



HIGH SPEED BIPOLAR AMPLIFIER

HSA42011

INSTRUCTION MANUAL

DA00082229-001

HIGH SPEED BIPOLAR AMPLIFIER

HSA42011

INSTRUCTION MANUAL

— Preface —

Thank you for purchasing the HSA42011 high speed bipolar power amplifier.

To ensure safe and proper use of this electric equipment, please read first **Safety Precautions** on the following pages.

● **Caution Symbols Used in This Manual**

The following caution symbols are used in this manual. Be sure to observe these caution symbols and their descriptions to ensure the safety of the user and avoid damage to the equipment.

WARNING

This contains information to avoid risks in equipment handling that could result in loss of life or bodily injury.

CAUTION

This contains information to avoid risks in equipment handling that could result in minor or moderate injury to person or damage to property or the equipment.

- This manual has the following chapter organization.

If reading this manual for the first time, start from **1. OVERVIEW**.

1. OVERVIEW

Describes the overview, features, applications, functions, and brief operation principles.

2. PREPARATIONS BEFORE USE

Describes various cautions regarding preparations to be made before using this product.

3. PANEL FEATURES AND BASIC OPERATIONS

Describes features, behavior, and basic operation of panel knobs. Read this chapter while operating the device.

4. ADVANCED OPERATIONS

Describes advanced operations.

5. TROUBLESHOOTING

Describes error messages and countermeasures to be taken when a failure is likely to have occurred.

6. MAINTENANCE

Describes how to store, re-pack, and transport the device, how to run the performance test, and so on.

7. SPECIFICATIONS

Describes the specifications including functions and performance.

— Safety Precautions —

To ensure safe use, be sure to observe the following warnings and cautions.

NF Corporation shall not be held liable for damages that arise from a failure to observe these warnings and cautions.

This product is a Class 1 product (with protective conductor terminal) that conforms to the JIS and IEC insulation standards.

- **Be sure to observe the contents of this instruction manual.**

The instruction manual contains information for the safe operation of the product.

Be sure to read the information first before using the product.

All the warnings in the instruction manual are intended for preventing risks that may lead to serious accidents. Ensure to obey them.

- **Be sure to ground the product.**

This product uses a line filter and must be grounded to avoid the risk of electric shock.

To prevent electric shock, be sure to safely implement grounding so that the ground resistance is 100 Ω or less.

This product is automatically grounded when its 3-prong power supply plug is connected to a 3-prong power outlet with a protective-ground contact.

This product does not come with a 3-prong to 2-prong conversion adapter. When using a separately sold 3-prong to 2-prong conversion adapter, be sure to connect the grounding wire of the adapter to the grounding terminal next to the outlet.

- **Check the power supply voltage.**

This product operates on the power supply voltage indicated in **Grounding and Power Supply Connection** in this instruction manual.

Prior to connecting the power supply, check that the voltage of the power supply matches the rated power supply of the product.

- **If you notice anything strange**

If this product emits smoke, an unusual smell, or abnormal noise, immediately power it off and stop using it.

If such an anomaly occurs, prevent anyone from using this product until it has been repaired, and immediately report the problem to NF Corporation or one of our representatives.

- **Do not operate in an explosive atmosphere.**

An explosion or other such hazard may result.

- **Do not remove the cover.**

The product may contain high-voltage parts. Never remove the cover.

Even when the inside of this product needs to be inspected, do not touch the inside. All such inspections are to be performed by service technicians designated by NF Corporation.

- **Do not modify this product.**

Never modify the product. Modification to the product may pose a new risk. We may refuse the repair of a modified product.

- **Avoid output voltage electric shock**

The maximum output of the HSA42011 is ± 75 V.

Make every effort to avoid an electric shock.

Directly touching the output or changing cable connections while output is on may cause electrical shock.

- **Ensure that water does not get into this product.**

Using the product in wet condition may cause electric shock and fire. When water etc. get into the product, immediately power it off, and contact NF Corporation or one of our representatives.

- **If lightning occurs, power off and disconnect this product.**

A lightning may cause an electric shock, a fire and a failure.

- **Safety-related symbols**

The general definitions of the safety-related symbols used on this product and in the instruction manual are provided below.



Instruction Manual Reference Symbol

This symbol is displayed to alert the user to potential danger and refer him/her to the instruction manual.



Electric Shock Danger Symbol

This symbol indicates locations that present a risk of electric shock under specific conditions.



Protective Ground-Terminal Symbol

This symbol identifies a pin that must be grounded to avoid an electric shock.

Before operating the device, be sure to safely implement grounding so that the ground resistance is 100 Ω or less.



Warning Symbol

This contains information to avoid risks in equipment handling that could result in loss of life or bodily injury.



Caution Symbol

This contains information to avoid risks in equipment handling that could result in minor or moderate injury to person or damage to property or the equipment.

- **Other symbols**



This symbol indicates the “on” position of the power switch.



This symbol indicates the “off” position of the power switch.



This symbol indicates that the external conductor of the connector is connected to the case.



This symbol indicates that the external conductor of the connector is connected to the signal ground.

- **Waste disposal**

To protect the environment, follow the guidelines described below for the disposal of this product.

- a) Use the services of an industrial waste disposal contractor for disposal of the entire product.
- b) This product does not use batteries.
- c) This product does not contain mercury.

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1. OVERVIEW

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1.1 General

This product is a wideband, high-speed bipolar power amplifier with a 1 MHz bandwidth capable of bipolar output of an output voltage and current.

Constant voltage (CV) output characteristics are supported, and the rated output voltage and current are ± 75 V and 1.06 Arms, respectively.

Since this product performs bipolar output, the output voltage and current supply ranges over all four quadrants. A general DC power supply can supply only positive current (source current) in the case of positive voltage output. However, this product can supply both positive and negative (source and sink) current. This product can be used with DC, so that an offset waveform or a waveform asymmetric with regard to polarity can also be amplified.

1.2 Features

- **Wideband, high speed, and large amplitude**

This product has a frequency bandwidth from DC to 1 MHz and a slew rate as high as 475 V/ μ s or more, and still can output a maximum amplitude of 150 Vp-p.

- **Low output impedance**

Since the output impedance is low, this product can drive loads at a constant voltage without depending on the load impedance.

Output impedance: $[0.19 + 0.0155\sqrt{f} \times (1 + j)] \Omega$ or less (typ.),

- **Gain setting function**

A gain can be set by fixed settings $\times 1$, $\times 10$, $\times 20$, $\times 50$ and variable settings $\times 1$ to 3.

- **Output polarity switching function**

A switch is provided to enable this product to be switched for use as an in-phase amplifier or a reversed-phase amplifier.

- **Fine output offset adjustment / DC bias setting function**

DC offset can be finely adjusted. Moreover, DC voltage can be superposed on the output with the DC bias setting function.

- **Protection function**

This product protects against output overload and also protects against power supply faults, abnormal internal temperatures, and so forth.

- **Output monitor function**

This product enables output voltage monitoring based on a monitor ratio of 1/100 (BNC connector output), and also enables output voltage/current checking (average value indication) with LED meters.

- **Output on/off function**

Output on/off control can be exercised by using the front panel switch or an external control.

Moreover, an output state (output off or output on) at power-on time can be selected using the DIP switch on the rear panel.

- **Support of worldwide power supply input voltages, Provided input power factor improvement function**

A voltage range from 100 to 230 VAC $\pm 10\%$ is supported. The input power factor correction (PFC) function is provided.

1.3 Applications

- For testing and characteristics analysis liquid crystals and so forth
- For testing and characteristics analysis of micro actuators and so forth
- For use as a booster amplifier for signal generators such as the WF series of NF Corporation
- For use as a power supply for capacitor ripple current testing
- For use as an actuator driver
- For characteristics testing of diodes and semiconductors such as SCR
- For characteristics testing of relays and switches
- For use as a power supply for testing in an inspection line for various components

1.4 List of Functions

The table below indicates the major functions of this product.

Table 1-1. List of Functions

	Function	Description
Input	Input on/off switching	Two independent inputs. Two inputs added when two are on.
	Input impedance switching	50 Ω /10 k Ω . Two batch-switched inputs.
Output	Output on/off switching	
	Fine DC offset tuning	± 0.5 V
	DC bias setting	Settable to ± 75 V or more. Settable to on/off.
	Gain setting	Fixed: $\times 1$, $\times 10$, $\times 20$, $\times 50$ Variable: $\times 1$ to $\times 3$
	Output polarity switching	In-phase or reversed-phase
	Overload protection and indication	
Monitor	Output voltage monitoring	BNC output, monitor ratio 1:100
	Monitor Output LED meter	0 to 100% levels of output voltage and current are displayed with 11LEDs respectively
Other	To be set at power-on time	Output on/off, gain, and so forth

1.5 Principle of Operation

This product consists of preamplifier block, power amplifier block, and power supply block. "Figure 1-1. Block Diagram" shows the block diagram of this product.

The preamplifier block is a wideband operational amplifier. It provides the gain tuning function, input impedance switching function, two-input addition function, offset tuning function, and bias addition function.

The power amplifier block performs power amplification and has protection functions.

The power supply block consists of the internal power supply block of this product, and the DC power supply block for the power amplifier.

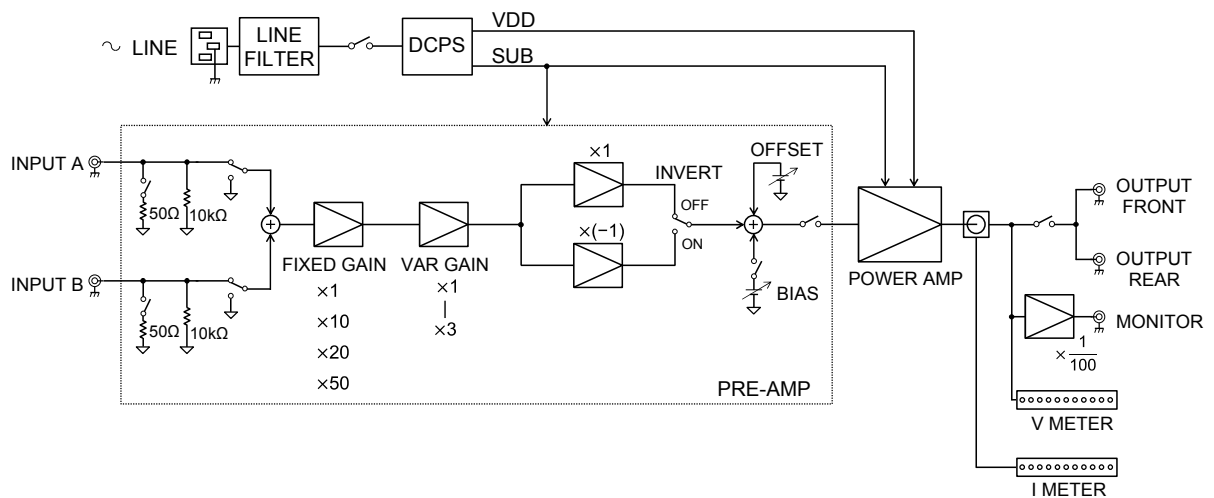


Figure 1-1. Block Diagram

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2.1 Checking Before Use

■ Safety check

To ensure safety in using this product, the user should read the following sections of this instruction manual before using this product:

- "Safety Precautions" (provided at the beginning of this instruction manual)
- "2.3 Grounding and Power Supply Connection"

■ Appearance and accessories check

If an abnormality (such as a flaw or dent) is found on the outside surface of the corrugated box, carefully check if the product is adversely affected when removing the product from the corrugated box.

After opening the corrugated box, check the items contained in the box.

If an abnormality such as a flaw or dent is found on the product or an accessory is missing, contact NF Corporation or its representative.

● Appearance check

Check that no abnormalities such as a flaw and dent are found on the panel, controls, connectors, and so forth.

● Accessories check

The accessories of this product are listed below. Check that there are no missing items and no flaws are found.

- | | |
|----------------------------------------------------------------------------------------------------|---|
| • Instruction manual (This document) | 1 |
| • Power cord set
(varies depending on destination, 7 A/125 V for Japan, 2 m, with 3-prong plug) | 1 |
| • BNC cover (Installed on this product) | 2 |



WARNING

This product contains high-voltage parts. Never remove the cover.

All internal inspections of this product are to be performed only by service technicians qualified by NF Corporation.

2.2 Installation

■ Installation location

Do not place this product, with its rear or side facing down, on a floor or desk.

Ensure that all of the four rubber legs at the bottom are placed on a plane surface such as a desk.

■ Caution on transportation

When transporting this product, hold on the sides and ensure that the product is level.

■ Installation location conditions

- Use this product indoors at an altitude of no higher than 2000 m.
- This product performs forced air cooling using fans. Separate the front, rear, and sides with air inlets and air outlets from the wall by 50 cm or more to assure ventilation.
- Install this product in a location that satisfies the following temperature and humidity ranges:

Operation guarantee	0 °C to +40 °C	5 % to 85 % RH. Absolute humidity 1 to 25 g/m ³ , with no condensation.
Performance guarantee	+5 °C to +35° C	5 % to 85 % RH. Absolute humidity 1 to 25 g/m ³ , with no condensation.
Storage condition	−10 °C to +50 °C	5 % to 95 % RH. Absolute humidity 1 to 29 g/m ³ , with no condensation.

Product reliability may decline in extreme temperature and/or humidity environments. An environment of approximately 25°C and 50%RH is recommended.

- Do not install this product in the following locations:
 - Location with flammable gas
 - An explosion may occur. Never install and use this product in such a location.
 - Outdoors or location exposed to direct sunlight or near a fire or heat source
 - The full performance of this product may not be obtained, or failure may occur.
 - Location with corrosive gas, moisture, or high humidity
 - This product may become corroded or fail.
 - Location near an electromagnetic field source, high-voltage device, or power line
 - This product may malfunction.
 - Location exposed to excessive vibration
 - This product may malfunction or fail.
 - Location with excessive dust
 - In particular, electrically conductive dust may cause failure of this product.

2.2 Installation

- This product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

2.3 Grounding and Power Supply Connection

- Be sure to ground this product.



WARNING

This product uses a line filter. Be sure to ground this product. Otherwise, an electric shock may occur.

To prevent an electric shock from occurring, be sure to ground this product so that the ground resistance is 100 Ω or less.

This product is automatically grounded when its 3-prong power supply plug is connected to a 3-pole power outlet with a protective-ground contact.

This product does not come with a 3-prong to 2-prong conversion adapter. When using a separately sold 3-prong to 2-prong conversion adapter, be sure to connect the grounding wire of the adapter to the grounding terminal next to the outlet.



CAUTION

The power code set can be used for disconnecting the product from AC power line in case of emergency. Maintain enough space around the inlet, to be able to remove the connector of a power cord from the inlet. Use a power socket located at convenient place with adequate space around so that the plug can be removed from socket.

- The power requirements of this product are as follows:

Voltage range:	100 V AC to 230 V AC $\pm 10\%$ (not exceeding 250 V) Overvoltage Category II
Frequency range:	50 Hz/60 Hz ± 2 Hz (single phase)
Power consumption:	290 VA or less

- Connect the power supply according to the following procedure:

1. Check that the commercial voltage supply to be connected is within the voltage range of this product.
2. Turn off the power switch of this product.
3. Insert the power cord supplied with the product into the inlet on the rear.
4. Insert the plug of the power cord into a 3-pole power outlet.



CAUTION

The power cord set delivered with this product is dedicated to this product.

Do not use the power cord for other products and applications.

Use only the attached power code set for connection to AC power line.

Note that the dielectric strength of only the main unit of this product is 1500 VAC.

2.4 Simplified Operation Check

This section describes the simplified operation check method, which may be used when this product is newly purchased or after being stored for a long time. For performance checking, refer to **"6.4 Performance Testing"**.



WARNING

This product contains high-voltage parts. Never remove the cover.
All internal inspections of this product are to be performed only by service technicians qualified by NF Corporation.

● Required measuring instruments

To make an operation check, the measuring instruments listed below are required.

No load test is conducted since a load (terminating) resistor is not needed.

Table 2-1. Required Measuring Instruments

Measuring instrument	Characteristics
Signal generator	Frequency: 1 kHz Waveform: Sine wave Output voltage: 0.5 Vrms or more (Load: 50 Ω) WF1947 1 CH 30 MHz multifunction generator manufactured by NF Corporation, or equivalent
Oscilloscope	Frequency bandwidth: 20 MHz or more Use an oscilloscope that can measure 100 V or higher by using a 10:1 probe ^{Note} .
Voltmeter	AC and DC voltage measurement Use a voltmeter that can measure 100 V or higher.

Note: When connecting an oscilloscope for measurements, be sure to use a 10:1 probe.

2.4 Simplified Operation Check

- Connection

As shown in "Figure 2-1 Standard Connection Diagram", connect a signal generator, voltmeter, and oscilloscope.

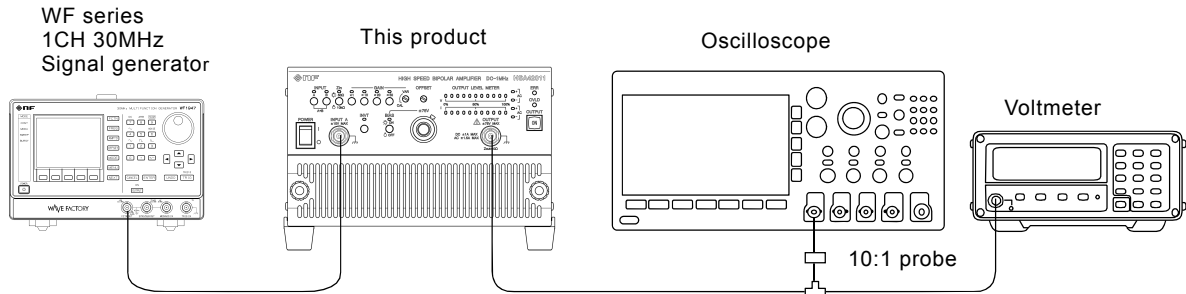


Figure 2-1. Standard Connection Diagram

- Panel setting

Set this product and signal generator as indicated below.

Table 2-2. Panel Setting for Operation Check

This product

Item	Setting
INPUT	Set A to ON.
Zin	50 Ω
GAIN	$\times 50$
VAR	CAL
INVT	OFF
BIAS	OFF (Dial scale: 5.00)

Signal generator (WF1947)

Item	Setting
Frequency (FREQ)	1 kHz
Waveform (FUNCTION)	Sine wave
Output level (AMPTD)	0
Offset (OFFSET)	0

- Operation

WARNING

If the product generates smoke, smell, or sound, disconnect the power cord from the outlet immediately, and leave a notice that the product must not be used until the product is repaired.

1. Turn on the power switch.

All LEDs above the switches, the 0% LED of output meter LEDs, the overload LED (OVLD), and the error LED (ERR) turn on. After all LEDs above the switches turn off and the error LED (ERR) blink for a few seconds, the overload LED (OVLD) and the error LED (ERR) turn off. Next, when the internal power supply is fixed, the state selected at power-on time is set.

If the gain setting is not $\times 50$, change the setting.

2. Check that the output LED meter indicates 0 %.
3. Set the frequency of the signal generator to 1 kHz, the waveform to sine wave, and the voltmeter for AC measurement.
4. Increase the level gradually from 0 V, and set this product input voltage to 1 Vrms (check the input voltage with the voltmeter). At this time, check that the output LED meter indication changes from 0 V to 50 V. (Indication level from 0% to 100% with 75 V as 100%)
5. Press the output ON/OFF switch then check, with the oscilloscope and voltmeter, that about 50 Vrms is output on the output connector (OUTPUT). At the same time, check that the waveform does not have any distortion, such as clipping.
6. Switch the gain setting then check the output level.

GAIN	Output Level
$\times 20$	20 Vrms
$\times 10$	10 Vrms
$\times 1$	1 Vrms

7. Set the level of the signal generator to 0 V, set the bias of this product to ON, and set the voltmeter for DC measurement. Next, by tuning the bias dial, check the output LED meter indication and output voltage.

Bias dial	0.71	2.00	5.00	8.00	9.29
Output	Approx. -75 V	Approx. -53 V	Approx. 0 V	Approx. +53 V	Approx. +75 V
Meter indication	Approx. -75 V	Approx. -53 V	Approx. 0 V	Approx. +53 V	Approx. +75 V

Upon completion of the operation check, set the bias to OFF and return the bias dial to 5.00 for safety.

2.5 Calibration

Ensure that this product undergoes the testing described in "**6.4 Performance Testing**" at least once a year, depending on the use environment and use frequency. It is recommended to conduct a performance test before using it for an important measurement or test.

A performance test should be conducted by a person who has a general knowledge of measuring instruments and is familiar with measuring instrument handling.

2.6 Radio Law

CAUTION

The high-frequency application equipment provisions of Japan's Radio Law may be applicable to this product, depending on the conditions of use.

a) Related laws and regulations are summarized as follows:

- Article 100 of the Radio Law defines the following equipment as "high-frequency application equipment":
 - (1) Telegraph, telephony, or other telecommunications facilities that apply a radio frequency current of 10 kHz or higher to an electrical line.
 - (2) Radio equipment and the equipment other than the equipment defined in (1), above that use a high-frequency current of 10 kHz or higher and specified by Ministry of Internal Affairs and Communications regulations.
- The "Ministry of Internal Affairs and Communications regulations" mentioned above refer to Article 45 of the Regulations for Enforcement of the Radio Law. Under this article, equipment that requires authorization is defined as follows:
 - (1) Medical equipment (equipment used for medical treatment that generates high-frequency energy and that uses output greater than 50 W)
 - (2) Industrial heating equipment (equipment used for industrial heating that generates high-frequency energy and that uses output greater than 50 W)
 - (3) Various types of equipment (equipment that imparts high-frequency energy to a load for heat generation or ionization and that uses output greater than 50 W)
- If the usage mode corresponds to "high-frequency application equipment" as defined above, according to Article 26 of the Radio Station License Procedure Regulations, the required application must be submitted to the Bureau of Telecommunications that has jurisdiction over the location where the equipment is installed, and the approval of the Minister of Internal Affairs and Communications must be received.

For details →

Refer to Article 100 of the Radio Law, Article 45 of the Regulations for Enforcement of the Radio Law, Article 26 of the Radio Station License Procedure Regulations, and Article 65 of the Radio Equipment Law.

b) The application forms and instructions can be obtained at the website of each Bureau of Telecommunications, as well as procedure details and information about other documents to be attached to the application forms.

2.6 Radio Law

- c) Applications must be submitted by the person who installed the equipment, since information such as the installation location must be filled in.
- d) This product's external view drawings or photographs are required as attached documents.

For any question or further information, contact an NF Corporation sales representative.

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3.1 Panel Component Designations and Operations

3.1.1 Front panel

The number to the right of each component designation in the figure indicates the section where the component is described in detail.

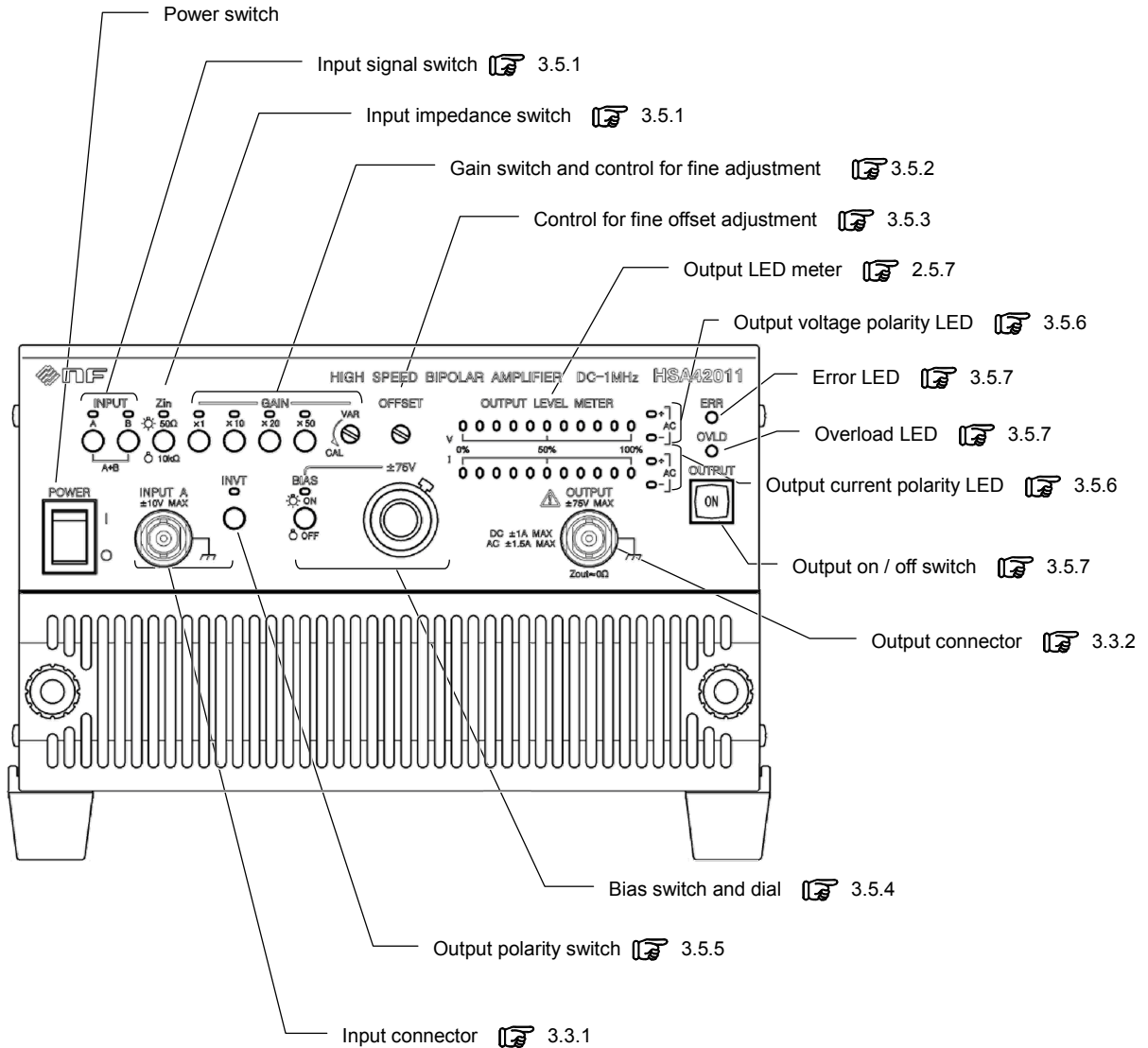


Figure 3-1. Front Panel

3.1.2 Rear panel

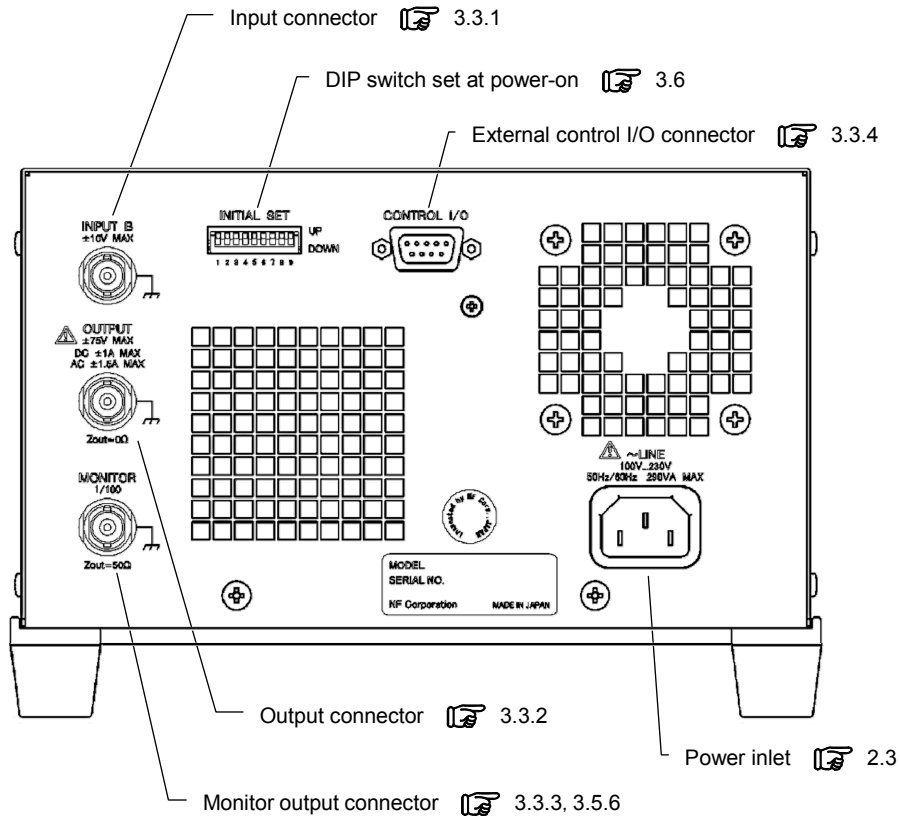


Figure 3-2. Rear Panel

3.2 Indications at Power-on and Initialization

When the power switch is set to ON, the internal circuitry is automatically checked, and this product becomes ready for operation if no abnormality is detected. On the panel, the values set with the DIP switch are set. For the initial setting of the DIP switch, refer to "3.6 Setting at Power-on".

If this product cannot be operated after the power is turned on, a fault has occurred. Turn off the power immediately and then contact NF Corporation or its representative.

For fault diagnosis at Power-on, refer to "5.1.1 Errors at Power-on".

All LEDs above the switches, the 0% LED of output meter LEDs, the overload LED (OVLD), and the error LED (ERR) turn on. After all LEDs above the switches turn off and the error LED (ERR) blink for a few seconds, the overload LED (OVLD) and the error LED (ERR) turn off. Next, when the internal power supply is fixed, the state selected at power-on time is set.

3.3 I/O Terminals

3.3.1 Input connector: A (front)/B (rear)

Signal input connectors are provided. Select A or B with the corresponding input signal selection switches (INPUT A/INPUT B). The LED of the selected input will light. If both of the A and B switches are pressed, both signals are added. However, the maximum input voltage is within ± 10 V for the sum of the 2 inputs.

• Input connector	BNC connector Number of terminal: 2 Input A: Front panel, Input B: Rear panel The Lo side is connected to the chassis.
• Input impedance	Select $50\ \Omega$ or $10\ \text{k}\Omega$. (Unbalanced, A and B two inputs are collectively switched)
• Maximum input voltage	± 10 V
• Non-destructive maximum input voltage	± 11 V

CAUTION

This product may be damaged if a voltage beyond the non-destructive maximum input voltage (± 11 V) is applied.

Never apply a voltage beyond ± 11 V.

3.3.2 Output connector (Main output)

A main output connector is provided.

For output voltage signal setting, refer to "**3.5.2 Output voltage adjustment**" to "**3.5.5 Output polarity switching**".

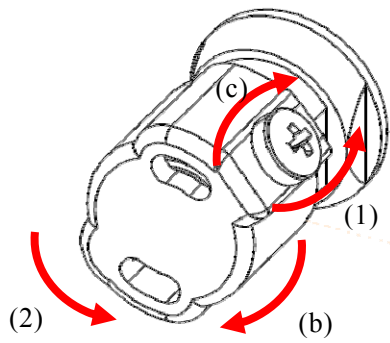
- Output connector BNC connector
 Number of terminal: 2 (front panel and rear panel)
 The Lo side is connected to the chassis.
 The front panel and rear panel terminals are connected in parallel.
- Maximum output voltage Resistance load 50 Ω
 53 Vrms 40 Hz to 1 MHz
 45 Vrms 20 Hz to 40 Hz
 Resistance load 75 Ω
 ± 75 V DC to 1 MHz
- Maximum output current (AC) 1.06 Arms, 3 Ap-p (40 Hz to 1 MHz)
- Maximum output current (DC) ± 1 A
- Output impedance $[0.19 + 0.0155\sqrt{f} \times (1 + j)] \Omega$ or less (typ.)
 f represents frequency, its unit is Hz

WARNING

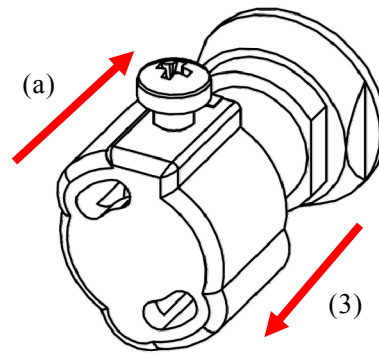
The maximum output voltage of this product is ± 75 V. An electric shock can occur if the output connector is directly touched. For safe use, be sure to observe the following:

- Turn off the power when making connections.
- Do not touch the output connector, output cable ends, load, or connected device terminals when the power is on. In particular, never touch these parts with wet hands.

This product has two output connectors. For safety, attach the BNC cover to those that are not connected to a load.



- How to remove the BNC cover
- (1) Loosen the screw.
- (2) Rotate the BNC cover counterclockwise.
- (3) Pull out the BNC cover.



- How to attach the BNC cover
- (a) Put in the BNC cover.
- (b) Rotate the BNC cover clockwise.
- (c) Tighten the screw.

Figure 3-3. How to remove and attach the BNC cover

3.3.3 Monitor output connector

This product has a monitor output connector for observing an output voltage. An output waveform can be observed by connecting an oscilloscope directly to the connector.

The monitor output connector outputs a voltage, regardless of the output on/off setting. A voltage as small as 1/100 of the main output level is output.

- Output terminal BNC connector (rear)
- Monitor ratio 1/100 of output voltage (in phase as output voltage)
- Output impedance 50 Ω

3.3.4 External control I/O connector

This product has an external control I/O connector with D-sub 9 pins.

To turn on output with the external control I/O function, turn on the power after depressing DIP switch 4 to be set at Power-on. (A DIP switch setting change made after operation is started is not reflected.)

Output on/off control can be exercised externally by using a no-voltage contact. (About the example used external switch Refer to “**Figure 3-5. Example for I/O control by using external switch**”.)

If output is turned on with the external control I/O function, the output on/off switch (OUTPUT) on the front panel can only be set to OFF.

To turn on output again after output is turned off using the output on/off switch (OUTPUT), the control signal must first be turned off prior to turning on.

The overload state and output on/off state can be monitored externally. The overload state is indicated when a short circuit is made between pins 3 and 8. The output on state is indicated when a short circuit is made between pins 9 and 5.

After the external signal input level was changed, approx. 10 ms or more might be required for the controller to execute a function as a maximum response time. “Output ON/OFF” additionally requires the similar time for a response of a relay device.

Table 3-1. List of External Control I/O Connector Pins

(See "Figure 3-4 External Control I/O".)

Pin No.	Name	Description
1	+5 V	Power supply for external output on/off (50 mA or less)
6	External output on/off (A)	Connected to the primary side of the photocoupler via 150 Ω
2	External output on/off (K)	
7	+5 V common	Connected to the +5 V common potential (chassis potential) via 100 Ω
4	Not used	—
3	Overload (C)	The overload state is set when a short circuit is made between pins 3 and 8. (15 V or less and 10 mA or less between the pins)
8	Overload (E)	
9	Output on/off (C)	The output on state is set when a short circuit is made between pins 9 and 5. (15 V or less and 10 mA or less between the pins)
5	Output on/off (E)	

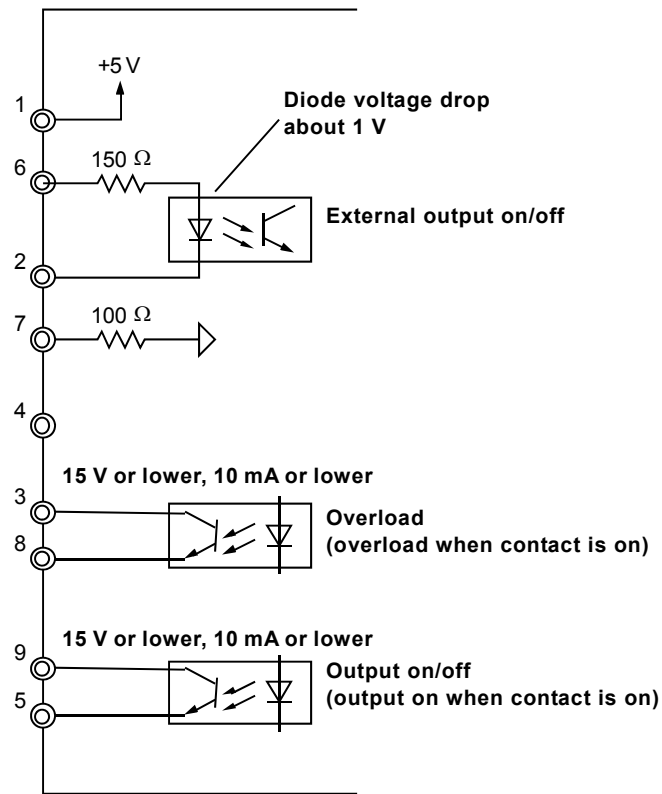


Figure 3-4. External Control I/O

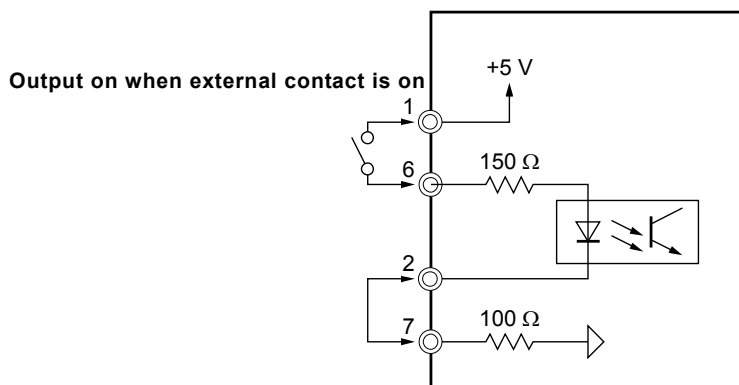


Figure 3-5. Example for I/O control by using external switch

3.4 I/O Connection

Figure 3-6 Basic Connection Diagram shows the connection diagram.

For full performance of this product, connect a signal generator, signal cords, and a load, observing the descriptions provided in "**3.4.1 Signal generator**" through "**3.4.3 Load**".

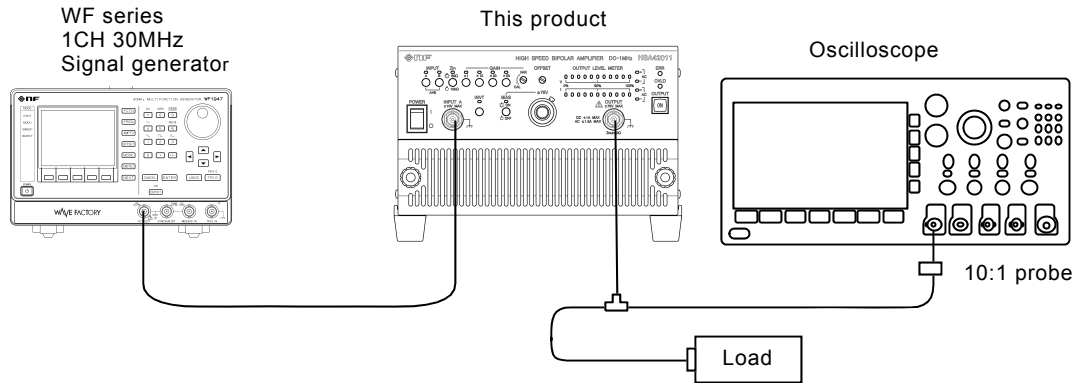


Figure 3-6. Basic Connection Diagram

3.4.1 Signal generator

When using a high frequency of 100 kHz or higher, use a signal generator with an output impedance of 50 Ω and set the input impedance of this product to 50 Ω .

When the output impedance of a signal generator is not 0 Ω but 50 Ω , for example, the output voltage of the signal generator needs to be set considering the input impedance of this product.

To obtain a necessary input voltage, set the voltage of the signal generator as follows:

$$\left(1 + \frac{\text{Output impedance of signal generator}}{\text{Input impedance setting of this product}} \right) \text{Times}$$

* With WF series, an output voltage for an arbitrary load impedance (1 Ω to 10k Ω) can be set.

3.4.2 Signal cords

For an input cord, use a coaxial cable.

For an output cord, similarly, attach a BNC connector near a load and use a coaxial cable.

When a high frequency is used, maximum power may not be supplied to a load because the output voltage of this product is partly consumed due to the inductance of the wire. If a capacitive load is used, LC resonance can occur with the wire inductance, resulting in ringing. Run a wire along a route as short as possible.

To avoid these effects, the inductance needs to be reduced, taking the length, structure, and material of the wire into consideration.

3.4.3 Load

Attach a BNC connector near a load, and make a connection by using a coaxial cable.

Place a load as close to this product as possible.

3.5 Examples of Basic Operations

3.5.1 Input selection and input impedance selection

Connect the output signal of the signal generator to input connector A or B through a coaxial cable.

Press input signal switch A or B (INPUT) connected to input connector A or input connector B, then select 50 Ω or 10 k Ω with the input impedance switch (Zin).

CAUTION

This product may be damaged if a voltage beyond the non-destructive maximum input voltage (± 11 V) is applied.

Never apply a voltage beyond ± 11 V.

When a waveform produced by adding two signals is needed, connect the signal generators to both of input connectors A and B, then press both of the input signal switches A and B. Set an addition ratio by adjusting the level of the connected signal generator.

When the output impedance of the signal generator is not 0 Ω but 50 Ω , for example, set the output voltage of this product by considering the input impedance of this product.

 Refer to "3.4 I/O Connection".

Note that even if the input signal switch (INPUT) or the input impedance switch (Zin) is pressed again before 1 second elapses after switching the input connector or input impedance, the input connector or the input impedance is not switched. To switch the input connector or input impedance in succession, insert a pause of at least 1 second.

3.5.2 Output voltage adjustment

A gain in the $\times 1$ to $\times 150$ range can be set by using the gain switch (GAIN), $\times 1$, $\times 10$, $\times 20$, and $\times 50$, and the control for fine adjustment (VAR) on the front panel.

Fine adjustment (VAR) can adjust gain for $\times 1$ to $\times 3$ range. When fine adjustment (VAR) turned completely in direction CAL, its gain becomes $\times 1$.

To obtain a maximum output voltage of 53 Vrms, the signal generator needs to generate an output voltage of at least 0.36 Vrms (gain 150 times)

Note that the gain is not switched even if a gain switch (GAIN) is pressed again before 1 second elapses after switching the gain. To switch the gain in succession, insert a pause of at least 1 second.

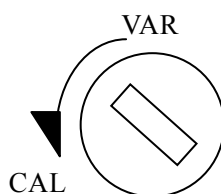


Figure 3-7. CAL Position of Control for Fine Adjustment (VAR)

3.5.3 Fine output offset adjustment

If trouble occurs because a DC component is superimposed on the signal due to inductance, make a fine adjustment to set the offset voltage included in the output signal of this product to zero. Before performing fine offset adjustment, wait for 30 minutes hour until the initial drift is stabilized after power-on.

Use the following procedure for fine offset voltage adjustment:

1. The output offset voltage varies depending on the gain setting, so set an output gain firstly.
2. Disconnect the input cord from the input connector.
3. Select the input to which the signal generator is connected by using the corresponding INPUT switch.
4. Set the input impedance to 50 Ω or 10 k Ω by using the Zin switch.
5. Connect a DC voltmeter (such as a digital voltmeter) to the output connector.
6. After the output on/off switch (OUTPUT) to ON, adjust the DC output voltage to zero by using the potentiometer (OFFSET on the front panel) for fine offset tuning.

Note: This function is for making fine adjustment to set the offset voltage included in the output signal to zero. Do not use this function when adding DC voltage to the output signal.

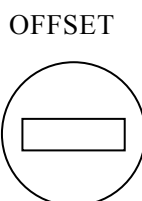


Figure 3-8. Center Position of Offset Fine Adjustment

3.5.4 DC bias addition

This product can add a DC voltage onto an output voltage signal for output.

For this setting, set the bias switch (BIAS) to ON and use the bias dial. A bias voltage beyond ± 75 V.

An added voltage can be monitored on the output LED meter, if the input level is zero.

The relationship between a dial scale mark and output bias voltage can be calculated as indicated below.

The polarity of a DC bias is not switched by the output polarity switch (INVT).

$$\text{Bias output voltage} = (\text{Set scale mark} - 5.00) \times 17.5 \text{ Vdc}$$

Note that the bias on/off state is not switched even if the bias switch (BIAS) is pressed again before 1 second elapses after switching the bias on/off state. To switch the bias on/off state in succession, insert a pause of at least 1 second.

CAUTION

The overload LED (OVLD) is turned on, if an output voltage exceeds the output voltage range. When adding a DC bias, ensure that the waveform does not clip.

Note: This function is for adding DC voltage to the output signal. Do not use this function when making fine adjustment to set the offset voltage included in the output signal to zero.

3.5.5 Output polarity switching

The output polarity can be set to be in-phase or reversed-phase by using the output polarity switch (INVT) on the front panel.

The LED on the output polarity switch (INVT) is turned on when the output polarity is in reversed phase. Note that the output polarity is not switched, even if the output polarity switch (INVT) is pressed again before 1 second elapses after switching the output polarity. Insert a pause of at least 1 second to switch the output polarity in succession.

3.5.6 Output voltage monitoring

Output voltage: An output voltage can be monitored by using the monitor output connector on the rear panel and the output LED meter on the front panel.

Output voltage: An output current can be monitored by using the output LED meter on the front panel.

- **Monitor output connector**

An output waveform can be observed by connecting an oscilloscope directly.

A waveform is output on the monitor output connector, regardless of the output on/off setting. A voltage with the level corresponding to 1/100 of the main output level is output.

- **Output LED meter**

With 11 LEDs, the level of 0% to 100% is displayed with the output voltage full scale of 75 V and the output current full scale of 1.06 A as 100%. The output meter is calibrated so that an RMS value is shown for a sine wave according to the full-wave rectified average detection method.

An average value is shown when an AC is superimposed on a DC. Examples are provided below.

- When a sine wave of 5 Vrms is superimposed on a DC of +10 V: Level of 10 V is shown.
- When the DC level is zero, and a sine wave of 5 Vrms is given: Level of 5 V is shown.

A polarity is shown by a meter polarity LED. The meter polarity LED for "+" turns on when positive voltage/current is output. The LED for "-" turns on when negative voltage/current is output. Both LEDs are turned on for an AC output voltage. The LEDs turn on alternately for a low frequency.

3.5.7 Output on/off control

The main output signal can be turned on or off by using the output on/off switch (OUTPUT) on the front panel or external control input. When external control is used, however, the output on/off switch (OUTPUT) can only be set to OFF.

The LED in the output on/off switch (OUTPUT) turns on when output is turned on.

The LED blinks when output is turned off by the protection function of this product.

For protection cancellation, press the output on/off switch (OUTPUT).

When output is turned off, an attempt to turn on output can be accepted only after 2 seconds elapse for safety.

To turn on output again, wait for at least 2 seconds after output is turned off.

A relay contact is used to turn on and off output. To protect the relay circuit, a muting circuit is actuated at the time of output on/off switching, so that the monitor output indicates zero for a very short period and voltage display on the output LED meter may fluctuate.

When output overcurrent, excessive internal power loss, abnormal internal temperature, or output overvoltage is detected, the protection function activates and the overload LED turns on.

When the overload LED is on, output cannot be turned on.

When output overvoltage is detected while output is on, output is turned off.

For other overload factors, output turns off when overload lasts 10 seconds or more.

[Precautions in use]

The relays switching the outputs on and off are the life span parts. Again and again switching the outputs on and off may damage the relays. In particular, under conditions of use that switching the outputs on and off frequently, failure may occur even within the warranty period of this product. So, please avoid such usage.

CAUTION









A high voltage can occur at the load when output is turned off if a load including an inductance component is connected, so be careful not to change the load current abruptly.

3.6 Setting at Power-on

Initial values for start-up time can be set by using the DIP switch on the rear panel.

"Table 3-2 List of DIP Switch Settings" indicates the function of each switch. Refer to each section indicated in the column "Section to be referenced" for setting details.

Table 3-2. List of DIP Switch Settings

No.	Function			Section to be referenced
1	Output on/off			 3.5.7 Output on/off control
	DOWN	Output on		
	UP	Output off		
2, 3	Output voltage gain setting			 3.5.2 Output voltage adjustment
	2	3	Gain	
	UP	UP	×1	
	DOWN	UP	×10	
	UP	DOWN	×20	
	DOWN	DOWN	×50	
4	External control on/off			 3.3.4 External control I/O
	DOWN	External control on		
	UP	External control off		
5	Output polarity inversion on/off			 3.5.5 Output polarity switching
	DOWN	Output polarity inversion on		
	UP	Output polarity inversion off		
6	Input on/off from input connector A			 3.5.1 Input selection and input impedance selection
	DOWN	A input on		
	UP	A input off		
7	Input on/off from input connector B			 3.5.1 Input selection and input impedance selection
	DOWN	B input on		
	UP	B input off		
8	Input impedance setting			 3.5.1 Input selection and input impedance selection.
	DOWN	50 Ω		
	UP	10 kΩ		
9	DC bias on/off			 3.5.4 DC bias addition
	DOWN	DC bias on		
	UP	DC bias off		

4. ADVANCED OPERATIONS

4.1	Maximum Output Current and Operation Range	4-2
4.2	Increasing of Output	4-4

4.1 Maximum Output Current and Operation Range

This product has a protection circuit that detects an output current and internal loss to limit the output current. A maximum output current is determined by this protection circuit. This limitation value varies, depending on the output time and output voltage. The relationships are shown in "Figure 4-1 Operation Range".

Each graph shows an AC (40 Hz) peak value range and a DC range.

In general, if the load is resistive for an AC signal, quadrants I and III cover an operation range. If the load is capacitive or inductive, all four quadrants cover an operation range.

If the load involves an electromotive force with a DC signal, and an operation is performed to supply current from the load, quadrants II and IV cover an operation range.

For square wave input, when waveform rise/fall is fast, even if a lower frequency (period) is used, the output current protection range may be reached by a charge current for output cable capacitance or stray capacitance inside this product, resulting in overload even if no load. In this case, decrease output voltage or slow the waveform rise/fall by using a signal generator (e.g., WF1947) that is capable of controlling waveform rise/fall.

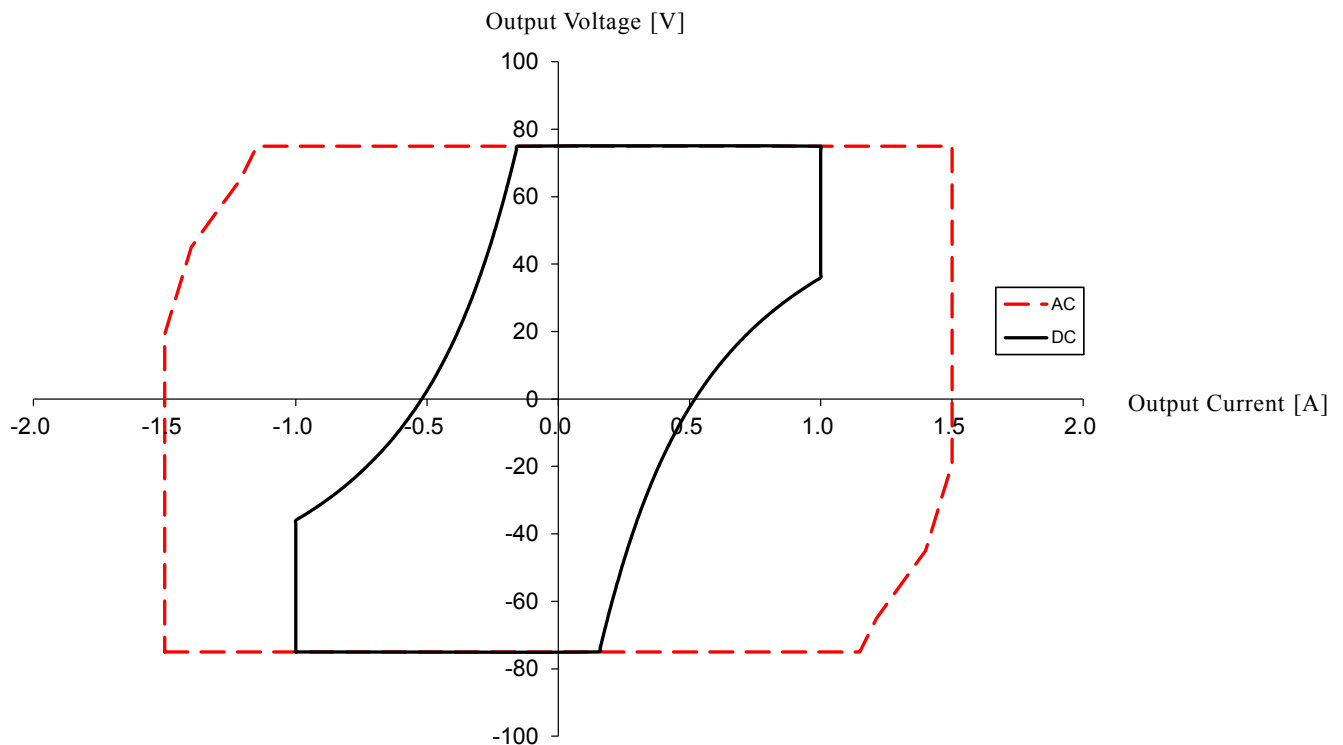


Figure 4-1. Operation Range

Shown below is an operation range in the case where the signal waveform is asymmetric with regard to polarity and a DC current is generated.

When a waveform as shown in "**Figure 4-2 Current Waveform Asymmetric with Regard to Polarity**" is given, separate the positive portion and negative portion from each other and consider the average value (+I_{ave}) and peak value (+I_{pk}) on the positive side, and consider the average value (–I_{ave}) and peak value (–I_{pk}) on the negative side.

The average values (+I_{ave}, –I_{ave}) and peak values (+I_{pk}, –I_{pk}) are limited by the DC operation limitation range and AC peak operation limitation range, respectively.

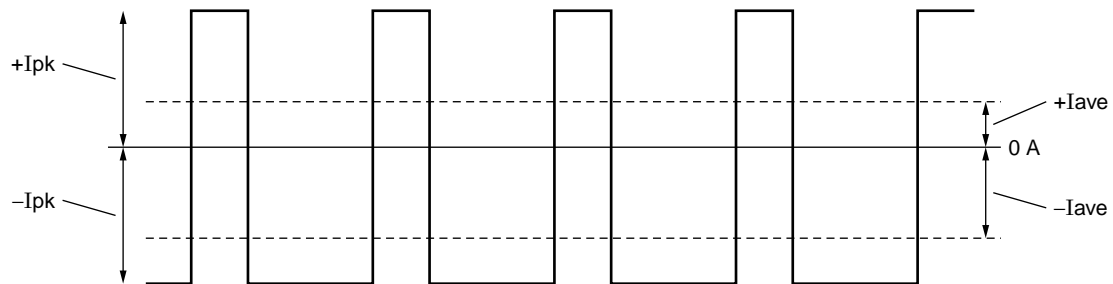


Figure 4-2. Current Waveform Asymmetric with Regard to Polarity

4.2 Increasing of Output Voltage by Balanced Output

The maximum output voltage can be doubled by using two product units. The maximum output current remains unchanged from the current output when one unit is used. Be sure to use the same type of high-speed bipolar amplifier.

As shown in "Figure 4-3 Connection of Two Units", divide the output of a signal generator with a T-type adapter for connection to the input connector (A or B) of each unit.

Set the output polarity switch (INVT) on one unit to INVT so that the output phase is opposite to that of the other unit. Set the input impedance to 10 k Ω on both units. Set the same gain on both units.

Connect a load between the outputs of the two units as shown in "Figure 4-3 Connection of Two Units". At this time, the connection terminal of a load cannot be connected to the chassis of this product or the signal generator. When a load is used in this mode of connection, the load must therefore be isolated from the ground potential and signal source.

Note that the polarity of the bias remains unchanged even when reversed phase (INVT).

The frequency characteristic, maximum output voltage, and maximum output current may be degraded than the specifications.

CAUTION

- The connection terminal of a load cannot be connected to the chassis of this product or the signal generator.
- Isolate the load from the ground potential and signal source.
- Check the output voltage with a high voltage differential probe.
- Near the maximum output voltage and maximum output current, the balance between the two units may be lost and the operation may become unstable, resulting in damage to the load.

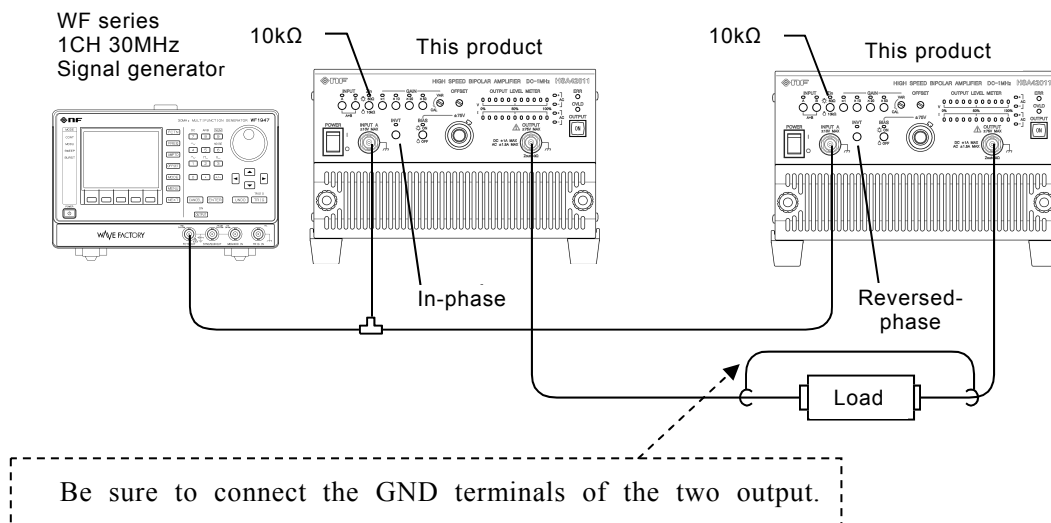


Figure 4-3. Connection of Two Units

5. TROUBLESHOOTING

5.1	Error Messages	5-2
5.1.1	Errors at Power-on	5-2
5.1.2	Errors related to the protection function	5-3
5.2	When Fault Symptoms Are Observed	5-5

5.1 Error Messages

Self-diagnosis is performed when the power is turned on. If an error is detected, the error state is set. The error state is also set when a wrong operation is performed.

Errors and their causes are described below, together with required actions.

5.1.1 Errors at Power-on

This product performs self-diagnosis when the power is turned on.

If an abnormality is found, contact NF Corporation or its representative.

Table 5-1. Diagnosis Performed at Power-on

Diagnosis item	Description
LED glow check	Visually check that all LEDs above the switches, the 0 % LED of output meter LEDs, the overload LED (OVLD), and the error LED (ERR) glow for about 1 second.
ROM sum check	Check whether the ROM is normal. If an abnormality is detected, this product cannot be operated.

5.1.2 Errors related to the protection function

The errors related to the protection function are shown below.

Contact NF Corporation or its representative if an abnormality is found.

Table 5-2. Errors Related to Protection Function (1/2)

State	Cause	Description
Overload	Output exceeded the allowable output voltage/current range of this product.	The overload LED (OVLD) is on. Output cannot be turned on in the overload state.
		If the overload state lasts for 10 seconds, output is turned off and the LED in the output on/off switch (OUTPUT) then blinks.
		The LED blink can be reset by pressing the output on/off switch.
		If the overload state lasts for 60 seconds, a transition is made to disable mode, and the overload LED (OVLD) blinks. This product cannot be operated in disable mode, so turn off the power.
		If the overload LED (OVLD) is on even when the input signal, bias, and output are off, this product may have failed.
Abnormal temperature	The internal temperature is abnormally high.	The overload LED (OVLD) is on. Output cannot be turned on when the temperature is abnormal.
		Output is turned off if the abnormal temperature state lasts for 10 seconds. The LED in the output on/off switch (OUTPUT) blinks at this time.
		The LED blink can be reset by pressing the output on/off switch.
		If the abnormal temperature state lasts for 60 seconds, a transition is made to disable mode, and the overload LED (OVLD) blinks. This product cannot be operated in disable mode, so turn off the power.
		If the overload LED (OVLD) is on even when the input signal, bias, and output are off, and the ambient temperature satisfies the specification, this product may have failed.

Table 5-3. Errors Related to Protection Function (2/2)

State	Cause	Description
Abnormal output voltage	Output voltage or voltage applied to the output terminal is an overvoltage.	<p>The overload LED (OVLD) is on.</p> <p>Output cannot be turned on when the output voltage is abnormal.</p> <p>Output is turned off immediately if an abnormal output voltage is detected when output is turned on. The LED in the output on/off switch (OUTPUT) blinks at this time.</p> <p>The LED blink can be reset by pressing the output on/off switch.</p>
		<p>A transition is made to disable mode, and the overload LED (OVLD) blinks if the abnormal output voltage state lasts for 60 seconds. This product cannot be operated in disable mode, so turn off the power.</p> <p>If the overload LED (OVLD) is on even when the input signal, bias, and output are off, this product may have failed.</p>
Internal power supply abnormality	Voltage of amplifier DC power supply (internal power supply) is lower than specification.	<p>Operations other than power-off are disabled while the LEDs are blinking.</p> <p>Turn off the power, and then turn it on again.</p> <p>If the LEDs keep blinking, this product may have failed.</p>

5.2 When Fault Symptoms Are Observed

When a fault symptom shown below is observed, perform the corresponding action required. Contact NF Corporation or its representative if the symptom cannot be corrected.

Table 5-4. When Fault Symptoms Are Observed (1/2)

Symptom	Possible cause	Action required
This product does not operate when the power switch is turned on.	This product is not connected to a live power.	Securely connect the power cord to a live power outlet and to the inlet of this product.
There is no output.	Signal not connected.	Connect the signal generator and correctly select an input signal selection switch.
	Input selection not made.	
	The output on/off switch (OUTPUT) is not set to ON.	Set the output on/off switch to ON.
	The output on/off switch (OUTPUT) cannot be set to ON.	Output cannot be turned off when the overload LED (OVLD) is turned on. Release the condition for turning on the overload LED referring to the required action shown in " Table 5-2 Errors Related to Protection Function (1/2) " for a case where the overload LED (OVLD) is turned on. When the overload LED (OVLD) is blinking, all switch operations are disabled. Turn off the power switch. Release the condition for blinking the overload LED then turn on the power switch referring to the required action shown in " Table 5-2 Errors Related to Protection Function (1/2) " for a case where the overload LED (OVLD) blinks.
The output voltage waveform is distorted when the overload LED (OVLD) is off.	AC peak current protection is working.	Overload occurs. If you drive a capacitive load with square wave, the output current flows more when the output voltage waveform rises or falls than when it is steady. Lower the load within the maximum output current (AC peak value) referring to " 4.1 Maximum Output Current and Operation Range " or slow the rise time or fall time of the input signal or lower the input signal (output voltage).
Overload occurs when the input signal is a square wave, even if with no load.	Since the input signal quickly rises and falls, the current that is charged to the stray capacitance in this product reaches the peak current protection level.	Lower the input signal (output voltage) or use a signal generator, such as the NF WF1947, that controls the rise and fall of waveforms to decrease the rise and fall time.

Table 5-5. When Fault Symptoms Are Observed (2/2)

Symptom	Possible cause	Action required
The overload LED (OVLD) is on.	An overload is imposed.	If the overload LED is turned off by removing the load, connect a load within the maximum allowable output range or reduce the output level.
	The signal level of the signal generator is excessively high.	Lower the level of the connected signal generator.
	An incorrect gain setting is made.	Set a proper gain by using a gain switch (GAIN).
	The ambient temperature is high.	When using this product, ensure that the ambient temperature is 40°C or below.
	The air filters are clogged.	Referring to " 6.2 Daily Maintenance ", clean the air filters.
	There is an obstacle to air circulation near the front panel air inlet or rear panel air outlet.	Install this product to satisfy the installation conditions described in " 2.2 Installation ".
	A voltage beyond the maximum allowable output of each voltage range is output.	The input signal level may be too high. Lower the input signal level. When bias addition is on, lower the bias addition level. Depending on the load, output voltage is higher than the voltage determined by the input voltage \times gain due to resonance.
DC is output.	Bias addition is set to ON.	Set bias addition to OFF with the bias (BIAS).
	DC voltage is superimposed onto the signal source.	Adjust the DC component of the signal generator to zero.
The output on/off switch (OUTPUT) blinks and output is turned off even when the overload LED (OVLD) is not turned on.	This product has turned off output since the overload state has lasted for 10 seconds or more.	An overload is imposed. Connect a load within the maximum allowable output range or reduce the output level.
	Protection against abnormal output voltage has been actuated.	Overcurrent protection may be actuated when an inductive load is connected, resulting in overvoltage output. Finely adjust the output offset voltage to zero, referring to " 3.5.3 Fine output offset adjustment ".

6. MAINTENANCE

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6.1 Introduction

This chapter describes the following:

- Notes on long-term storage and the method of storage
- Notes on transportation and repacking for transportation
- Performance test required, for example, for preventive maintenance, acceptance testing, and performance confirmation after repair

See section "**2.4 Simplified Operation Check**" for simplified operation checking.

Contact NF Corporation for calibration or repair if an operation check or performance test cannot be made successfully.

6.2 Daily Maintenance

- When the panel or case surface is soiled

Wipe off stains with a soft cloth. Wipe resistant stains with a cloth that has been soaked in a neutral detergent solution and then wrung well.

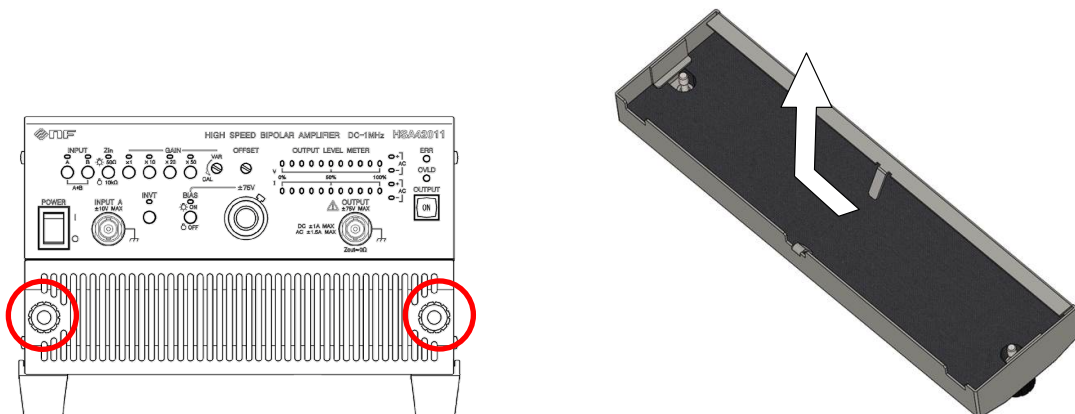
Do not use a volatile solvent such as a thinner or benzene, or a chemical wipe, which may degrade the material quality or remove the paint.

- When the air filter is dirty

The air intake vent on the front panel has an air filter for removing dust and dirt from input air.

Dust and dirt adhering to the filter, if not removed, can clog the filter and reduce the air flow, causing the temperature inside this product to rise and lowering its reliability. Periodically check the air filter for dust and dirt. Clean the air filters monthly, in general, when a fine buildup of dust or dirt is observed on the filter.

If the air filter is dirty, remove the dust and dirt from the filter by washing them in water and reinstall the filter after completely drying them.



- (1) Unscrew the right and left screws of the intake vent on the front panel.
- (2) The intake vent is disengaged from the main unit, so hold the left and right ends of the intake vent and pull it entirely toward you until it comes off the main unit.
- (3) Remove an air filter from the rear side of the intake vent and clean the filter.
- (4) When the air filter has dried completely, reinstall the intake vent by reversing steps (1) through (3).

Figure 6-1. Air Filter Cleaning Procedure

The air filter will not function normally if the filter is soiled by very fine dust (fine powder) or clogged. Do not install this product in a place where this product is exposed to much dirt and dust (including fine powder) or the humidity is high and condensation can easily occur.

6.3 Storage, Repacking, and Transportation

- Long-term storage

- Disconnect the power cord from the power outlet and the main unit.
- Store this product in a place, e.g., on a shelf or rack, so that no object will fall on this product and it will not be exposed to dust.

If this product may be exposed to dust, place a cloth or polyethylene cover on this product.

- The environment conditions allowable are: -10°C to $+50^{\circ}\text{C}$ and 5% to 95% RH. Avoid placing this product in a place that experiences steep temperature changes and is exposed to direct sunlight, and store this product at room temperature whenever possible.

- Repacking and transportation

Note the following when repacking this product for transportation or repair:

- Enclose the main unit with a polyethylene envelope or sheet.
- Prepare a corrugated cardboard box that can sufficiently withstand the weight of the main unit and is large enough.
- When repacking this product, insert cushioning materials to protect the six faces of the main unit.
- When asking a carrier to transport this product, notify the carrier that this product is a precision device.
- Be sure to include the instruction manual at transportation.

6.4 Performance Testing

Performance testing is conducted as part of preventive maintenance to prevent performance degradation of this product. Performance testing is also conducted as part of acceptance inspection, periodic inspection, performance verification after repair, and so forth.

If the result of a performance testing does not meet the specifications, calibration or repair is required.

WARNING

This product contains high-voltage parts. Never remove the cover.

All internal inspections of this product are to be performed only by service engineers qualified by NF Corporation.

- The following measuring instruments are used for performance testing.

Measuring instrument	Major performance	Recommendation
Signal generator	20 Hz to 1 MHz Sine wave, 20 Vp-p	WF1947 of NF Corporation
AC voltmeter	10 Hz to 1 MHz, 1 mV to 100 V	3458A of Keysight
DC voltmeter	0 to ± 100 V	
Frequency response analyzer	10 Hz to 1 MHz	FRA51602 of NF Corporation
Oscilloscope	DC to 50 MHz, 10 mV to 100 V	MDO3032 of Tektronix
Spectrum analyzer		
THD meter	40 Hz to 100 kHz, 0.1%FS	2015 of Keithley
Terminating resistor	50 Ω $\pm 1\%$ /allowing application of 50 W, and 75 Ω $\pm 5\%$ /allowing application of 75 W	

CAUTION

- As a terminating resistor (50 Ω), use a pure resistor with a minimum parallel capacitance and inductance component in the DC to 1 MHz range.
- For output wiring, use a coaxial cable of 50 Ω not exceeding a total length of 50 cm.
- Be sure to use a 10:1 probe when connecting an oscilloscope.
- Be sure to use a 1/100 voltage divider resistance when connecting a spectrum analyzer.

- Check the items shown below before conducting a performance testing.

 See "3.5.3 Fine output offset" for the method of fine tuning.

- Check that the supply voltage range is 90 V AC to 250 V AC.
- Check that the ambient temperature is within the range 5°C to 35°C, and the ambient humidity is within the range 5% to 85% RH.
- Check that there is no condensation.
- Check that 30 minutes or more has elapsed after the power has been turned on.

6.4.1 Measurement of maximum output voltage (AC)

- Connection

Connect a signal generator, AC voltmeter, oscilloscope, and terminating resistor as shown in "Figure 6-2 Measurement of Maximum Output Voltage".

- Setting

Set this product as follows:

Item	Setting
Input	A
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Gain setting	$\times 50$ (CAL)
Terminating resistor	50 Ω

- Test procedure

<1> Set the waveform of the signal generator to sine wave, and set the frequencies shown in "Table 6-1 Judgment of HSA42011 Performance".

<2> Set the output on/off switch of this product to ON.

<3> Increase the output voltage of the signal generator gradually from 0 V.

<4> Observe the waveform on the oscilloscope. Record the output voltage value when the waveform begins to be distorted or the overload LED (OVL D) begins to be glow.

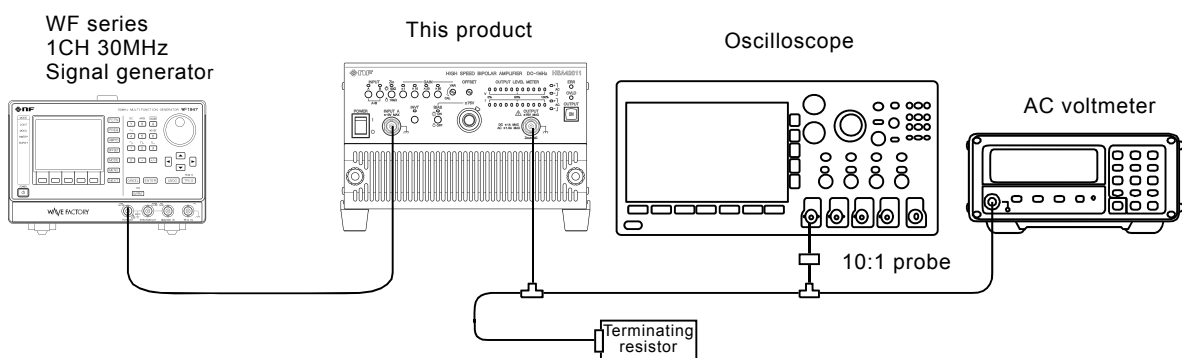


Figure 6-2. Measurement of Maximum Output Voltage (AC)

6.4.2 Measurement of maximum output Voltage (DC)

- Connection

Connect a signal generator, DC voltmeter, and terminating resistor as shown in "Figure 6-3 Measurement of Maximum Output".

- Setting

Set this product as follows:

Item	Setting
Input	OFF for both of A and B
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Gain setting	$\times 50$ (CAL)
Terminating resistor	75 Ω

- Test procedure

- <1> Set the output on/off switch of this product to ON.
- <2> Set bias addition to ON, and increase the dial gradually from 5.00.
- <3> Record the output voltage value immediately before the overload LED (OVL D) lights.

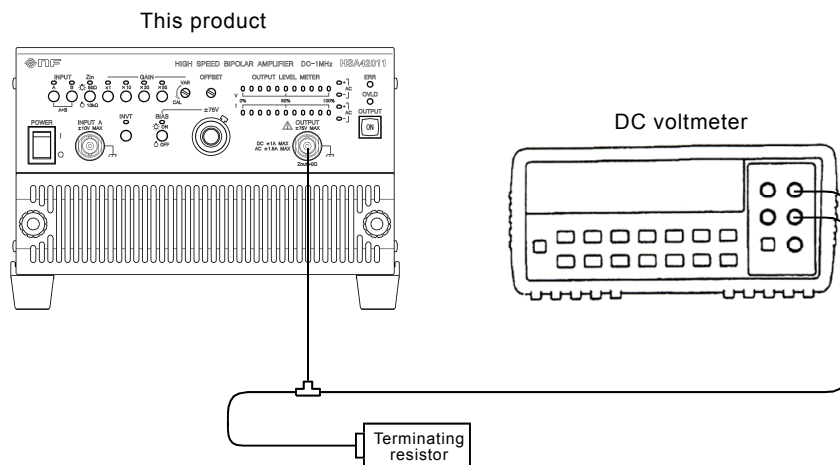


Figure 6-3. Measurement of Maximum Output Voltage (DC)

6.4.3 Measurement of frequency characteristics

- Connection

Connect a frequency response analyzer (FRA) and terminating resistor as shown in "Figure 6-4 Measurement of Frequency Characteristics".

- Setting

Set this product as follows:

Item	Setting
Input	A
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Gain setting	$\times 50$ (CAL)
Terminating resistor	50 Ω

Set the FRA as follows:

Item	Setting
Output	Sine wave 0.565 V _{peak}
Sweep frequency	100 Hz to 1 MHz, log sweep
Analysis	ch1/ch2
Indication	logF–logR– θ

- Test procedure

<1> Turn on the outputs of this product and FRA.

<2> Perform UP (or DOWN) sweep operation for measurement at 100 Hz to 1 MHz.

<3> Move the cursor after measurement to read the gains at 400 Hz, 100 kHz, 500 kHz, and 1 MHz.

6.4 Performance Testing

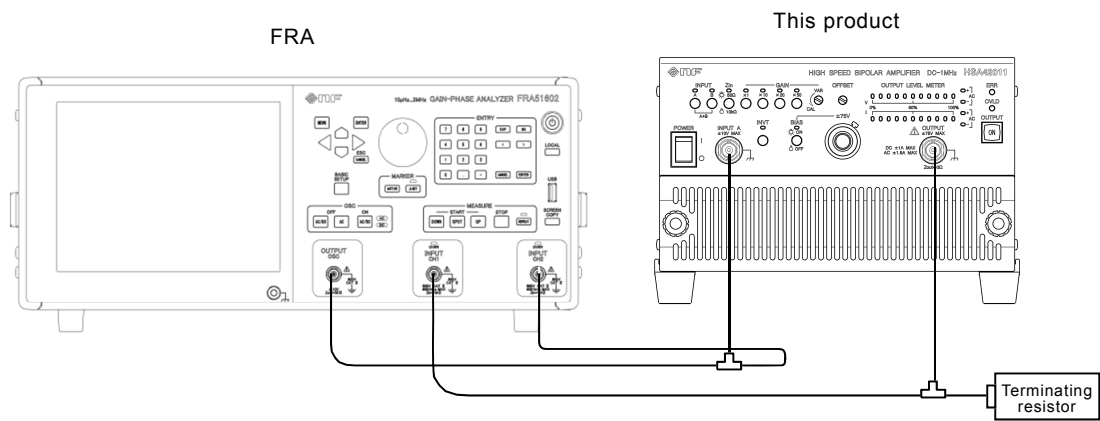


Figure 6-4. Measurement of Frequency Characteristics

6.4.4 Measurement of gain accuracy

- Connection

Connect an FRA and terminating resistor as shown in "**Figure 6-4 Measurement of Frequency Characteristics**".

- Setting

Set this product as follows:

Item	Setting
Input	A
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Terminating resistor	50 Ω

Set the FRA as follows:

Item	Setting
Output	Sine wave
Frequency	400 Hz
Analysis	ch1/ch2
Indication	logF-R- θ

- Test procedure

<1> Set the gain of this product and the output voltage of the FRA as shown in "**Table 6-1 Judgment of HSA42011 Performance**".

<2> Turn on the outputs of this product and FRA.

<3> Make a measurement in the continuous mode.

6.4.5 Measurement of sine wave distortion ratio

- Connection

Connect a signal generator, THD meter or spectrum analyzer and terminating resistor as shown in "Figure 6-5 Measurement of Sine Wave Distortion Ratio".

- Setting

Set this product as follows:

Item	Setting
Input	A
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Gain setting	×50 (CAL)
Terminating resistor	50 Ω

- Test procedure

- 40 Hz, 1 kHz

<1> Adjust the output level of the signal generator so that the output voltage of this product is 40 Vrms.

<2> Measure the sine wave distortion ratio at frequencies of 40 Hz and 1 kHz.

- 100 kHz

<1> Adjust the output level of the signal generator so that the output voltage of this product is 40 Vrms.

<2> Measure the 2nd to 10th harmonic spectrum at a frequency of 100 kHz, and convert it to the distortion ratio.

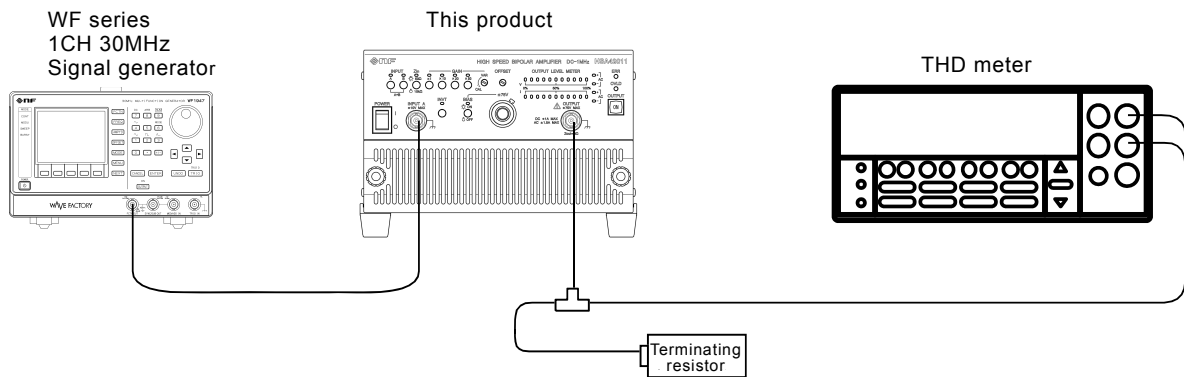
$$\text{Distortion ratio \%} = \sqrt{\frac{\frac{V_2}{10^{10}} + \frac{V_3}{10^{10}} + \dots + \frac{V_{10}}{10^{10}}}{\frac{V_1}{10^{10}}}} \times 100$$

V_1 : Fundamental spectrum [dBm]

V_2 to V_{10} : 2nd to 10th harmonic spectrum [dBm]

6.4 Performance Testing

- 40 Hz, 1 kHz



- 100 kHz

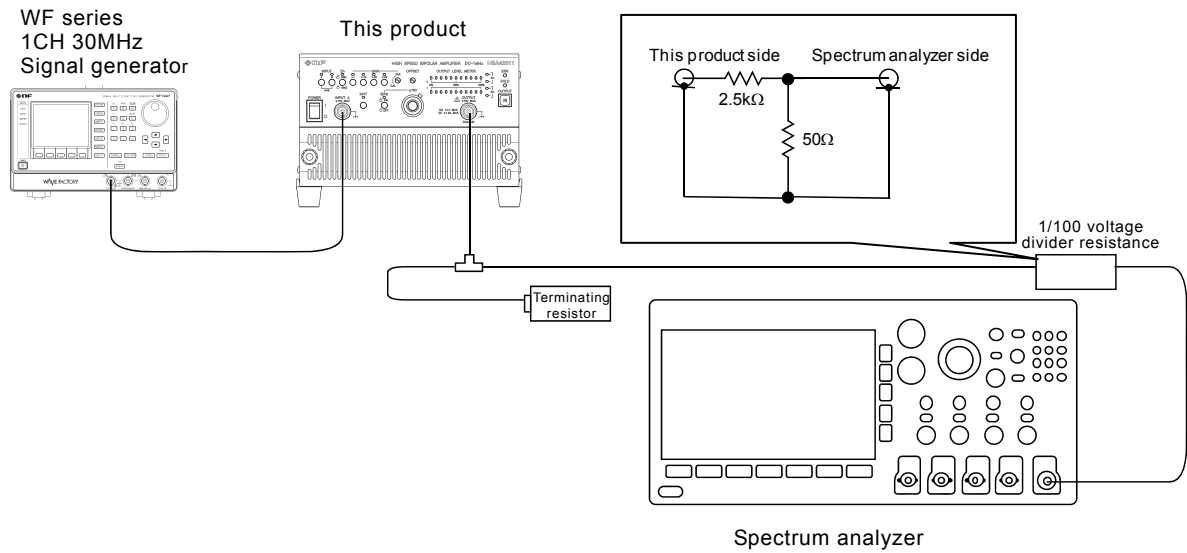


Figure 6-5. Measurement of Sine Wave Distortion Ratio

6.4.6 Measurement of bias-added voltage

- Connection

Connect a DC voltmeter and terminating resistor as shown in "Figure 6-6 Measurement of Bias-Added Voltage".

- Setting

Set this product as follows:

Item	Setting
Input	OFF for both of A and B
Input impedance	50 Ω
Bias addition	OFF, dial 5.00
Polarity switching (INVT)	OFF
Gain setting	$\times 50$ (CAL)
Terminating resistor	50 Ω

- Test procedure

- <1> Before starting a measurement, adjust the offset voltage of this product to zero according to "3.5.3 Fine output offset adjustment".
- <2> Set bias addition of this product to ON and change the dial gradually from 5.00.
- <3> Measure the output voltages at scale marks of 0.71 and 9.29.
- <4> After a measurement, set bias addition to OFF and set the dial to 5.00 for safety.

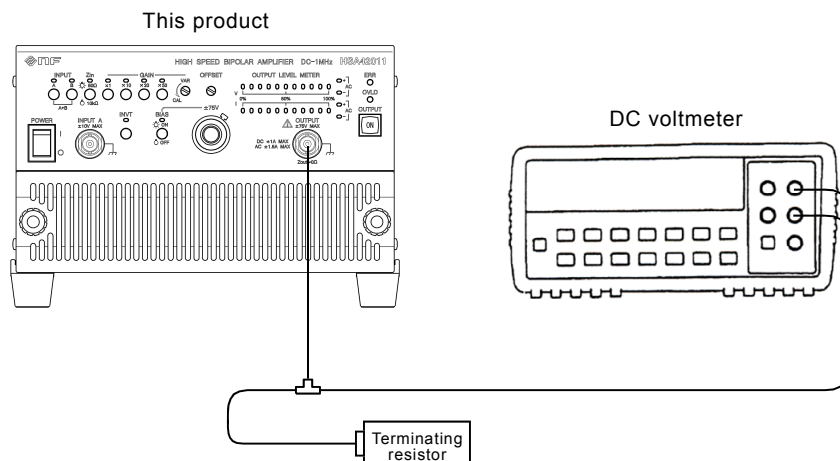


Figure 6-6. Measurement of Bias-Added Voltage

6.4 Performance Testing

The performance of this product is normal if the following criteria are satisfied:

Table 6-1. Judgment of HSA42011 Performance

6.4.1 Measurement of maximum output voltage (at 20 Hz, 40 Hz, 500 kHz, and 1 MHz)	Set frequency	Criterion	Measured value	Judgment
	20 Hz	45 Vrms or more	__ . __	Pass/Fail
	40 Hz	53 Vrms or more	__ . __	Pass/Fail
	500 kHz	53 Vrms or more	__ . __	Pass/Fail
	1 MHz	53 Vrms or more	__ . __	Pass/Fail

6.4.2 Measurement of maximum output power [Voltage immediately before the overload LED (OVLD) is turned on]	Frequency	Terminating resistor	Criterion	Measured value	Judgment
	DC	75 Ω	75 V or more	__ . __	Pass/Fail

6.4.3 Measurement of frequency characteristics (at 100 kHz, 500 kHz, and 1 MHz with the value at 400 kHz used as a reference (0 dB))	Set frequency	Criterion	Measured value	Judgment
	400 kHz	0 dB (reference)	0 . 00	Used as reference
	100 kHz	-1.0 to +1.0 dB	__ . __	Pass/Fail
	500 kHz	-3.0 to +1.0 dB	__ . __	Pass/Fail
	1MHz	-3.0 to +1.0 dB	__ . __	Pass/Fail

6.4.4 Measurement of gain accuracy At Gain $\times 1$ (CAL), $\times 10$ (CAL), $\times 20$ (CAL), $\times 50$ (CAL)	Gain setting	FRA output voltage	Criterion	Measured value	Judgment
	$\times 1$ (CAL)	10 Vpeak	0.95 to 1.05	__ . __	Pass/Fail
	$\times 10$ (CAL)	10 Vpeak	9.5 to 10.5	__ . __	Pass/Fail
	$\times 20$ (CAL)	7.5 Vpeak	19.0 to 21.0	__ . __	Pass/Fail
	$\times 50$ (CAL)	3.0 Vpeak	47.5 to 52.5	__ . __	Pass/Fail

6.4.5 Measurement of sine wave distortion ratio (at each frequency)	Set frequency	Criterion	Measured value	Judgment
	40 Hz	0.1% or less	0 . __	Pass/Fail
	1 kHz	0.1% or less	0 . __	Pass/Fail
	100 kHz	0.5% or less	0 . __	Pass/Fail

6.4.6 Measurement of bias-added voltage (at each dial scale mark)	Dial setting	Criterion	Measured value	Judgment
	0.71	About -75 V	-__ . __	Pass/Fail
	9.29	About +75 V	+__ . __	Pass/Fail

7. SPECIFICATIONS

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Values that indicate accuracy are guaranteed values, but values that do not indicate accuracy are reference or typical (typ.) values. The reference values are supplemental data and are not guaranteed.

7.1 Input

Unless otherwise noted, the following conditions are adopted after a warm-up period of 30 minutes at least:

Item	Description
Output waveform	Sine wave
Output polarity	In-phase
Load	Resistance 50 Ω (power factor 1, nominal value)
Input impedance	50 Ω
Gain setting	$\times 50$ (CAL)

7.1 Input

Item	Description
Input mode	Input A, input B, or addition of input A and input B (when the two inputs are on, provided that the maximum total voltage of the two inputs is within ± 10 V)
Input impedance	Switchable between 50 $\Omega \pm 5\%$ and 10 k $\Omega \pm 5\%$ (unbalance, common setting for input of A and B)
Maximum input voltage	± 10 V
Non-destructive maximum input voltage	± 11 V
Input terminal	BNC connector Number of terminals: 2 Input A: Front panel, Input B: Rear panel The Lo side is connected to the chassis.

7.2 Output

Item	Description
Operation mode	Constant voltage (CV)
Output polarity	In-phase or reversed-phase (switchable with the switch on the front panel)
Gain setting function	Fixed: $\times 1$, $\times 10$, $\times 20$, $\times 50$ Variable: $\times 1$ (CAL) to $\times 3$ continuous A set gain is (Fixed) \times (Variable).
Gain accuracy	$\pm 5\%$ (Fixed gain: $\times 1$, $\times 10$, $\times 20$, $\times 50$ and Variable gain: CAL, at 400 Hz)
Maximum output voltage	Resistance load 50 Ω 53 Vrms (40 Hz to 1 MHz) 45 Vrms (20 Hz to 40 Hz) Resistance load 75 Ω ± 75 V (DC \sim 1 MHz)
Output voltage and current ranges	See “ Figure 7-2. Output Voltage / Current Range ”
Maximum output current (AC)	1.06 Arms, 3 Ap-p (40 Hz to 1 MHz)
Maximum output current (DC)	± 1 A
Small-amplitude frequency characteristics	DC to 100 kHz -1 dB to $+1$ dB 100 kHz to 1 MHz -3 dB to $+1$ dB (Output amplitude 10 Vrms, 400 Hz used as a reference)
Slew rate	475 V/ μ s or more (Input square wave, output 150 Vp-p)
Output DC offset	Adjustable range: ± 0.5 V or more (input terminal shorted) Temperature drift: Within $\pm(1+0.1 \times G)$ mV/ $^{\circ}$ C (typ.) *G represents a gain (DC bias off)
Output DC bias	Adjustable range: ± 75 V or more The switch on the front panel can be used to turn on and off output DC bias.
Harmonic distortion ratio	0.1 % or less (40 Hz to 1 kHz, output 40 Vrms) 0.5 % or less (1 kHz to 100 kHz, output 40 Vrms)
Spurious	-30 dBc or less (100 kHz to 1 MHz, output 40 Vrms)
Output noise	($3.6+0.08 \times G$) mVrms or less *G represents a gain (Input terminal shorted, measurement band 10 Hz to 1 MHz)
Output impedance	$[0.19 + 0.0155\sqrt{f} \times (1 + j)] \Omega$ or less (typ.) *f represents frequency, its unit is Hz.
Output terminal	BNC connector Number of terminals: 2 (front panel and rear panel) The Lo side is connected to the chassis. The front panel and rear panel terminals are connected in parallel.

7.3 Monitor Output

Item	Description
Monitor ratio	1/100 of output voltage (1 V/100 V), in phase as output voltage
Monitor accuracy	±5.0 % (DC to 1 MHz) (Error between the output voltage and conversion voltage obtained from the monitor voltage, monitor output load impedance 1 MΩ)
Output impedance	50 Ω ±5 %
Output terminal	BNC connector (rear panel)

7.4 Output LED meter

Item	Description
Indicated data	Output voltage and output current 11 LEDs display levels from 0 % to 100%
Detection method	Average value detection (AC+DC), calibrated with a sine wave
Full scale (100 %)	Voltage: 75 V Current: 1.06 A

7.5 Protection Function

Item	Description
Output overload	When an excessive output current or an excessive internal power loss is detected, the output current is clipped and the overload LED on the front panel is lit. Output turns off if the overload state lasts for 10 seconds or more. If the overload state lasts for 60 seconds, a transition is made to disable mode.
Output overvoltage	Output turns off when an abnormality is detected. If the output overvoltage state lasts for 60 seconds, a transition is made to disable mode.
Power supply section abnormality	When an abnormality is detected, the error LED blinks, output turns off, and a transition is made to disable mode.
Abnormal internal temperature	When an abnormality is detected, the overload LED on the front panel is turned on. If the abnormal temperature state lasts for 10 seconds, output turns off. If the state lasts for 60 seconds, a transition is made to disable mode.
FAN abnormality	When an abnormality is detected, output turns off and a transition is made to disable mode.

* Disable mode: All the operations except power-off are disabled.

7.6 External Control I/O

Item		Description
Control input	Control item	Output on/off
	Control input enable or disable	The DIP switch on the rear panel is used.
	Input level	Hi : +4.0 V or more Lo : +1.0 V or less
	Maximum non-destructive input	+6 V/-5 V
	Input circuit	Photocoupler LED input (150 Ω in series)
	Detection cycle	50 ms
State output	Output circuit	Open collector output
	Usable voltage and current	15 V or less, 10 mA or less
	State item	Output on/off (short when output is on) Overload (short when output is overload)
	Update cycle	10 ms
Terminal		D-sub 9-pin multiconnector (rear panel)

7.7 Output On/Off Control

Item	Description
Output on/off	Controllable using the switch on the front panel or external control input (When external control is used, the switch on the front panel can be set to OFF only.)

7.8 Setting at Power-on

Item	Description
Setting method	The DIP switch on the rear panel is used.
Setting items (8 items in total)	Output on/off Gain External control on/off Output polarity Input A on/off Input B on/off Input impedance 50 Ω /10 k Ω DC bias on/off

7.9 Power Input

Item	Description
Voltage range	100 V AC to 230 V AC $\pm 10\%$ (not exceeding 250 V) Overvoltage Category II
Frequency range	50 Hz/60 Hz ± 2 Hz (single phase)
Power consumption	290 VA or less
Power factor	0.95 or more

7.10 Withstand Voltage, Insulation Resistance

Item	Description
Withstand Voltage	AC 1500 V
Insulation Resistance	10 M Ω or higher (DC 500 V)

Power supply input terminals in batch vs. Other terminals and chassis in batch

7.11 Operating environment

Item	Description
Operating environment	Indoor use, Pollution degree 2
Altitude	2000 m or lower
Operation guarantee	0 °C to +40 °C/5 % to 85 % RH The absolute humidity must be within the range 1 to 25 g/m ³ , with no condensation.
Performance guarantee	+5 °C to +35 °C/5 % to 85 % RH The absolute humidity must be within the range 1 to 25 g/m ³ , with no condensation.
Storage condition	−10 °C to +50 °C/5 % to 95 % RH The absolute humidity must be within the range 1 to 29 g/m ³ , with no condensation.

Figure 7-1 shows the ambient temperature and humidity ranges.

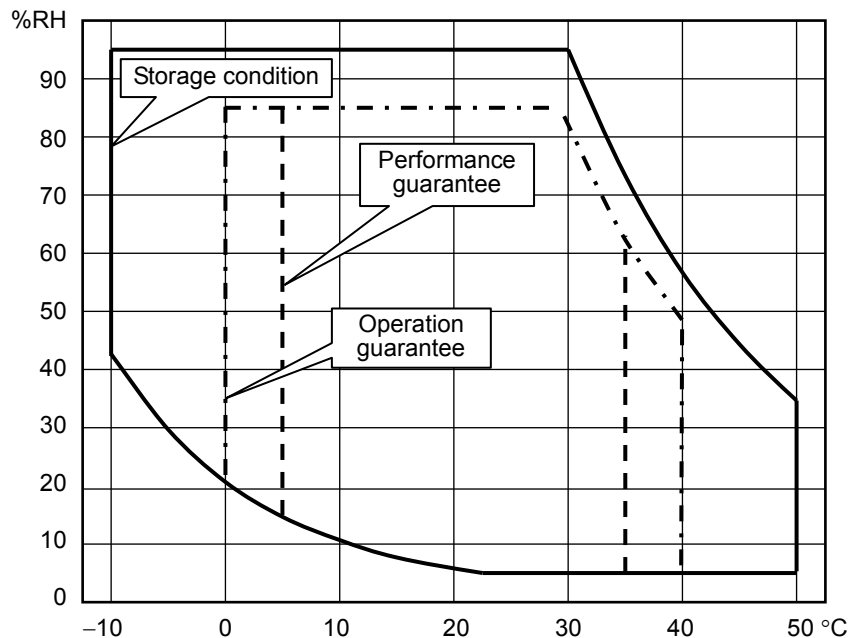


Figure 7-1. Ambient Temperature / Humidity Ranges

7.12 External Dimensions and Weight

Item	Description
External dimensions (Width × Height × Depth, Projections are not included)	220×132.5×450 mm
Weight	About 9 kg

7.13 Output Voltage / Current Range

The DC output range shows the relationship between the voltage and current that can be output at DC. It also shows the output range of voltage and current including DC offset in AC of 40 Hz or less.

The AC output range shows the relationship between the DC voltage and the peak current of a sine wave of 40 Hz or higher that can be output.

All are typical values.

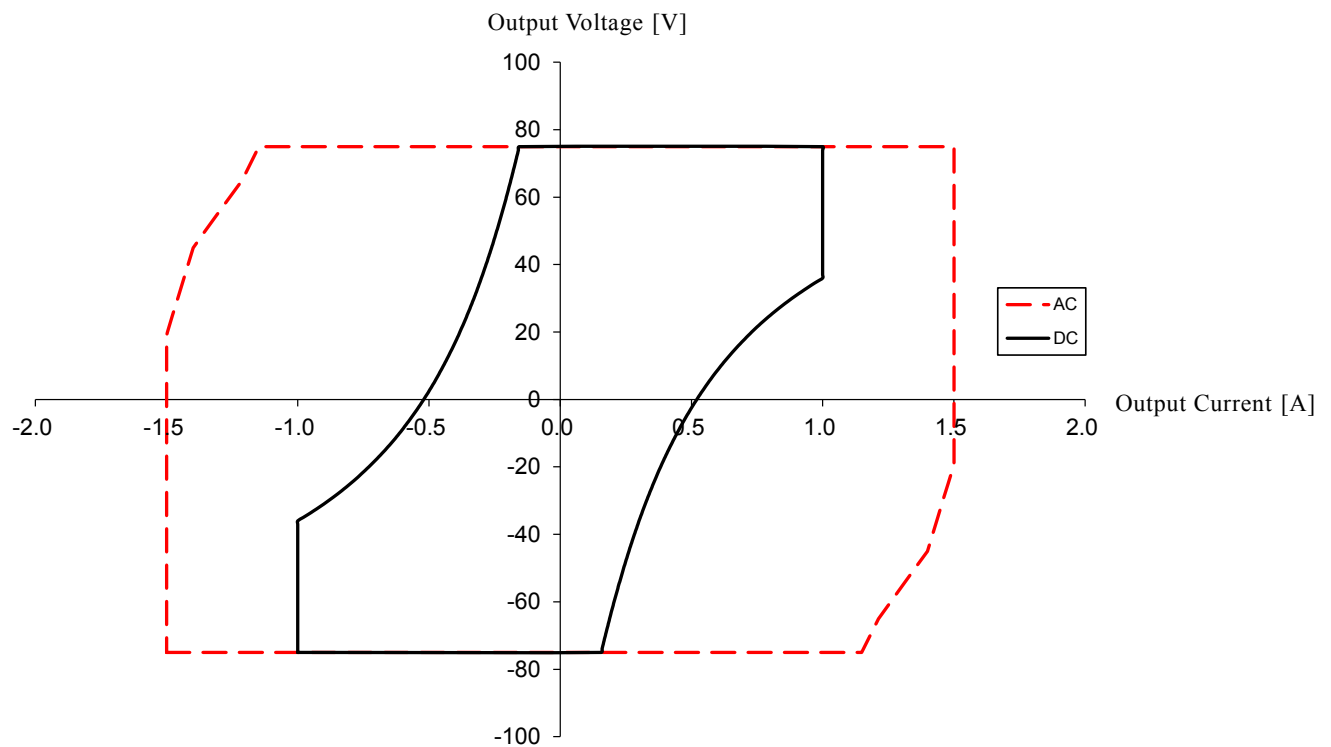


Figure 7-2. Output Voltage / Current Range

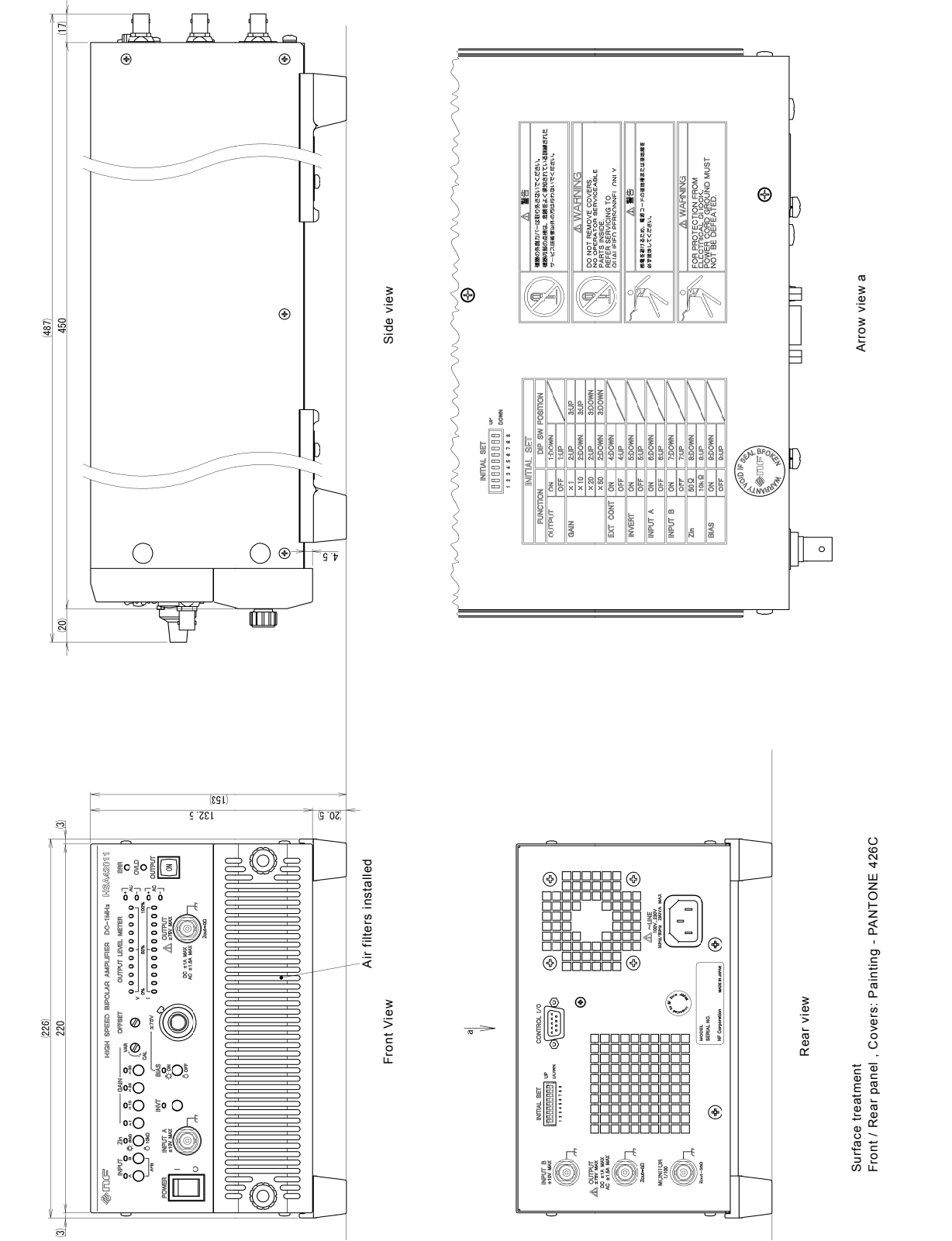


Figure 7-3. External Dimensions

——— WARRANTY ———

NF Corporation certifies that this product was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory. In the unlikely event that you experience an issue during use, please contact our company or agency of our company from which you purchased the product.

All NF products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period, NF will repair the defective product without any charge for the parts and labor.

For repair service under warranty, the product must be returned to either NF or an agent designated by NF. The Purchaser shall prepay all shipping cost, duties and taxes for the product to NF from another country, and NF shall pay shipping charges to return the product to the purchaser.

This warranty shall not apply when corresponding to following particulars.

- A) Failure caused by improper handling or use of the product in a manner that does not conform with the provisions of the Instruction Manual.
- B) Failure or damage caused by transport, dropping, or other handling of the product after purchase.
- C) Failure caused by repair, adjustment, or modification of the product by a company, organization, or individual not approved by NF.
- D) Failure caused by abnormal voltage or the influence of equipment connected to this product.
- E) Failure caused by the influence of supply parts from the customer.
- F) Failure caused by such as corrosion that originate in the use of causticity gas, organic solvent, and chemical.
- G) Failure caused by the insect or small animal that invaded from the outside.
- H) Failure or damage caused by fire, earthquakes, flood damage, lightning, war, or other uncontrollable accident.
- I) Failure caused by the reason that was not able to be foreseen by the science and technology level when shipped from our company.
- J) Replacement and replenishment of consumables such as batteries.

NF Corporation

WABUN: (DA00082228-001)

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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HSA42011 Instruction Manual

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