact our sales representative specifying either millimeter or inch.

 **CAUTION**

For rack mount

- Use a rack mount with an effective mounting depth of 70 cm or more.
- Be sure to use a rail or shelf to support the HSA4101 so that it can resist shock and vibration.
- Provide upper and lower spaces of 5 cm or more to prevent an air flow from being blocked for the purpose of cooling inside the HSA4101. Furthermore, keep a space behind the rack, 30 cm or more apart from the wall to avoid convection of the exhaust air from the rear panel in the rack.

Installation condition

- The HSA4101 performs forced air cooling using a fan. Keep the front, back and side where the air inlet and outlet are located away from the wall at least 30 cm to secure air circulation.

The allowable ranges of temperature and humidity are as follows:

During operation 0 to +40°C 20 to 90% RH

During storage -20 to +50°C 10 to 80% RH

However, keep the HSA4101 in an environment without condensation.

- Do not install HSA4101 in the following places:
 - Place exposed to inflammable gas
Danger of explosion. Do not install or use the HSA4101 in such a place under any circumstances.
 - Outdoors or place exposed to direct sun light or near fire or heat source
Can cause the HSA4101 to fail to satisfy performance or malfunction.
 - Place exposed to corrosive gas, water, dust, dirt or humid place
Can cause the HSA4101 to corrode or malfunction.
 - Place near electromagnetic field source or high-voltage equipment or power line
Can cause misoperation.
 - Place subject to vibration
Can cause misoperation or malfunction.

2.4 Power Supply and Grounding

The HSA4101 has the following power supply conditions:

Supply voltage:	100/115 V range	85 to 138 VAC	single-phase
	200/230 V range	170 to 250 VAC	single-phase
Frequency range:	48 to 62 Hz		
Power consumption:	700 VA (400 W) or less		

Connect the power cable according to the following procedure:

1. Turn off the power switch of the HSA4101.
2. Insert the provided power cord into the inlet on the back of the HSA4101.
3. Insert the power cord plug into the 3-pole power receptacle.

Observe the power fuse rating

 **WARNING**

Danger of fire. When replacing the fuse, use one with the same rating.

The 100/115 V range fuses of the HSA4101 are 10 A/250 V $\phi 5.2 \times 20$ mm.

The 200/230 V range fuses are 5 A/250 V time-lag type $\phi 5.2 \times 20$ mm.

When replacing the fuse, be sure to remove the power cord from the receptacle.

The rated current of the HSA4101 fuse is 10 A for a supply voltage of 100/115 V and 5 A for a supply voltage of 200/230 V.

The HSA4101 is provided with a supply voltage changeover switch on the rear panel. Set the switch according to the supply voltage used.

! WARNING

Wrong setting using the supply voltage changeover switch can damage the system. Pay attention to the following points:

- Be sure to turn off the power switch and remove the power cable before changing the switch setting.
- Be sure to set the supply voltage according to the actual power supply used.
- Supplying a voltage outside the range or changing the setting while power is on can cause the HSA4101 to malfunction. Never do so under any circumstances.
- Once the setting has been changed, be sure to use the fuse that matches the set supply voltage.
- Once the setting has been changed, be sure to use the specified power cord. The accessory power cord is for a supply voltage of 100/115 V. To use it for a supply voltage of 200/230 V, consult us or our sales agency.

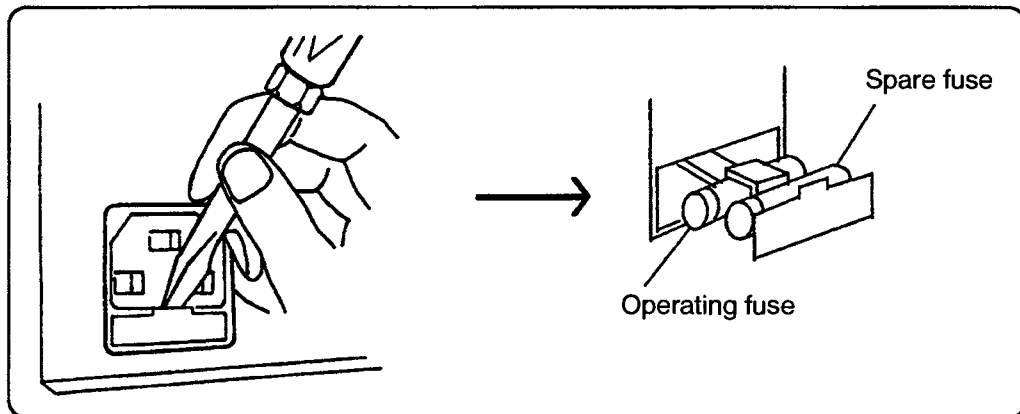


Figure 2-1 Replacement of Fuse

Be sure to ground

! WARNING

The HSA4101 uses a line filter. Failing to ground it can cause electric shock. To avoid electric shock, make sure to ground the HSA4101 for safety.

Be sure to properly connect the ground. By connecting the 3 conductor power cable to a grounded 3-terminal wall socket, HSA4101 is automatically grounded.

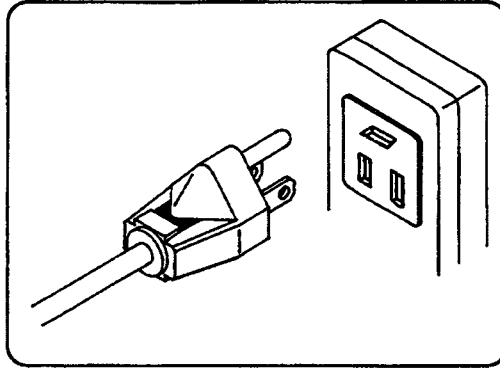


Figure 2-2 Connection of Power Supply

2.5 Simple Operation Check

This section describes a simple receiving check when you purchase the product and an operation check after storage for an extended period of time.

 **WARNING**

Do not remove the outer cover of the HSA4101.

No persons other than trained service technicians who are familiar with danger should check the interior of the product.

Connection

According to "Figure 2-3 Standard Connection Diagram", connect a signal generator, voltmeter and oscilloscope.

Panel setting

Set the panel knob and push button as follows:

Input coupling: DC; gain setting: $\times 100$ CAL; bias: OFF; dial: 5.00; polarity: in-phase; supply voltage changeover: 100/115 V

Operation

1. Turn on the power. After the overload lamp turns on transiently, the power lamp turns on, the output ON lamp turns off and the overload lamp turns off. Check that the level meter points to 0 V.
2. Use a sine wave, at frequency 1 kHz for the signal generator, gradually increase the output level from 0 V and set the input level of the HSA4101 to 0.5 Vrms. Check that the monitor output (front panel) changes from 0 V to 0.5 Vrms at input A.
3. Press the output ON switch and check with an oscilloscope or voltmeter that a sine wave of approximately 50 Vrms is output from the output connector (on the rear panel). At this time, check that no distortion such as clip is generated on a waveform.
4. Check that when the gain range is set to $\times 50$, $\times 20$ and $\times 10$, the output level becomes 25 V, 10 V and 5 V, respectively.
5. Set the level of the oscillator to 0 V, turn on the bias and adjust the bias dial, then check the reading of the output level meter and output voltage.

Dial setting	0.00	2.00	5.00	8.00	10.00
Output	-70 V	-42 V	0 V	+42 V	+70 V
Reading of meter	-70 V	-42 V	0 V	+42 V	+70 V

Necessary measurement instruments

The following measurement instruments are necessary for an operation check:

Signal generator: Frequency/1 kHz; waveform/sine wave; output voltage/0.5 V or more; manufactured by NF CORPORATION, WF1946, 2ch 15 MHz pro-synthesizer, etc.

Oscilloscope: Frequency band/100 MHz or more, 100 V or more using a 10:1 probe

Voltmeter: AC and DC voltage measurement/range of 100 V or more

Since a load test is not performed, no load (terminator) resistor is required.

⚠ WARNING

When smoke is produced from the equipment or you feel abnormal smell or abnormal sound, immediately unplug the power cord from the receptacle and do not use the product until it is completely repaired.

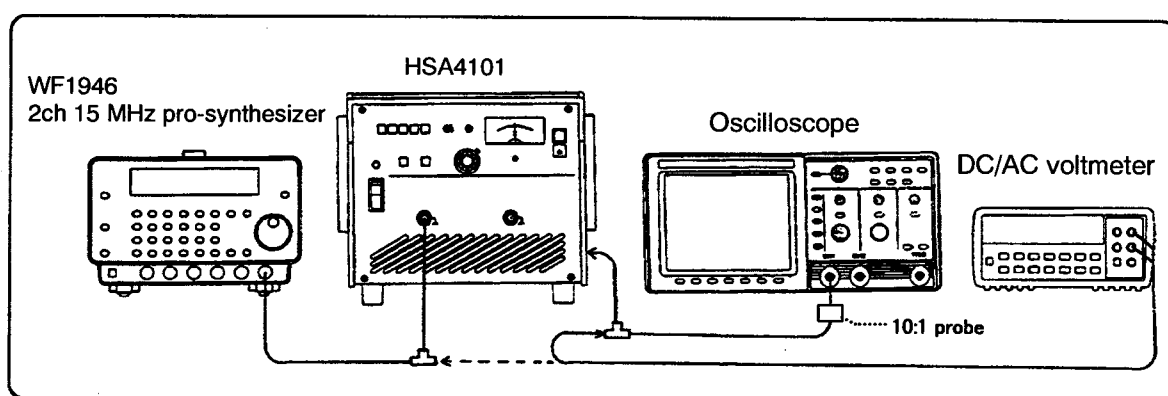


Figure 2-3 Standard Connection Diagram

2.6 Calibration

Perform "5.4 Performance Test" on the HSA4101 at least once a year. If the HSA4101 is used frequently and/or under a severe operating environment, it is necessary to perform the test more frequently.

Moreover, when conducting an important measurement or when the product is used for testing, it is recommended to carry out a performance test immediately before use. Performance tests should be conducted by persons who have general knowledge of measuring instruments.

3. Description of Panel and Basic Operations

3.1 Names and Operations of Panel Components

Front panel

Power display lamp

This lamp turns ON when the HSA4101 is operating.

Power switch

Turns ON power. Power is automatically turned "OFF" in the event of an internal temperature rise or power error.

Input signal changeover switch

Switches between AC and DC modes.

Gain switch/fine adjuster

Variable from $\times 4$ to $\times 100$ by changing gain combinations

BIAS switch dial

When ON, allows a bias voltage of DC voltage ± 70 V to be added.

Offset fine adjuster

Can adjust a DC offset of output to 0 V.

Output meter (DC bias monitor)

Displays a bias addition voltage.

Output ON/OFF

Turns ON/OFF output.

A lamp turns ON when output is ON.

Overload lamp

This lamp turns ON when the HSA4101 is overloaded and output current is restricted.

Input connector

Signal input connectors

Monitor output

Outputs a voltage of 1/100 of main output.

Polarity changeover switch

Sets the phase to in-phase (no inversion) or inverse phase (inversion).

Rear panel

Main output connector

This is the main output of the HSA4101. Produces a maximum of 50 Vrms, ± 71 Vdc.

Power input fuse

Has a dual function as an inlet and fuse holder.

Use a fuse of a specified value.

Supply voltage switching

Can set the supply voltage range to 100/115 V or 200/230 V.

External control input

Can switch the output of the HSA4101 between ON/OFF by an external device or contact.

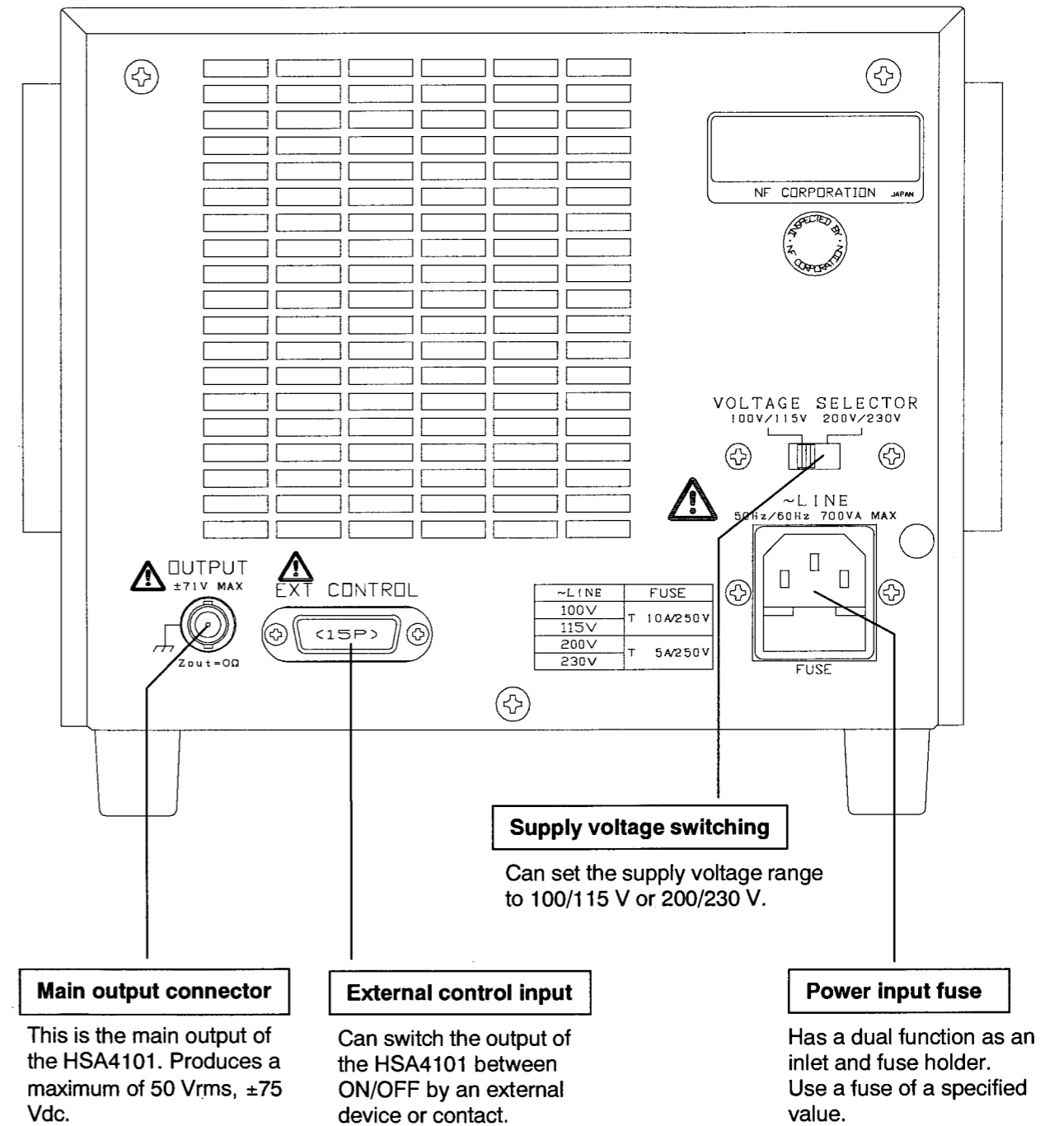
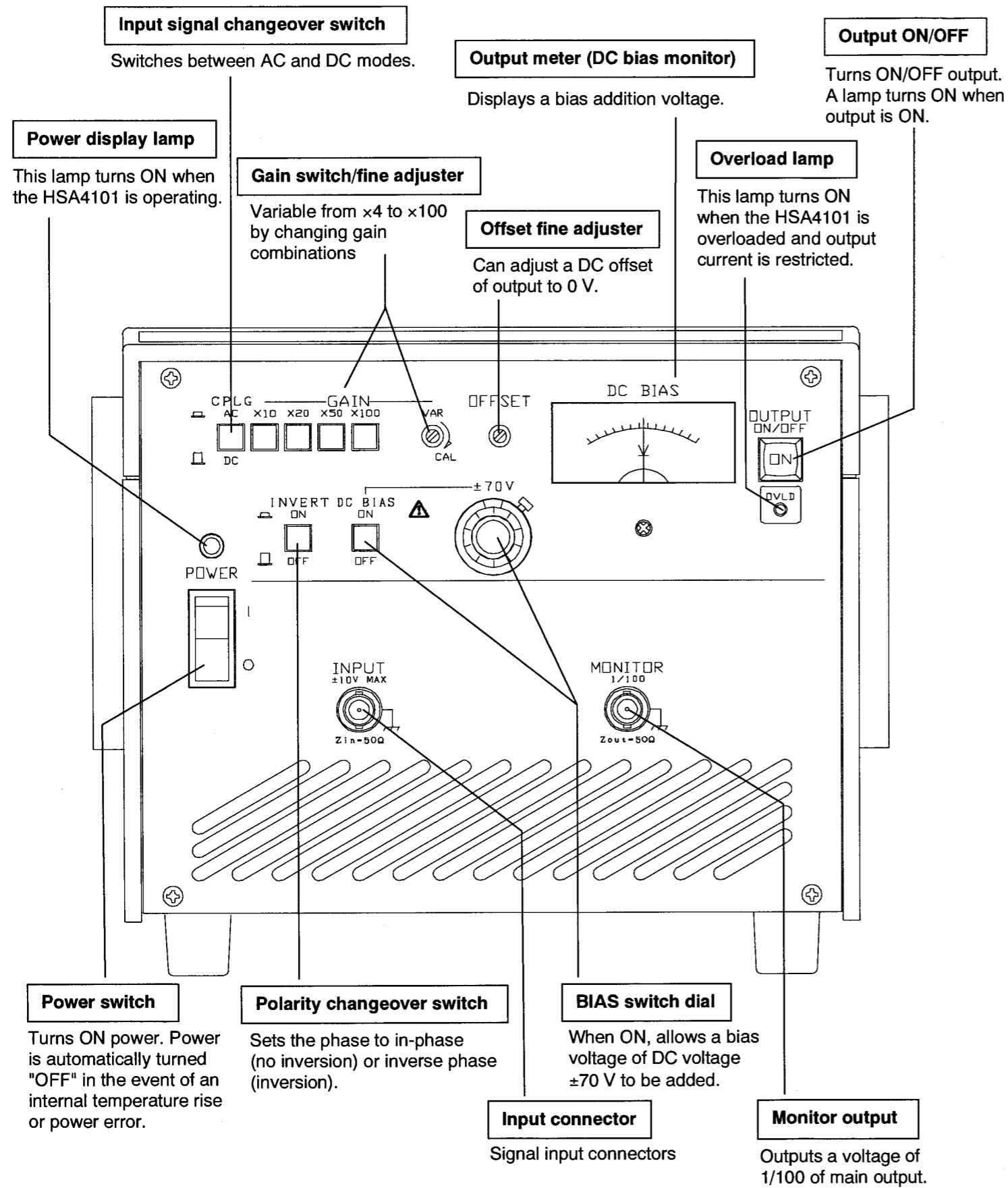


Figure 3-1 Front/Rear View of Panel

3.2 Display on Power Up and Initial Setting

3.2 Display on Power Up and Initial Setting

When power is turned on for the first time, perform the following initial setting:

Input coupling: DC; gain: $\times 20$ CAL; bias: OFF; dial: 5.00; polarity: in-phase

When power is turned ON, the power lamp turns ON, output ON lamp turns OFF, overload lamp turns OFF and the output meter indicates (DC bias monitor) 0 V.

3.3 Input/Output Terminals

Input BNC connector

This is a signal input connector.

Input connector: BNC-R (front)

Input impedance: Select 600Ω or 50Ω

Maximum allowable voltage: ± 10 V

 **CAUTION**

Applying a voltage of a maximum allowable input ± 10 V or more may damage the product. Be careful not to exceed the allowable input voltage range.

Main output

Output BNC connector. To use this output with a high frequency of 100 kHz or more, use a provided BNC cord as the signal cord connected up to the load.

 **CAUTION**

If a single vinyl wire, etc. is used as the cord to connect the load, inductance of the wire material is approximately $1\mu\text{H}/1\text{m}$ and impedance at 1 MHz is approximately 6Ω . If a low-impedance load is used, pay special attention to the wiring length.

Output connector: BNC-R (rear)

Maximum output voltage

± 71 V	DC to 40 Hz	Load resistance 71Ω
Sine wave 50 Vrms	40 Hz to 100 kHz	Load resistance 50Ω
Sine wave 46 Vrms	100 kHz to 1 MHz	Load resistance 50Ω
Sine wave 35 Vrms	1 MHz to 10 MHz	Load resistance 50Ω
Sine wave 17 Vrms	10 MHz to 20 MHz	Load resistance 50Ω

Maximum output current

± 1.0 A	DC to 40 Hz	Load of resistance (non-inductive)
± 1.4 A	40 Hz to 100 kHz	Load of resistance (non-inductive)
± 1.3 A	100 kHz to 1 MHz	Load of resistance (non-inductive)
± 1.0 A	1 MHz to 10 MHz	Load of resistance (non-inductive)

Output impedance: $1.5\Omega + 0.5\mu\text{H typ}$

! WARNING

The maximum voltage of the HSA4101 is ± 71 V or more. Touching the HOT side of the output may cause electric shock. Observe the following precautions for safe use:

- Turn OFF power when conducting wiring.
- When power is ON, do not touch the HOT side of the output. Do not touch it when your body is wet in particular.

Monitor output

The HSA4101 is provided with a monitor output connector to observe the output voltage and allows you to observe an output waveform by directly connecting an oscilloscope to it. Monitor output is also output when the output is OFF. A voltage equivalent to 1/100 of the main output is output.

Output connector: BNC-R (front)

Output voltage: 1/100 of main output (in-phase with respect to input)

Output impedance: 50Ω

! CAUTION

The monitor output is derived from the main output by dividing it through resistors. Thus, note that it may include a certain error caused by input impedance of devices connected.

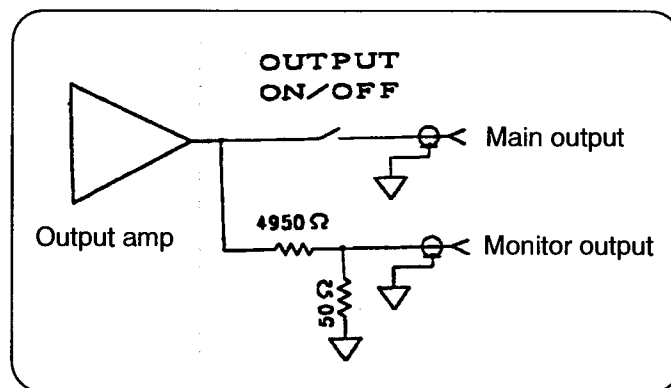


Figure 3-2 Main Output & Monitor Output

3.3 Input/Output Terminals

External control input

It is possible to perform ON/OFF control over the HSA4101 output from an external device or contact.

Shorting (L) between pin No. 1 and pin No. 9 (GND potential) makes the output turn ON and disconnecting (H) these pins makes the output turn OFF.

Connector: D-SUB connector 15-pin receptacle

Allowable voltage: 0 to +30 V

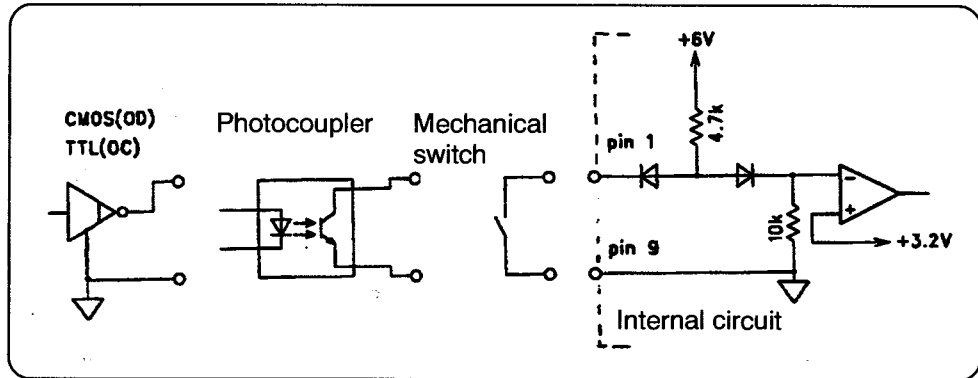


Figure 3-3 Externally Controlled Input Circuit

3.4 Input/Output Connection

A connection diagram is shown in "Figure 3-4 Basic Connection Diagram." To exploit full performance of the HSA4101, the following points should be noted on the signal generator, connection cord and load.

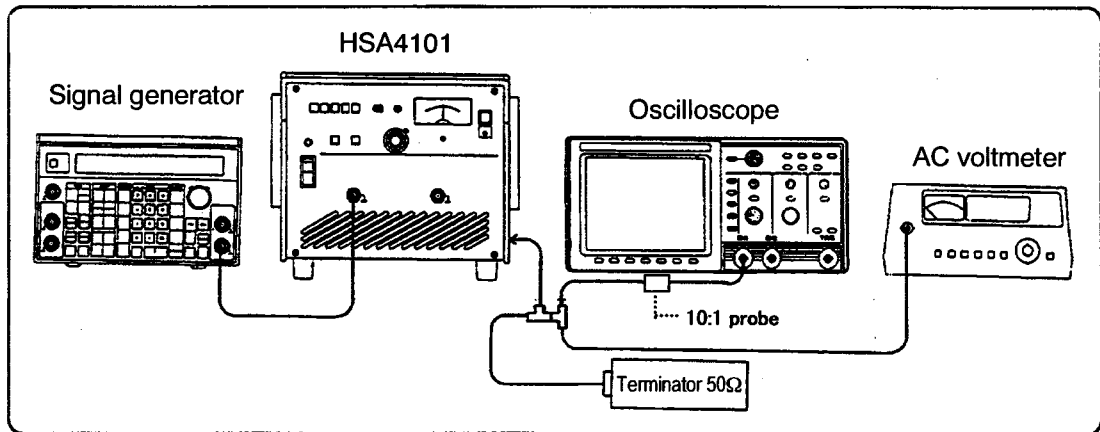


Figure 3-4 Basic Connection Diagram

Signal generator

Use a signal generator, which provides an accurate waveform at the frequency used and output of 2 to 5 Vrms.

When using a high frequency of 100 kHz or more, use a signal generator with output impedance of 50Ω.

Signal cord

Use the provided BNC cable as the input cord.

For the output cord, also attach a BNC connector near the load and use the provided BNC cable.

Load

Attach a BNC connector near the load and use the provided BNC cable.

Place the load near the HSA4101 whenever possible and use it within the range of the length of the provided cable.

3.5 Basic Operation Example

Signal connection

Connect the input connector and the output of the signal generator using the provided signal cord.

 **CAUTION**

- Applying a voltage exceeding the allowable input voltage may damage the equipment. Be careful not to exceed the allowable input voltage range ± 10 V.

Adjustment of output voltage

The gain can be set within the range of $\times 4$ to $\times 100$ using gain changeover switch of $\times 10$, $\times 20$, $\times 50$ and $\times 100$ and pre-set variable resistor of $\times 0.4$ to $\times 1.0$.

To obtain a maximum output voltage of 50 Vrms, the signal generator must have an output voltage of 0.5 (gain $\times 100$) to 7 V (gain $\times 7.2$). Moreover, when output impedance of the signal generator is other than 0Ω , like 50Ω , the output voltage is affected by input impedance 50Ω of the HSA4101.

Use a signal generator of high output of 0.5 to 5 Vrms whenever possible.

Polarity (phase) changeover switch setting

The polarity changeover switch allows the polarity of the HSA4101 to be set to in-phase (non-inversion amplifier) or inverse phase (inversion amplifier). The DC bias addition voltage also changes depending on the setting.

☞ See "Table 3-2 Polarity Switching and DC Bias Addition Voltage."

AC/DC mode setting

The HSA4101 can select and use two modes (AC/DC) by the input coupling changeover switch. In DC mode, the amplifier amplifies from a DC and the DC bias addition function is also valid. It is possible to superimpose a ± 70 VDC component on a signal using a DC bias dial. The frequency band is DC to 10 MHz.

In AC mode, the DC bias addition function is invalid and the DC component included in the signal is cut and the DC component included in the output is controlled to zero by the internal correction circuit. The frequency band is 40 Hz to 10 MHz.

Table 3-1 Input Coupling Setting and Bias Addition/Offset Fine Adjustment Function

Input coupling setting	DC mode	AC mode
Offset fine adjustment range	± 1 V	± 10 mV
DC bias addition	Valid ± 70 V	Invalid

Fine adjustment of output offset

In the case of a problem that occurs if a DC component is superimposed on a signal such as inductance, it is possible to perform fine adjustment that sets the offset voltage included in the output signal of the HSA4101 to zero. Perform fine adjustment of the offset voltage according to the following procedure.

First, remove the input cord. Change the AC/DC mode setting to AC mode or DC mode. Connect the DC voltmeter (digital voltmeter, etc.) to the output and adjust the DC output voltage to zero using pre-set variable resistor for offset fine adjustment. The range of offset fine adjustment varies depending on the AC/DC mode setting. It is possible to perform fine adjustment of ± 10 mV in AC mode and ± 1 V in DC mode.

This offset fine adjustment is performed with the output ON/OFF switch set to ON.

The product can be used more stably if offset fine adjustment is performed 30 minutes to 1 hour after initial drifts are completed after power is turned on.

After fine adjustment of output offset is completed, connect the removed input cord between the input connector (A or B according to the selected signal) and the output of the signal generator.

Addition of DC bias

During DC mode setting, the HSA4101 can output the output voltage signal with a DC voltage added. Turn ON the bias switch and perform this setting using a bias dial. The range of the bias addition voltage is ± 70 V. The added voltage can be monitored from the output meter (DC bias monitor).

The bias addition voltage varies depending on the setting of the polarity changeover switch.

The relationship between the dial memory and output bias addition voltage can be calculated as follows:

In-phase (non-inversion) Bias addition voltage = (set scale - 5.00) \times 14 Vdc

Inverse phase (inversion) Bias addition voltage = (5.00 - set scale) \times 14 Vdc

 **CAUTION**

If the maximum output voltage exceeds ± 71 V, the output waveform is clipped and the overload lamp turns ON. When adding the DC bias, be careful not to allow the waveform to be clipped.

Table 3-2 Polarity Switching and DC Bias Addition Voltage

Dial setting	0.00	2.00	5.00	8.00	10.00
Polarity: In-phase	-70.0 V	-42.0 V	0.0 V	+42.0 V	+70.0 V
Inverse phase	+70.0 V	+42.0 V	0.0 V	-42.0 V	-70.0 V

3.5 Basic Operation Example

Monitoring output voltage

The monitor output connector allows an output waveform to be observed by directly connecting an oscilloscope and the output waveform is output irrespective of output ON/OFF. As the output voltage, a voltage equivalent to 1/100 of the main output is output.

The monitor output is derived from the main output by dividing it through resistors and output. Therefore, the monitor output decreases because it is influenced by input impedance (load resistance) of the device connected.

The influence of the load is calculated as follows:

$$\text{Monitor output} \times \left(1 - \frac{50\Omega}{50\Omega + \text{load resistance } (\Omega)}\right)$$

Output ON/OFF control

The main output signal can be turned ON/OFF. ON/OFF is changed through a relay contact.

ON/OFF control can be performed not only by the ON/OFF switch on the front panel but also by an external contact signal.

 CAUTION
--

<p>Note that if a load containing an inductance component is connected, turning OFF the output may generate a high voltage.</p>

4. Applications

4.1 External Control

The HSA4101 has a connector for external control on the rear panel, which can turn ON/OFF the main output. The control signal is a mechanical contact or semiconductor switch.

To perform external control, set the ON/OFF switch on the front panel to OFF. Note that if the ON/OFF switch remains ON, the main output maintains the ON state, which cannot be changed from outside.

The connector that fits this connector is DA-15P (manufactured by Japan Aviation Electronics Industry or compatible). Do not use any connector other than the specified one.

When the HSA4101 is controlled by logic, consider the H/L level is H level (+4 V or above) and L level (0 to 2 V).

- ☞ For connections, see the external control input of "3.3 Input/Output Terminal" and "Figure 3-3 Externally Controlled Input Circuit."

CAUTION

- When performing control from outside using this connector, be sure to set the main output ON/OFF switch to OFF.
- Do not connect anything to pins other than the specified pins (1 and 9).
- The connector that fits this connector is DA-15P (manufactured by Japan Aviation Electronics Industry or compatible).

Do not use any connector other than the specified one. Doing so can damage the contact and cause a contact defect.

- Do not input a voltage outside the allowable input voltage range of 0 to +30 V.

4.2 Maximum Output Current and Operation Area

The HSA4101 is provided with an output current restriction protection circuit that detects and restricts a peak output current and the maximum output current is determined by this protection circuit. This restriction value depends on the output voltage and has a relationship as shown in the graph in "Figure 4-1 Operation Area."

In general, if the load when an AC signal is used is resistance, the 1st quadrant and 3rd quadrant are the operation area and if the load is capacitive or inductive, all quadrants become the operation area.

Furthermore, if the load has an electromotive force even when a DC signal is used and power is poured from the load, the 2nd quadrant and 4th quadrant become the operation area. An electronic-load-like operation corresponds to this case.

With the HSA4101, if the operation area reaches the 2nd or 4th quadrant depending on the condition, the current restriction value becomes a value lower than the 1st or 3rd quadrant according to the output voltage at that time.

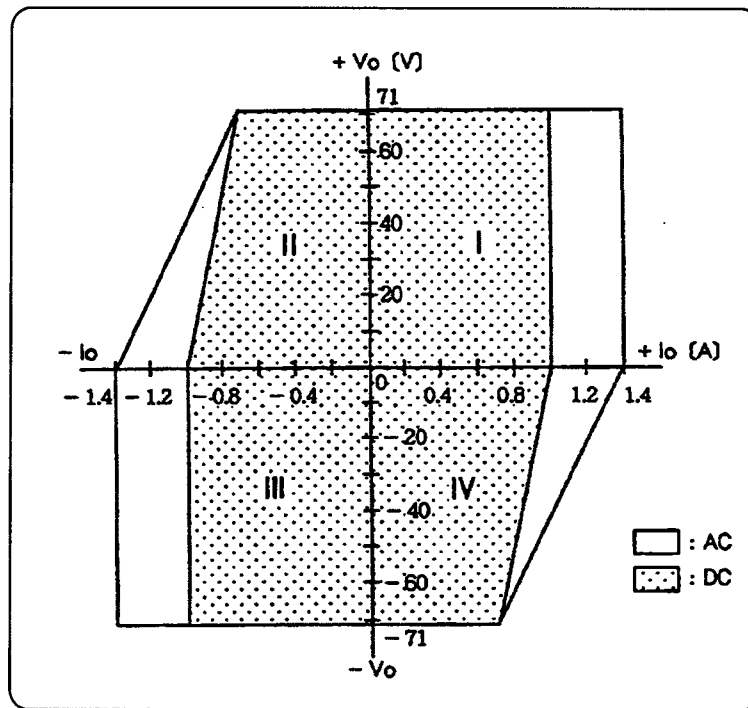


Figure 4-1 Operation Area

4.3 Increase of Output by Balanced Output

When balanced output connection is implemented using two HSA4101s, it is possible to double the output voltage and output power (the output current remains the same as with one HSA4101). As shown in "Figure 4-2 Connection of Balanced Output", set the polarity of the master device to in-phase (non-inversion) and the polarity of the slave device to inverse phase (inversion) so that the master and slave have mutually opposite phases.

Then, perform the same gain setting, bias setting and AC/DC mode setting for the master and slave devices and equalize their respective output voltages (their phases become mutually opposite).

During this connection, since inputs of the HSA4101 are connected in parallel, the input impedance viewed from the signal source is 25Ω . When using a signal generator with signal source impedance of 50Ω , it is recommended to insert a distributor called "power splitter" (e.g.,: B-50D3 manufactured by Iwatsu Electric) between the signal generator and HSA4101 for adjustment.

Connect the load between the master device and slave device as shown in "Figure 4-2 Connection of Balanced Output." At this time, it is not possible to connect one of the load terminals commonly to the chassis of the HSA4101 and signal generator. Therefore, when used for this connection, the load must be insulated from the grounding potential and signal source.

CAUTION

Insulate the load from the grounding potential and signal source.

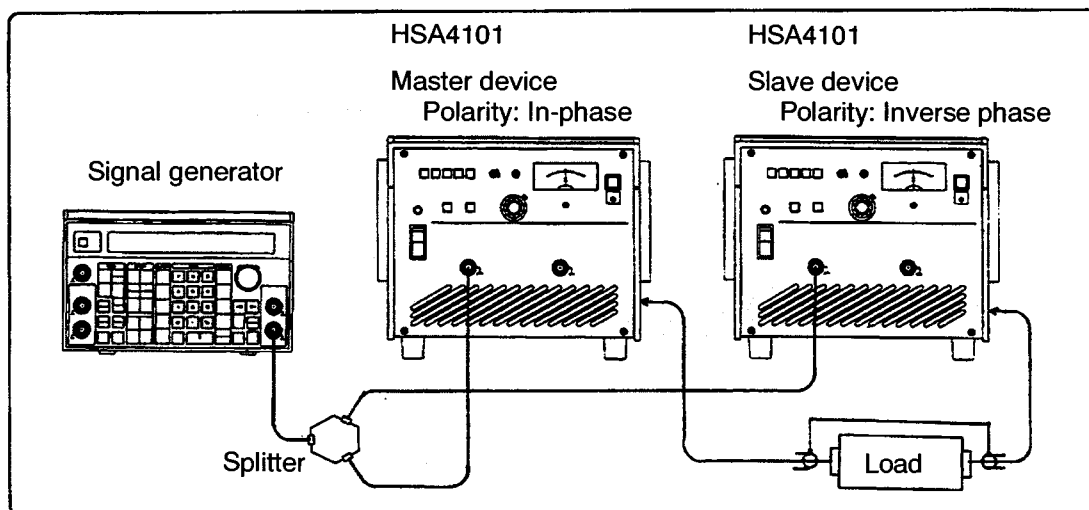


Figure 4-2 Connection of Balanced Output

5. Maintenance

5.1 Introduction

This section describes the following:

- Cautions and storage method when product is not used for extended period of time
- Cautions for repacking and transportation
- Performance tests necessary for receiving inspection for preventive maintenance and performance check after repair
- Symptoms and action for apparent fault

☞ **For a simple operation check, see "2.4 Simple Operation Check."**

When the product does not pass an operation check or performance test or malfunctions, ask us or our sales agency for calibration or repair.

5.2 Daily Care

When panel or case is dirty

When the panel or case is dirty, wipe it using a soft cloth. If the panel or case is extremely dirty, wipe it with a cloth soaked in a detergent. Using an organic solvent such as thinner and benzene or chemical cloth may alter the quality or damage the paint rendering characters illegible.

5.3 Storage, Repacking and Transport

Storage in case of non-use for extended period of time

- Remove the power cord from the receptacle and HSA4101.
- Store the product in a shelf or rack, etc. places where there is no falling object or dust. If the product is possibly subject to dust, put a cloth or polyethylene cover.
- The environmental condition for storage is -20°C to 50°C , 10% to 80% RH, but avoid places with drastic temperature variations or exposed to direct sunlight and store in an environment at ordinary temperatures.

Repacking and transport

When repacking the product for transport or asking for repair, consider the weight of the HSA4101 and note the following points.

- Put the HSA4101 in a polyethylene bag or wrap it with a sheet.
- Prepare a cardboard box which will withstand the weight of the HSA4101 and provide a sufficient space.
- Put a cushioning material to protect the six sides of the HSA4101 and pack it. Ideally, use the cardboard box and stuffing materials provided at the delivery.
- When asking for transport, inform the transport company that this product is a precision instrument.

5.4 Performance Test

- A performance test is conducted to prevent deterioration of the performance of the HSA4101 or as part of preventive maintenance. It is also conducted when a receiving inspection, periodic inspection or a performance check after repair is required. If the performance test result shows that the product does not meet the specification, calibration or repair is required.



Do not remove the outer cover of the HSA4101.

Inspections of the interior of the product should not be performed by any persons other than trained service technicians who are familiar with danger.

- The measuring instruments used for performance tests are as follows:

Measuring instrument	Main performance	Recommended product
Signal generator	0.01 Hz to 20 MHz Sine wave, square wave, 20 Vp-p	1940 manufactured by NF Electronic Instruments
Low distortion signal generator	10 Hz to 1 MHz low distortion	E-1205 manufactured by NF Electronic Instruments
AC voltmeter	10 Hz to 20 MHz, 1 mV to 100 V	8920A manufactured by Fluke Corporation
Digital voltmeter	0 to ±100 V	
Oscilloscope	DC to 100 MHz, 10 mV to 100 V	
Distortion meter	10 Hz to 600 kHz	DM-153B manufactured by NF Electronic Instruments
Terminator (for high frequency)	50Ω ±1%/50W 10Ω ±5%/22W 71Ω ±5%/75W	

- Before starting performance tests, check the following items:
 - Is the supply voltage within the proper range?
 - Are the ambient temperature and ambient humidity within the range of 15°C to 35°C, 25% to 75% RH?
 - Is there condensation?
 - Have 30 minutes or more elapsed after power is turned on?
- Perform fine adjustment of the offset voltage of the HSA4101 to zero.
- ☞ For the fine adjustment method, see "3.5 Basic Operation Example Output Offset Fine Adjustment."

5.4.1 Measuring Maximum Output

Connection

Connect the signal generator, AC voltmeter, oscilloscope and terminator of 50Ω as shown in "Figure 5-1 Maximum Output/Frequency Characteristic Check."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; polarity: in-phase (non-inversion); gain setting: $\times 20$ CAL; bias addition: OFF, dial 5.00

Test procedure

Select a sine wave as the waveform of the signal generator, adjust the frequency to a check frequency and turn ON the output ON/OFF switch of the HSA4101. Gradually increase the output voltage of the signal generator from 0 V. Observe the waveform using an oscilloscope and record the output voltage when the waveform starts to clip (or distortion increases).

Judgment

The product passes the test if it satisfies the judgment criteria at 40 Hz, 100 kHz, 1 MHz and 10 MHz.

Setting frequency	Judgment criteria	Measured value	Judgment
40 Hz	50 Vrms or more	---.---	Acceptable/rejected
100 kHz	50 Vrms or more	---.---	Acceptable/rejected
1 MHz	46 Vrms or more	---.---	Acceptable/rejected
10 MHz	35 Vrms or more	---.---	Acceptable/rejected

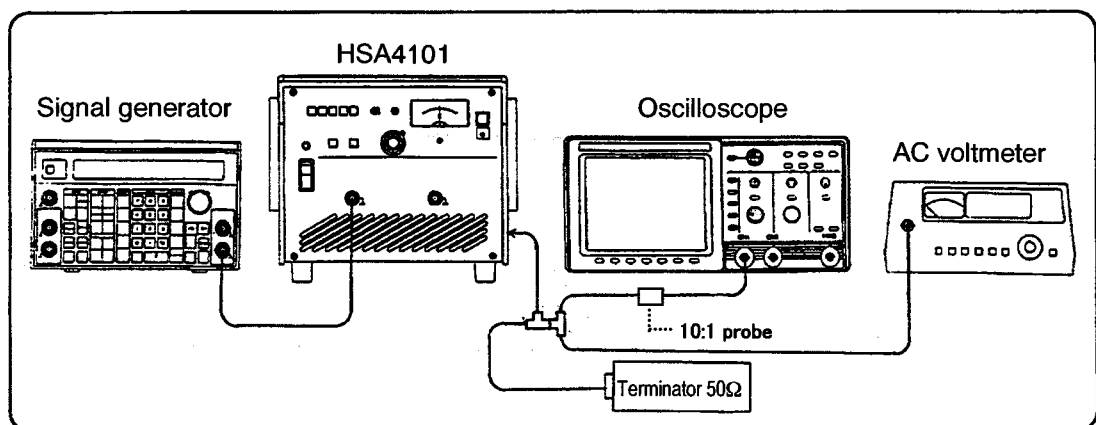


Figure 5-1 Maximum Output/Frequency Characteristic Check

5.4.2 Measuring Maximum Output Current

Connection

Connect the signal generator, AC voltmeter, oscilloscope and terminator of 10Ω as shown in "Figure 5-2 Maximum Output Current Check."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; polarity: in-phase (non-inversion); gain setting: ×20 CAL; bias addition: OFF, dial 5.00

Test procedure

Select a sine wave as the waveform of the signal generator, adjust the frequency to 400 Hz and turn ON the output ON/OFF switch of the HSA4101. Gradually increase the output voltage of the signal generator from 0 V. Observe the waveform using an oscilloscope and record the output voltage when the waveform starts to clip. (Check that the overload lamp is dimly lit).

Judgment

The product passes the test if the voltage at which clipping starts is 10.0 Vrms or more.

Setting frequency	Judgment criteria	Measured value	Judgment
400 Hz	10.0 Vrms or more	---	Acceptable/rejected

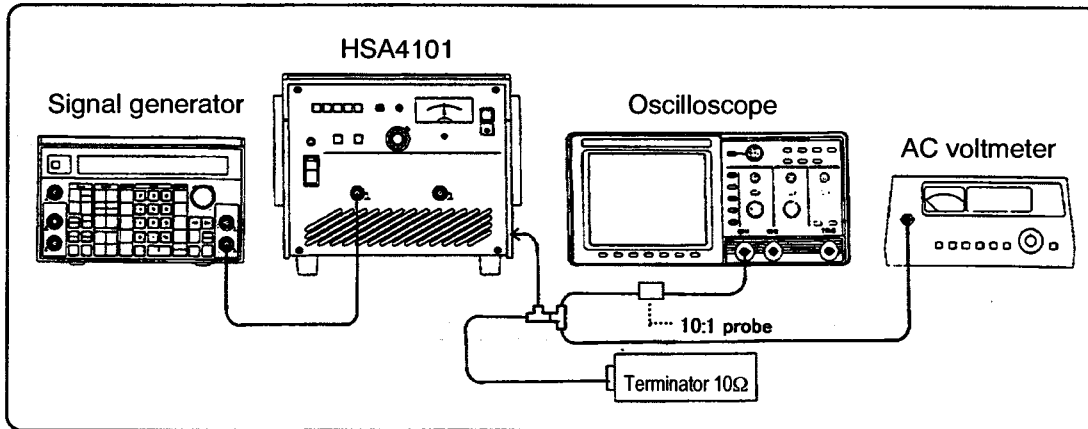


Figure 5-2 Maximum Output Current Check

5.4.3 Measuring Frequency Characteristic

Connection

Connect the signal generator, AC voltmeter, oscilloscope and terminator of 50Ω as shown in "Figure 5-1 Maximum Output/Frequency Characteristic Check."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; polarity: in-phase (non-inversion); gain setting: $\times 20$ CAL; bias addition: OFF, dial 5.00

Test procedure

Set the output voltage of the signal generator so that the reading of the AC voltmeter is 10 Vrms at a frequency of 400 Hz. While keeping the output of the signal generator constant, read the gain at 1 MHz, 3 MHz and 10 MHz.

Judgment

The product passes the test if it meets the judgment criteria at 1 MHz, 3 MHz and 10 MHz relative to 400 Hz (assumed to be 0 dB).

Setting frequency	Judgment criteria	Measured value	Judgment
400 Hz	0 dB (reference)	0 . 0 0	Set this as reference
1 MHz	-1.0 to +0.5 dB	__ . __	Acceptable/rejected
3 MHz	-1.0 to +0.5 dB	__ . __	Acceptable/rejected
10 MHz	-3.0 to +0.5 dB	__ . __	Acceptable/rejected

5.4 Performance Test

5.4.4 Measuring Gain Error

Connection

Connect the signal generator, AC voltmeter, oscilloscope and terminator of 50Ω as shown in "Figure 5-3 Gain Error Check."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; polarity: in-phase (non-inversion); bias addition: OFF; dial 5.00;
Signal generator setting: Sine wave, 400 Hz

Test procedure

Make the signal level of the signal generator variable so that the output voltage of the HSA4101 becomes approximately 10 Vrms.

Set the gain to $\times 10\text{CAL}$, $\times 20\text{CAL}$, $\times 50\text{CAL}$, $\times 100\text{CAL}$ and $\times 100\text{UNCAL}$ minimum, and alternately measure the input voltage (V_i) and output voltage (V_o) of the HSA4101 using an AC voltmeter and calculate the gain (V_o/V_i). Moreover, observe the output waveform at this time using an oscilloscope and check to see if there is any abnormality with the waveform.

Judgment

The product passes the test if it meets the judgment criteria at gain $\times 10\text{CAL}$, $\times 20\text{CAL}$, $\times 50\text{CAL}$, $\times 100\text{CAL}$ and $\times 100\text{UNCAL}$ maximum.

Set gain	Input voltage	Judgment criteria	Measured value	Judgment
$\times 10\text{CAL}$	1.0 Vrms	9.5 to 10.5	---	Acceptable/rejected
$\times 20\text{CAL}$	0.5 Vrms	19.0 to 21.0	---	Acceptable/rejected
$\times 50\text{CAL}$	0.2 Vrms	47.5 to 52.5	---	Acceptable/rejected
$\times 100\text{CAL}$	0.1 Vrms	95 to 105	---	Acceptable/rejected
$\times 100\text{UNCAL}$	0.1 Vrms	40 or less	---	Acceptable/rejected

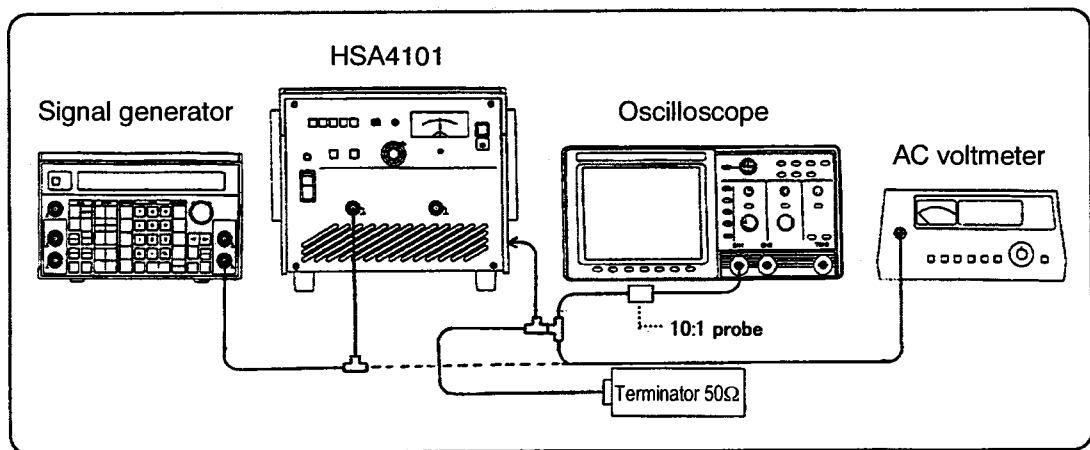


Figure 5-3 Gain Error Check

5.4.5 Measuring Sine Wave Distortion Rate

Connection

Connect the low distortion oscillator, distortion meter, oscilloscope and terminator of 50Ω as shown in "Figure 5-4 Measuring Sine Wave Distortion Rate."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; polarity: in-phase (non-inversion); gain setting: $\times 20$ CAL; bias addition: OFF, dial 5.00

Test procedure

Adjust the output level of the low-distortion oscillator so that the output voltage of the HSA4101 becomes the measured level. Measure the sine wave distortion rate at frequencies of 1 kHz, 100 kHz and 500 kHz.

Judgment

The product passes the test if it meets the judgment criteria at different frequencies.

Setting frequency	Output voltage	Judgment criteria	Measured value	Judgment
1 kHz	50 Vrms	0 to 0.05%	0. _ _ _	Acceptable/rejected
100 kHz	40 Vrms	0 to 1.0%	0. _ _ _	Acceptable/rejected
500 kHz	40 Vrms	0 to 3.0%	_ . _ _	Acceptable/rejected

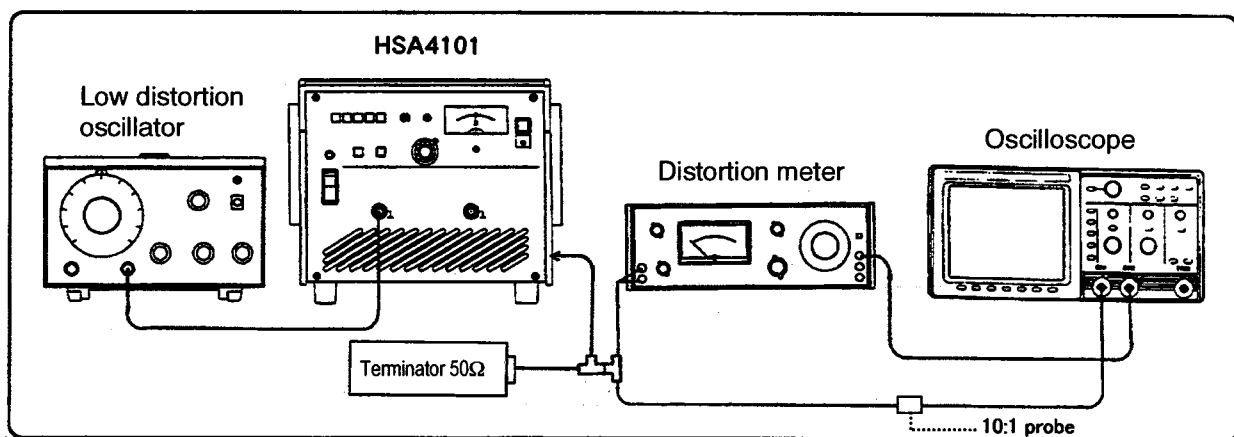


Figure 5-4 Measuring Sine Wave Distortion Rate

5.4 Performance Test

5.4.6 Measuring Bias Addition Voltage

Connection

Connect the digital voltmeter and terminator of 71Ω as shown in "Figure 5-5 Measuring Bias Addition Voltage."

Setting

Set the HSA4101 as follows:

Input coupling: DC mode; gain setting: $\times 20$ CAL

Test procedure

Before testing, perform fine adjustment of the offset voltage of the HSA4101 to zero with special care. Set the polarity of the HSA4101 to in-phase or inverse phase, turn ON bias addition, gradually change the dial from 5.00 and measure the output voltage at dial settings of 0.00, 2.00, 5.00, 8.00 and 10.00.

After the measurement is completed, set bias addition "OFF/dial 5.00" for safety.

Judgment

The product passes the test if it meets the judgment criteria at different frequencies.

Polarity setting	Dial setting	Judgment criteria	Measured value	Judgment
In-phase	0.00	-74.0 to -70.0 V	---	Acceptable/rejected
In-phase	2.00	-44.5 to -42.0 V	---	Acceptable/rejected
In-phase	5.00	-1.0 to +1.0 V	---	Acceptable/rejected
In-phase	8.00	+42.0 to +44.5 V	---	Acceptable/rejected
In-phase	10.00	+70.0 to +74.0 V	---	Acceptable/rejected
Inverse phase	0.00	+70.0 to +74.0 V	---	Acceptable/rejected
Inverse phase	5.00	-1.0 to +1.0 V	---	Acceptable/rejected
Inverse phase	10.00	-74.0 to -70.0 V	---	Acceptable/rejected

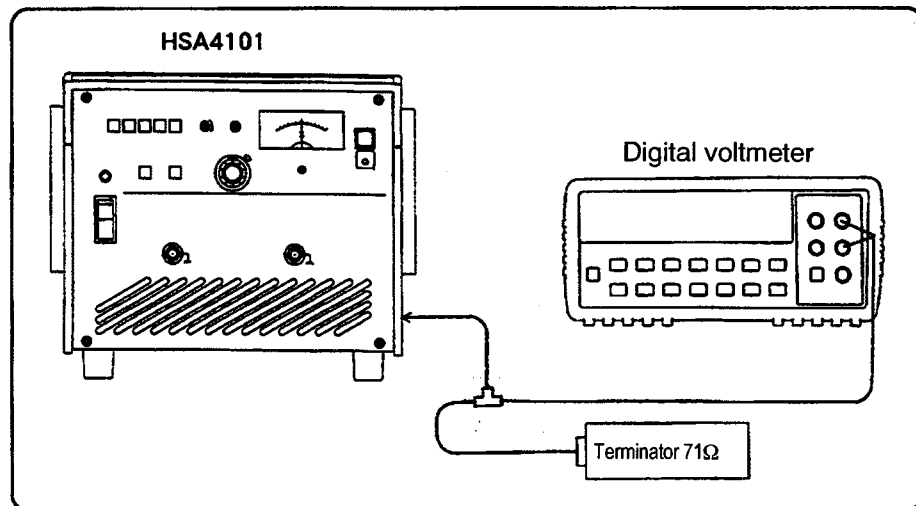


Figure 5-5 Measuring Bias Addition Voltage

5.5 Handling Apparent Faults

The product may be suspected to be malfunctioning if the following phenomena occur. Take the "necessary action." If the product is not recovered from these phenomena, contact us or our sales agency.

Table 5-1 Apparent Faults

Phenomenon	Possible cause	Necessary action
No operation on power up	Fuse is blown out.	Replace the fuse with a normal one.
	Power line is not connected.	Securely insert the power cord into the plug.
No output	Signal is not connected.	Connect the signal generator.
	Output ON/OFF switch is not turned ON.	Turn ON the output ON/OFF switch.
Overload lamp turns ON	Overload?	Remove the load and if the overload lamp turns OFF, connect a load within the range of maximum output.
	Signal level of signal generator is excessive.	Reduce the level of the signal generator connected.
	Is gain setting correct?	Set the gain setting switch to an appropriate range.
DC is output	Bias addition switch is ON.	Turn OFF the bias addition switch.
	Is DC superimposed on signal source?	Set the DC component of the signal generator to zero or set AC mode.

6. Specifications

6.1 Input

Input impedance

50Ω ±5%, unbalanced

Maximum allowable input voltage

±10 V

Input connector

BNC-R: One for front panel

Connect GND to chassis.

6.2 Output

Maximum output voltage

±71 V	DC to 40 Hz	Load of resistance 71Ω (non-inductive)
Sine wave 50 Vrms	40 Hz to 100 kHz	Load of resistance 50Ω (non-inductive)
Sine wave 46 Vrms	100 kHz to 1 MHz	Load of resistance 50Ω (non-inductive)
Sine wave 35 Vrms	1 MHz to 10 MHz	Load of resistance 50Ω (non-inductive)
Sine wave 17 Vrms	10 MHz to 20 MHz	Load of resistance 50Ω (non-inductive)

Maximum output current

±1.0 A	DC to 40 Hz	Load of resistance (non-inductive)
±1.4 A	40 Hz to 100 kHz	Load of resistance (non-inductive)
±1.3 A	100 kHz to 1 MHz	Load of resistance (non-inductive)
±1.0 A	1 MHz to 10 MHz	Load of resistance (non-inductive)

Area of voltage/current that can be output

The maximum output current of the HSA4101 is restricted by the output voltage. Moreover, the current value is restricted by both a peak value and average value.

☞ See "Figure 4-1 Operation Area."

Output impedance

1.5Ω + 0.5μH typ

Output noise level

50 mVrms or less

At frequency band of 10 Hz to 10 MHz

6.2 Output

Output DC offset voltage

Adjustable to zero using pre-set variable resistor

Adjustment range: DC mode ± 1 V or more
AC mode ± 10 mV or more

Temperature drift: DC mode ± 3 mV/ $^{\circ}$ C typ
AC mode ± 30 μ V/ $^{\circ}$ C typ

DC bias

Setting range: Valid in DC mode
 ± 70 V or more: According to 10-turn potentiometer

Output connector

BNC-R: One on back

Connect GND to chassis.

Monitor output

Output voltage: $1/100 \pm 10\%$ of main output, no load

Output impedance: $50\Omega \pm 10\%$

Output connector: BNC-R one on front panel

Monitor meter

Function: Indicates DC component of output voltage
Center zero-type DC voltmeter
Full scale ± 75 V

Accuracy: Within $\pm 5\%$ of full scale

6.3 Input/Output Characteristics

Gain

Setting range:	4 to 100 times
Function:	4 ranges of $\times 10$, $\times 20$, $\times 50$, $\times 100$ Use of pre-set variable resistor provides continuously variable gain from $\times 0.4$ to $\times 1$.
Error:	$\pm 5\%$ (gain adjustment: CAL, at frequency of 400 Hz)

Small signal frequency characteristic

Within ± 0.3 dB	At DC to 100 kHz
Within -1 to $+0.5$ dB	At 100 kHz to 1 MHz
Within -3 to $+0.5$ dB	At 1 MHz to 10 MHz

(DC mode, gain setting: CAL, 400 Hz reference, 10 V_{rms} output, 50 Ω load)
(In AC mode, a high-pass filter with cutoff frequency of 33 Hz is inserted.)

Harmonics distortion rate/spurious

Harmonics distortion rate

- 0.1% typ (1 kHz, output 50 V_{rms})
- 0.1% or less (40 Hz to 1 kHz, output 40 V_{rms})
- 1.0% or less (1 kHz to 100 kHz, output 40 V_{rms})
- 3.0% or less (100 kHz to 500 kHz, output 40 V_{rms})

Spurious

- -25 dBc or less (500 kHz to 10 MHz, output 35 V_{rms})

Step response

Overshoot/sag:	5% or less Output ± 50 V, with 50 Ω load
Slew rate:	5000 V/ μ s typ
Phase between input/output:	Switchable between in-phase and inverse phase
In-phase (non-inversion):	Input and output are in-phase.
Inverse (inversion):	Input and output have mutually opposite phases. For the bias, also a voltage opposite to in-phase voltage is added.
Mode changeover:	Switchable between 2 modes, AC mode and DC mode
DC mode:	DC bias addition function is valid.
AC mode:	A HPF with the cutoff frequency of approx. 33 Hz is inserted. The DC bias addition function is invalid.

6.4 General Specifications

External control: Can turn ON/OFF the output from an external contact or semiconductor switch.

Power supply

Rated frequency: 50/60 Hz, single-phase

Operating frequency range: 48 to 62 Hz

Rated voltage: 100/115/200/230 V
Switchable with rear panel switch

Operating voltage range: 100/115 V range: 85 to 138 V
200/230 V range: 170 to 250 V

Maximum power consumption: 700 VA (400 W) or less
(With 400 Hz, 50 Vrms output, 50Ω load, 100 VAC)

Insulation/withstand voltage

Insulation: Between power input and chassis, other total: 30 MΩ or more at DC 500 V

Withstand voltage: Between power input and chassis, other total: 1500 VAC/1 minute

Temperature range/humidity range

During operation: 0 to +40°C, 10 to 90% RH (no condensation)

During storage: -20 to +50°C, 10 to 80% RH (no condensation)

External dimensions/weight

External dimensions: 238 (W) × 193 (H) × 538 (D) mm (Max.)
220 (W) × 177 (H) × 450 (D) mm (Excluding handle, rubber legs)

☞ For details, see "Figure 6-1 External Dimensions."

Weight: Approximately 7.8 kg

6.5 Option

Rack mount bracket

The HSA4101 can be mounted on a standard millimeter or inch rack using auxiliary brackets. Contact our sales representative specifying either millimeter or inch.

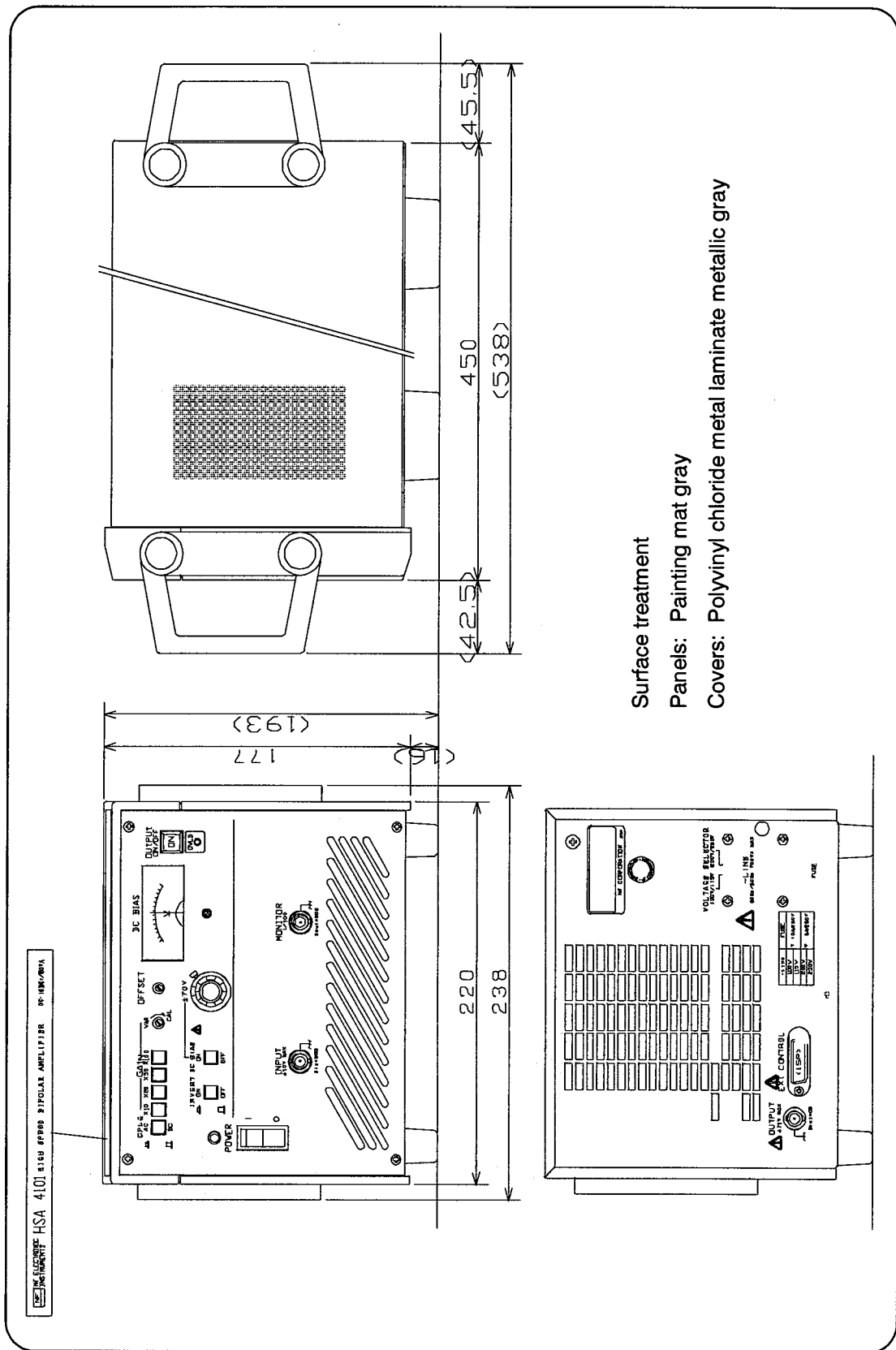


Figure 6-1 External Dimensions

WARRANTY

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

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date shipment. During the warranty period of, **NF** will, at its option, either will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to a service center designated by **NF**. Purchaser shall be prepay shipping charge, duties, and taxes for the product to **NF** from another country, and **NF** shall pay shipping charge to returned the product to purchaser.

This warranty shall not apply to any defect, failure or damage caused by improper use, improper or inadequate maintenance and care or modified by purchaser or personnel other than **NF** representatives.

NF CORPORATION

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

NOTES

- Reproduction of the contents of this manual is forbidden by applicable laws.
- The contents of this manual may be revised without notice.
- Information provided in this manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of this manual.
- We assume no responsibility for influences resulting from the operations in this manual.

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