



# Measure League

DIFFERENTIAL AMPLIFIER

**5307**

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OPERATION MANUAL

NF Corporation

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5307  
Differential Amplifier  
**Operation Manual**



# Foreword

Thank you very much for procuring the 5307 Differential Amplifier. At the outset, please take a few minutes to read the Safety Precautions indicated in this manual in order to use this equipment safely and correctly.

## ● Warning and Caution notices

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



### WARNING

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



### CAUTION

Risk of damage to the equipment.

## ● Manual composition

### Section 1 Overview

Provides a general description of the equipment.

### Section 2 Preparation

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

### Section 3 Operations

Panel functions and operations are described. Read while operating the equipment.

### Section 4 Typical data

Frequency-amplitude, distortion factor and others characteristics of the equipment are described.

### Section 5 Specifications

Equipment specifications 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.

## ● **Observe text instructions**

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

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

## ● **Be sure to connect ground**

Since the unit includes a built-in line filter, there is risk of shock if used without grounding.

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

## ● **Confirm power source voltage**

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

Refer to the Grounding and Power Supply section of this manual.

## ● **Use only the properly rated fuse**

Improperly rated fuses present a fire hazard and other risks. Refer to the Grounding and Power Supply section of this manual and confirm the fuse rating.

Be sure to disconnect the equipment from the power source before replacing the fuse.

## ● **Smoke, odor, noise**

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

## ● **Flammable gas**

Do not use this equipment in the presence of flammable gas. There is danger of fire and explosion.

## ● **Do not remove covers**

This equipment contains dangerously high voltages. Do not remove external covers.

Refer all internal inspection and service to a qualified service technician who fully understands the hazards.

## ● **Do not modify**

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

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

● **Safety indications**

Notices designated by **WARNING** and **CAUTION** are indicated in this manual and on the equipment. These are defined as follows.



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



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



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





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## 1.1 Overview

The 5307 is a differential amplifier commonly used for wide band that realizes a frequency range of DC to 10 MHz. Although it has a wide frequency range, it also has low noise ( $4 \text{ nV}/\sqrt{\text{Hz}}$  typical), low drift ( $8 \text{ } \mu\text{V}/^\circ\text{C}$  typical), a low distortion factor (0.02 % max), and obtains a maximum gain of 1000 times at a  $50 \text{ } \Omega$  load (2000 times with no-load).

In addition to the wide band range, it has also superior pulse response with very little overshoot and ringing. A 1 MHz low-pass filter can be inserted if necessary and the frequency band can be controlled to 1 MHz while maintaining the desired pulse response.

This model can select either the differential input or the single-ended input. The single-ended input is available to cancel the DC offset up to  $\pm 5 \text{ V}$  and to select the reverse or the non-reverse amplitude mode. When the differential is used, a high common mode voltage of  $\pm 10 \text{ V}$  and a large CMRR of 120 dB are obtained and complete protection from excessive input is provided by the input protector.

As the input impedance is  $1 \text{ M}\Omega$ , the probe for the oscilloscope can be used. If the internal short plug in the unit is changed, an input impedance is changeable to  $100 \text{ M}\Omega$  and the CMRR deterioration with the unbalance of the single source impedance can be minimized.

The output impedance is  $50 \text{ } \Omega$  and this unit can drive a  $50 \text{ } \Omega$  load up to  $\pm 5 \text{ V}$  (the full power band width is DC to 3 MHz) and stabilized operations are possible even under capacity load conditions.

The wide range function necessary for the amplifier and the accumulated performance for the unit use a wide-range general purpose preamplifier and a wide-range for the differential amplifier.

## 1.2 Features

(1) Wide frequency range

The frequency characteristic is DC to 10 MHz for all gain settings, the rise-time is 35 ns and the pulse response is extremely desirable.

(2) High gain

The gain can be set in 1-2-5 steps from 10 to 1000 times for a  $50 \text{ } \Omega$  load and 20 to 2000 times for no-load.

(3) Difference input

Both the differential and single-ended connections can be switched with one-touch. Single-ended connections use the non-inverting for **[A]** input and inverting for **[-B]** input.

(4) High CMRR

A CMRR of 120 dB minimum is obtained at DC to 1 kHz.

(The  $V_{cm} = \pm 5 \text{ V}$  when the gain is 1000 times, refer to the typical data).

(5) Low noise

The Equivalent input noise is  $4 \text{ nV}/\sqrt{\text{Hz}}$  typical (gain = 1000 times,  $f = 1 \text{ kHz}$  with an input short circuit).

(6) Low distortion factor

Adequate correspondence and highly accurate measurements can be obtained due to the low distortion factor of 0.02 % maximum (gain = 10 times,  $f = 1$  kHz,  $V_o = \pm 5$  V,  $R_L = 50 \Omega$ , refer to the typical data).

(7) High common mode voltage

The common mode voltage range is  $\pm 10$  V.

(8) Input protection

The input is protected for excess voltages of up to  $\pm 50$  V by the input protector.

The input protector operates at  $\pm 10.5$  V and is automatically restored after approximately 5 seconds.

(9) Internal DC cancel circuit

The DC component at single-ended input can be canceled up to a maximum of  $\pm 5$  V converted to input level by the internal offset function.

(10) Internal band control filter

A low noise level can be attained due to the band control. The filter that is used has superior pulse correspondence since it is a phase linear type.

## Section 2 Preparation

### 2.1 Check before using

#### ■ Safety check

Before using the 5307, refer to the **Safety Precautions** of this manual and confirm safety.

Also, before connecting the power, refer to **Section 2.2 Grounding and power source** and thoroughly check the safety.

#### ■ Unpacking and re-packing

First, inspect the equipment for possible damage in shipping.

Check for the presence of the following items.

Mainframe .....	1
Operation Manual .....	1
Supplied accessories	
Power cable (3-conductors, 2 meters) .....	1
Fuse (time lag, 0.5 A/250 V, 5.2 dia. x 20 mm) .....	1
Signal cable (BNC-BNC, 50 $\Omega$ , 1 m) .....	1

When repacking the equipment for transportation, use a packing carton having ample strength to protect the equipment and bear the weight of stacking.

## 2.2 Grounding and power source

### ■ Grounding

#### ⚠ WARNING

This equipment must be grounded in order to prevent electric shock accidents.

Confirm the protective ground terminal is connected to ground before connecting the equipment for measurements. The 5307 protective ground is connected to ground by the 3-prong power supply plug.

Use the supplied power supply cable to connect to a 3-terminal power outlet that has a protective ground contact.

### ■ Power source

#### ⚠ CAUTION

Be sure to observe the following in order to prevent damage to the equipment.

Confirm the power source voltage is within the range specified for the 5307.

Check the power source voltage indication on the rear panel above the power source inlet. The 5307 operates from the following commercial power source.

Power supply voltage range : As indicated on rear panel

Power supply frequency range : 48 to 62 Hz

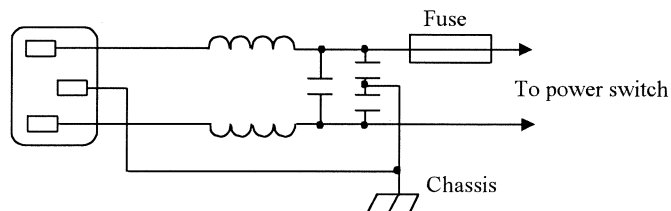
Power consumption : Max. 30 VA

Confirm the power switch is off before connecting the power cable.

### ■ Line filter

The following line filter circuit is used in the 5307.

Maximum leakage current at 250 V 60 Hz is 0.5 mA rms. Since there is risk of electric shock by touching metal parts, in the interest of safety, be sure to ground the equipment.



## ■ Power supply fuse

### **WARNING**

Use only a fuse with the specified rating.

There is risk of fire from an improperly rated fuse. Be sure to disconnect the power cable before replacing the fuse.

Fuse : time lag, 0.5 A/250 V, 5.2 dia. x 20 mm

## 2.3 Installation

### ■ Installation conditions

Observe the following ambient temperature and humidity ranges when installing and storing the equipment. Moisture condensation must also be absent.

Operating ambient: 0 °C to 40 °C, 10 %RH to 90 %RH

Storage ambient : -10 °C to 50 °C, 10 %RH to 80 %RH

Avoid installing the equipment in the following types of locations.

- In direct sunlight or near heat sources
- Where subjected to dust, salt or metallic dust
- Corrosive gas, steam or oily smoke
- Flammable gas or vapors
- Strong vibration
- Strong magnetic or electromagnetic fields
- Near pulse type noise sources

### ■ Fan

A fan is used for cooling the 5307. Obstructing the airflow can lead to damage.

### **CAUTION**

The 5307 has air intakes at the sides and exhaust at the rear. Allow for good airflow by locating the unit away from walls or other obstructions.

If the fan has stopped, immediately cutoff power and contact service. Continued operation without the fan function can increase the severity of damage and render service difficult.

## ■ Panel and case cleaning

Use a soft cloth to wipe dust from the panel and case. If soiling is severe, moisten the cloth slightly with a neutral detergent.

Do not use sprays, petroleum distillates or commercial cleaning cloths, which can deform or peel the finish.



### 3.1 Introduction

The operational procedures for the 5307 are explained in this chapter. Each operation switch for the amplifier is contained in the front panel and the switches for the power supply are contained in the rear panel.

The following operations are controlled by the switches on the front panel.

(1) Input mode switching

The input to the 5307 can be switched between single-ended input and differential input.

(2) Input offset adder

The DC component of the input signal can be canceled when single-ended input is used.

(3) GAIN setting

The gain can be set from 10 to 1000 times (at 50  $\Omega$  load).

(4) BAND WIDTH switching

The frequency range can be switched between 1 MHz and the full band width (10 MHz).

#### 3.1.1 Front panel Description (refer to Fig 3.14)

① INPUT SEL  A

This switch selects whether the measurement signal connected to INPUT  A is connected to the non-inverting input of the differential amplifier. If this switch is pressed in, the INPUT  A and the differential amplifier non - inverting input are connected.

If this switch is set and the OFFSET ON/OFF switch ④ is set to ON, the internal DC voltage set by ⑤ and ⑭ is applied to the non-inverting input.

② INPUT SEL  -B

This switch selects whether the measurement signal connected to INPUT  -B is connected to the inverting input of the differential amplifier. If this switch is pressed in, the INPUT  -B and the differential amplifier inverting input are connected.

If this switch is set off and the OFFSET ON/OFF switch ④ is set to ON, the internal DC voltage set by ⑤ and ⑭ is applied to the inverting input.

\* Both switches ① and ② must be pressed in when the 5307 is used for the differential amplifier.

The desired input switch ① or ② must be pressed in when single-ended amplifier is used.

③ INPUT PROTECT

The input breaks automatically when a voltage that exceeds  $\pm 10.5$  V is fed to either INPUT  A or INPUT  -B. This lamp flashes when the input protector operates. When the excessive input is removed, the input protector resets automatically in approximately 5 seconds and the lamp goes out.

#### ④ OFFSET ON/OFF

This switch only become effective for single-ended input.

Since the 5307 is configured for differential input , the amplifier reference point can be freely selected by adding DC voltage to the input of the other side that is not used when single-ended input is used.

Offset can be added when this switch is pressed in and the DC voltage set by ⑤ and ⑭ can be used for the amplifier reference point.

The amplifier reference point is 0V if this switch is set to off. (Refer to Fig. 3.1)

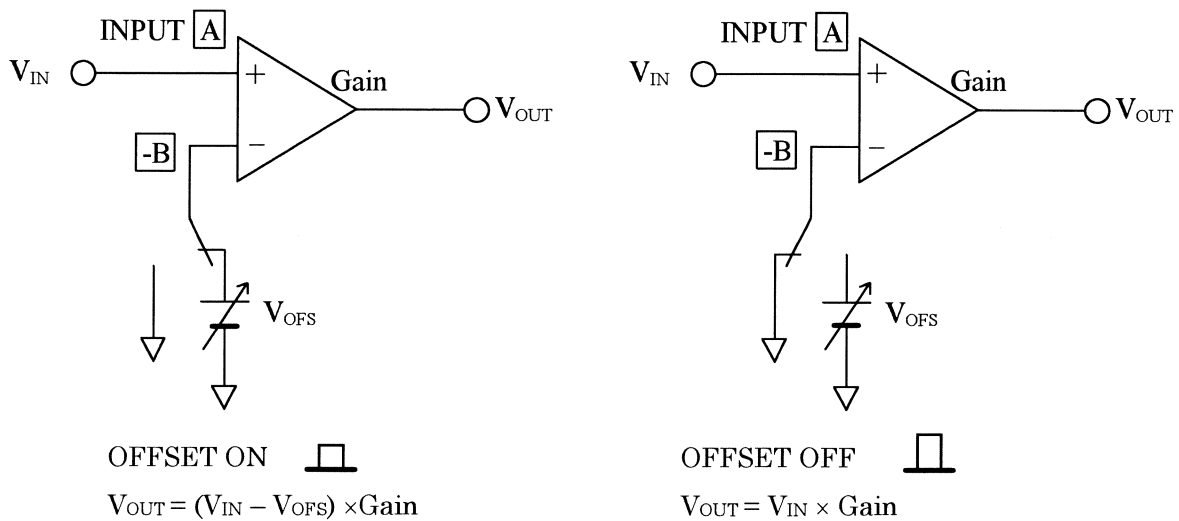


Fig. 3.1 The OFFSET ON/OFF when the single-ended input **A** is used

#### ⑤ OFFSET $\pm 5\text{ V}/\pm 0.5\text{ V}$

The offset voltage range that can be used for the single - ended input is selected.

The offset voltage can be set up to  $\pm 5\text{ V}$  when this switch is pressed , and up to  $\pm 0.5\text{ V}$  when it is not pressed.

The actual offset voltage is adjusted continuously by potentiometer ⑭.

#### ⑥ GAIN 10, 20, 50, 100

The differential amplifier gain of in the first stage is set. The actual setting gain is multiplied by setting the switch ⑥ and ⑦ at a  $50\ \Omega$  load. Therefore, when there is no load the gain becomes 2 times of the indicated value on the front panel.

\* In order to attain the optimal SN ratio, increase the GAIN setting level ⑥ as much as possible.

If the gain is still small set the GAIN ⑦ to the  $\times 10$  position.

(A desirable SN ratio can be attained by setting of  $100 \times 1$  time rather than  $10 \times 10$  times)

#### ⑦ GAIN $\times 10 / \times 1$

If this switch is pressed the GAIN setting value increases by 10 times.

This enables a maximum gain of 1000 times to be obtained when there is a  $50\ \Omega$  load (2000 times for no load ). If this switch is set to  $\times 1$ , the signal is by-passed the 10 times amplifier and the gain reaches a level of the setting GAIN ⑥  $\times 1$ .

⑧ BAND WIDTH 1 MHz/FULL

The band width can be selected for use at 1 MHz or for the full range. The band is limited to 1 MHz when this switch is pressed in. Use this setting when it is necessary to attain less noise or eliminate the high frequency components. The pulse response is not disturbed because the band limiting filter uses a phase linear type. This switch is set to full only the complete band range (10 MHz) can be used.

⑨ POWER

This lights when the power supply to the 5307 is turned on to indicate that the 5307 can be operated.

⑩ POWER PULL ON

This is the power switch. Pull it out to set it ON and supply power to the 5307.

The power lamp ⑨ lights at this time and the 5307 can be operated.

⑪ INPUT  A

This is the non-inverting input terminal. The allowable maximum input voltage is  $\pm 50$  V.

The input protector operates for input voltages greater than  $\pm 10.5$  V.

⑫ INPUT  -B

This is the inverting input terminal. The allowable maximum input voltage is  $\pm 50$  V.

The input protector operates for input voltages greater than  $\pm 10.5$  V.

⑬ ZERO

This is zero offset adjustment for the front-end of the differential amplifier.

An adjustment range referred to input is  $\pm 0.5$  mV.

⑭ OFFSET (dial)

DC offset can be added to the input that is not used by pressing switch ④ in when single-ended input is used. This potentiometer is used to set the offset voltage.

Table 3.1 Dial Readings and Offset Voltage

Dial Reading	$\pm 0.5$ V Range (V)	$\pm 5$ V Range (V)
0.0	- 0.5	- 5.0
2.0	- 0.3	- 3.0
4.0	- 0.1	- 1.0
5.0	0.0	0.0
6.0	+ 0.1	+ 1.0
8.0	+ 0.3	+ 3.0
10.0	+ 0.5	+ 5.0

⑮ OVER

This lamp indicates overload. It lights when the output voltage exceeds a certain level. The lamp lights when the output voltage exceeds  $\pm 5$  V (50  $\Omega$  load). The lamp goes out when the overload condition is removed.

⑯ OUTPUT

This is the output terminal, and the output impedance is 50  $\Omega$ . The maximum rated output is  $\pm 10$  V when there is not load. Be careful when making connection with a unit that has limited input voltage since the output voltage is  $\pm 5$  V at 50  $\Omega$  load.

### 3.1.2 Rear Panel Description (Refer to Fig. 3.2 and 3.14)

⑰ VOLTAGE SELECTOR

This is the power supply voltage selector. Set it appropriately according to the current of the voltage that is used. Refer to Fig. 3.2 for the switch setting method.

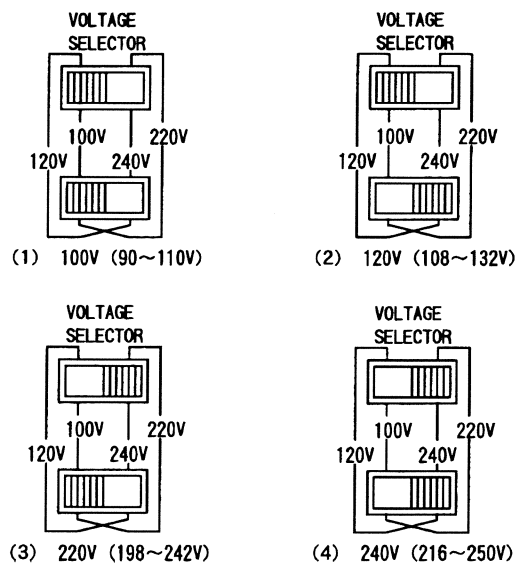


Fig. 3.2 Power supply voltage setting method

⑱ ~ LINE

This is the power supply input connector which connects to the accessory power cable. There is a fuse holder in the lower part which contains two fuses. The method for changing the fuses is shown in Fig. 3.3. Use 0.5 A time-lag fuses.

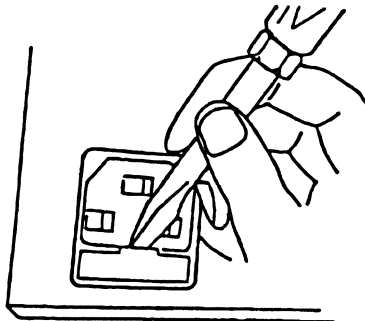


Fig. 3.3 Fuse Replacement

## 3.2 Beginning

Make sure that the usage voltage conforms to the ~LINE ⑰ power supply voltage setting on the rear panel before inserting the power supply plug. The POWER lamp ⑨ lights if the power cable is inserted and the POWER switch ⑩ pulled ON (towards the front).

Allow the 5307 to warm up at least 30 minutes to stabilize the internal circuits when performing accurate measurements.

### 3.2.1 Input Connections

The [A] input and [-B] input both gave an input resistor of 1 M $\Omega$  for the ground of the 5307 and the input capacity of 35 pF maximum. Refer to Fig. 3.4 for the relation of the input impedance and the frequency.

The signal source impedance should be as low as possible, and it is important that the source impedance be as balanced as possible when using the differential input. Even if the same signal source impedance is used, the desired CMRR will not be obtained, if the connection cable capacity is not balanced.

The 5307 has a 10 MHz band width, but when the signal source impedance is high, the band limitation is imposed by the input capacity of the 5307 and the connection cable. If the capacity of the cable and other components is not balanced, the CMRR deteriorates at high frequencies.

The frequency band width (-3 dB) limited by the input is determined as follows.

$$B_w \doteq \frac{160}{(R_s \times C_c)} \text{ (MHz)}$$

$R_s$  = Signal source impedance (k $\Omega$ )  
 $C_c$  = Cable equivalent capacity + input capacity (33 pF typical)

For example, if the signal source impedance is 500 $\Omega$  and a 1 meter RG-58C/u cable is used, the frequency bandwidth is limited by the input as follows.

$$B_w \doteq \frac{160}{0.5 \times (100 + 33)} \doteq 2.41 \text{ (MHz)}$$

Accordingly, it is necessary to make shorter connections by a small-capacitance cable in order to obtain the desired frequency characteristics. There may be increased noise, but if a 10:1 oscilloscope probe is used, the deterioration of the frequency characteristic by the load capacitance can be minimized. When the signal source impedance is 50  $\Omega$ , use 50  $\Omega$  coaxial cable for connection and terminate the 5307 input at 50  $\Omega$  to obtain optimum frequency response.

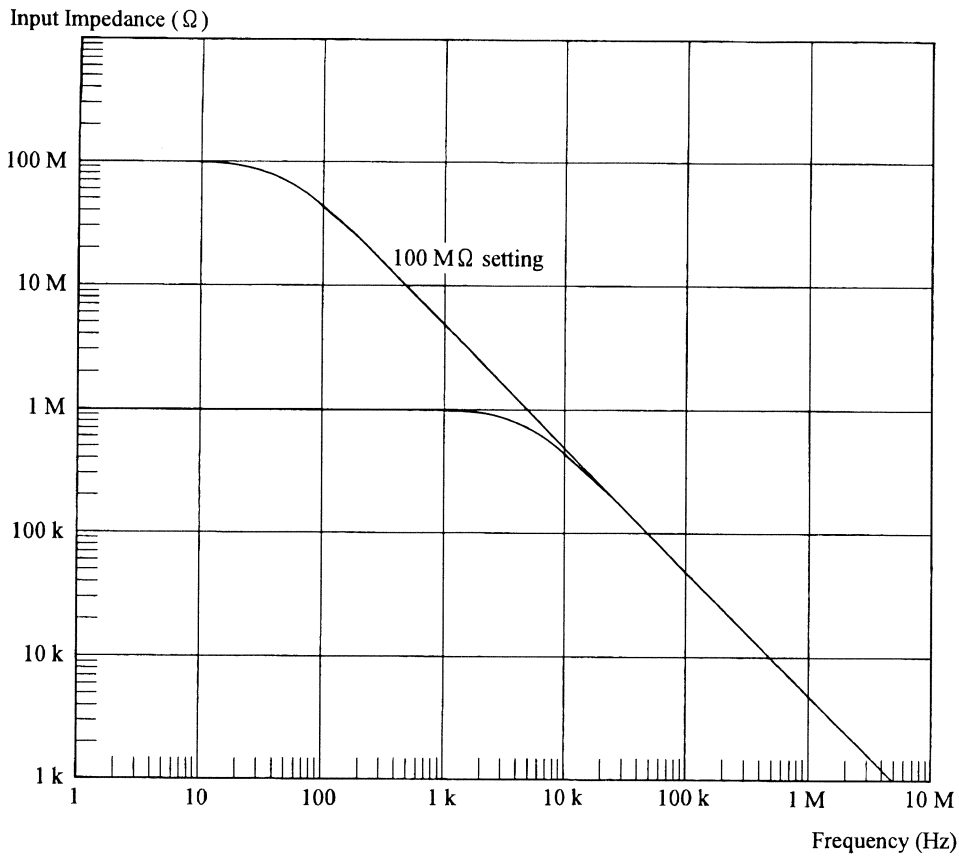


Fig. 3.4 Input Impedance characteristic

### 3.2.2 Common Mode Noise

The common mode noise can be lowered if the 5307 input mode is used by the differential.

The common mode rejection ratio (CMRR) of 120 dB minimum (gain = 1000 times) can be obtained for DC to 1 kHz. The maximum common mode voltage is  $\pm 10$  V, but the optimal CMRR is obtained if within  $\pm 5$  V is used.

If a first stage gain is large, a large CMRR is obtained. For example, rather than using a gain setting of  $10 \times 10$  times for a 100 times setting, a setting of  $100 \times 1$  time should be used. Be careful when the single-ended input mode is used since there is no common mode noise rejection capability.

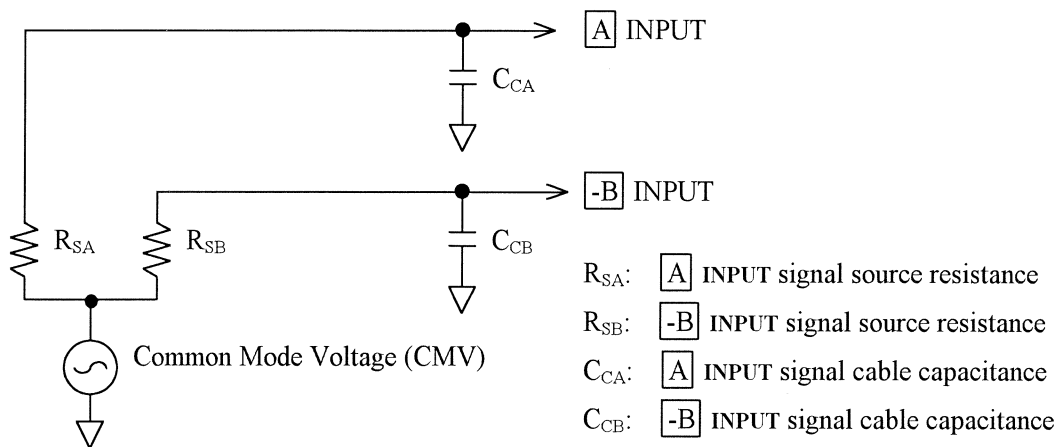


Fig. 3.5 Common Mode Voltage (CMV) input model

The common mode voltage (CMV) can be considered as the feeding signal to the input terminal of the

5307 in the model in Fig. 3.5. The CMRR can deteriorate for the following reasons.

- (1)  $R_{SA}$  and  $R_{SB}$  are large and also  $R_{SA}$  and  $R_{SB}$  are not equal.
- (2)  $C_{CA}$  and  $C_{CB}$  are large (signal cable long) and also  $C_{CA}$  and  $C_{CB}$  are not equal (the signal cables are different lengths).

Therefore, in order to use at the optimum common mode rejection ratio (CMRR), measures need to be taken for low signal source impedance, low electrostatic capacity in the signal cable, and as short a cable length as possible. By changing the 5307 input impedance to  $100\text{ M}\Omega$ , CMRR impairment due to the signal source resistance can be reduced.

The input impedance can be changed as described below. However, when the input is open at  $100\text{ M}\Omega$  impedance, a positive or negative voltage due to input bias current appears at the output. This is not a malfunction.

### 3.2.3 Input Impedance Alteration

The input impedance of the 5307 is  $1\text{ M}\Omega$  for standard operations, and can also be set to  $100\text{ M}\Omega$  by replacing the internal short plug. Make sure that the influence from the input bias current of the 5307 increases when the input impedance reaches  $100\text{ M}\Omega$ .

To change the input impedance, turn the 5307 unit over, then take the bottom plate off (Refer to Fig. 3.6).

Replace the short plug position which is right close to the input connector (Refer to Fig.3.7). It can be removed easily at this by using a needle-nose pliers.

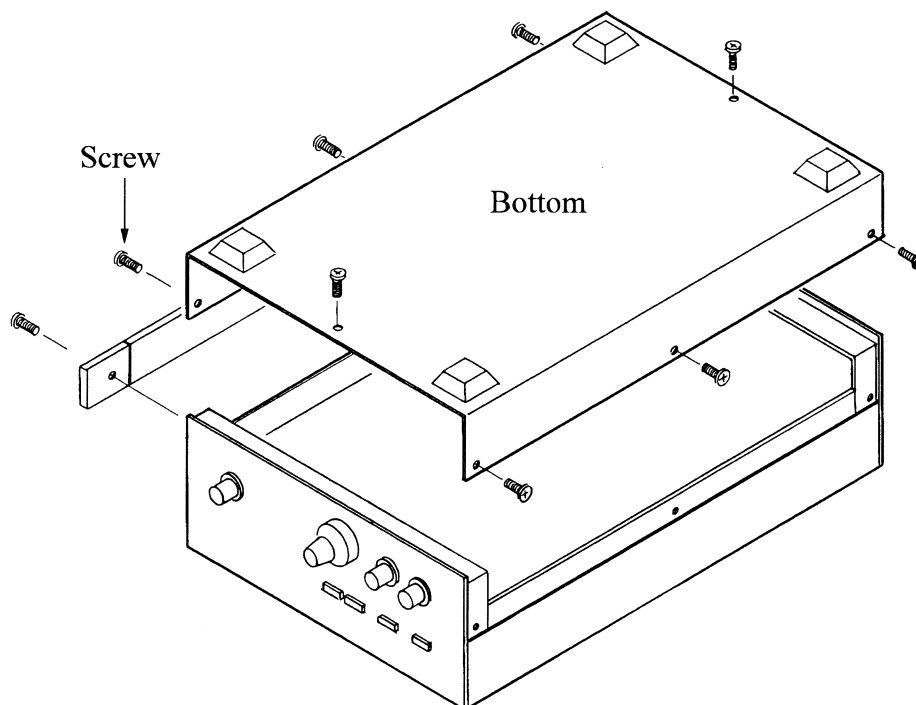


Fig. 3.6 Removing the bottom plate

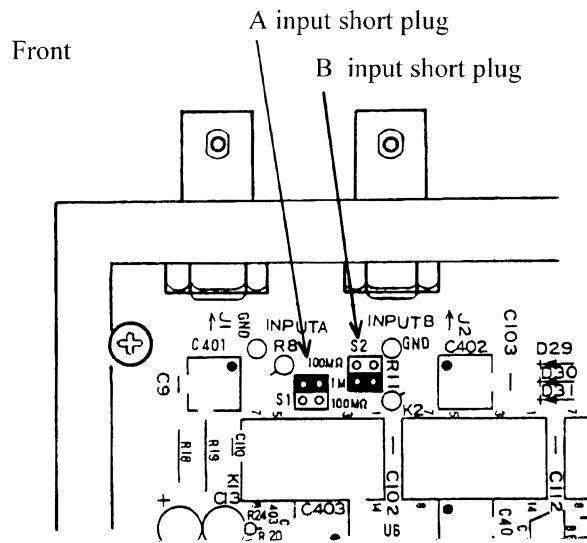


Fig. 3.7 Input short plug position

### 3.2.4 Input connection Examples

Typical examples of input connections are shown below. Contact your local sales representative for details regarding other methods of making more complicate connections to the signal source.

Although the connection examples in Figures 3.8 and 3.9 are the easiest connection methods, there is no function to cancel the common mode. These can be used when the common node noise is low or if the signal level is comparatively high.

Install the input shield completely and connect it so it does not make a large loop.

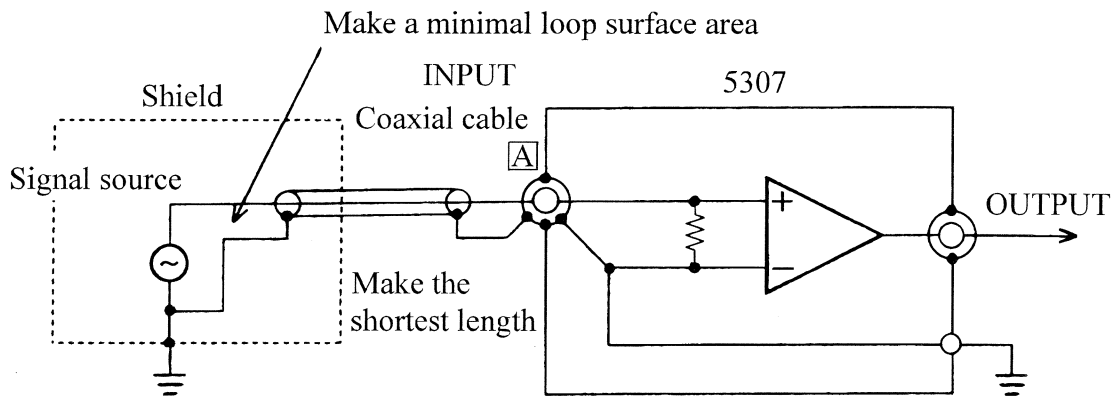


Fig. 3.8 Using the 5307 with a single-ended input (The signal source is grounded.)

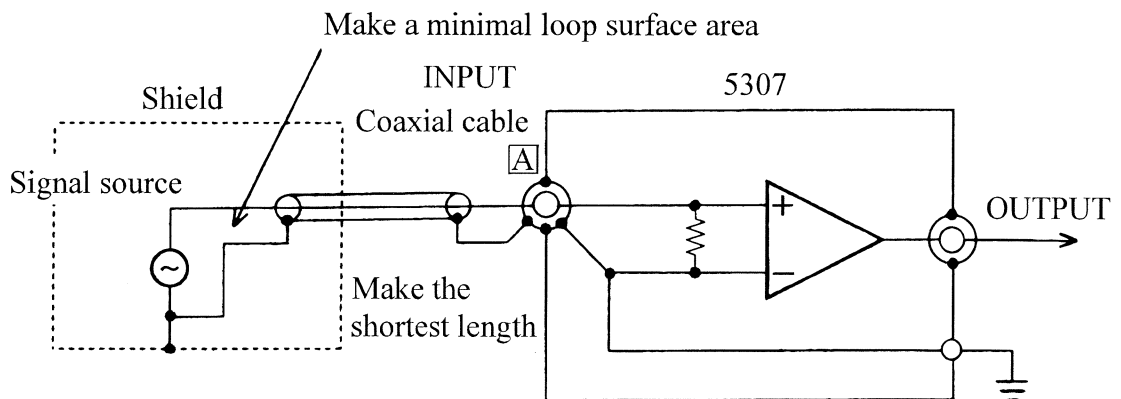


Fig. 3.9 Using the 5307 with a single-ended input (The signal source is not grounded.)



When there is a large common mode noise, it is effective to remove the ground lead (\*1) and ground the GND of the main unit. However, the high frequency characteristics become worse and sometime un-stabilized ringing is brought about in the pulse response. When the frequency characteristic greater than 1 MHz is required, connect the ground lead (\*1) to the signal source ground point with the shortest possible lead.

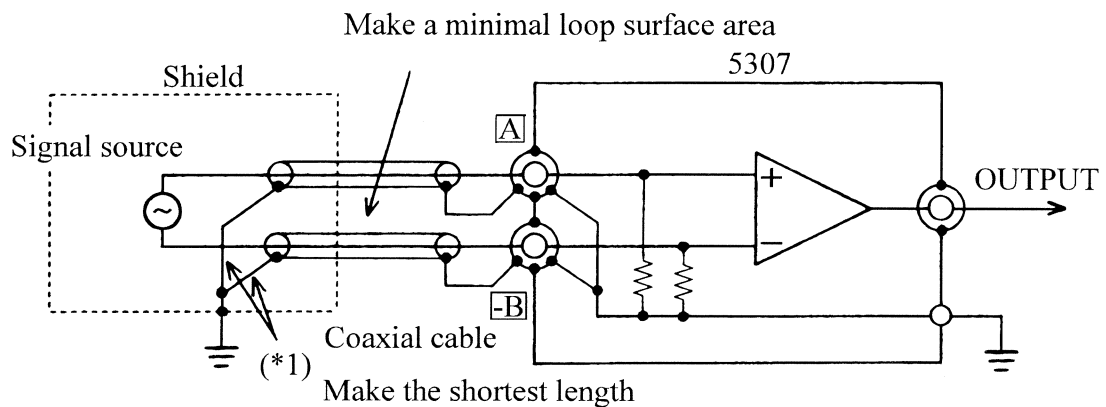


Fig. 3.10 Using the 5307 with a differential input (The signal source is grounded.)

When the signal source is not grounded, a stabilized and favorable SN ratio can be obtained by shielding the signal source with the ground lead (\*2).

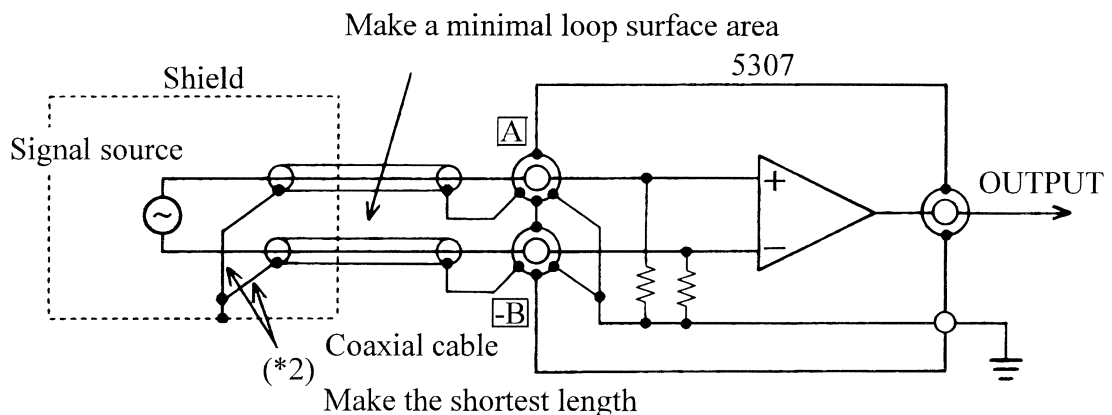


Fig. 3.11 Using the 5307 with a differential input (The signal source is not grounded.)

Connect the 5307 shown in Fig. 3.12 when the signal source can use a center tap at the differential mode.

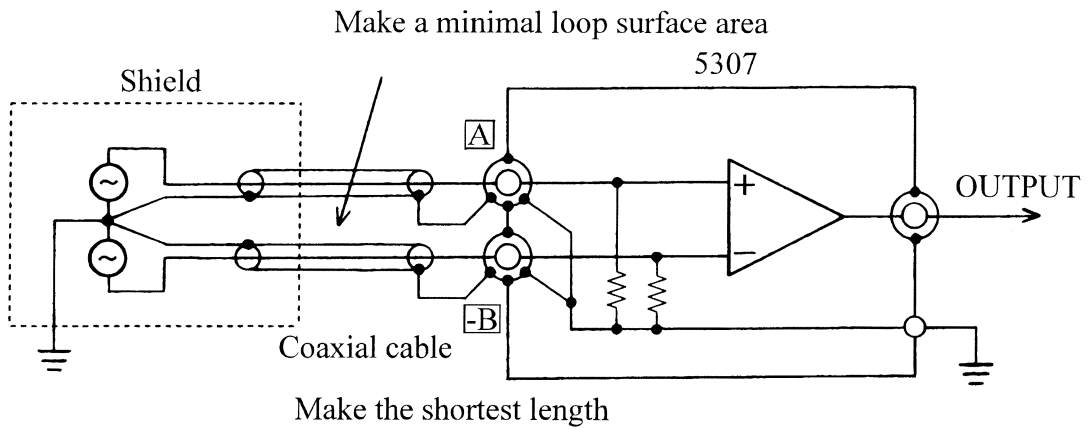


Fig. 3.12 Differential source signal input

The basic points to consider when the 5307 is used with differential input are shown in Fig. 3.13. The shortest possible length of coaxial cables with BNC connectors should be used. It is necessary to have a signal source shield and attach the BNC connector to the signal source to obtain low noise and easily reproducible data.

The two coaxial cables should be tightened by the binder to minimize the loop surface area and reduce the influence of external electromagnetic induction. It is more effective if the external cables are twisted together.

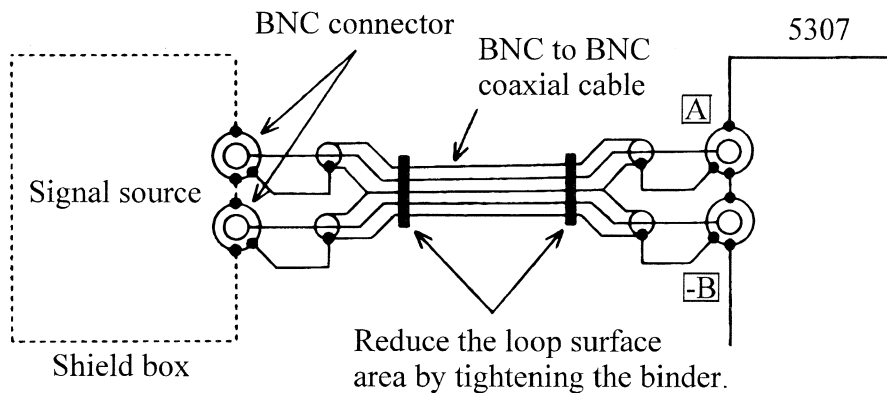


Fig. 3.13 Preferred connection method when using the 5307 with the differential input

### 3.2.5 Output connection

The output impedance of the 5307 is  $50\ \Omega$ , and it is designed to drive a  $50\ \Omega$  load. The gain of the 5307 is prescribed at a  $50\ \Omega$  load, therefore it becomes 2 times at no load. This is also stabilized to a capacitive load. Connect the  $50\ \Omega$  terminal resistor with  $50\ \Omega$  coaxial cable to obtain the best frequency characteristic and pulse response.

**CAUTION**

Be careful when the 5307 is connected to equipment that has an input voltage limit, such as a spectrum analyzer, since it can drive a  $50\ \Omega$  system with a comparatively large output. If there is a possibility that the output voltage of the 5307 may damage other equipment, insert the proper attenuator at the output.

## 3.3 Operation

### 3.3.1 Input Mode Setting

The differential or the single-ended input should be selected. When the 5307 is used with the single-ended input, the [A] input is used for the non - inverting and the [-B] input is used for the inverting. The switches ① and ② are used for performing above.

### 3.3.2 Offset Cancellation

If switch ④ is set to ON when single-ended input is performed, the internal DC voltage is added to the unused input and the DC voltage included in the signal can be canceled. Select the range at ⑤ and adjust the internal offset voltage at ⑭. Since the Dc voltage is canceled at the input, the gain change can be ignored when the set offset voltage potentiostat ⑭ is readjusted unless the DC component in the input signal does not vary.



When the 5307 is used with the differential input, the offset cancel function ④, ⑤ and ⑭ cannot be performed. The cancellation cannot be performed by the offset cancel function of the 5307 if the DC voltage exceeds  $\pm 5$  V including the input even when the single-ended input is performed.

### 3.3.3 Gain Setting

The gain of the 5307 is displayed on the panel when a  $50 \Omega$  load is connected to the output terminal. The gain is 2 times the display value on the panel when there is no load. The first stage gain is set at ⑥ and the second stage gain at the switch ⑦. Higher first stage gain (set value at GAIN ⑥) settings improves noise, offset drift and CMRR.

### 3.3.4 Over load

The OVER lamp ⑮ lights when the output amplitude of the 5307 is excessive and the input and output characteristics enter the non-linear range. The light level of the OVER lamp is  $\pm 5$  V at a  $50 \Omega$  load. The OVER lamp goes out when the excessive output condition is removed.

### 3.3.5 Input Protector

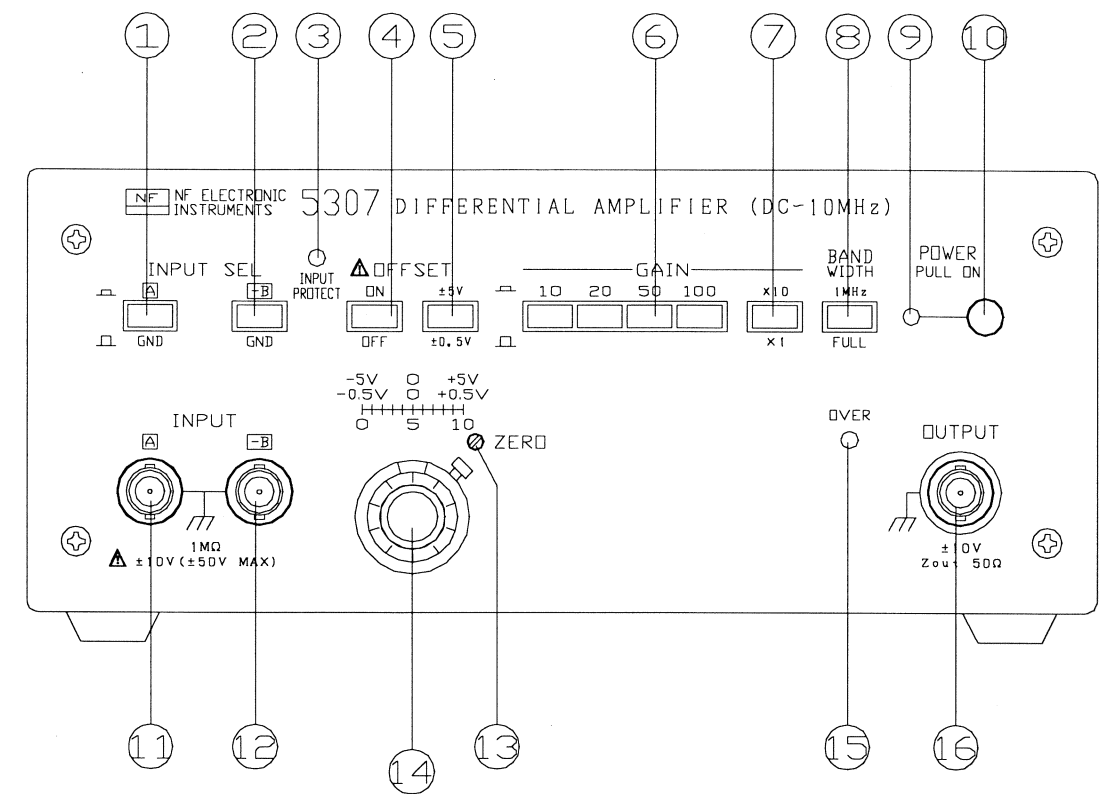
The 5307 is equipped with a circuit breaker type of input protector which protects it against excessive input from  $\pm 10$  V to  $\pm 50$  V. The 5307 may be damaged if the voltage more than  $\pm 50$  V is applied.

The input protector indicates a warning with the INPUT PROTECT lamp ③ to light for approximately 5 seconds when it is activated. The lamp ③ goes off approximately 5 seconds after the excessive input is over.

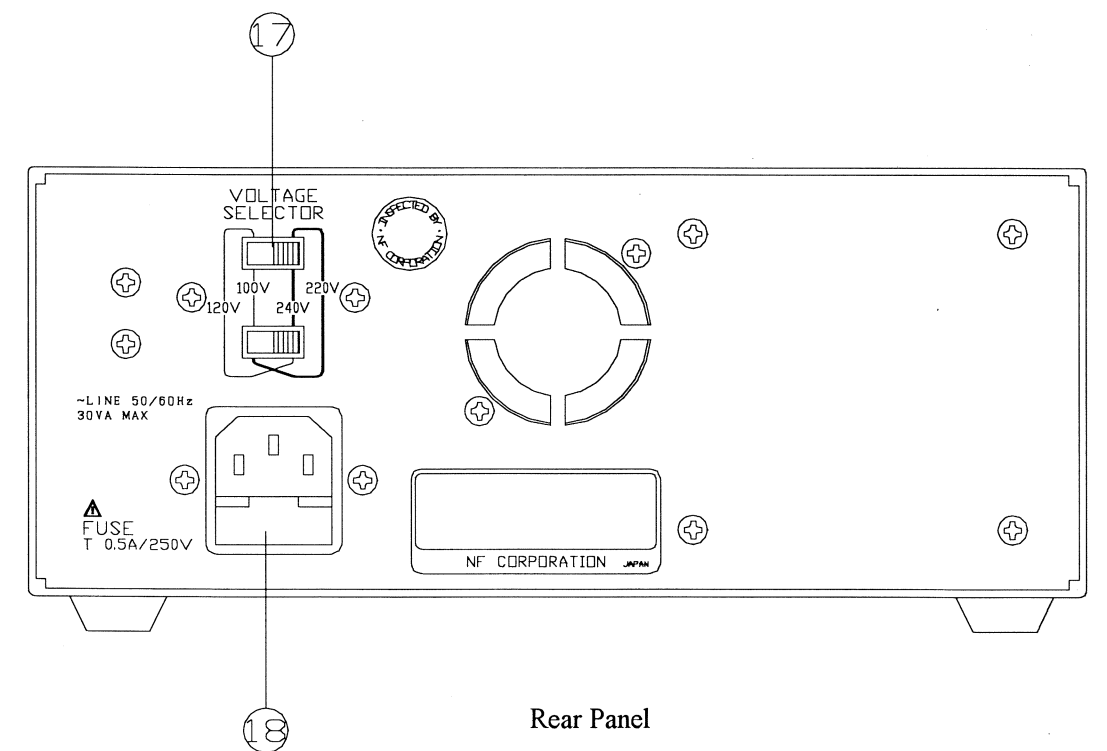
### 3.3.6 Frequency Band-width Limitations

The frequency band-width of the 5307 is limited from 10 MHz to 1 MHz by pressing the switch ⑧. Although the frequency band is limited, the noise level is lowered and the SN ratio is improved.





Front Panel



Rear Panel

Fig. 3.14 Front and Rear Panel









### 4.1 Notes on Typical Data

Typical data has been provided regarding the performance of the 5307. One of the major quality control efforts being made at NF CORPORATION is in the area of minimizing the variations related to the typical performance data.

The data provided represents the values that would be obtained by averaging the performance of a number of instruments and may not be exactly the same as indicated in this data. We are confident that every instrument meets its required specifications at the time of shipment as a result of the strict testing program.

### 4.2 Typical Data

Fig. 4.1	Frequency Characteristics ( $\times 1$ Range)
Fig. 4.2	Frequency Characteristics ( $\times 10$ Range)
Fig. 4.3	Pulse Response ( $V_o = \pm 1 V_p$ )
Fig. 4.4	Pulse Response ( $V_o = \pm 5 V_p$ )
Fig. 4.5	1MHz Band Limit Filter Pulse Response
Fig. 4.6	Frequency versus Common Mode Rejection Ratio
Fig. 4.7	Equivalent Input Noise Density
Fig. 4.8	Maximum Output Voltage without Distortion
Fig. 4.9	Frequency versus Total Distortion Factor Characteristics
Fig. 4.10	Frequency versus Harmonic Distortion Factor Characteristics
Fig. 4.11	Output Voltage versus Total Distortion Factor Characteristics
Fig. 4.12	Settling Characteristics (Gain $10 \times 1$ time, $V_o=5 V_p$ )
Fig. 4.13	Settling Characteristics (Gain $100 \times 1$ time, $V_o=5 V_p$ )
Fig. 4.14	Settling Characteristics (Gain $100 \times 10$ times, $V_o=5 V_p$ )
Fig. 4.15	Overload Recovery Characteristics ( $\times$ Range, +5 V step input)
Fig. 4.16	Overload Recovery Characteristics ( $\times$ Range, +5 V step input)

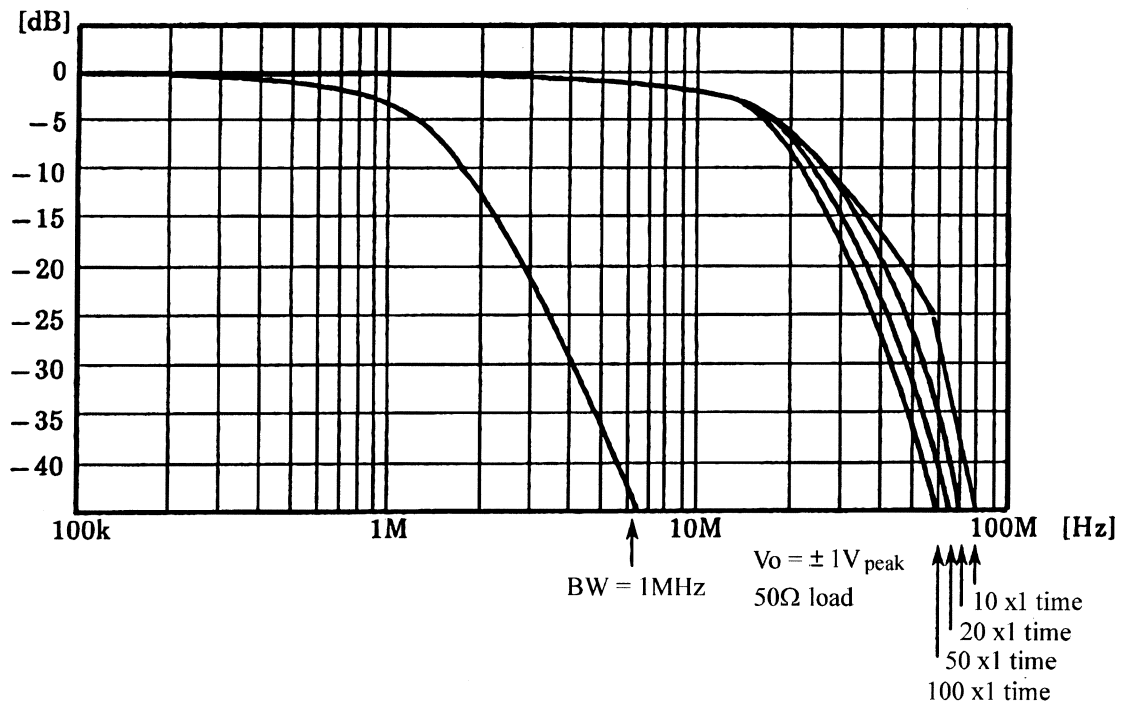


Fig. 4.1 Frequency Characteristics ( $\times 1$  Range,  $V_o = \pm 1 V_p/50 \Omega$  load)

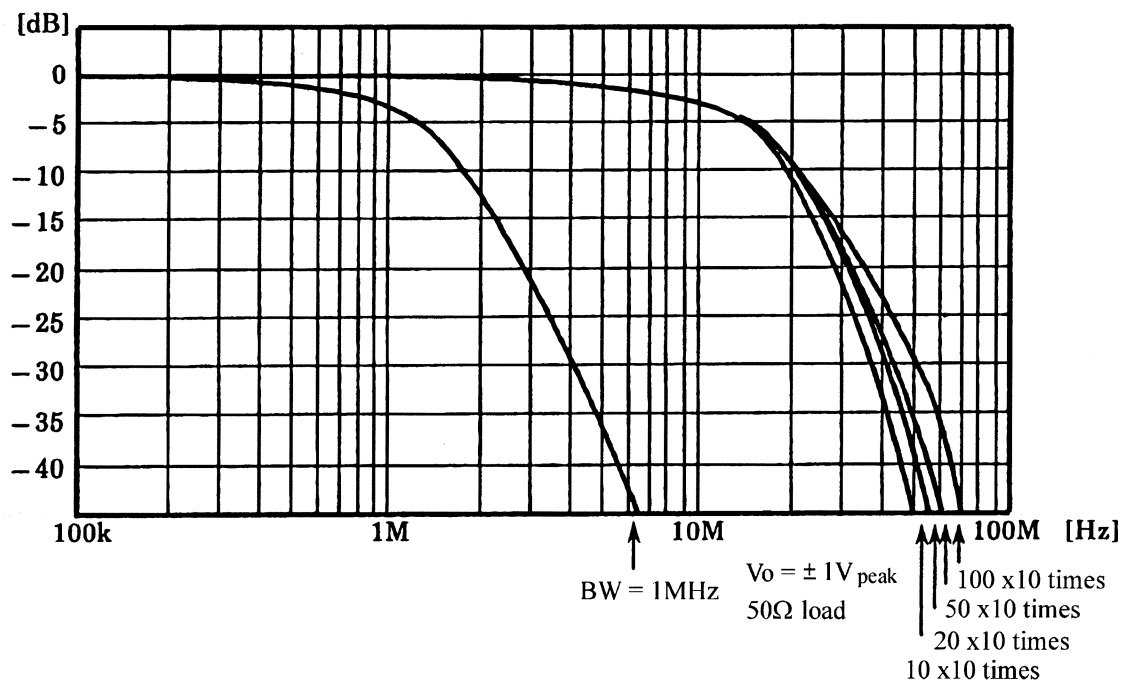


Fig. 4.2 Frequency Characteristics ( $\times 10$  Range,  $V_o = \pm 1 V_p/50 \Omega$  load)

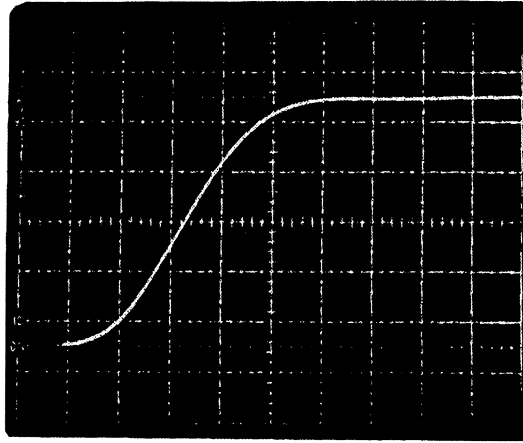


Fig. 4.3 Pulse Response ( $V_o = \pm 1 V_p/50 \Omega$  load)

INPUT SELECT	Single-ended <input type="checkbox"/> A input
GAIN	100 × 1 time
	0.4 V/DIV
	10 ns/DIV

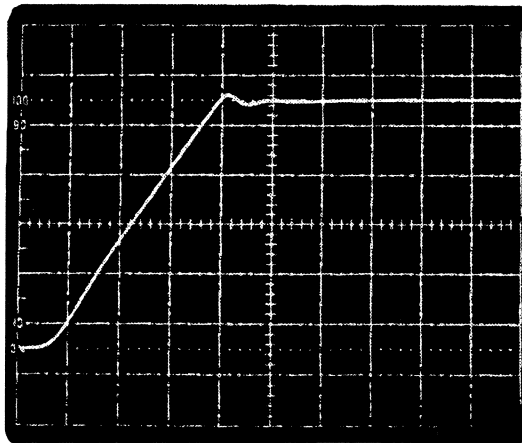


Fig. 4.4 Pulse Response ( $V_o = \pm 5 V_p/50 \Omega$ )

INPUT SELECT	Single-ended <input type="checkbox"/> A input
GAIN	100 × 1 time
	2 V/DIV
	20 ns/DIV

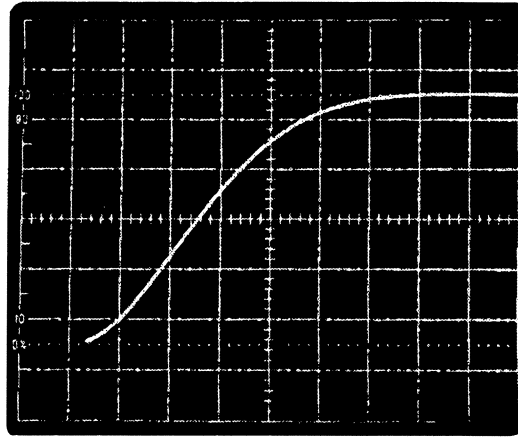
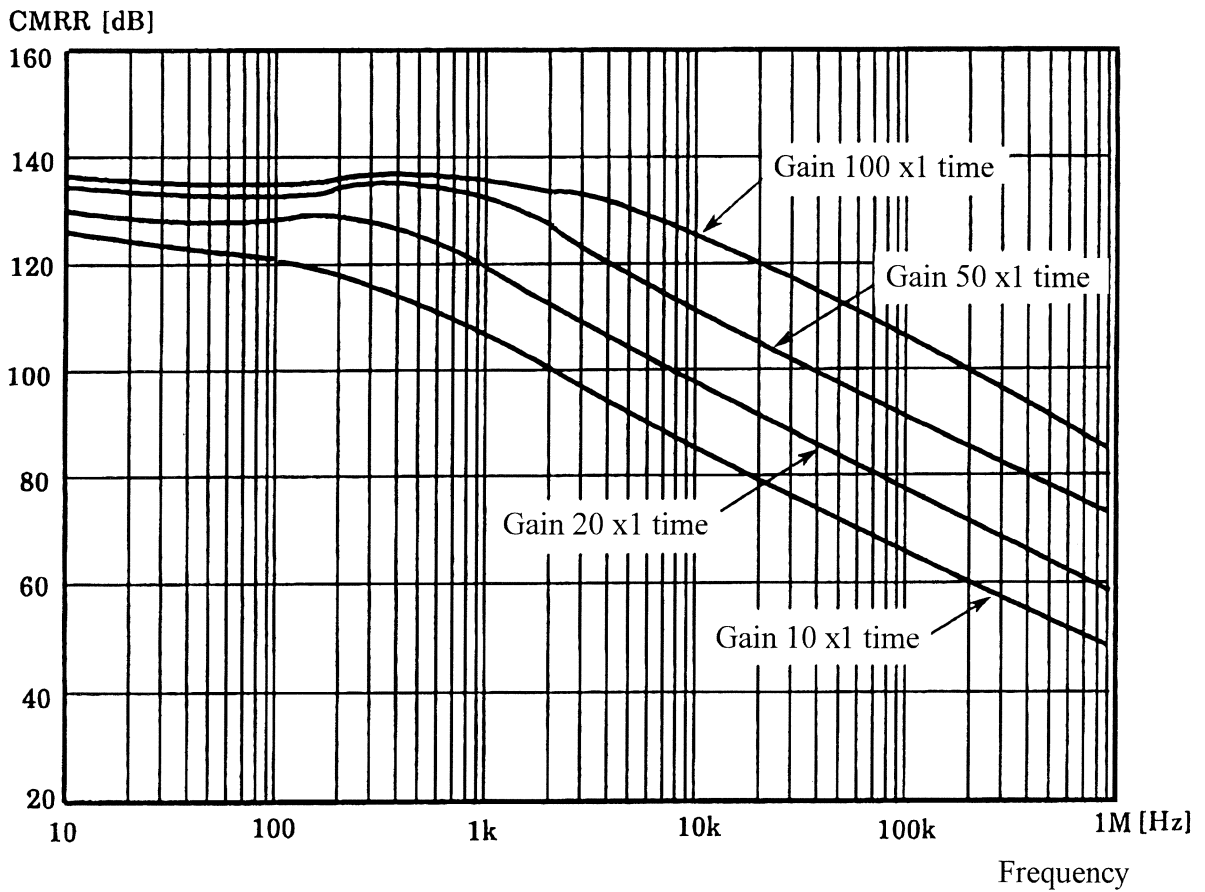


Fig. 4.5 1MHz Band Limit Filter Pulse Response ( $V_o = \pm 5 V_p / 50 \Omega$  load)

INPUT SELECT	Single-ended <input type="checkbox"/> A input
GAIN	100 $\times$ 1 time
	2 V/DIV
	0.1 $\mu$ s/DIV

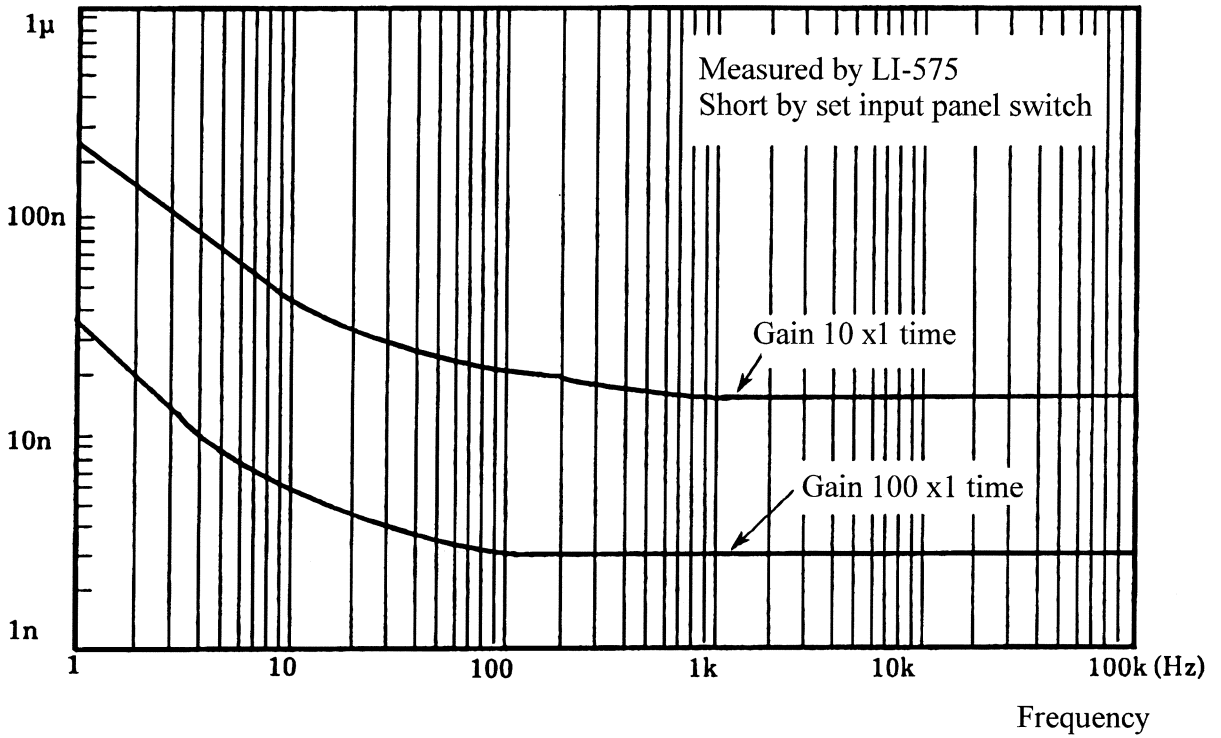


(The CMRR does not vary in either the  $\times 1$  or  $\times 10$  mode)

Fig. 4.6 Frequency versus Common Mode Rejection Ratio

Noise density ( $V / \sqrt{Hz}$ )

LI-575: Lock-in Amplifier



(Equivalent input noise dose not vary in the  $\times 1$  and  $\times 10$  mode)

Fig. 4.7 Equivalent Input Noise Density

Output Voltage ( $V_{p-p}/50 \Omega$  load)

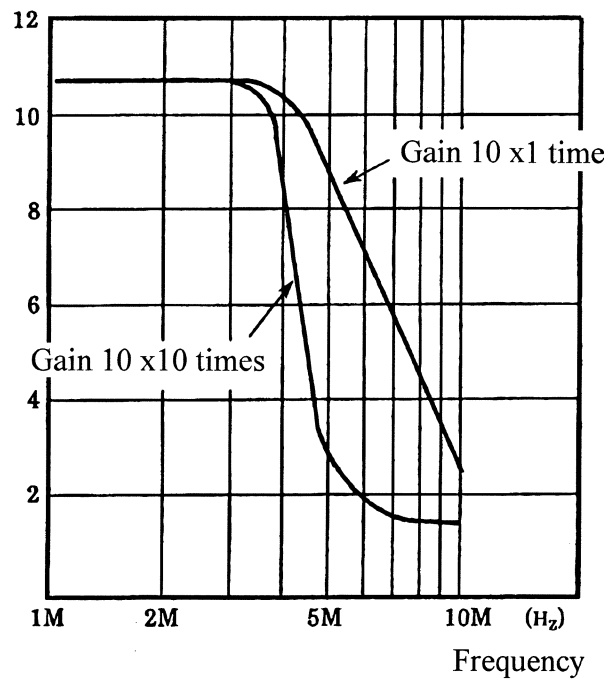


Fig. 4.8 Maximum Output Voltage without Distortion

Note: The maximum output voltage without distortion is defined as the third harmonic that reaches to  $-40$  dB when the output voltage is increased gradually.

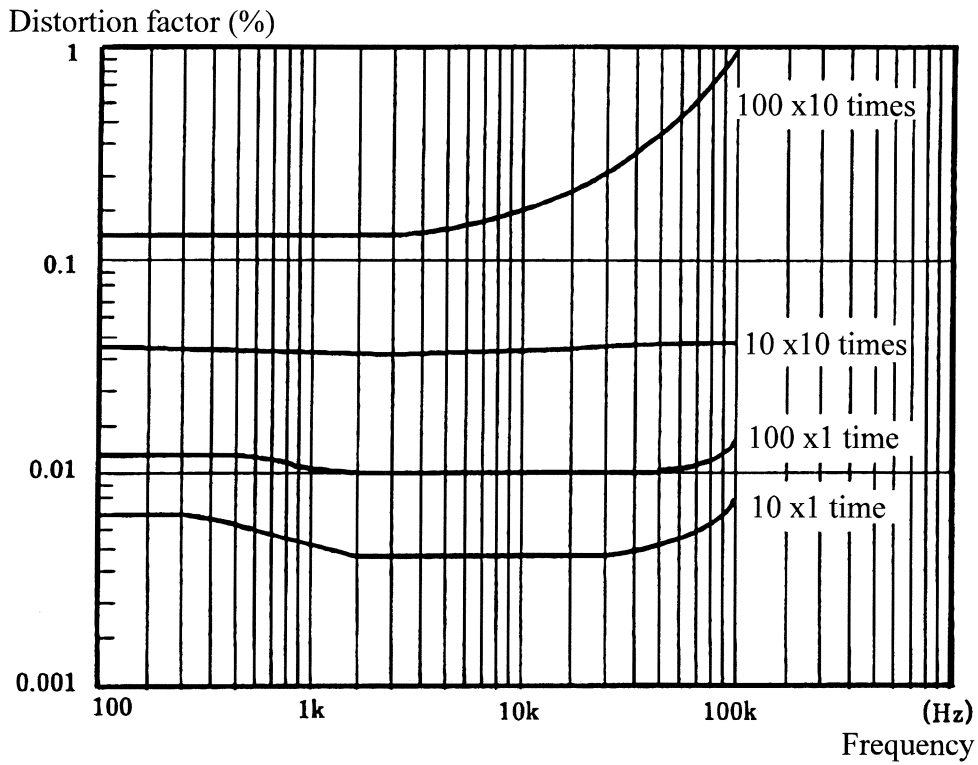


Fig. 4.9 Frequency versus Total Distortion Factor Characteristics ( $V_o = \pm 5 V_p/50 \Omega$  load)

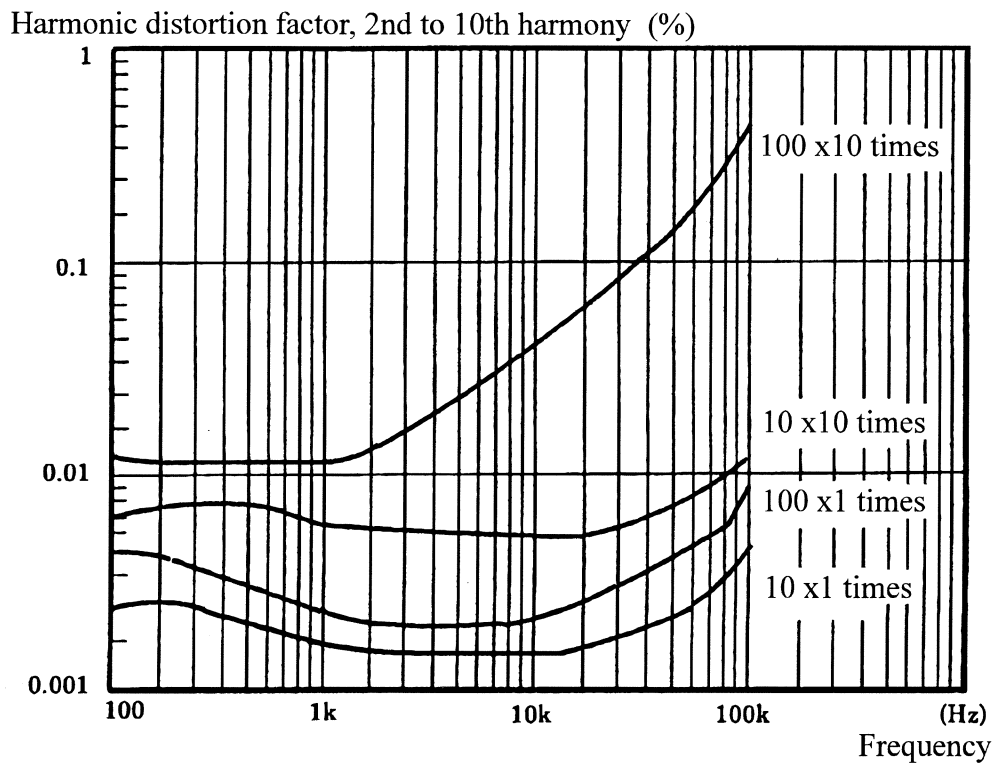


Fig. 4.10 Frequency versus Harmonic Distortion Factor Characteristics ( $V_o = \pm 5 V_p/50 \Omega$  load)

Distortion factor (%)

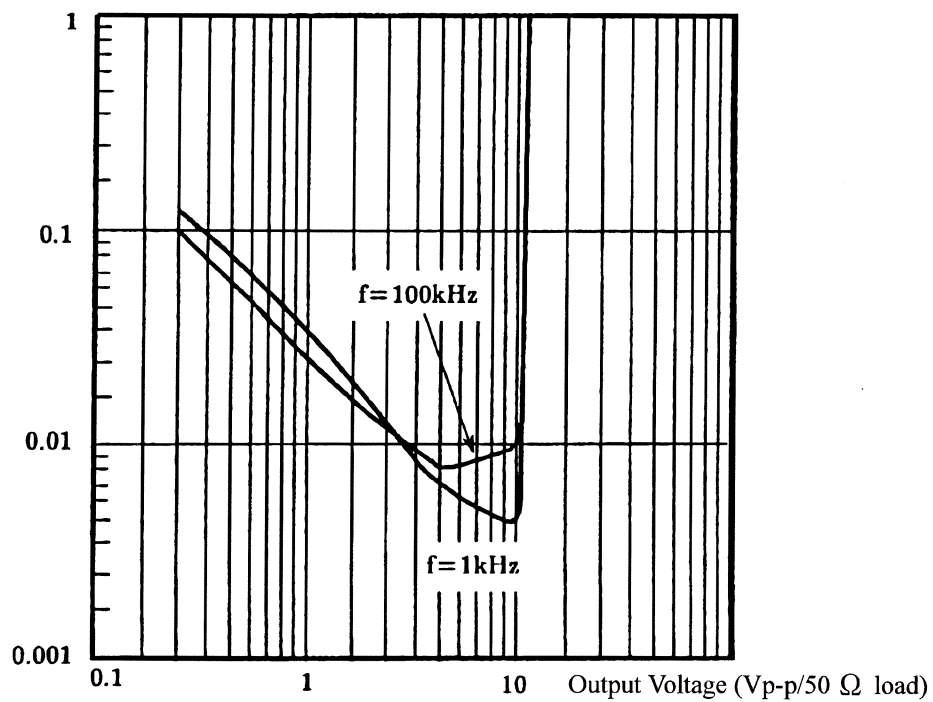


Fig. 4.11 Output Voltage versus Total Distortion Factor Characteristics

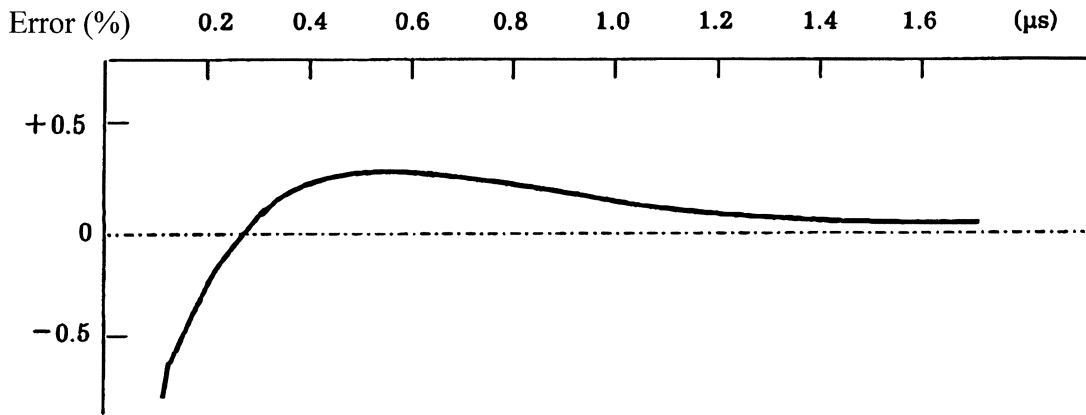


Fig. 4.12 Settling Characteristics (Gain  $10 \times 1$  time,  $V_o = 5 V_p / 50 \Omega$  load)

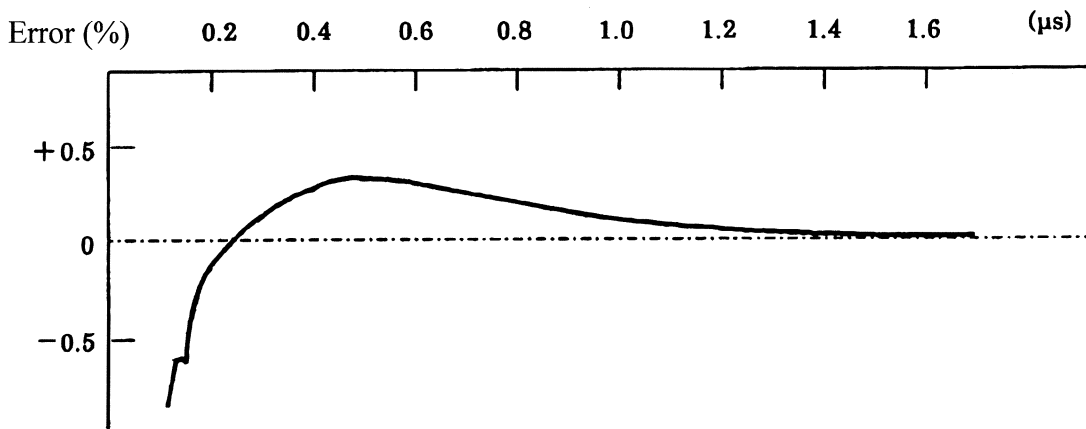


Fig. 4.13 Settling Characteristics (Gain  $100 \times 1$  time,  $V_o = 5 V_p / 50 \Omega$  load)

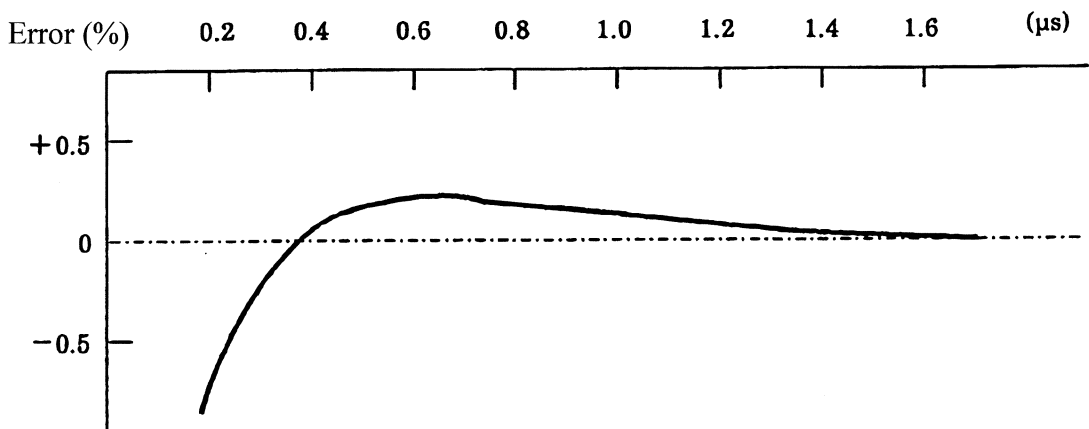


Fig. 4.14 Settling Characteristics (Gain  $100 \times 10$  times,  $V_o = 5 V_p / 50 \Omega$  load)



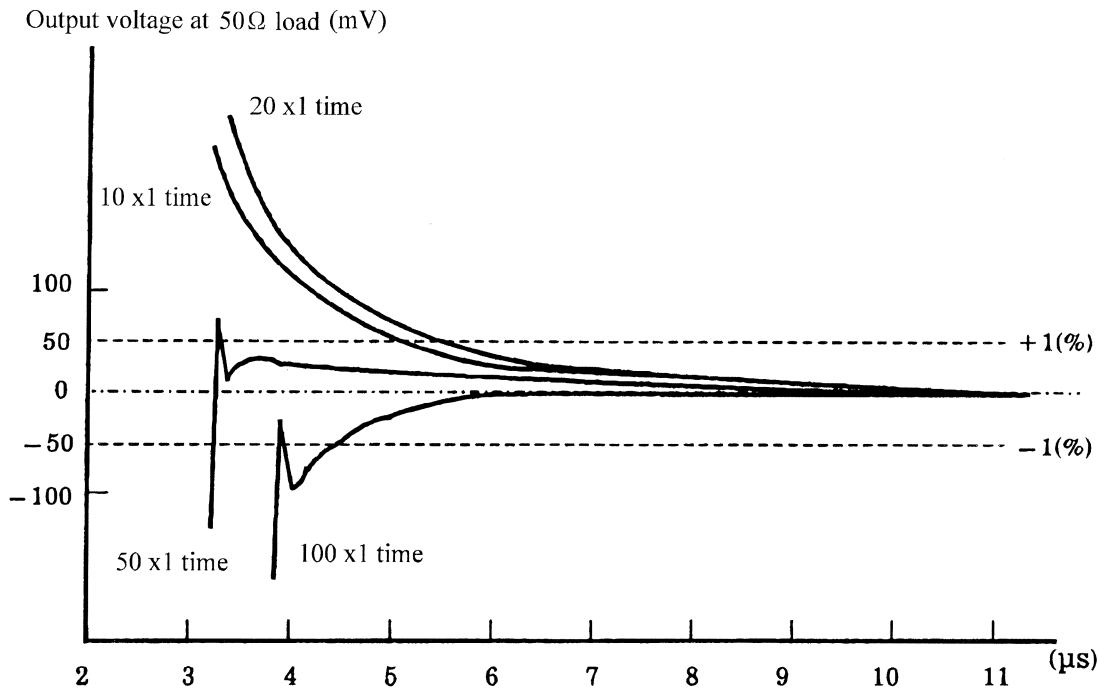


Fig. 4.15 Overload Recovery Characteristics ( $\times 1$  Range, +5 V step input)

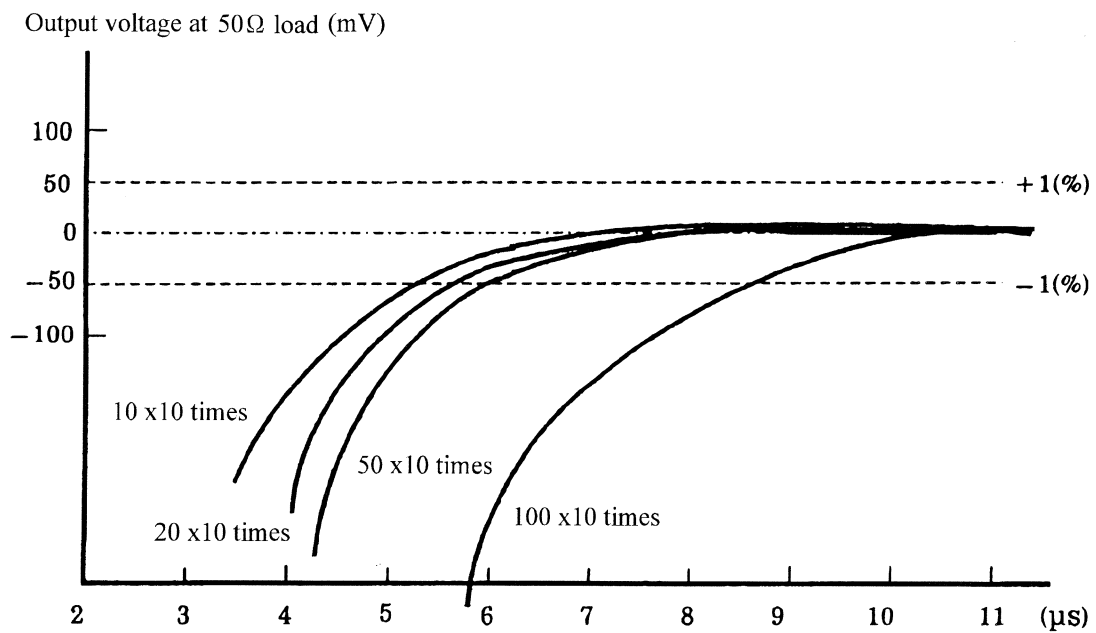


Fig. 4.16 Overload Recovery Characteristics ( $\times 10$  Range, +5 V step input)



## Section 5 Specifications

### 5.1 Input section

Input type: Differential input, 2 BNC connectors

A-B (differential input)

A, -B, A-OFS, -B + OFS (single-ended input)

GND (input short-circuit)

Selectable on the panel, OFS = internal offset

Input impedance: Resistance;  $1\text{ M}\Omega \pm 2\%$

Capacitance; Less than 35 pF

A, -B Input capacitance matching; Less than 3 pF

The resistance of 100 M $\Omega$  is obtained by switching an internal short plug.

Input bias current: 3 nA typical (23 °C) 2 times/10 °C up

Allowable maximum input voltage:  $\pm 50\text{ V}$  (input protector works at  $\pm 10.5\text{ V}$ , and the unit recovers automatically approximately 5sec. after the excessive input is removed)

Common mode voltage:  $\pm 10\text{ V}$  (linear operation)

Common mode rejection ratio: 120 dB minimum (at DC 1 kHz, gain = 1000 times, common mode voltage =  $\pm 5\text{ V}$ )

Equivalent input noise voltage:  $4\text{ nV}/\sqrt{\text{Hz}}$  typical ( at 1 kHz, input shunted, gain = 1000 times)

Input offset voltage adjustment: Adjustable to 0 V (An adjustment range referred to input is  $\pm 0.5\text{ mV}$  minimum)

Stability :  $\pm 8\text{ }\mu\text{V}/^\circ\text{C}$  typical (input shorted, gain = 1000 times, equivalent input value)

DC offset cancellation range: For single-ended connection input, the DC component is canceled up to an input equivalent value of  $\pm 5\text{ V}$  by the internal offset function.

Offset voltage cancellation voltage range :  $\pm 0.5\text{ V}, \pm 5\text{ V}$  2 range, accuracy within  $\pm 3\%$  of full scale

Stability : less than  $\pm 200\text{ ppm}/^\circ\text{C}$

## 5.2 Output section

Output type : Single-ended output, BNC connector

Output impedance :  $50 \Omega \pm 2\%$  ( $f = 1 \text{ kHz}$ )

Rated output voltage :  $\pm 5 \text{ V}$  ( $R_L = 50 \Omega \pm 1\%$ , DC to 3 MHz)  
 $\pm 10 \text{ V}$  ( $R_L \geq 1 \text{ M}\Omega$ , DC to 3 MHz)

Maximum output voltage :  $\pm 5.2 \text{ V}$  ( $R_L = 50 \Omega \pm 1\%$ , DC to 3 MHz)  
 $\pm 10.4 \text{ V}$  ( $R_L = 1 \text{ M}\Omega$ , DC to 3 MHz)

Maximum output current :  $\pm 100 \text{ mA}$

Slew rate :  $150 \text{ V}/\mu\text{s}$  typical ( $R_L = 50 \Omega$ ,  $V_0 = \pm 5 \text{ V}$ )  
 $300 \text{ V}/\mu\text{s}$  typical ( $R_L \geq 1 \text{ M}\Omega$ ,  $V_0 = \pm 10 \text{ V}$ )

Overload detecting voltage :  $\pm 5 \text{ V} +10\%/-0\%$  ( $f = 1 \text{ kHz}$ ,  $R_L = 50 \Omega \pm 1\%$ )

Output noise : Within  $20 \text{ mV}_{\text{rms}}$  (input shorted, gain = 1000 times, band width = 10 MHz,  $R_L = 50 \Omega$ )

## 5.3 Amplifier section

Gain : 10 to 1000 times ( $R_L = 50 \Omega$ ) 1-2-5 steps

Gain accuracy : Within  $\pm 3\%$  ( $f = 1 \text{ kHz}$ ,  $R_L \geq 1 \text{ M}\Omega$ )

Gain stability : Within  $\pm 200 \text{ ppm}/\text{C}^\circ$  ( $f = 1 \text{ kHz}$ ,  $R_L \geq 1 \text{ M}\Omega$ )

Frequency characteristic : DC to 10 MHz  $+0.2/-3 \text{ dB}$  ( $R_L = 50 \Omega$ ,  $V_0 = \pm 1 \text{ V}$ )

Full power band width : DC to 3 MHz ( $R_L = 50 \Omega$ ,  $V_0 = \pm 5 \text{ V}$ )

Distortion factor : Less than  $0.02\%$  ( $f = 1 \text{ kHz}$ ,  $R_L = 50 \Omega$ ,  $V_0 = \pm 5 \text{ V}$ , gain = 10 times)

Settling time :  $300 \text{ ns}$  typical ( $\pm 1\%$  error, gain = 10 times,  $R_L = 50 \Omega$ )  
Band width limit filter OFF, Output 5 V step

Overload recovery time : Within 10  $\mu$ s (gain = 10 to 100  $\times$  1 time)  
Within 50  $\mu$ s (gain = 10 to 100  $\times$  10 times)  
This is the time for the output voltage to be restored to the rated output voltage  $\pm 1$  % after adding a +5 V or -5 V voltage to the input in 10 ms.

Propagation delay time : 55  $\pm$  10 ns typ. (band limit filter FULL)  
310  $\pm$  10 ns typ. (band limit filter 1MHz)

Band limit filter : Cut off frequency 1 MHz  $\pm$  10 % (-3 dB)  
-18 dB/OCT, phase linear

## 5.4 General

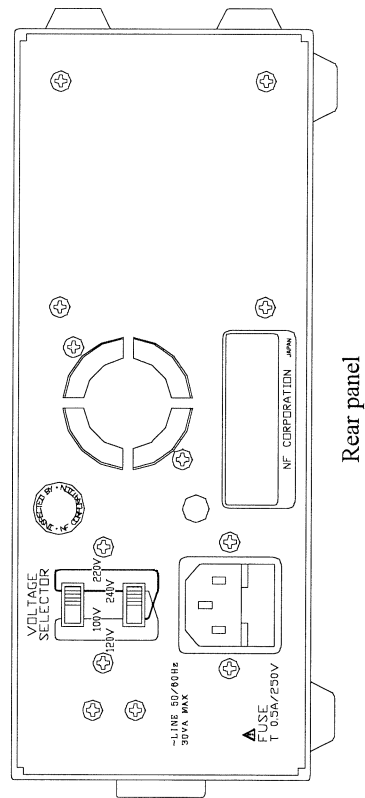
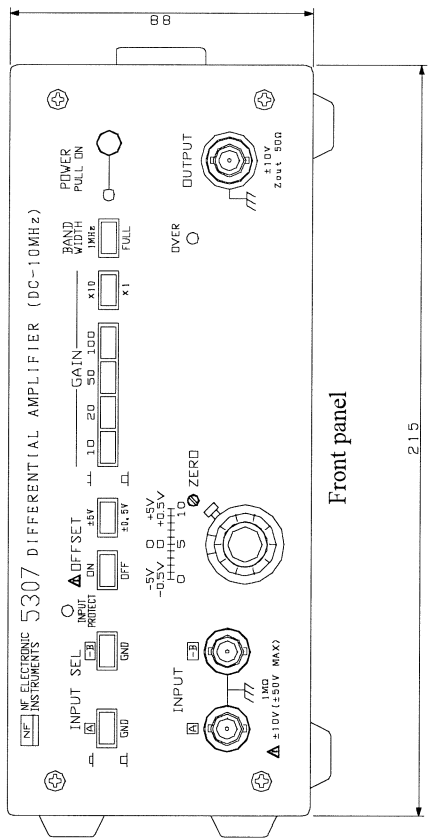
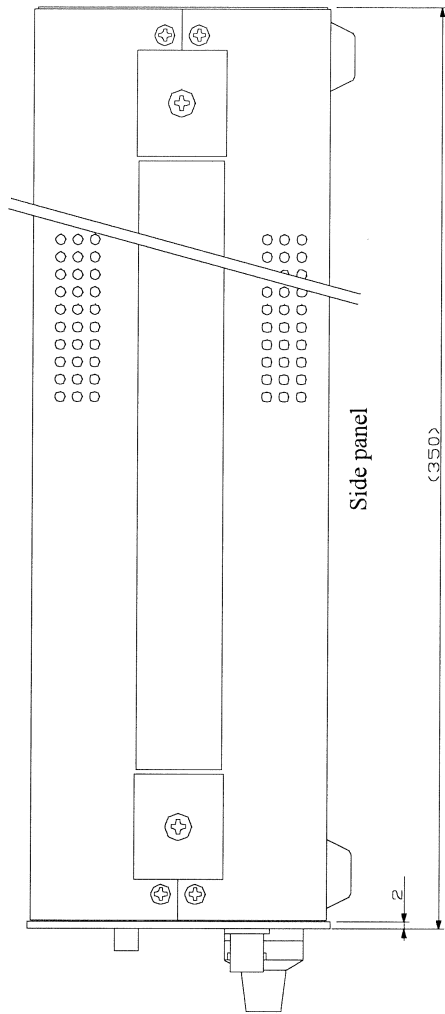
Power : AC 100 V (120 V, 220 V, 240 V switchable )  $\pm$  10 % (250 V Max), 48 to 62 Hz, 30 VA max  
Insulation resistance; 30 M $\Omega$  minimum, DC 500 V  
Withstand voltage; AC 1500 V for 1 minute

Operating temperature and humidity: 0 to 40  $^{\circ}$ C, 10 to 90 %RH (no condensation)

Storage temperature and humidity: -10 to 50  $^{\circ}$ C, 10 to 80 %RH (no condensation)

External dimensions: 215  $\times$  88  $\times$  350 mm (excluding projections)

Weight: Approximately 3.2 kg



Panel finish  
 Panels: Metallic gray finish  
 Cover: Hardened polyvinyl chloride metallic gray

Fig 5.1 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**





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5307 DIFFERENTIAL AMPLIFIER Operation Manual

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