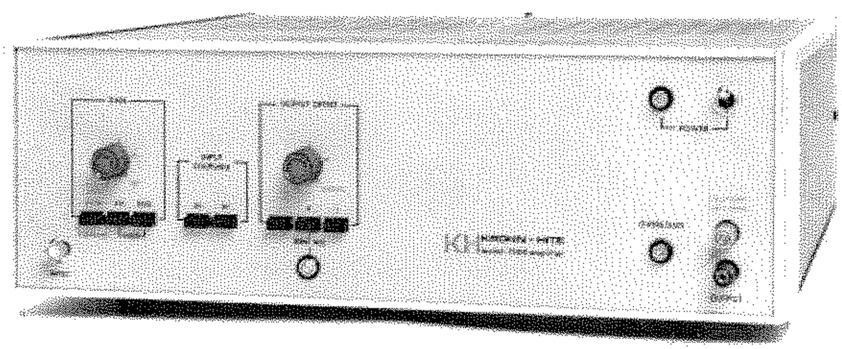
Model 7500

DC to 1MHz
Wideband Power Amplifier



Operating Manual

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DC to 1MHz
WIDEBAND POWER AMPLIFIER
MODEL 7500

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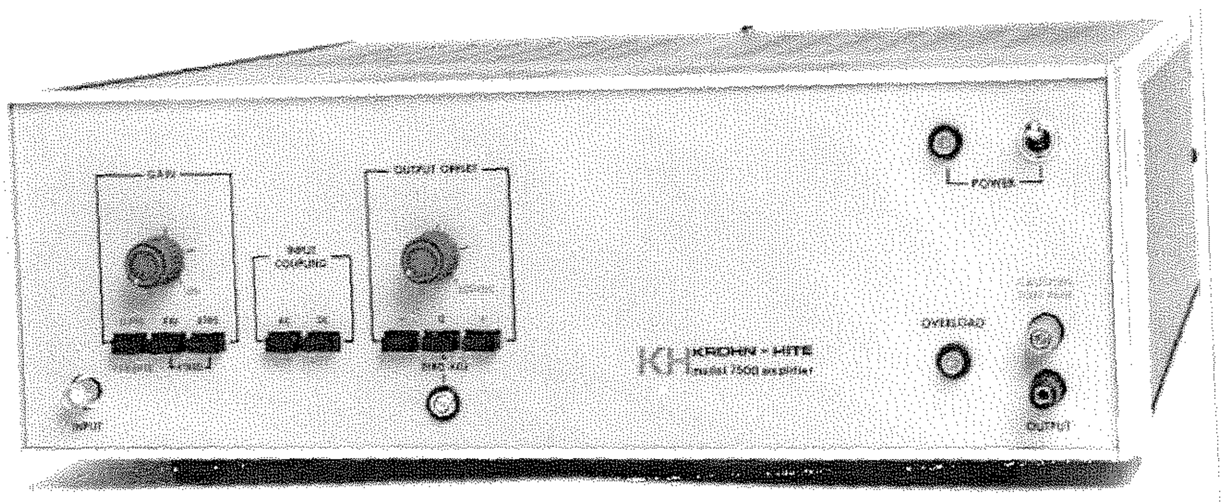


Model 7500 Wideband Power Amplifier

SECTION 1
GENERAL DESCIPTION

1.1 INTRODUCTION

The Krohn-Hite Model 7500, shown in Figure 1, is an all solid state, direct coupled amplifier, that provides 75 watts of continuous power (150 watts at DC), at 125 volts RMS, from DC to 100 kHz. Frequency response of the 7500 is flat to within 0.1db, and harmonic distortion at full power output is less than 0.1%, from DC to 10 kHz. A front panel control selects 20 db (10) or 40 db (100) of fixed gain, or zero to 40 db of continuously variable gain. The output of the 7500 can be offset ±200 volts, open-circuit, by means of a front panel DC offset control. The 7500 provides selectable input coupling, either direct (DC) or capacitive (AC).

The amplifier's output is protected from short-circuit or other abnormal load conditions by a unique output protection circuit, that uses a modified form of foldback current limiting. The output stage is convection cooled by a special heat sink configuration.

An optional rack-mounting kit (part no. RK-519) is available for installing the unit in a standard 19" rack spacing.

The amplifier is carefully inspected, aged and adjusted before shipment, and should be ready for operation when it is unpacked. If it appears to have been damaged in shipment, make a claim with the carrier, and notify Krohn-Hite immediately.

1.2 SPECIFICATIONS (Specifications apply after a 30 minute warm-up.)

Frequency Range

DC to 1 MHz

Output Power, Voltage & Current (Specifications apply using a 200 ohm resistive load):

Power: 75 watts, DC to 100 kHz; 40 watts at 500 kHz; 10 watts at 1 MHz.

Voltage: 125 volts RMS, DC to 100 kHz; 90 volts RMS at 500 kHz; 45 volts RMS at 1 MHz.

Current: 625 milliamperes RMS, DC to 100 kHz; 450 milliampers RMS at 500 kHz; 225 milliamperes RMS at 1 MHz.

Frequency Response

Flat to within ±0.1 db, DC to 1kHz; ±1.5 db to 500 kHz; -3 db at approximately 1 MHz.

Harmonic Distortion

At 75 watts into 200 ohms, less than 0.1% to 10 kHz, approximately 1.5% at 100 kHz.

Voltage Gain

Fixed, 20 db ±0.2 db (X10) or 40 db ±0.2 db (X100), or continuously variable, zero to 40 db.

Gain Stability

Less than ±0.1 db change for a 10% change in line voltage.

Dynamic Range

Greater than 85 db.

Phase Shift

Zero ±1 degree from DC to 10 kHz. Phase shift increases linearly to 100 degrees (lagging) at 1 MHz.

Square Wave Response (At 100 $V_{p\text{-}p}$ into 200 ohms)

Risetime, less than 500 nsec, overshoot less than 5%. Zero droop in DC coupled mode.

Maximum Input Voltage

±20 volts peak in the VARIABLE and X100 GAIN positions; ±200 volts peak in the X10 GAIN position.

Maximum DC Component

±200 volts (except VARIABLE GAIN position) in the AC position of the INPUT COUPLING switch.

Input Sensitivity

1.5 volts RMS at maximum gain setting.

Input Coupling

Either direct (DC), or capacitive coupling (AC) with low frequency cutoff at approximately 1 Hz.

Input Impedance

1 megohm in parallel with 85 pf in fixed gain modes; 5,000 ohms in variable gain mode.

Output Regulation

No load to 200 ohms, less than 0.5%, DC to 10 kHz.

Output Hum and Noise (1 MHz Bandwidth)

Less than 4 millivolts RMS with input shorted; less than 10 millivolts RMS with input open and shielded.

Output Coupling

Direct.

Output DC Level

Normally zero volts. Adjustable.

Output DC Offset (No Load)

Variable, zero to ±200 volts. Combined AC plus DC offset limited to ±200 volts.

Output DC Level Stability (After Warm-Up)

Vs. Line (short term): Less than 1 mv for 10% line voltage change.
Vs. Time: Less than 2 mv/8 hr.
Vs. Temperature: Less than 5 mv/°C.

Internal Impedance

Less than 1 ohm, DC to 10 kHz; less than 10 ohms at 100 kHz;l less than 75 ohms at 1 MHz.

Load Impedance

Capable of drivign any load within the voltage and current limitations of the amplifier.

Load Power Factor

1.0 to zero, leading or lagging.

Ambient Temperature

o°C to 45°C.

Controls

Front Panel: POWER switch, 3 position push-button GAIN selector, variable GAIN control, 3 position push button DC OFFSET selector, variable OFFSET control, screwdriver control for DC output level.

Rear Panel: CHASSIS/FLOATING ground switch.

Front Panel Indicators

Power ON, output OVERLOAD

Terminals

Front Panel: BNC for INPUT, binding posts for OUTPUT.

Rear Panel: BNC for INPUT, binding posts for OUTPUT, AC power receptable.

Power Requirements

105-125 or 210-250 volts, single phase, 50-400 Hz, 85 watts quiescent, 400 watts maximum.

Fuse Protection

AC line, 5 ampere slow blow (115 V), 2.5 ampere slow blow (230 V); output stage unregulated supplies, 1 ampere fast blow (each supply).

Dimensions and Weights

Model 7500: 16-5/8" wide, 5-1/4" high, 17" deep, 35 lbs/16 kgs net, 40 lbs/18.2 kgs shipping.

Optional Rack-Mounting Kit

Part No. RK-519: Permits installation of the 7500 into a standard 19" rack spacing.

1.3 PERFORMANCE CHARACTERISTICS

The performance characteristics of the Model 7500 are illustrated in Figures 2-7. Figure 2 represents the amplifier's typical output power levels for different resistive loads. The maximum power output of 75 watts is obtained with a 200 ohm load. Figures 3 and 4 represent the amplifier's RMS voltage and current output, under similar load conditions. The amplifier's maximum output voltage is approximately 140 volts RMS, open-circuit. The maximum output current is obtained with a 100 ohm load. Figure 5 shows the typical distortion of the 7500 at full power (75 watts) output. Distortion in the 7500 is less than 0.1% over most of its range. Figure 6 represents the frequency response of the 7500 for both open-circuit and full power output conditions. The frequency response of the 7500 to a square wave input is shown in Figure 7 (b); the input of the 7500 is shown in Figure 7 (a). Note that the amplifier produces very little ringing or overshoot on the signal, and that there is little, if any, rounding of the square wave's corners.

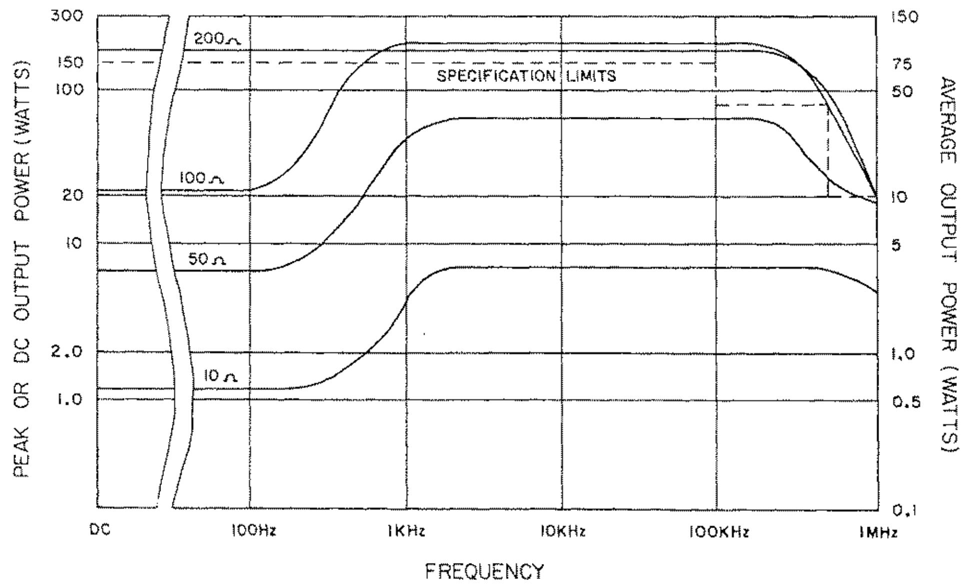


Figure 2. Typical Average Power Output vs. Frequency, for Different Resistive Loads.

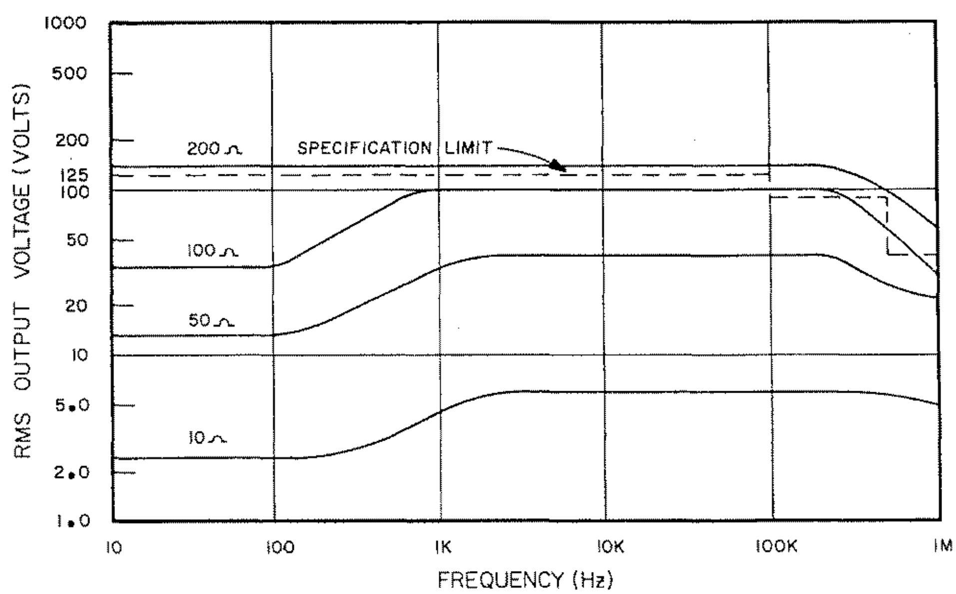


Figure 3. Typical RMS Voltage Output vs. Frequency for Different Resistive Loads.

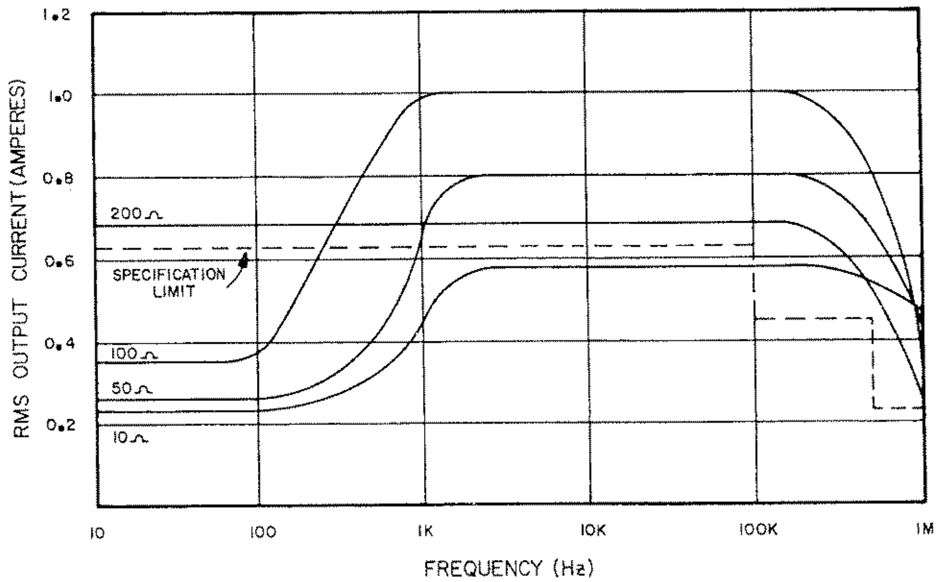


Figure 4. Typical RMS Output Current vs. Frequency, for Different Resistive Loads.

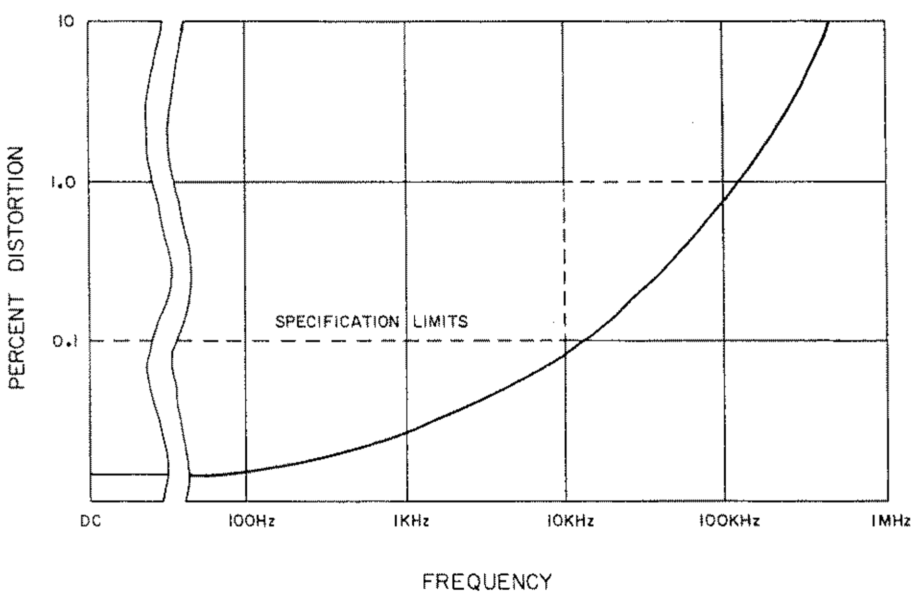


Figure 5. Typical Distortion vs. Frequency at Full Power Output.

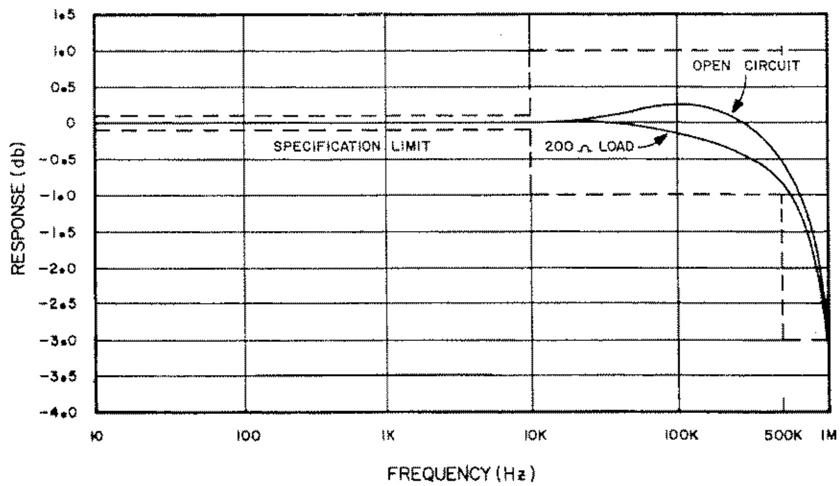
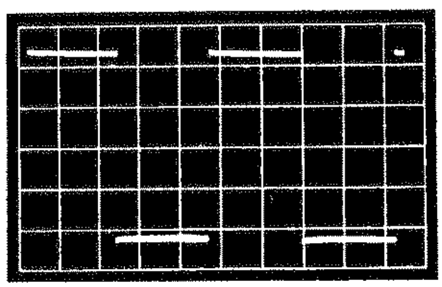


Figure 6. Typical Frequency Response

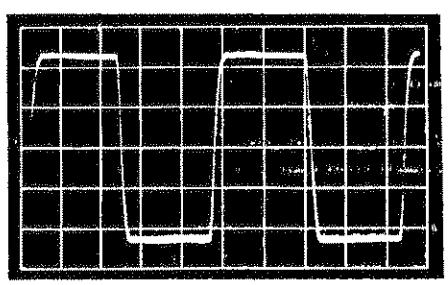
(a)



Amplifier Input

Vertical: 0.2V/cm
Horizontal: 2µs/cm

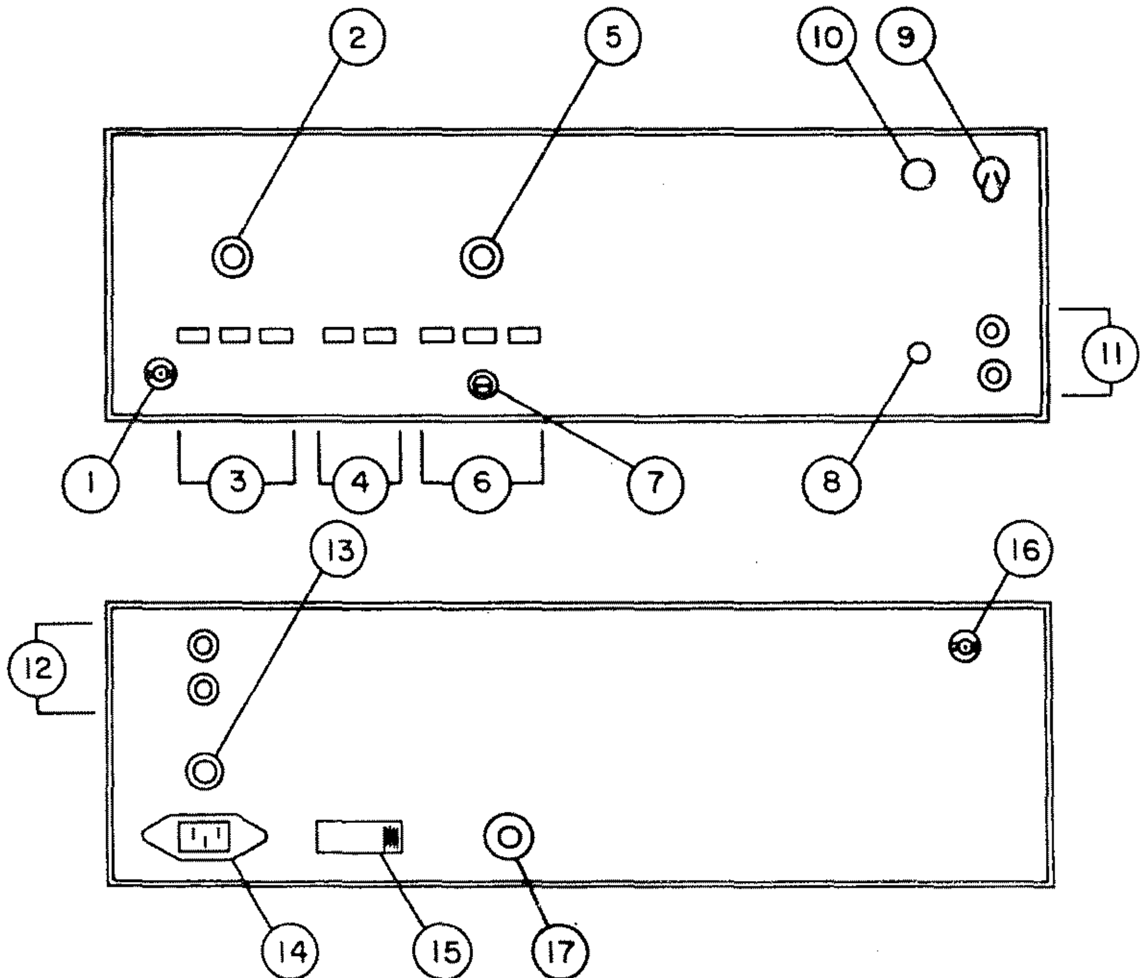
(b)



Amplifier Output

Vertical: 20V/cm
Horizontal: 2µs/cm

Figure 7. Response to Square Wave Input



1. FRONT INPUT (BNC)
2. VARIABLE GAIN CONTROL
3. OUTPUT GAIN SELECTOR SWITCHES
4. AC/DC INPUT COUPLING SELECTOR SWITCHES
5. VARIABLE DC OFFSET CONTROL
6. OUTPUT DC OFFSET SELECTOR SWITCHES
7. OUTPUT DC LEVEL SCREWDRIVER ADJUST
8. OUTPUT OVERLOAD INDICATOR
9. POWER SWITCH
10. POWER-ON INDICATOR
11. FRONT OUTPUT(BINDING POSTS)
12. REAR OUTPUT (BINDING POSTS)
13. FUSE
14. AC POWER RECEPTACLE
15. CHASSIS/FLOATING GROUND SWITCH
16. REAR INPUT (BNC)
17. CHASSIS GROUNDING POST

Figure 8. Operating Controls, Connectors and Indicators.

SECTION 2
OPERATION

2.1 POWER REQUIREMENTS

The Model 7500 Power Amplifier may be wired for operation from a single phase, AC power source of either 105-125 volts, 50-400 Hz, or 210-250 volts, 50-400 Hz. When the amplifier is wired for 105-125 volt operationg, the power transformer's primary windings are connected in parallel by installing jumpers between pins 1 and 3, and pins 2 and 4, which are located on the transformer (figure 9a). A 5 ampere, slow-blow fuse is requred for 105-125 volt operationg. When 210-250 volt operation is required, the primary transformer windings are connected in series by placing a jumper between pins 2 and 3 (figure 9b). When the amplifier is wired for 210-250 volt operationg, a 2.5 ampere, slow-blow fuse must be used.

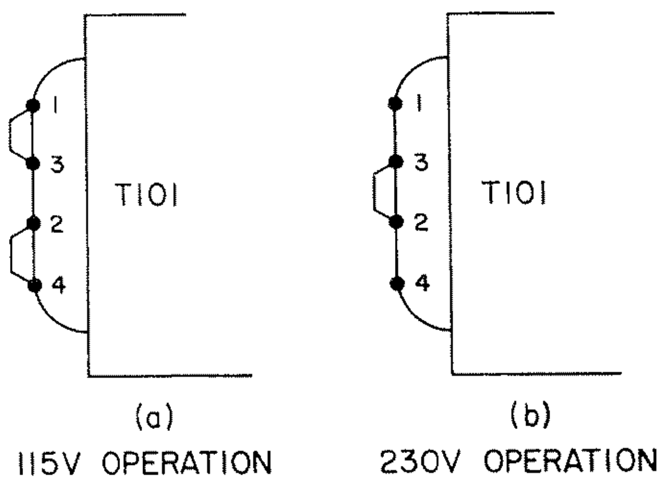


Figure 9. AC Input Wiring Diagram

2.2 OPERATING CONTROLS< CONNECTORS AND INDICATORS (See figure 8)

2.2.1 Front Panel Controls

POWER: On-Off toggle switch.

GAIN: 3 position push-button switch plus single-turn potentiometer for adjusting the amplifier's output voltage gain. The GAIN control provides a 20 db (X10) and 40 db (X100) fixed gain mode, plus a zero to 40 db variable mode.

INPUT COUPLING: 2 position push-button switch for selecting direct (DC) or capacitive (AC) coupling. In the AC mode, the low-cutoff frequency is approximately 1 Hz.

OUTPUT OFFSET: 3 position push-button switch for selecting zero, (+) or (-) DC offset, plus a single-turn potentiometer for controlling the offset from zero to 200 volts peak, open-circuit.

ZERO ADJ: Single turn screwdriver control for adjustment of the amplifier's output DC level.

2.2.2 Rear Panel Controls

CHASSIS/FLOATING: 2 position slide switch that disconnects the amplifier's signal ground (⊥) from its chassis ground (⊥), when used in the FLOATING mode.

2.2.3 Connectors

FRONT PANEL: BNC for INPUT, binding posts for OUTPUT.

REAR PANEL: BNC for INPUT, binding posts for OUTPUT; AC power receptacle, chassis grounding post.

2.2.4 Indicators (Front Panel Only)

POWER-ON: Neon indicator that lights to indicate a power-on condition.

OVERLOAD: Neon indicator that lights when the amplifier's output voltage approaches clipping as a result of an output overload.

2.3 OPERATION

2.3.1 Initial Set-Up

To operate the 7500 power amplifier, proceed as follows:

1. Make appropriate power connections (Section 2.1).
2. Set the OUTPUT OFFSET control to zero.
3. Set the GAIN selector to the VARIABLE position and GAIN potentiometer to the Max. CCW end.
4. Set the INPUT COUPLING switch to the desired mode.
5. Connect a voltmeter to the OUTPUT and adjust the OUTPUT DC Level by means of the front panel ZERO ADJ screwdriver control.

Select the desired GAIN and OFFSET modes, and make the appropriate connections to the INPUT and OUTPUT connectors.

Allow a 30 minute warm-up to obtain rated performance specifications.

CAUTION!

The 7500 is capable of as much as 200 volts peak on its OUTPUT terminals. To prevent the possibility of electrical shock, extreme caution should be used in connecting or disconnecting any cable or load from the amplifier's OUTPUT terminals, whenever these voltages are present.

2.3.2 Gain Control

The GAIN control on the 7500 consists of a 3 position, push-button switch that selects 20 db (10) or 40 db (100) of fixed gain, or zero to 40 db of variable gain controlled by a single-turn potentiometer. The output voltage of the 7500 is in phase (non-inverted) with respect to the input, in all three GAIN modes. A minimum input signal of 1.5 volts $MS is required to obtain a maximum output voltage of 140 volts RMS in the 40 db FIXED or zero to 40 db VARIABLE positions.

CAUTION!

The maximum allowable input voltage is ±20 volts peak in the VARIABLE and X100 GAIN positions, and ±200 volts peak in the X10 GAIN positions.

2.3.3 Output Offset Control

The OUTPUT OFFSET control consists of a 3 position, push-button switch that selects zero, positive or negative DC offset. The positive or negative offset is controlled by a single-turn log taper potentiometer and is adjustable from zero to ±200 volts peak, open-circuit. The amplifier's output can be offset ±200 volts DC plus AC peak. That is, if the amplifier's AC output is 50 volts peak, then the signal may be offset by 150 volts maximum. The smaller the AC peak value, the greater the DC offset value. If no AC signal is applied to the amplifier's input, then the DC offset will provide a DC voltage on the amplifier's output, adjustable from zero to ±200 volts, open-circuit. In this condition, the amplifier may be used as an auxiliary DC supply, within the amplifier's specified limitations for voltage and current.

2.3.4 Reactive Loads

The 7500 is capable of driving capacitive and inductive loads within its voltage and current limitations. The 7500 will provide a minimum of 75 volt-amperes for a minimum load impedance of 200 ohms over most of its range.

2.3.5 Output Circuit Protection

The 7500 uses a modified form of foldback-current limiting to protect its output stages from damage caused by short-circuit or abnormal loads. Unlike a constant-current limiter, the circuit used in the 7500 varies the output limiting current as a function of output voltage, load and frequency. When the circuit limit is engaged, the front panel OVERLOAD indicator will light. Figure 10 shows typical current-limiting values for several resistive loads.

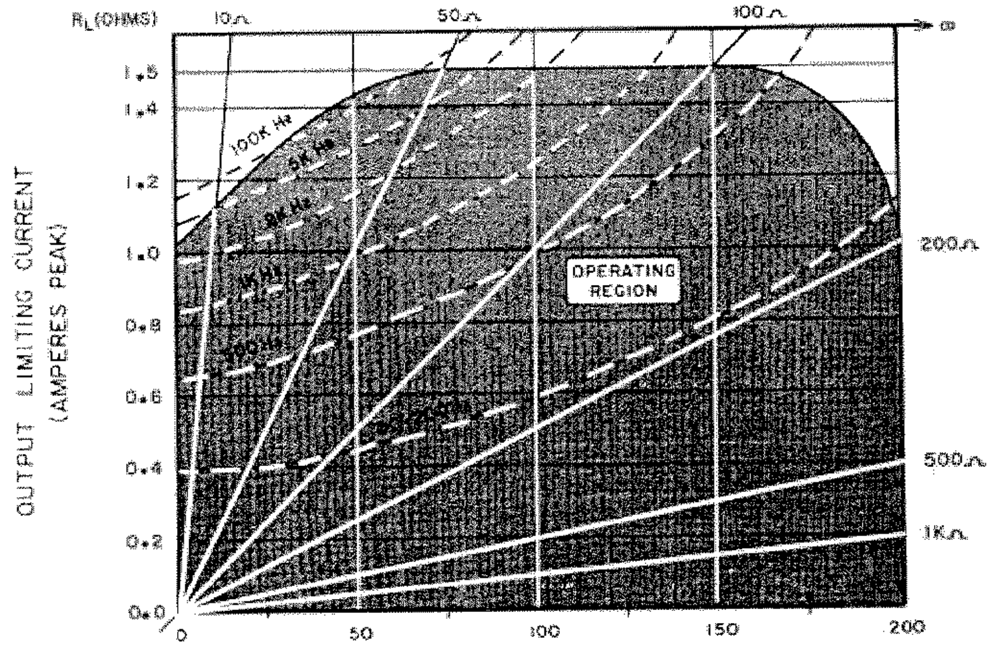


Figure 10 Output Current Limiting

The shaded area of the graph represents the amplifier's maximum operating region. Note that the peak limiting current is reduced at peak voltages below 75 volts (resistive load below 50 ohms). Hence the name "foldback limiting". The load lines on the graph are drawn from the origin (o.o/0) and are labeled on the edges of the graph which consists of a linear scale, in ohms, that extends to infinity. The 200, 500 and 1k ohm load lines are extended only to where they intercept the limiting voltage.

The maximum power output of the amplifier is determined by the peak power dissipated in the output transistors. Since the output stage operates in a class B mode, the peak power can be averaged over a full cycle at high frequencies. For resistive loads of 200 ohms or greater, the power dissipated in the output stage is low enough to allow the amplifier to provide its full output voltage swing at all frequencies.

The amplifier's limiting current is dependent upon frequency, as indicated by the dashed lines on the graph, which are related to the thermal time constant of the output transistors. The limiting current will be determined by the point where the load line intersects the frequency curve. For example, with a 100 ohm load, the output current is limited to approximately 400 ma at frequencies below 200 Hz (essentially DC), and limited to 1 ampere up to about 500 Hz. Above 500 Hz, the output current can increase until its maximum limiting value is reached.

SECTION 3
INCOMING ACCEPTANCE AND PERFORMANCE CHECKS

3.1 INTRODUCTION

The following procedure is provided to insure that the Amplifier is operating within its rated specifications, both for incoming inspection and for routine servicing. Tests should be made with all covers in place, and the procedure given below should be followed in sequence. Refer to Section 2, Operation, before beginning this procedure.

3.2 TEST EQUIPMENT REQUIRED

(a) Oscilloscope, bandwidth of at least 50 MHz, vertical sensitivity from 5 V/ cm to 50 V/cm, Tektronix type 465, or equivalent, with probe.
(b) Low Distortion Oscillator, frequency range .01 Hz to 1MHz, output voltage at least 1.5 volts RMS, and harmonic distortion less than .02% to 10 KHz and less than 0.1% to 100 KHz, Krohn-Hite Model 4100A or equivalent.
(c) RMS Voltmeter, Fluke Model 931A or equivalent.
(d) AC Voltmeter, Ballantine Model 314A or equivalent.
(e) Digital Voltmeter (DVM) to measure up to ±250 volts DC.
(f) Resistive load, 200 ohms, 100W, 5%, non-inductive.

3.3 INITIAL SET-UP

After allowing the instrument to warm up for at least 30 minutes, set the 7500 controls to the following positions:

GAIN	Variable, Pot Max CCW
INPUT COUPLING	DC
OUTPUT OFFSET	0, Pot Max CCW
GROUND	Chassis

CAUTION!

The 7500 is capable of providing as much as 200 volts peak on its OUTPUT terminals. To prevent the possibility of electrical shock, extreme caution should be used in connecting or disconnecting any cable or load from the amplifier's OUTPUT terminals, whenever these voltages are present.

3.4 POWER OUTPUT, VOLTAGE AND CURRENT

The power output of the 7500 can be measured by a stndard wattmeter. If a wattmeter is not available, an alternative method, illustrated in Figure 11 may be used.

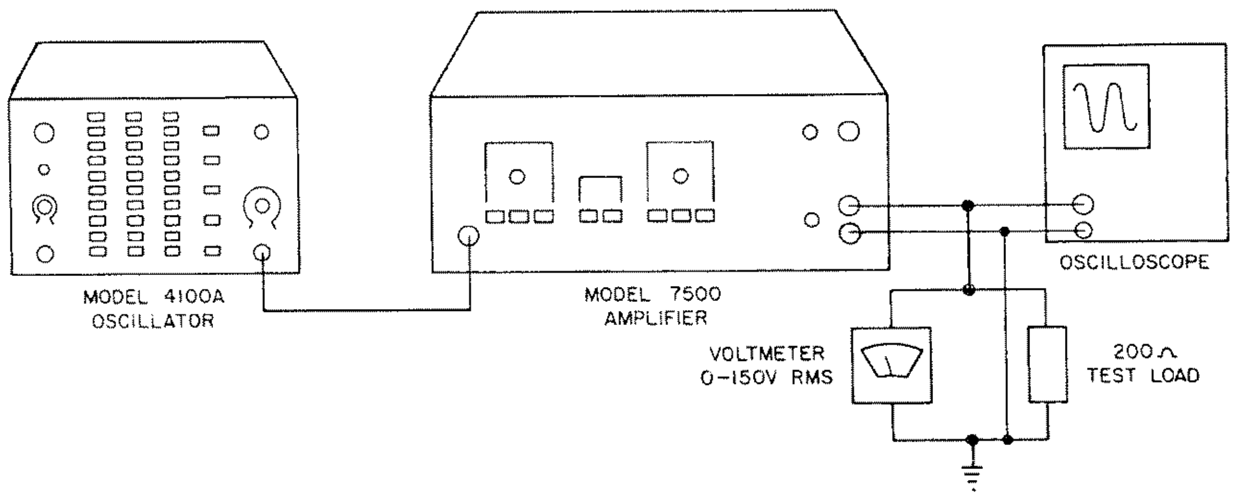


Figure 11. Test Setup for Measuring Power Output

The Amplifier's maximum power output is obtained with a 200 ohm resistive load. First adjust the output of the oscillator to approximately 1.5 volts RMS, then increase the Amplifier's VARIABLE GAIN control while monitoring the scope, until a maximum output signal is obtained; make sure the signal is not clipped or distorted. The maximum power output, in watts, can now be calculated from the expression,

$$P_{ave} = \frac{E_{RMS}^2}{R_L}$$

The values for maximum output current are obtained from the relation,

$$I_{RMS} = \frac{E_{RMS}}{R_L}$$

Refer to figures 2, 3 and 4 for typical values of output power, voltage and current, respectively, for various resistive loads.

3.5 FREQUENCY RESPONSE

The frequency response of the Amplifier is defined as the variation in output voltage, Δe_o, vs frequency, for a constant input, and may be expressed either in percentage or db as follows:

$$\% \text{ Deviation} = \frac{\Delta e_o}{e_o} \times 100\% \text{; dB} = 20 \log \frac{e_o + \Delta e_o}{e_o}$$

Refer to Figure 6 on Page 6 for typical characteristic curves.

When performing the response measurements, the Amplifier's output voltage should be kept within its maximum output limitations over the entire frequency range. A recommended procedure is to set the Amplifier's GAIN control to X100, DC coupled, and adjust the oscillator's output voltage for approximately 10 volts RMS on the Amplifier's output. A suitable Voltmeter, such as the Model 931A, should be used, since it allows greater resolution of small amplitude variations. The oscillator output should be kept constant at all times. Measure the response of the Amplifier from approximately 100 Hz to about 10 KHz; amplitude variation should be less than ±100 mv RMS (±1%). Tune the oscillator from 10 KHz to about 500 KHz; amplitude variations should be within ±1 volt RMS. Increase the frequency of the oscillator; the Amplifier's output voltagbe should drop to 7 volt RMS at approximately 1 MHz.

3.6 HARMONIC DISTORTION

Connect the 200 ohm test load to the Amplifier's output and adjust the oscillator's output voltage for 122.5 volts RMS on the Amplifier's output (75 watts). Measure the distortion at several frequencies, using the HP333A Distortion Analyzer; the distortion should be less than 0.1% up to 10 KHz, and less than 1% up to 100KHz. Monitor the Amplifier's output signal on the scope to make sure it is not clipped or distorted.

3.7 VOLTAGE GAIN, FIXED MODE

Set the frequency of the oscillator to approximately 1 KHz and adjust its output voltage for exactly 1 volt RMS. Switch the Amplifier's GAIN control to the x10 position, and measure the voltage on the output terminals. Tolerance: 10V ± 0.2V RMS.

Switch the Amplifier's GAIN control to the X100 position and measure its output voltage.

Tolerance: 100V, ±2V RMS. (Recheck the Amplifier's input when switching from X10 to X100).

3.8 OUTPUT REGULATION

Output regulation is defined as the Amplifier's percentage change in its output voltage, when a 200 ohm load is connected to the output terminals. Set the oscillator frequency to 1 KHz and adjust the oscillator's output voltage for 100 V RMS on the Amplifier's output. Connect the 200 ohm test load and observe the change in output voltage. Tolerance: less than 0.5%. Disconnect the oscillator.

3.9 DC OFFSET

Short the input to the Amplifier and connect a DC Voltmeter to the Amplifier's output. Switch the Amplifier's OFFSET control to "+" and adjust the variable OFFSET control to its maximum clockwise position. The output DC offset should be greater than +200V.

Switch the OFFSET control to the "-" position. The output DC offset should be greater than –200V. Return the OFFSET control to the "0" position.

3.10 OUTPUT HUM AND NOISE

The Amplifier's internally generated hum and noise can be measured with a Ballantine 314A Voltmeter. Short the Amplifier's input and measure the hum and noise on the Amplifier's output. Tolerance: less than 4 millivolts RMS.

Remove the short and connect a suitable shield to both the Amplifier's front and rear input terminals. Measure the output hum and noise. Tolerance: less than 10 millivolts RMS.

3.11 SQUARE WAVE RESPONSE

The typical square wave response of the 7500 is shown in Figure 7, Page 7.