



INSTRUCTION MANUAL

DELTA OMEGA™ 2000 INTERFACE VELOCITY CONTROLLED AMPLIFIER

CROWN INTERNATIONAL, INC. 1718 W. MISHAWAKA RD. ELKHART, INDIANA 46517

The information furnished in this manual does not include all of the details of design, production, or variations of the equipment. It does not cover all the possible contingencies which may arise during operation, installation, or maintenance. Should special problems arise, or further information be desired, please contact the Crown International Customer Services Department.

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WARNING

**TO PREVENT SHOCK OR FIRE HAZARD DO NOT EXPOSE TO
RAIN OR MOISTURE!**

CAUTION

**TO PREVENT ELECTRIC SHOCK DO NOT USE THIS
(POLARIZED) PLUG WITH AN EXTENSION CORD,
RECEPTACLE OR OTHER OUTLET UNLESS THE BLADES
CAN BE FULLY INSERTED TO PREVENT BLADE EXPOSURE.**

ATTENTION

**POUR PREVENIR LES CHOCS ELECTRIQUES NE PAS
UTILISER CETTE FICHE POLARISEE AVEC UN
PROLONGATEUR. UNE PRISE DE COURANT OU UNE AUTRIE
SORTIE DE COURANT, SAUF SI LES LAMES PEUVENT ETRE
INSEREES A FOND SANS EN LAISSER AUCUNE PARTIE A
DECOUVERT.**



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SECTION 1

GENERAL INFORMATION

1.1 Introduction/Purpose of Equipment

The Delta Omega™ 2000 is a high power interface velocity controlled amplifier used for precision amplification of frequencies through the audio range. It features extremely low harmonic and intermodulation distortion and very low noise.

For special applications, it features a remote protect connector giving access to control of the high voltage power supply which may be interfaced with external controllers.

The output circuitry uses 32 rugged 150W transistors (4800W dissipation) in a Crown developed and patented bridge circuit having one end of the load common to ground. This circuit effectively doubles the available output voltage without increasing the operating voltage of the output transistors, resulting in increased reliability since fragile high voltage transistors or series output circuitry are not required.

A red indicator lamp indicates the presence of AC power. The power switch is a visually-indicating type which engages only the low power supplies and cooling system. These in turn control the high power supplies by means of a 30A solid state switch.

A self-contained, forced-air cooling system, having a 1900W cooling capacity in 25°C air, is used with a two-speed fan to minimize noise output and dust loading of the input filter at times of low dissipation.

The high power supply contains two transformers and computer-grade filter capacitors to give 100 joules of energy storage.

The low voltage power supply furnishes two ± 15 VDC outputs from current-limited IC regulators. These regulators are protected by automatic thermal shutdown devices. Shutdown of this power supply simultaneously disables the high power supply.

The output transistors operate in the Crown patented AB+B mode of operation, where all quiescent current is carried by the driver transistors. Electronic overload

protection is provided by the proprietary SPACE controller (Signal Programmed Automatic Current Executor). The SPACE controller acts as a signal-variable current limiter at sonic frequencies and as a VI limiter at subsonic frequencies and DC.

If the unit should overheat due to a cooling system failure, or if the line voltage becomes excessive, the high voltage power supply will be disengaged, placing the unit in the Standby mode. The low power supply and cooling system will remain on.

On the rear of the unit are switches used to engage a 4-5 second turn-on delay and a low frequency load protector (if they are desired by the user). Actuation of those systems results in the unit going into Standby mode. This mode is indicated by an amber indicator light located on the front panel (see Fig. 3.9).

The panel display features a dynamic range display, signal presence indicator and 70.7 VRMS led.

1.2 Service Policies

Due to the sophisticated circuitry of your unit, only qualified, fully trained technicians should be allowed to service it. Please observe the following label on the unit: **CAUTION: TO PREVENT ELECTRIC SHOCK DO NOT OPEN. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO A QUALIFIED TECHNICIAN.**

For service, return the unit to the factory in the original packing or in replacement packing obtainable from the Crown factory. For warranty service, the unit must be returned to the factory or an approved service station (Amcron customers consult your local representative). In either case, fill out and enclose the Service Information form located at the rear of this manual. This will help to ensure a speedy and effective response.

Crown will pay shipping costs (in the U.S.) for warranty service upon receiving copies of all shipping receipts.

Before returning your unit to the factory for service, authorization should be obtained from the Crown

Technical Service Department. All shipments should be sent UPS or truck freight (insured). The factory will then return your serviced unit by one of the above methods.

Upon receipt of the warranty registration card from your dealer, Crown will register your unit on our computer warranty file.

Retain your copy of the bill of sale from your Crown dealer. This is your proof of purchase.

When you need service for your unit from an authorized Crown Service Station, simply present your bill of sale. With it, the service station can promptly initiate any needed paperwork. It will save you time and effort.

The bill of sale is also your proof of ownership should you need it for insurance or legal reasons.



SECTION 2

SPECIFICATIONS AND PERFORMANCE

2.1 Specifications

General Protection: High line voltage or over temperature result in shutdown of the high voltage power supplies. Controlled-slewing-rate voltage amplifiers protect the amplifier against RF burnouts. Input overload protection is furnished by a resistor and the input of the amplifier to limit input current.

High Voltage Power Supply: Two transformers with computer-grade capacitors storing 100 joules are powered through a 30A solid state switch.

Low Voltage Power Supply: ± 15 VDC supplies are provided by current-limited shortproof regulators which have automatic thermal shutdown. Shutdown of these supplies results in shutdown of the high voltage power supplies.

Power Requirements: 50-60 Hz Ac with adjustable taps for 100, 120, 200, 220 and 240V $\pm 10\%$ operation. Draws 80W or less on idle, 1KW at 600W output into 8 ohms.

Displays: (see Figs. 3.8 and 3.9)

SPI (signal presence indicator) yellow LED lamp (indicates source material signal is present).

Dynamic Range 6 - 25 db amber LED lamps (indicate instantaneous dynamic range of source material signal, comparing average amplitudes to the peak).

STANDBY amber neon lamp (indicates high voltage power supply is deactivated).

70.7 VRMS green LED light (indicates that output voltage has reached 70.7 VRMS).

POWER red neon lamp (indicates power is applied to unit).

PROTECT red LED lamp (indicates that Delta Omega™ ohm pot or remote device has reached the critical point (see Section Three).

Controls: (see Figs. 3.8 and 3.9)

Note: For proper installation and operation of the Delta Omega™ 2000, carefully read Section Three of this manual before attempting to use this unit.

Push/Push OFF/ON power switch (turns unit off and on).

AC/DC Input Coupling dial (selects proper input configuration, AC or DC).

Local/Remote switch (permits Delta Omega™ procedure to be done using the local pot or an external remote device).

OFF/ADJ/ON Mode dial (selects the mode of operation for the unit).

Delta Omega™ Adjust Pot (permits adjustment of desired match of Delta Omega™ 2000 and speaker load).

INPUT ATTENUATOR dial (permits adjustment of volume).

LF Protection switch, on rear panel (puts unit into Standby if low frequency outputs of more than 10 volts occur).

Delay switch, on rear panel (inserts a 4 to 5 second time delay in the state transition from Standby to high power supplies on).

Remote Protect: The unit may be remotely to external control to place in standby mode. The Standby mode may be initiated by closing an external common to ground contact of 15 V 3mA rating (i.e. an open collector high voltage TTL output or an opto-isolator output).

Connectors: Input three terminal barrier strip routes to input plug in:

- terminal number 1 = ground.
- terminal number 2 = positive.
- terminal number 3 = negative.

Note: proper installation of input lines may be achieved by reviewing Section Three of this manual and the FOR RATED OUTPUT table silkscreened on the unit's rear panel (see Fig. 3.8).

AC Line - three wire 20A, 120V male connector with five feet minimum cable.

Remote Protect - eleven pin "octal-type" socket.

Construction: Aluminum chassis with $\frac{1}{4}$ " thick front panel, reinforced with steel to retain the power transformers. $\frac{1}{8}$ " aluminum side panels. Heavy duty handles on front for ease of transport. Plug-in printed circuit boards.

Dimensions: 19" (48.26 cm.) standard rack mount, 8 $\frac{3}{4}$ " (22.22 cm.) height, 16 $\frac{1}{2}$ " (41.91 cm.) behind mounting surface, handles extend 2" in front of mounting surface.

Weight: 92 pounds (41.7 kilograms).

Center of Gravity: nearly centered at 5" behind the mounting surface.

Finish: Front panel is coated with durable textured polyurethane. Carbide black front panel and black painted aluminum chassis and covers.

***Power Response:** DC to 45KHz at 600W continuous average output power into 8 ohms with no more than .05% Total Harmonic Distortion.

Power at Clip Point (Less than .01% THD): Music power at clip point into 2.2 ohm load, 10 to 500Hz; 2000W RMS using a 50Hz, 50% duty cycle tone burst signal source.

***DC Output (Delta Omega™ 2000 used as a conventional voltage amplifier):** Typically, 20A maximum at 100 V or 2KVA (see V-I plot).

***Frequency Response:** ±.1dB DC-20KHz at 1W into 8 ohms.

***Phase Response:** +0, -15 degrees DC-20 KHz at 1 W into 8 ohms (see graph).

***Slew Rate:** 32V/microsecond (slew rate is the maximum value of the first derivative of the output signal, or the maximum slope of the output signal).

***I.M. Distortion (60Hz-7KHz 4:1):** Less than .05% from .01W to 600 watts (peak equivalent to a single sinusoid, rms) into 8 ohms.
Less than .01% at 600W into 8 ohms or 1200W into 4 ohms.

***Harmonic Distortion (True RMS Measure):** Less than .05% from DC-45KHz at 600W into 8 ohms.
Less than .001% from 20Hz-400Hz and increasing linearly to .05% at 600W into 8 ohms.

Output Impedance: Variable (+8 ohms to -8 ohms).

***Load Impedance:** Primarily used at 8 ohms or less; maximum continuous sinusoidal output power, lower impedance affects only maximum power. Unit will drive a completely reactive load with no adverse effects. See operating area graph.

***Input Voltage Gain:** 20 +1% (26dB) at standard input with input attenuator fully CW (-1 ±1% at remote protect connector input).

***Standard Input Sensitivity:** 3.46 V rms ±5%; (1.73 V rms ±5% selectable). (See Fig. 3.6.)

***Input Impedance:** 25K ±5% with standard balanced bridging input. 44.76K ±5% at unbalanced remote protect connector input.

***Hum and Noise (20Hz-20KHz):** 120dB below 600W into 8 ohms. Typically 128dB.

***DC Drift at Output:** Typically less than 100 microvolts/°C with all inputs grounded.

Heat Sinking: Forced air with high efficiency coolers (8) which can dissipate 1900W with 25°C intake air at 1 atmosphere. (Dissipation derates to zero at 75°C). A two-speed fan with an intake filter (washable) forces air through the coolers and out both the top and bottom of the amplifier. (A dual fan single speed option is available for high temperature environments.)

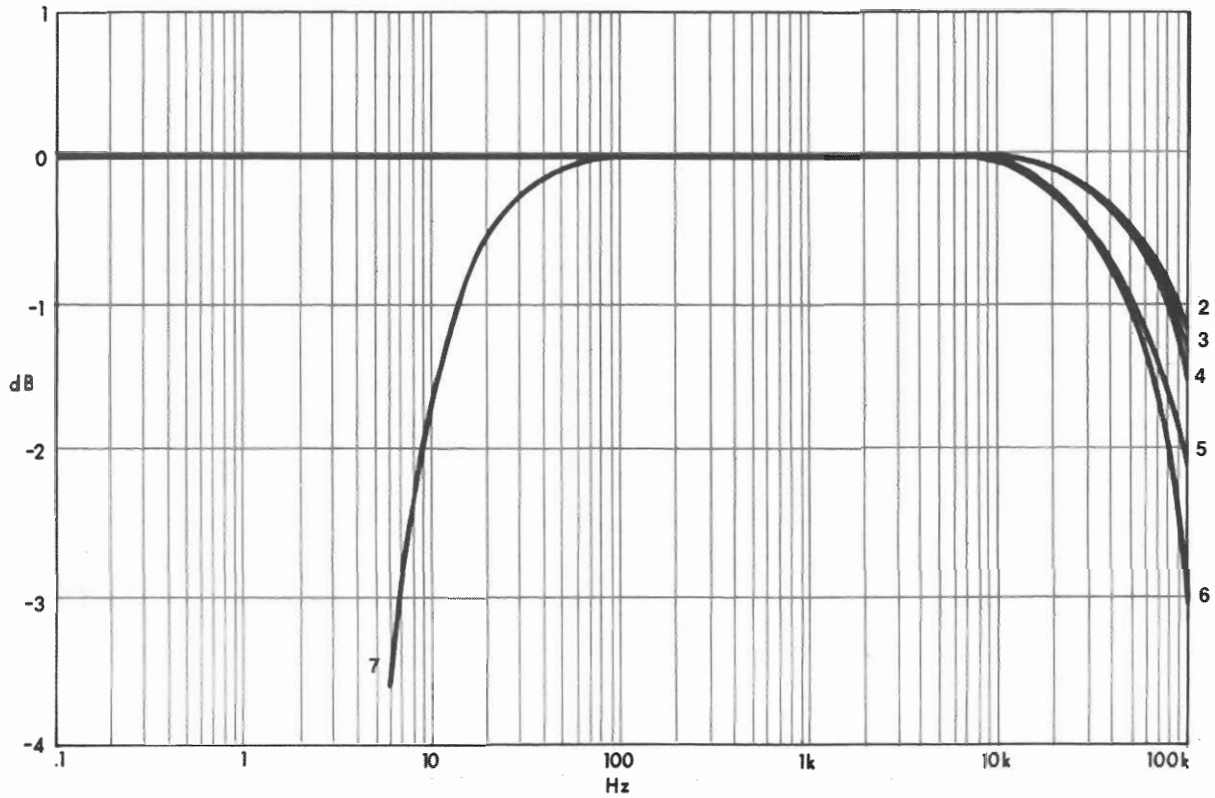
Turn-On: May be switch selected for instantaneous or 4-5 seconds of delay after applying power.

Low Frequency Load Protection: May be switch selected to produce shutdown of the high voltage power supply for DC outputs greater than 6V or low frequency outputs greater than 600W at 20Hz and 8 ohms.

Output Transistor Protection: Short, mismatch and open-circuit proof; electronic protection operates without thumps or shutdown.

* Delta Omega™ 2000 used as a conventional voltage amplifier.

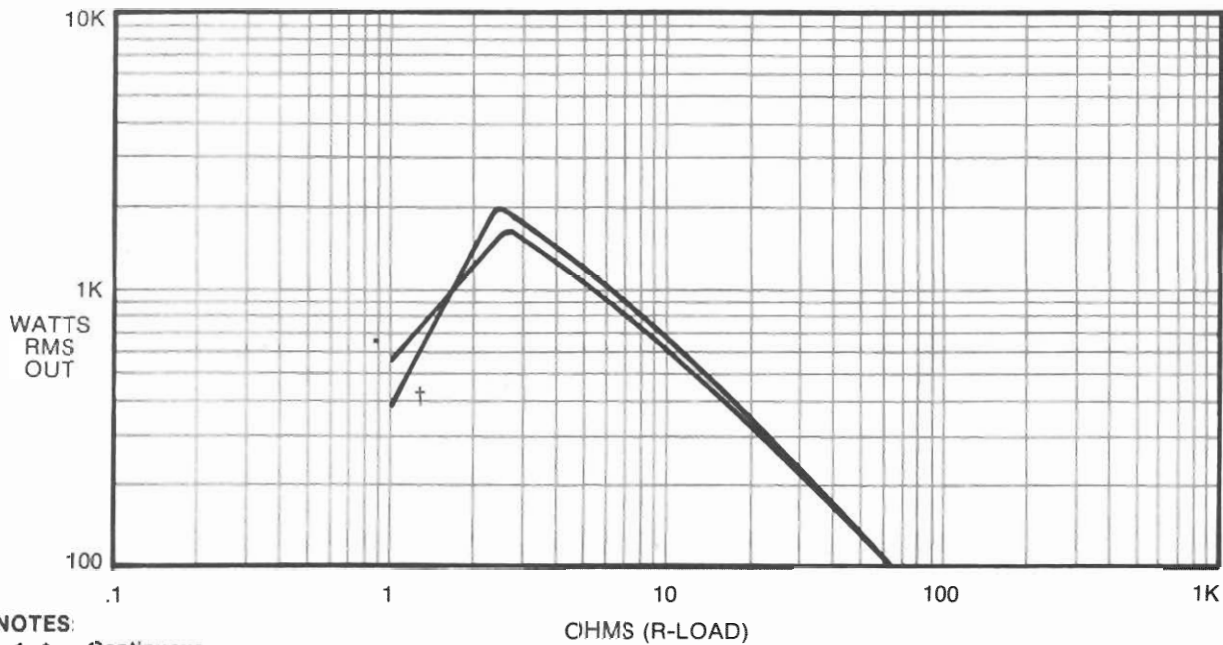
2.2 Performance Graphs



NOTES:

- | | |
|---|--|
| 1. For Curve Identification: Start at 100KHz, Top Curve | 4. Third Curve 8 Ohm Load |
| 2. First Curve No Load | 5. Fourth Curve 4 Ohm Load |
| 3. Second Curve 16 Ohm Load | 6. Fifth Curve 8 Ohm Load (Atten. Set at -6 - W/C) |
| | 7. *AC Input Coupling |

*Fig. 2.1 Typical Frequency Response:
2.828 Volts Output*



NOTES:

1. * — Continuous
2. † — Tone Burst

Fig. 2.2 Output vs. R (Load) at 1KHz

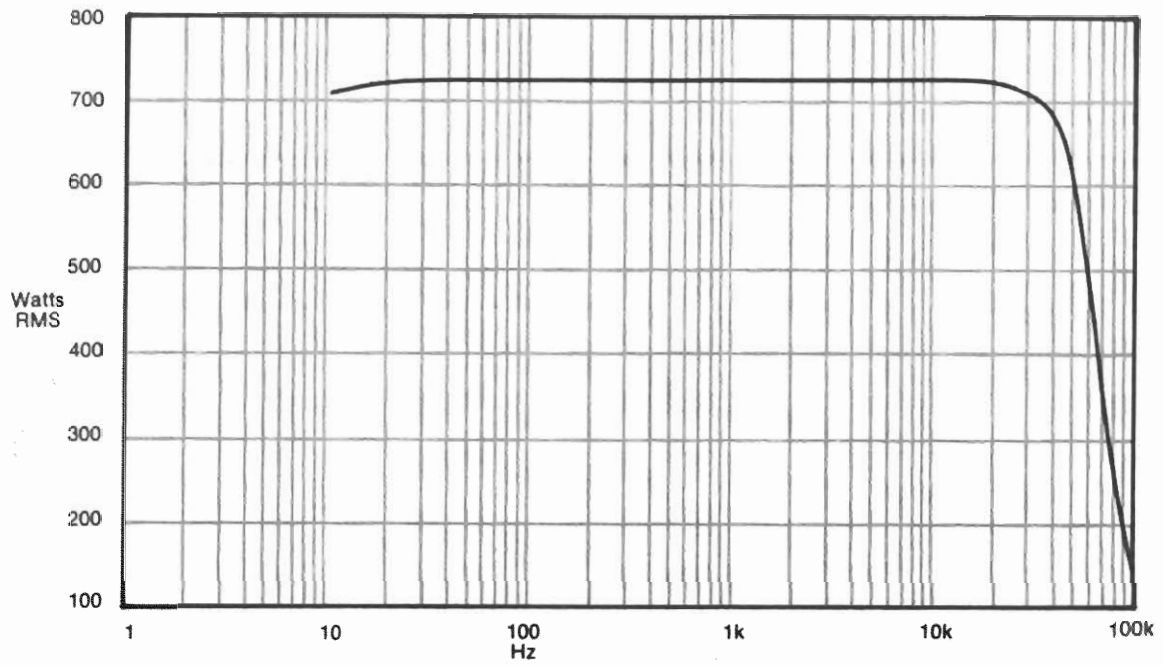


Fig. 2.3 Typical Power Output: 8 Ohm Load

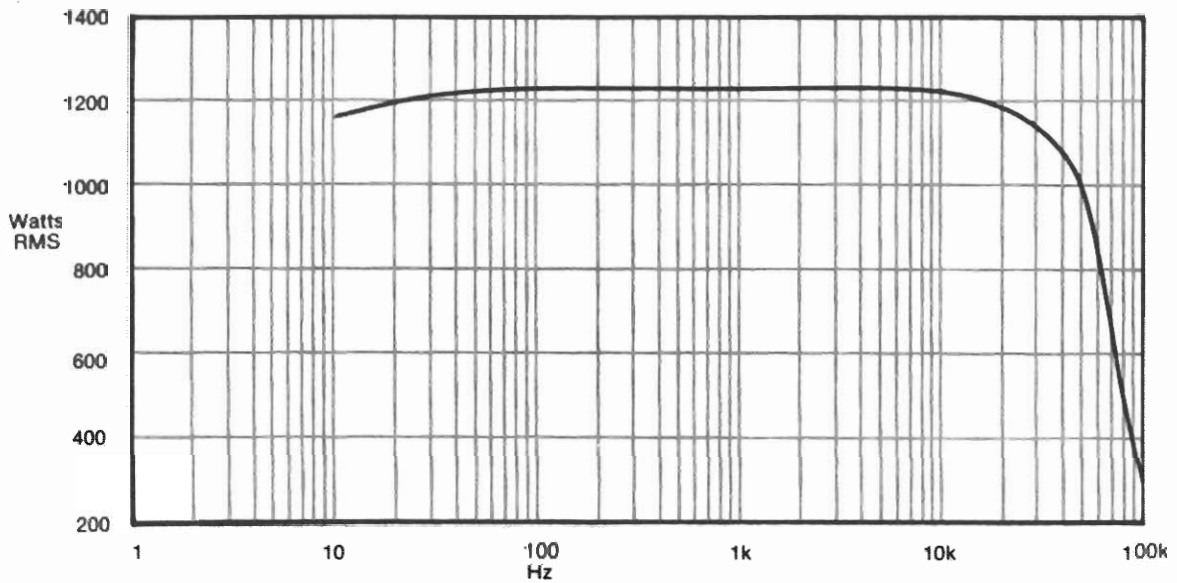
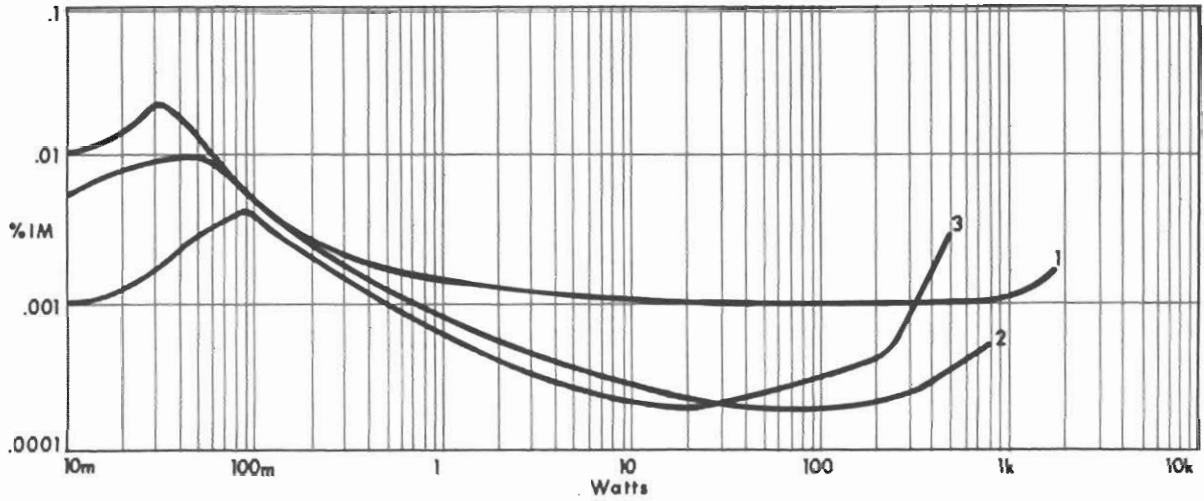


Fig. 2.4 Typical Power Output: 4 Ohm Load



NOTES:

- 1. Curve 1 — 4 Ohm Load
- 2. Curve 2 — 8 Ohm Load
- 3. Curve 3 — 16 Ohm Load

Fig. 2.5 I.M. Distortion

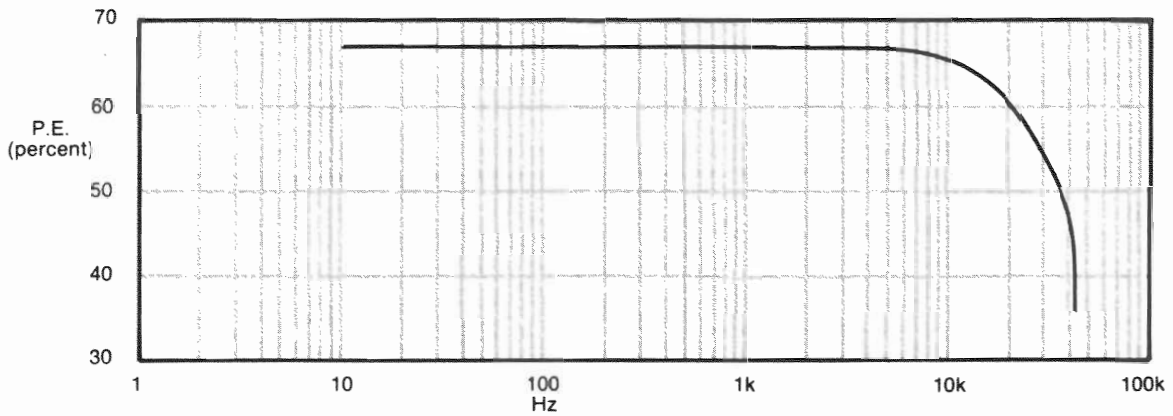
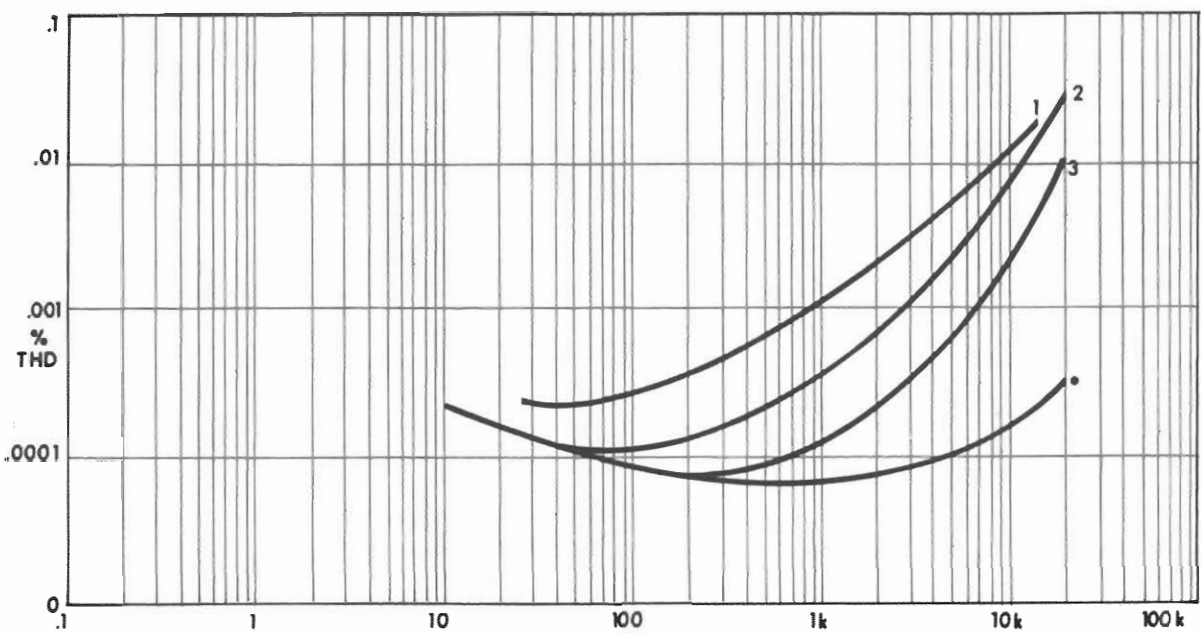
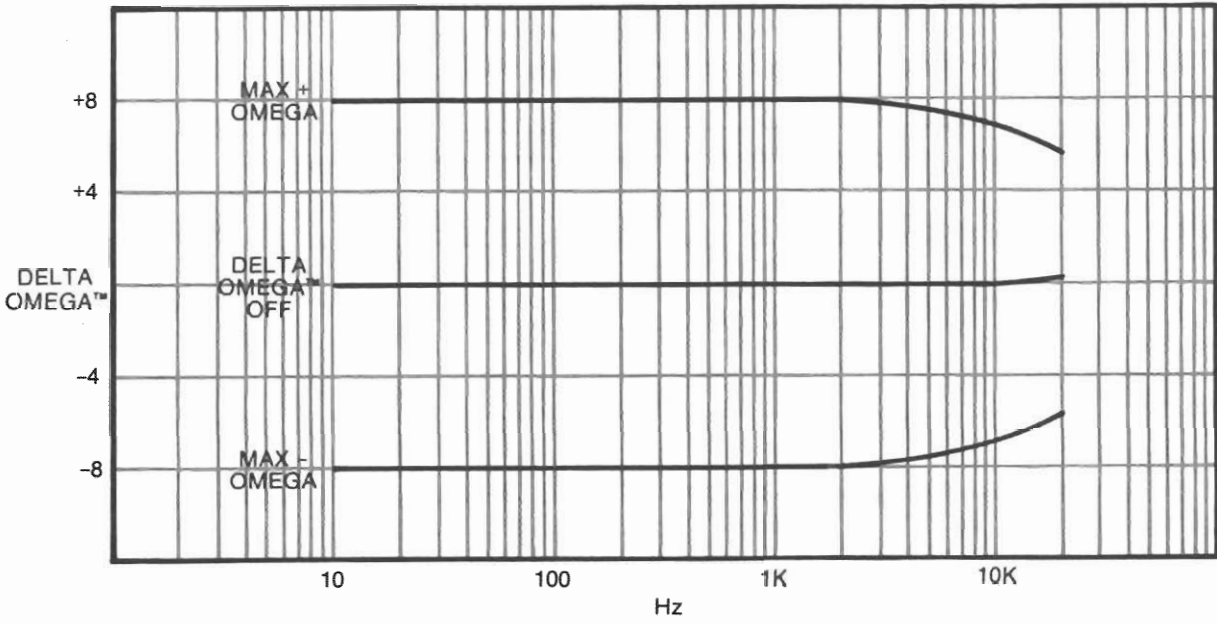


Fig. 2.6 Typical Power Efficiency: 120 VAC-Driven to Maximum Undistorted Level at 8 Ohms



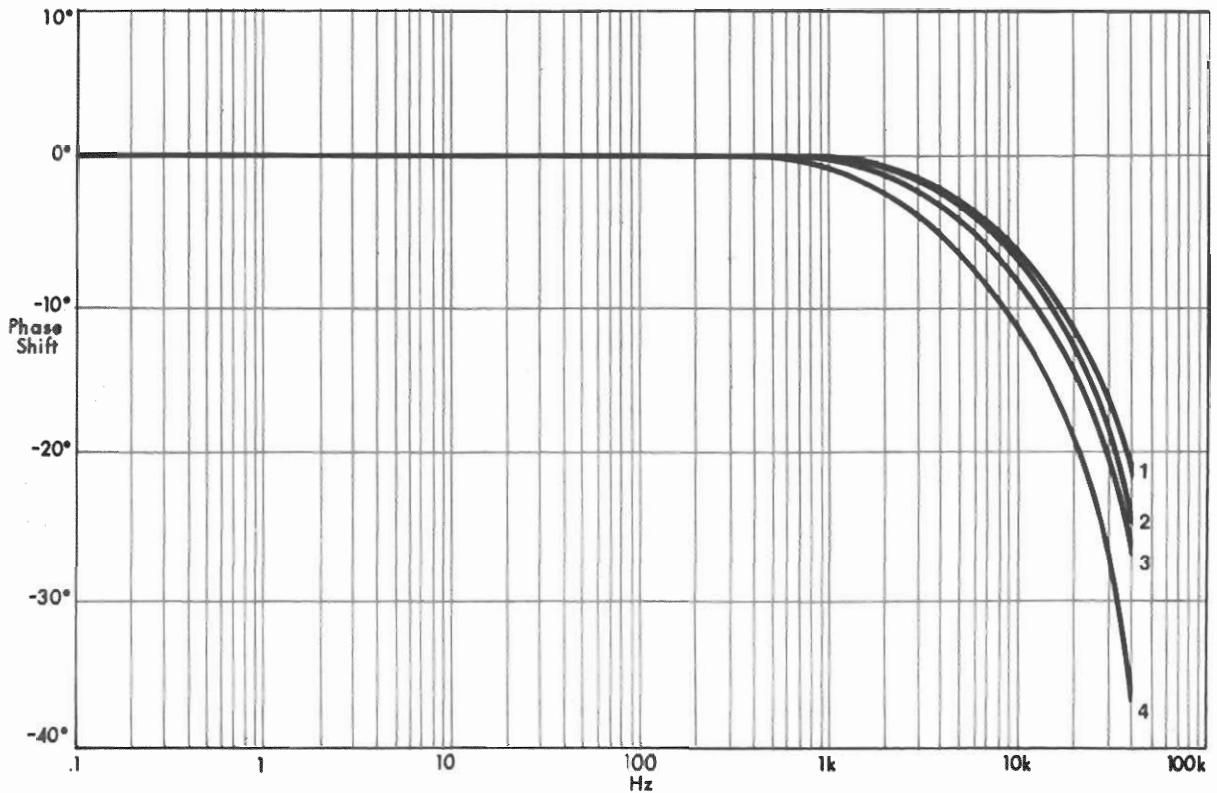
- NOTES:**
- 1. *Instrument Residual
 - 2. Curve 1 — 4 Ohm Load
 - 3. Curve 2 — 8 Ohm Load
 - 4. Curve 3 — 16 Ohm Load

Fig. 2.7 Percent Total Harmonic Distortion



- NOTES:**
- 1. 1 Amp Test Level

Fig. 2.8 Output Impedance

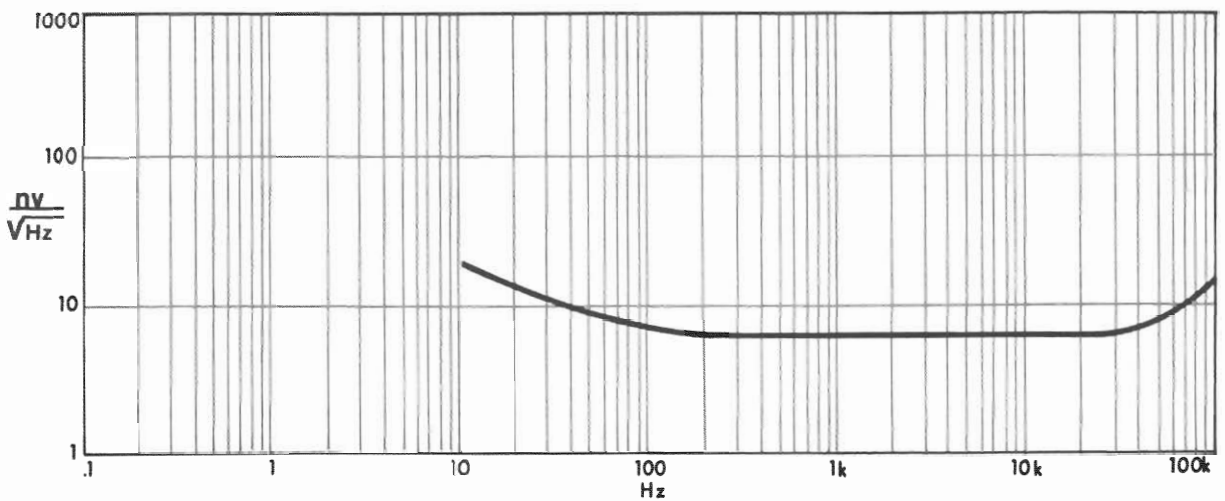


NOTES:

1. Curve 1 — Open Ckt and 16 Ohm Load
2. Curve 2 — 8 Ohm Load
3. Curve 3 — 4 Ohm Load
4. Curve 4 — Input Atten. Set to -6 : 8 Ohm Load (Worst Case)
5. Effective Signal Delay $T_d=1.5 \mu\text{SEC}$ — Open

6. $=1.6 \mu\text{SEC}$ — 16 Ohms
7. $=1.7 \mu\text{SEC}$ — 8 Ohms
8. $=1.9 \mu\text{SEC}$ — 4 Ohms
9. $=2.6 \mu\text{SEC}$ — Worst Case
10. Output 2.828 Volts All Loads

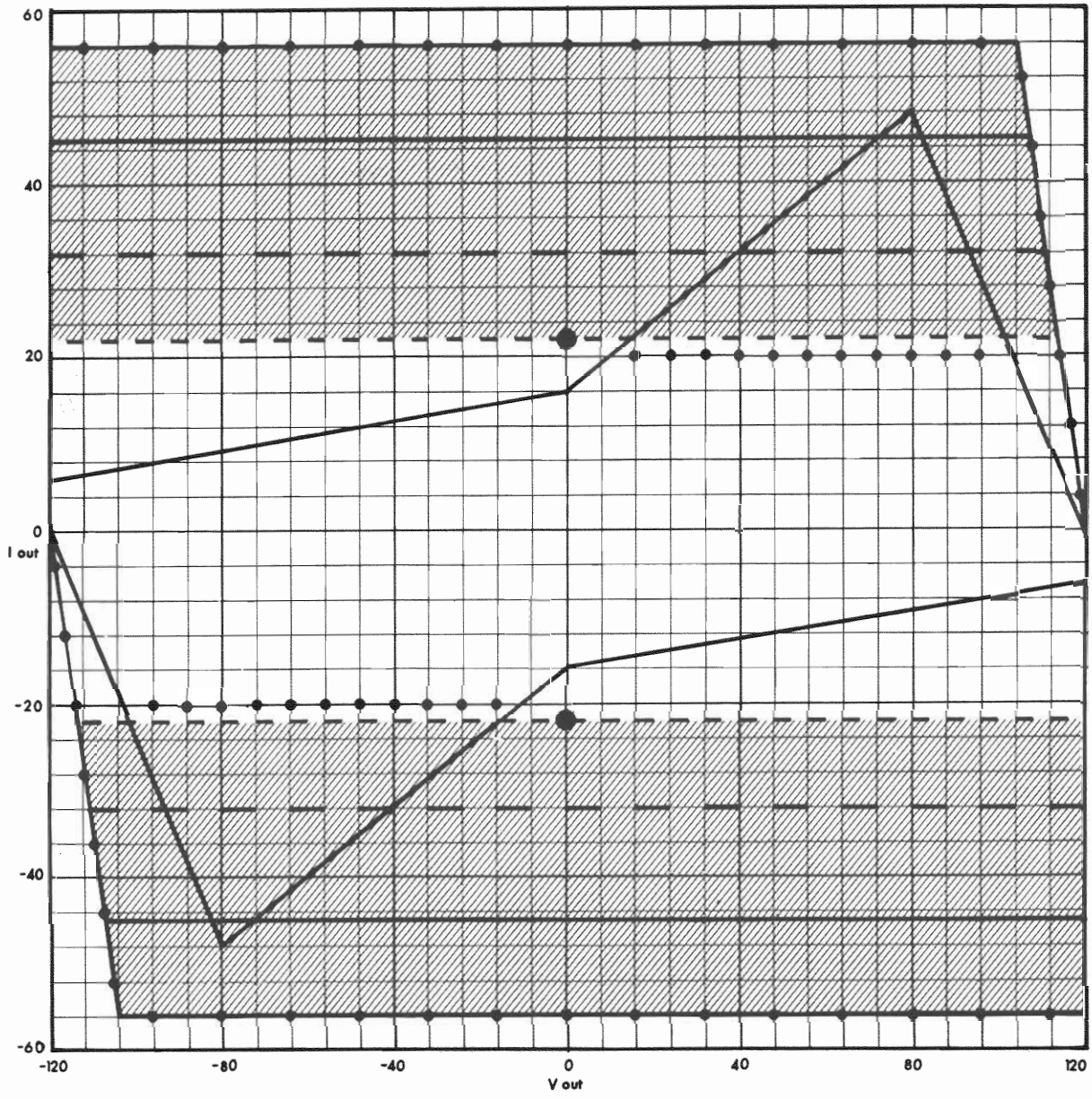
Fig. 2.9 Phase Response



NOTES:

1. Vertical Scale Calibrated in $\frac{nV}{\sqrt{Hz}}$
2. Spectrum Total is Equivalent to 1.7 μV Input
3. Noise Over a 20Hz to 20KHz Bandwidth

Fig. 2.10 Noise Spectrum



- AC LINE FUSE BLOWS
 - MID-FREQ. BURST LIMIT
5 CYCLE AT 1000 Hz
1 SEC REPEAT
 - ● SHORT CIRCUIT CONTINUOUS LIMIT
 - MAX. AC LIMIT (ZL V OUT (SINE) AT MAX.)
 - MAX. CONT. AC POWER (Z'A = 2.75 OHMS)
 - MIN. A.C. LIMIT (Za AT MIN.)
- AREA OVER WHICH LIMITER (AC) VARIER (SIGNAL DEPENDENT)

Fig. 2.11 Typical Limits of VI Output



SECTION 3 INSTALLATION AND OPERATION

3.1 Unpacking

As soon as the unit is received, please inspect for any damage incurred in transit. Since the unit was carefully inspected and tested at the factory, it left unmarred. If damage is found, notify the transportation company immediately. Only the consignee may institute a claim with the carrier for damage during shipment. However, Crown will cooperate fully in such an event. Be sure to save the carton as evidence of damage for the shipper's inspection.

Even if the unit arrived in perfect condition, as most do, it is advantageous to save the packing materials. They will prove valuable in preventing damage should there ever be occasion to transport or ship the unit. Note the carton and internal pack - each is designed for protection during transit. **Do not ship the unit without this factory pack!**

Be sure to return the warranty registration card yourself or through your dealer within ten days.

3.2 Mounting

The amplifier is designed on a standard 19 inch rack mounting format (Fig. 3.1). If the rack is to be subjected to portable or other usages likely to result in mechanical shock to the rack, additional internal support should be provided to prevent rack damage.

The simplest form of support is to use chassis supporting angles, joined to the side of the rack which support the amplifier from underneath. If chassis slides are used, care should be taken to avoid toppling the rack when the slides are extended. The center of gravity of the amplifier is approximately five inches behind the front panel.

Mounting in any structure of less constructional integrity than an industrial rack requires the construction of a supporting or shelf under the amplifier.

If a number of units are being racked on electrically common rails and a very high signal-to-noise ratio is to be maintained, the inputs should be independent. That is, all the input commons should not be joined together if they are common to chassis, as is the standard input, since AC

potentials would typically appear throughout the rack, creating ground loops. There are three basic alternatives in this situation:

1. Use the bridging input on each of the amplifiers.
2. Use a multiplicity of signal sources, one per amplifier.
3. Separate the chassis grounds of the units by insulating the units from the mounting rails.

A minimum rack clearance of $1\frac{3}{4}$ " should be allowed above and below the unit for hot air discharge. If amplifiers are mounted above one another, a $1\frac{3}{4}$ " minimum spacing should be allowed between units. If the $1\frac{3}{4}$ " clearance rule is followed, it will usually not be necessary to remove the rubber feet from the bottom of the unit which extends below the $8\frac{3}{4}$ " standard rack height. Should the feet need to be removed, two oval head screws are provided to replace the front feet screws.

A source of cooling air should be provided for the fan intake. In some cases a vent tube to the outside of the rack may be required if the rack ventilation is poor and/or the amplifier heat output is high. In no case should the unit be contained by a small sealed box because automatic thermal shutdown will occur if the unit is operated for any length of time.

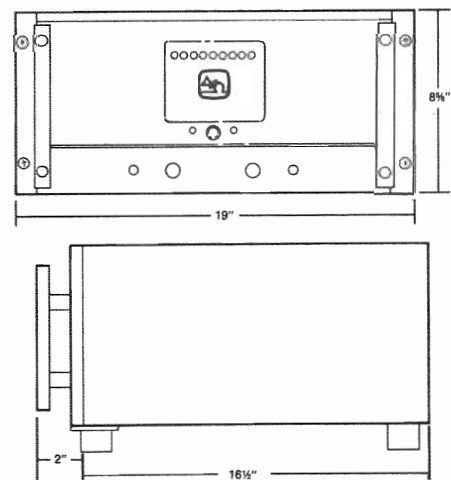


Fig. 3.1 Mounting Dimensions

If the air is unusually dusty it may be desirable to prefilter the air supply using commercial furnace filters, etc, to prevent rapid loading of the unit's own air filter. If the unit's filter becomes plugged, it can be cleaned with mild soap and water; replacement is not necessary.

As the Delta Omega™ 2000 is a very high power, high current amplifier it must have available to it a very low loss AC main input power line, so as to produce its full capacity power rating.

3.3 Connecting Output Lines

Warning: The output potentials can be hazardous! Connections should only be made with power and input signals removed from the unit!

The amplifier connector is located on the rear of the amplifier as shown in Fig. 3.2. Output cables should always be carefully laced together so that large magnetic fields are not formed, resulting in current carrying loops. Such fields often will couple the input signal path and result in undesired feedback and oscillations. Of course, the output cables should never be routed with input cables for the same reason.

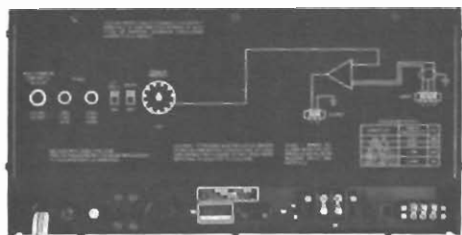


Fig. 3.2 Delta Omega™ 2000 Outputs

Amplifier input and output grounds should never be joined external of the unit. Such a connection is almost always a form of regenerative feedback and results in system oscillations. High frequency coupling between output signals and input ground and signals is frequently difficult to eliminate. A common cause of this problem is capacitive coupling through the AC mains where the output and input signals are attached to AC powered devices. In some situations the only solution may be to low pass filter the input at the amplifier.

Output cabling must be of sufficient wire gauge to support the output current without excessive overheating, power loss or increase in output impedance. For best results, it is recommended to use a foil shielded cable. The increase in output resistance is shown in Fig. 3.3. The effects of parallel 2 wire cable on output inductance is shown in Fig. 3.4. The most typical output cabling would be #12 duplex primary wire. Only two wires are needed to connect the Delta Omega™ 2000 to its speaker load.

3.4 Connecting Input Lines

Ground loops producing hum and noise are one of the most common problems. While the solution to them is theoretically trivial, the practical implementation often is not. Theoretically, ground loops will never occur if one and only one ground path (circuit) is allowed between any two device grounds. The input and output grounds of the amplifier, while they are internally joined, should not be externally joined since this would provide a second ground path forming a loop with the internal path. The output ground is connected to the chassis on the rear connector panel, thereby allowing the chassis mounting to be a possible source of ground loops if other devices attached to the amplifier inputs and outputs are mounted in an electrically common rack and are likewise internally chassis-ground joined. A circumstance such as this requires the isolation of the most appropriate units from the rack so that a loop is not formed.

Another likely source of a ground loop is the third wire of the AC power connector. Only one piece of equipment in a system should deploy this terminal where the terminals are tied to the system's signal ground.

Transducers may have their electrical common tied to their mountings. If so, the mounting should be insulated from ground structures, providing they are not the only building on earth grounds.

Unintentional feedback of output signals into input signal lines can result in system oscillations, or gain errors.

Input signals should never be supplied to the amplifier via the current carrying output common lead, except in the case of driving the unity gain inverting input. Under normal circumstances, input signals should be supplied to the standard input via their own independent ground lead which is in no external way connected to the output signal circuits.

The AC power lines frequently form a high frequency feedback path between input and output devices which are powered by the mains. The amplifier itself couples the mains due to its floating supply-lead grounded bridge circuit, which couples some output signal back to the AC mains through approximately 200PF. For this reason it is advisable that the third wire ground of the amplifier be connected in preference to any other system-earth ground. It is always desirable that AC mains coupling be minimized in devices coupling to the output signals.

If oscillations are present, the typical result is excess amplifier and load heating. Sometimes a hum will accompany a yellow SPI indication which will vanish as soon as the input level is turned down. If a system has multiple level controls, the output to input feedback loop causing the oscillation will enclose the level control

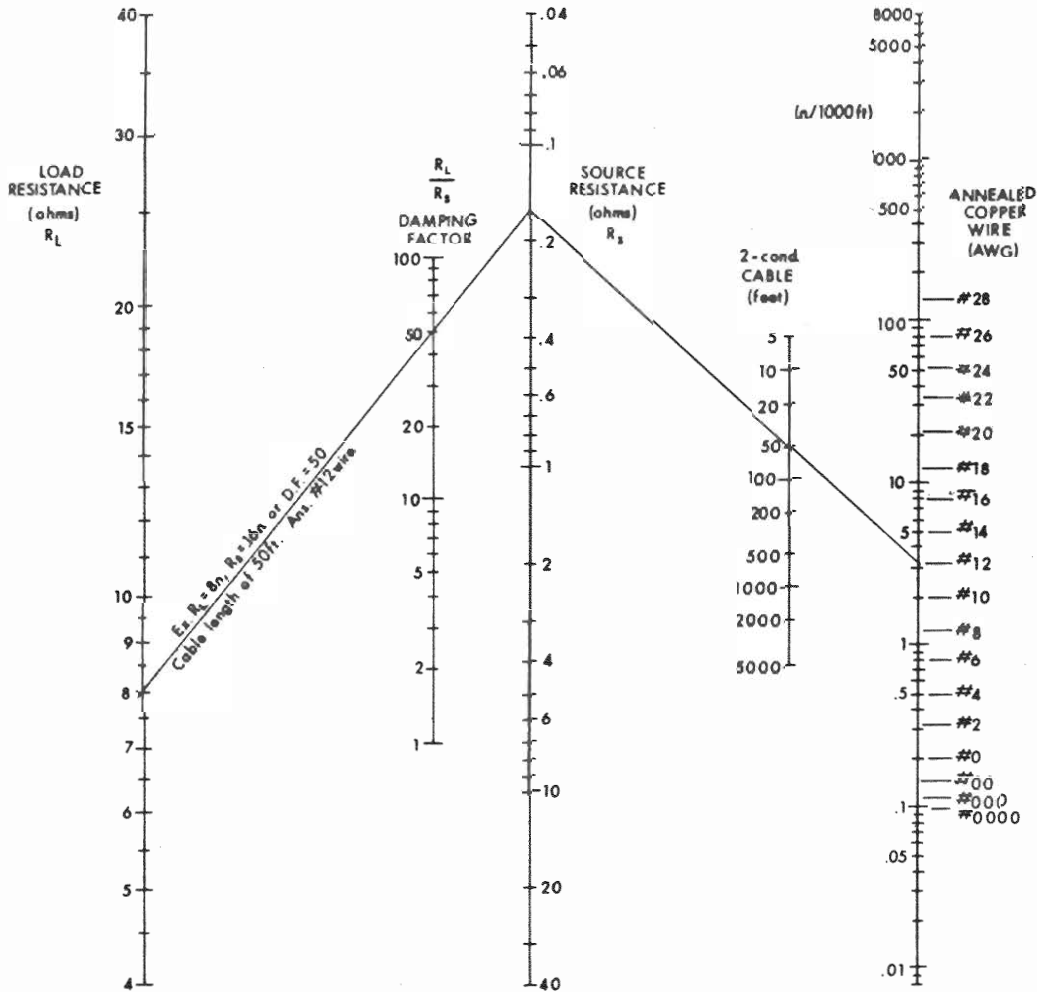


Fig. 3.3 Source Resistance and Damping Factors vs. Length and Size of Output Leads

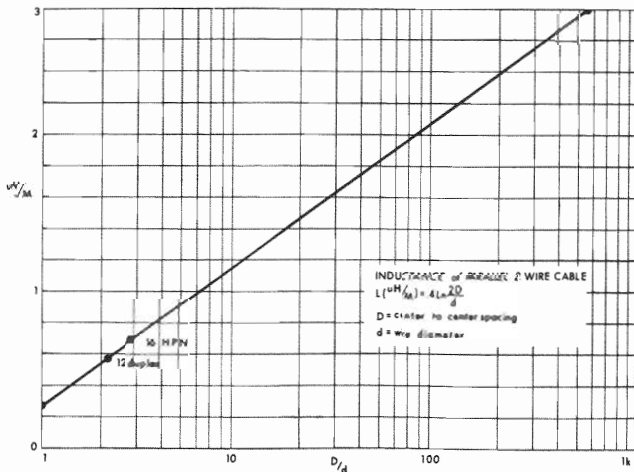


Fig. 3.4 Inductance of Parallel Wire

closest to the input which controls the oscillation. Multiple loops may be present.

If it is not feasible to eliminate the feedback path, the high frequency system gain may be reduced by deploying a lowpass filter of the amplifier's input.

If system instability is being caused by high frequency signals being produced along the common (ground) of the input cabling between the signal source (unbalanced) and amplifier, the problem may be alleviated by using the balanced input and cabling as shown in Fig. 3.5. The normal input configuration for the Delta Omega™ 2000 is to use the balanced input.

Note that any potential difference between the signal source and amplifier grounds will appear as a common

mode signal at the balanced input and produce no net input to the power amplifier.

Low pass filters are useful for much more than preventing system oscillations. Should ultrasonic or RF input signals which would either damage a load or slew rate jam the amplifier be present, they may be appropriately subdued with a low pass filter.

High pass filters are similarly useful if a load is being overdriven with a low frequency signal. The simplest filter is a capacitor in series with the input. Active filters should be used if a good sharp cutoff characteristic is desired.

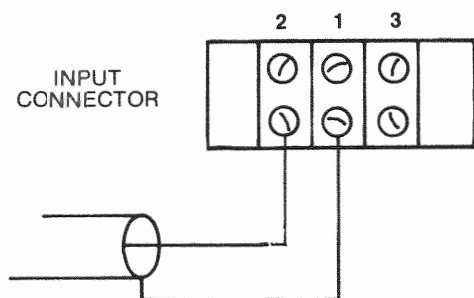


Fig. 3.5 Proper Use of Balanced Input with Unbalanced Signal Sources

Should discreet frequencies such as AC mains frequency hum contaminate the input signal, a band reject or notch filter may be used to improve the signal-to-noise without limiting the overall bandwidth.

Cascaded notch filters are frequently needed to reject signals, such as AC mains hum, since substantial harmonics of the fundamental frequency are usually present.

For design details concerning more elaborate filters, consult the following references:

1. "Operational Amplifiers" by Tobey, Graeme and Huelsman - McGraw Hill, 1971.
2. "Active Filters: Lumped, Distributed, Integrated, Digital and Parametric" by Huelsman - McGraw Hill, 1970.
3. "Active Inductorless Filters" by Mitra - IEEE Press, 1971.
4. "Modern Filter Theory and Design" by Temes and Mitra - J. Wiley, 1973.
5. "Analysis and Synthesis of Linear Networks" by Mitra - J. Wiley, 1969.
6. "Theory and Design of Active RC Circuits" by Huelsman - McGraw Hill, 1968.
7. "The State Variable Active Filter Configuration Handbook, Second Edition" by Estep - Estep Enterprises, 1974.
8. "Analog Techniques for Filter Simulation" by Bridgeman - EAI Applications Reference Library, 8.411a.

3.5 Connecting Power

The amplifier is furnished with a three-wire 20A, 120V AC plug as standard equipment. Should another type of connector be required, the standard plug should be removed and the desired type installed (which should have an integral cable strain-relief).

The third wire ground should be used with caution since it may introduce a ground loop in a system (read Section 3.4).

Power must be 50 or 60Hz AC. Operation at 400Hz is not possible since the cooling fan motor becomes inoperative!

The amplifier power supplies offer multiple connections for operation at different line voltages. The serial plate indicates for which voltage the amplifier was factory-wired. The application of an AC voltage more than 10% above the indicated voltage will result in automatic removal of power from the high voltage supplies, placing the unit in the "standby" mode.

Converting from one voltage connection to another is a complex operation and should be attempted only by a competent technician. The high-voltage supplies use dual power transformers which must be wired identically. Failure to properly wire the primaries can result in transformer damage should the transformer not share the load properly.

Note: The conversion involves two power supplies - a high voltage supply and a low voltage supply. Since different transformers have been used in several production batches, careful identification is imperative. In order to change the voltage, it is first necessary to disconnect power and to remove the top and bottom covers from the unit. (**Caution - the main supplies often remain charged for several minutes.**) The voltage connections are made with push-on connectors and terminal strips.

After the correct operating voltage has been chosen, and all the primary leads identified, the conversion can be performed following the connect drawing of Fig. 3.6. The drawings in Fig. 3.6 are presented chronologically according to production. Notice the three possible transformer combinations. Also note that the three combinations all offer different combinations of operating voltage connections.

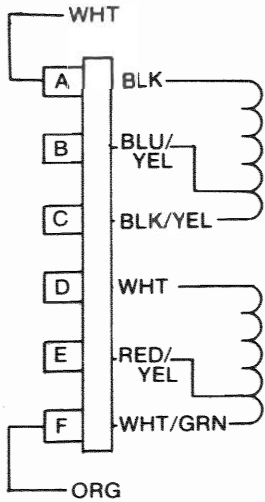
When testing the amplifier, the line voltage must be the peak equivalent to a sinusoid of the indicated line voltage when at full load. Line regulation problems can introduce a substantial reduction in the available output power on an amplifier of this size.

Voltages above 150V (120V connection) or 300V (220 or 240V connection) are potentially damaging to the $\pm 15V$ regulators and are to be avoided.



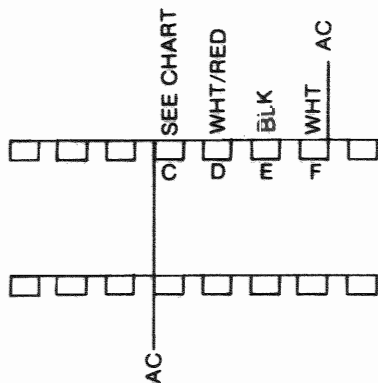
HIGH VOLTAGE WIRING, (two places)

Transformer part numbers 4004, D4004-4 or D5781-6.
Both large transformers have their own terminal block, change both.



Line voltage	Jumper(s)	Connect orange wire to terminal	Required fuse
100	A-D/B-E	E	20A, 125V
120	A-D/C-F	F	20A, 125V
200	B-D	E	10A, 250V
220	C-D	E	10A, 250V
240	C-D	F	10A, 250V

LOW VOLTAGE WIRING, (one place)



Line voltage	Jumper	Transformer wire on terminal A	Transformer wire on terminal C	Required fuse
100	B-C/E-F	Blk/Red	Blk/Grn	.5A, 125V
120	C-D/E-F	Blk/Grn	Blk/Red	.5A, 125V
200	B-E	Blk/Red	Blk/Grn	.25A, 250V
220	D-E	Blk/Red	Blk/Grn	.25A, 250V
240	D-E	Blk/Grn	Blk/Red	.25A, 250V

Fig. 3.6 Power Supply Jumper Connections for Various Power Input Voltages

If the line voltage connection is converted from 100/120VAC to 200/220/240VAC or vice-versa, the over-voltage adjustment (R414) found on the power supply control module (a small board at the rear of the unit) should be readjusted. This readjustment requires a variac and voltmeter. If a peak sensing line voltage monitor such as Fig. 3.7 is not available a DC voltmeter reading of the main supply potential V_{cc} will suffice. With no input signal $+V_{cc}$ will be found on the top heat sinks and when the line voltage is 10% high will read +67 volts. Adjust R414 fully CW as seen from the knob side of the control. Adjust the variac for 10% above nominal voltage. Set the time delay and low frequency protection switches to off. Slowly rotate R414 CCW until the power relay drops open. This is the correct setting for R414.

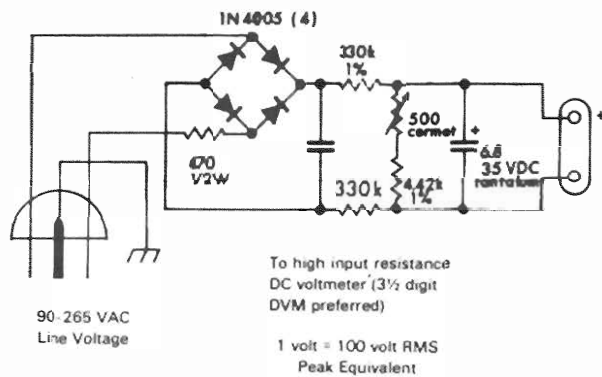


Fig. 3.7 Peak Sensing Line Voltage Monitor

3.6 Operation Controls

3.6.1 Switches and Dials

The AC power switch, mounted between Standby and Power indicators (see Fig. 3.9), is of a mechanically indicating push-push type. If the AC power switch is engaged, the power indicator should be on, unless power is not connected or a fuse is blown.

The Input Coupling dial (Fig. 3.9) is used to select either AC or DC incoming signal. Select the proper position for proper operation.

The Local switch is used to select either local or remote adjustment of the Delta Omega™ 2000 with the speaker load. See subsection 3.7.1 for proper operation of this switch.

The Input Attenuator dial is used to adjust the volume to the speaker load attached to this unit.

The Mode switch (Fig. 3.9) is used to select the mode of operation for the unit. In the OFF position, the Delta Omega™ 2000 operates as a regular voltage amplifier. In the ADJ (adjust) position, the match to the speaker load may be adjusted (see the Delta Omega™ Power Efficiency Transfer Ratio Method). In the ON position, the unit is in a high power interface velocity controlled amplifier

mode. Precautions on using this switch are listed under subsection 3.7.1. On the rear of the unit are mounted two slide switches labeled DELAY and L.F. PROT. (Low Frequency Protection). Engaging the DELAY switch (up position) inserts a 4 to 5 second time delay in the state transition from Standby to high power supplies on.

Engaging the L. F. PROT. switch (up position) causes the unit to go to the Standby mode if low frequency (subsonic) outputs of more than 10 volts occur. The 4 to 5 second time delay is automatically engaged by this switch.

3.6.2 Status Lamps

The Dynamic range display section at the front of the unit (see Fig. 3.9) contains twelve amber and one yellow LED lamp for monitoring an input signal. The yellow SPI (signal presence indicator) lamp indicates the presence of an input signal. The twelve amber db (decible) lamps are in six pairs and labeled 6, 9, 12, 15, 20 and 25 db. These are used for determining the dynamic range of the input signal. As variations occur in the amplitude of the incoming signal, these amber lamps will display the peak amplitude of the signal and compare it to the average amplitude.

The amber STANDBY lamp indicates the unit is in Standby mode. In this state, the high voltage power supply is deactivated and the instrument is inoperable. This can occur if the unit overheats, is in the normal turn-on delay of four to five seconds (DELAY switch enabled), if low-frequency outputs are sensed (L.F. PROTECT switch enabled) or if the line voltage is high. Once the cause of the Standby is corrected, the unit should return to full operation. 70.7 VRMS green LED on the display indicates that the output voltage of the amplifier has reached this RMS level.

The red PROTECT lamp indicates a dangerously high output power condition has been entered by the operator. This may be encountered particularly during the Delta Omega™ Power Efficiency Transfer Ratio Method. See subsection 3.7.1 for more information regarding this condition.

3.7 Delta Omega™ 2000 Set Up Procedures

Once the unit is properly installed within the system, the Delta Omega™ 2000 control can be adjusted for proper match to the loudspeaker load. The following three procedures can be used for this purpose. Each method ultimately achieves the same goal; that is vastly improved audio performance of the loudspeaker system. Placement of each system is solely dependent on experience and goals of the Delta Omega™ 2000 operator.

Please see Figs. 3.8 and 3.9 for location of the controls described below.

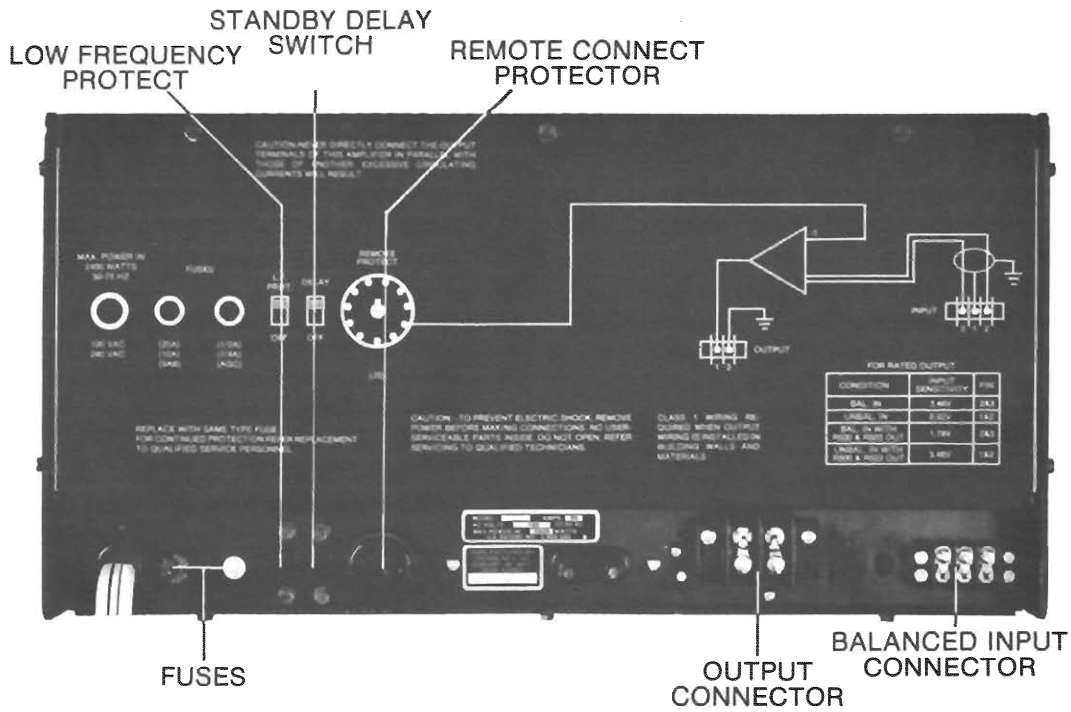


Fig. 3.8 Delta Omega™ 2000 Rear View

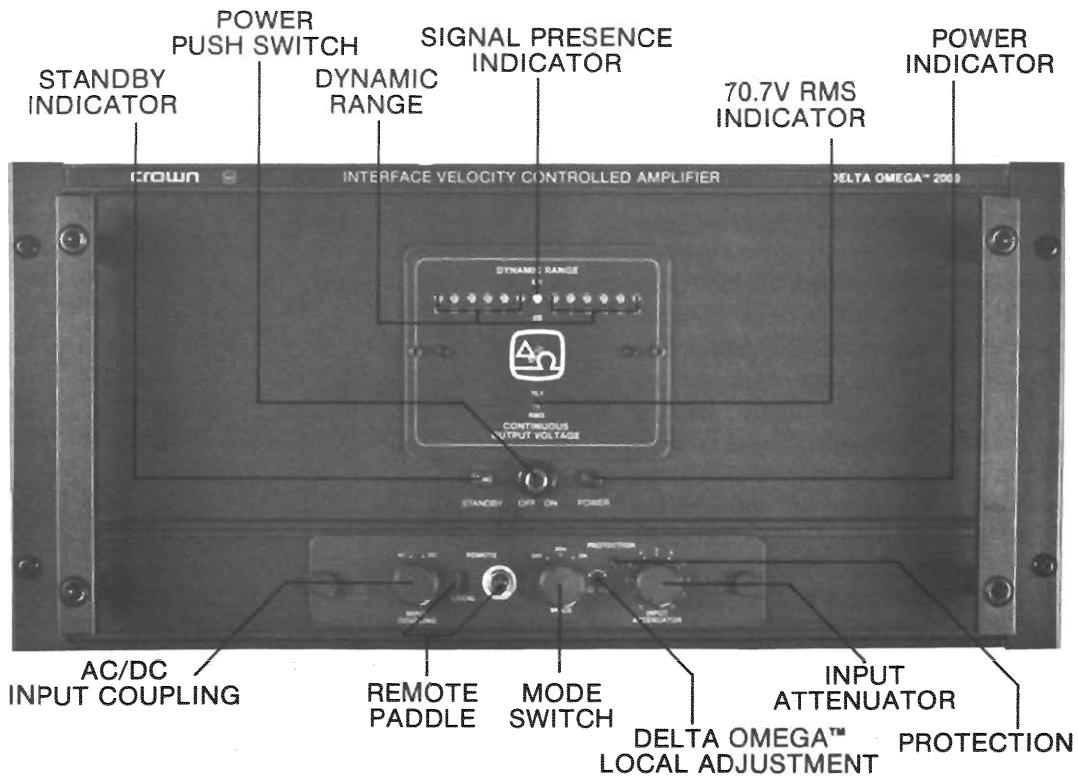


Fig. 3.9 Delta Omega™ 2000 Front View

Note: Please read Section 3.11 on load protection before proceeding.

3.7.1 Delta Omega Power Efficiency Transfer Ratio Method

These adjustments are all made utilizing the Delta Omega™ adjust pot.

1. Attach the loudspeaker load to the unit's rear output connection screws 1 and 2.
2. Activate the amplifier by depressing the ON/OFF Power switch to the "on" position (green indicator showing) and adjust the AC/DC Input Coupling switch to the AC position.
3. Turn the REMOTE switch to Local (down) and the Mode dial to ADJ (adjust). In the ADJ mode, the loudspeaker load is protected (i.e., internal energy limiting circuitry in the amplifier) thus allowing full rotation of the Delta Omega™ 2000 to negative or positive ohms without damage to the loudspeaker load. When the mode switch is turned to the ON position which should only be done after the proper adjustment of the control has been made, the amplifier's energy limiting system is deactivated and full amplifier power will be available.

Note: When the mode dial is turned to the OFF position the Delta Omega™ 2000 acts as a conventional voltage amplifier with enormous power.

4. Advance the input attenuator level control until a comfortable listening level is obtained.
5. Using a small screwdriver or a small trimpot adjustment tool (available at most retail electronic stores), adjust the Delta Omega™ control pot (see Fig. 3.9. for location) for the desired speaker matching characteristics. Clockwise rotation increases the load power transfer efficiency, counterclockwise decreases it. This method essentially uses the human ear as a test instrument, a very fine one indeed. As the operator turns the control in the clockwise position, the music signal will suddenly appear to come out of the loudspeaker. The kick drum will have more punch, more front to back depth. Even with mono source material it will be immediately apparent. The mid-range will become more articulate. As this control is advanced past the point of maximum coupling efficiency, the signal will begin to ring and eventually go into oscillation. As long as the control is in the ADJUST position this oscillation will not harm the transducer. Once this ringing is audible, carefully back off the control to the point where again the sound becomes clean. What we're hearing is the increase in the power efficiency transfer from amplifier to transducer.

Warning: Adjusting the Delta Omega™ potentiometer to give too high an efficiency transfer may produce a tone burst out of the speakers attached to this unit. High-energy is only available when the mode switch is in the ON position. The energy PROTECT system, indicated by the red LED labeled

PROTECT on the front panel, will illuminate when this level is present and afford some measure of protection for loudspeaker transducers. Never change the load impedance by either adding or removing speaker loads when the unit is in the ADJUST or ON mode.

6. Once the Delta Omega™ pot has been adjusted, turn the mode switch to the ON position. While switched to the On or OFF position, the adjust pot is interlocked mechanically to prevent the user from accidentally misadjusting the system by attempting to re-adjust this pot with the mode switch on or off.

3.7.2 Square Wave Set-up Procedure

This method of Delta Omega™ alignment is accomplished by using a minimal amount of instrumentation including a precision square wave generator and high quality oscilloscope. The alignment procedure is as follows:

1. Connect the square wave generator to the amplifier's input terminals. Adjust the level control so that the amplifier attains an output of approximately 10 volts peak-to-peak utilizing a 20Hz square wave. The input coupling switch must be in the DC position for this alignment procedure. See Fig.3.10 to add an internal AC to DC jumper on the front panel plug in card. This must be done for this test method to work properly, the Delta Omega™ is sold without this jumper, in the AC mode.
2. Attach the probe leads of the DC coupled oscilloscope to the voice coil terminals of the loudspeaker attached to the amplifier.

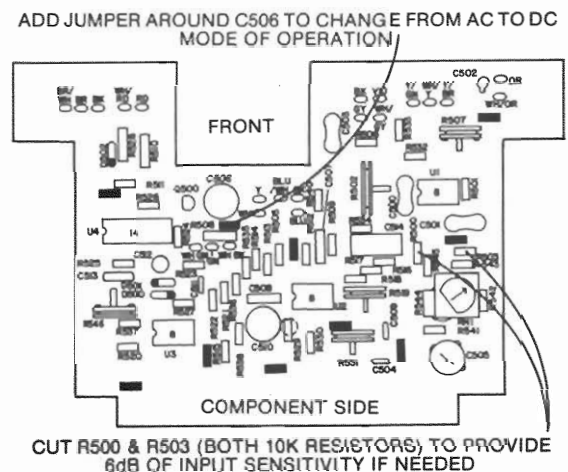


Fig. 3.10 Input Board - Option Locations Front Panel Accessible

3. Note the shape of the square wave as it appears on the oscilloscope. It should be nicely squared with no rounding of the edges or signal drooping. If it is not nicely squared turn the Delta Omega™ potentiometer clockwise gradually until the edges of the square wave begin to sharpen. At this point the Delta Omega™ has compensated up to the input of the speaker voice

coil making it equivalent to other four wire systems being sold today. In order to fully compensate for the speaker voice coil itself it will be necessary to advance the Delta Omega™ control slightly further to enable the amplifier to velocity compensate into the voice coil, not just the conductors. The final point of adjustment should occur slightly before any ringing is noted on the oscilloscope trace.

Note: It can be very informative for the operator of the Delta Omega™ 2000 to use this square wave test to evaluate the proper signal transfer characteristics of speaker cables and connectors. This can be accomplished by placing the oscilloscope probe on the output of the amplifier and adjusting the Delta Omega™ compensation pot for a perfect square wave. The next step is to move the probe to the other end of the speaker cable (still with the loudspeaker load connected) and then recompensate the Delta Omega™ pot to resquare the wave. The amount of compensation required will demonstrate the amount of transfer error of the cable and/or connector.

3.7.3 Effective Radiated Distortion Method "ERD"

This method demonstrates still another model of the effect of this amplifier on control of interface velocity. The object here is to reduced the amount of effective radiated distortion by Delta Omega™ 2000 compensation. As with the square wave set-up procedure some external test equipment is required. To properly facilitate this set-up procedure a suitable distortion analyzer of low residual distortion levels and also a low distortion microphone are required. If the distortion set does not include a low distortion sine wave oscillator this is also required. The object of this alignment procedure is to literally reduce or tune the Delta Omega™ to reduce radiated distortion of the loudspeaker system.

Adjust the oscillator to sine wave position at a frequency of approximately twice that of the fundamental resonance of the speaker system. Adjust the amplifier output at approximately 10 V RMS. Place the measurement microphone somewhere in the near field listening area. Attach the microphone output appropriately to the harmonic distortion analyzer. With the Delta Omega™ mode switch set to ADJ, tune the Delta Omega™ control pot to the point of minimal total harmonic distortion. Repeat this procedure using second, then third harmonic distortion measurements. Repeat this procedure placing the microphone in

different room locations in order to avoid any misinterpretations due to room standing waves. Naturally as in the other procedures the alignment will be done with the mode switch in the adjust position. This alignment procedure like many other alignment procedures requires some practice or user proficiency. The goal in this case being slightly different in that the velocity is adjusted to minimize Effective Radiated Distortion (ERD) of the loudspeaker system in the listening area. This procedure should be repeated at other oscillator frequencies for further user edification.

3.8 Using a Remote Delta Omega™ Adjustment Paddle

The "remote" slide switch and front panel connector permits the user to remotely adjust the Delta Omega™ function. This feature when implemented, defeats the internal screwdriver front panel control and as such, is not mechanically interlocked to the mode control. The user should always do the adjustment with the mode switch in the ADJ position. **Note:** Crown International is not responsible for damage to any amplifier load incurred during improper tune up of the Delta Omega™ 2000. (i.e., adjusting the remote Delta Omega™ paddle with the mode switch in the ON position; or with the remote Delta Omega™ paddle adjusted to either extreme while switching to the ON mode).

Tune-up methodology continues as defined under Section 3.7.1. See Fig. 3.11 for the remote paddle equivalent circuit.

3.9 The Protection Mechanisms

The amplifier is protected against all the common hazards which plague high power amplifiers, including shorted, open and mismatched loads, overloaded power supplies, excessive temperature, chain destruction phenomena, input overload damage, high frequency overload blowups and high line voltage.

Protection against shorted and low impedance loads is provided by the SPACE control (Signal Programmed Automatic Current Executor). It functions as an automatic current limiter at audio frequencies whose value of current limiting threshold is dependent on the

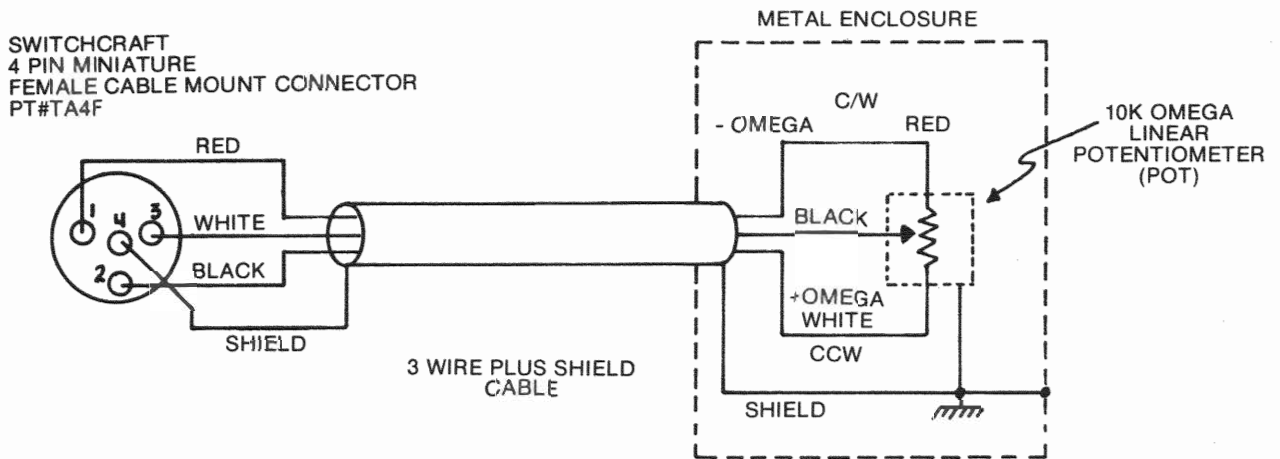


Fig. 3.11 Remote Paddle Schematic

history of the output signal (output current causes the threshold to decrease while output voltage causes the threshold to increase). The no signal threshold is high enough to allow tone bursting without premature limiting.

Since the limiter has no instantaneous response to output voltage, flyback transients do not appear in the output when limiting occurs on inductive loads. Flyback transients are a necessary response of a VI limiter when limiting drive to an inductive load. The actual response of the flyback pulse is that the amplifier yields to the load resulting in a pulse emanating from the load which returns the inductive energy of the load to the opposite polarity power supply of the amplifier, as that supply that produced the excessive output.

A current limiter will not yield to the load but will sustain the constant current demands of the inductive load without flyback.

At subsonic frequencies, the SPACE control behaves as a VI limiter and provides the increased protection needed at DC to prevent destruction due to the heat buildup in the half of the output stage that is being driven.

Fuses inherently protect the power supplies against overload. The AC line for the main supply (20VAC) is

fused with a 20A 250V type AB fuse (on 240, 220VAC, 10A type AB 250V).

The low power supply and cooling fan are fused with a 1/2A type AGC fuse on 120VAC and a 1/4A type AGC fuse on 220 or 240VAC. The use of any other fuse sizes will invalidate the warranty.

Warning: Never change fuses with power applied!

Thermal switches controlling the fan speed are mounted on two of the heat sinks. Should heat sink temperature rise above 60°C, the fan will go into high speed to remove the excess heat. When the heat is removed, the fan will resume its low speed operation.

On two pairs of the heat sinks are mounted semiconductor heat sensors (moxies) which at 75°C will put the unit into Standby. The fan continues to operate while in the Standby mode and should quickly remove the excess heat. Such a condition would normally not occur unless a high ambient temperature and high dissipation condition were occurring simultaneously (or, possibly, a dirty fan filter).

All of the amplifier's voltage-amplifier circuitry is designed to be inherently current-limited. Therefore, if any of the devices should fail (which is unlikely), no

damage will occur to the rest of the stages. The input stage is protected against overdrive damage by a series limiting resistor, should the input signal level ever become excessive.

The amplifier features a controlled slewing rate which, coupled with the SPACE controller, protects the amplifier from blowups when fed large RF input signals.

3.10 Operating Precautions

The following are a number of operating precautions given as an aid to understanding proper and improper amplifier usage:

1. Use care in making connections, selecting signal sources and controlling the output level. The load you save may be your own! **Crown is not liable for any damage done to loads due to careless amplifier usage or deliberate over-powering. For pointers on load protection, see Section 3.11.**
2. Never **directly** parallel the output with any other amplifier's output. Damage incurred by such operation is not covered by the warranty.
3. Never drive a transformer-coupled device or any other device which appears as a low frequency short (less than 3 ohm) without a series isolating capacitor. Such operation may damage the device and/or needlessly waste output power. This will not damage the amplifier.
4. Do not short the ground lead of an output cable to the input signal ground as oscillations may result from forming such a ground loop.
5. Operate and fuse the amplifier only as set forth in Section 3.9.
6. Operate the amplifier from AC mains of not more than 10% above the selected line voltage and only on 50 or 60 Hz AC. Failing to comply with these frequency limits will also invalidate the warranty.
7. Never connect the output to a power supply output, battery or power main. Damage by such a hookup is not covered by the warranty.
8. Do not ground either side of the output connector.
9. Tampering in the circuit by unqualified

personnel or the making of unauthorized circuit modification to other than the front panel plug-in board invalidates the warranty.

3.11 Load Protection Methods

Never change load impedance while the Delta Omega™ 2000 is in the ADJ or ON mode.

The most common of all load protection schemes is a fuse in series with the load. The fuse may be single, fusing the overall system. Or, in a case as a multiway speaker system, it may be multiple with one fuse on each speaker.

Fuses help to prevent damage due to prolonged overload, but provide essentially no protection against damage that may be done by large transients and such. To minimize this problem, high-speed instrument fuses such as Littlefuse 361000 series are most appropriate for such applications. For a nomograph showing fuse vs. loudspeaker ratings, refer to Fig. 3.12.

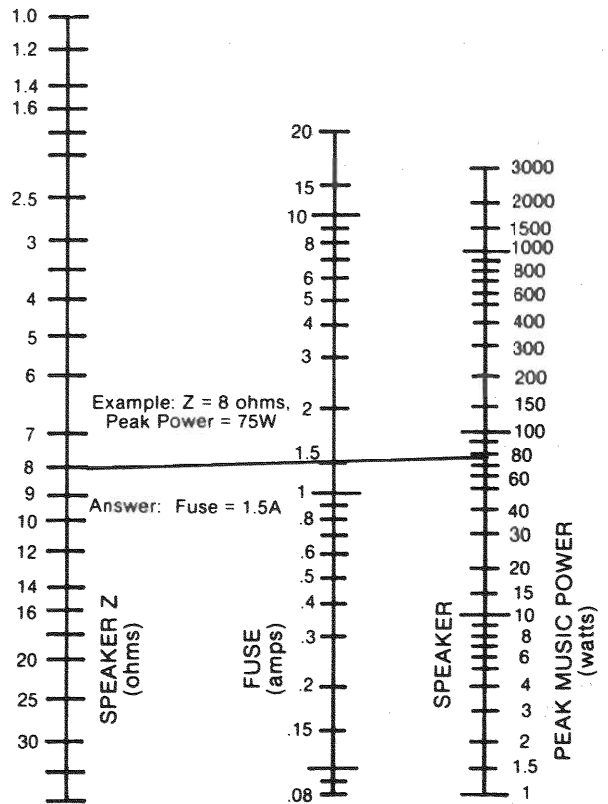


Fig. 3.12 Fuse Selector Nomograph for Loudspeaker Protection

Another form of load protector is shown schematically in Fig. 3.13. Whenever the load is overdriven, a relay switches a lamp in series with the load, smoothly relieving the overload. The lamp then doubles as an overload indicator as it glows. If overdrive is unreasonably severe, the lamp will serve as a fuse. By adjusting the relay tension adjustment and the protection level control, this system is useful from 25 to 200 watts for a typical 8 ohm load.

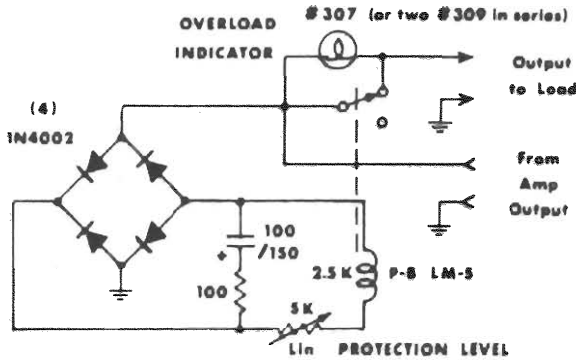


Fig. 3.13 Relay Controlled Protector with Overload Indicator

Should a system encounter offensive turn-on transients, the delay mode switch (rear of unit) should be engaged to prevent sustained output power, which may damage the load. The delay is automatically engaged with this function. The unit will automatically cycle back on from the Standby mode 4 to 5 seconds after the excessive low frequency output has subsided. Approximately 10 volts of DC output are required to trigger this detector.

If an overload condition of a load or transducer can be electrically or electro-mechanically detected, measures can be taken to:

1. Reduce or limit the amplifier's input drive.
2. Disconnect or decouple the load from the amplifier.
3. Place the amplifier in the Standby mode (high voltage supply not powered).

To externally control the Standby mode, a rear panel remote protect has been provided. Its operation is described next.

Caution: Do not cut speaker wires with Input Attenuator control turned fully counter-clockwise and the Off/On switch in the ON position (power applied). Cutting speaker wires in this situation will cause the Delta Omega™ 2000 circuit to sense an extremely low shunt in the output which it will attempt to correct by increasing the magnitude of the signal, thereby creating a dangerously high output.

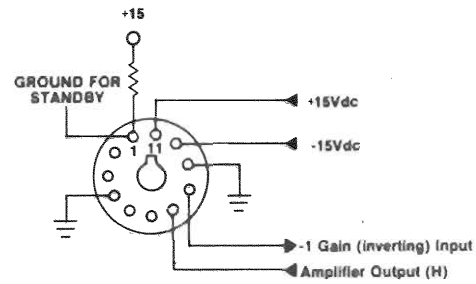


Fig. 3.14 Remote Protect Receptacle

3.12 The Remote Protect

The 11 pin socket on the rear of the unit provides all necessary connections for the remote system control and is shown in Fig. 3.14. Fig. 3.15 shows the standard Delta Omega™ 2000 remote protect plug supplied with the unit.

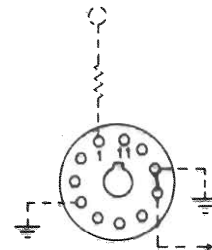


Fig. 3.15 Standard Remote Protect Plug

Allowing the standby terminal (pin 1) to rise above the 10 volt threshold, the main AC power solid state switch will engage. An internal resistor pulls pin 1 up to the +15 volt supply, while an internal FET pulls pin 1 to ground potential to hold the amplifier in Standby mode.

Grounding pin 1 externally will put the amplifier into Standby mode. The current is 150 microamps. Such a current may be easily switched by external sensors or control circuits.

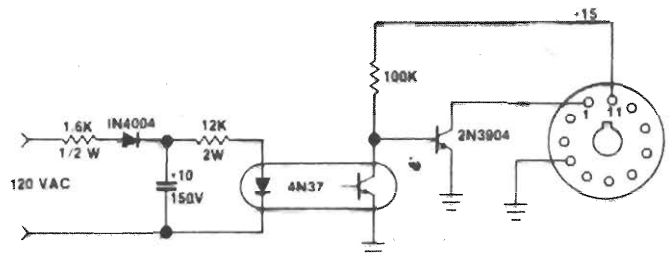


Fig. 3.16 AC Power Remote Start

If large common mode signals exist between the controller and the amplifier, an optical coupler may be used to close the remote circuit. Fig. 3.16 shows an AC powered remote start controller.

Remote protect may also be developed by digital logic. In Fig. 3.17 is a TTL IC (Hex Inverter, Open collector output) used in such a function.

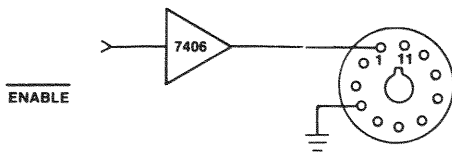
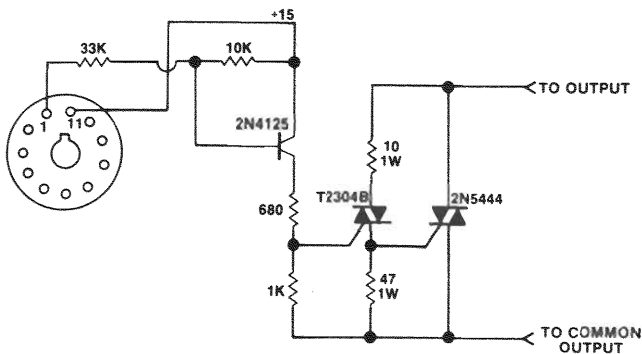


Fig. 3.17 Digital Controller Interface

Should crowbaring the output to protect a load be necessary at the time of initiating the Standby mode, it may be achieved as indicated in Fig. 3.18.



*Selection of this device may be needed for critical dv/dt (off state) spec.

Fig. 3.18 Output Crowbar

3.13 Cleaning

The amplifier has a dust filter on the air intake to the cooling system (see Fig. 3.19). Should this filter become clogged, the unit will demonstrate impaired cooling and may cycle repeatedly into the Standby mode due to an over temperature condition. This filter is easily removed by loosening the four mounting screws and rotating the plastic inset. Use mild dishwashing detergents and warm water for best cleaning results. Replacement filters may be ordered from the factory.

Dust filters are not 100% efficient and eventually cleaning of the heat sinks will be required, especially if the environment is dusty. Such cleaning is best done with compressed air. The amplifier top and bottom covers must first be removed for adequate access of the heat sinks. Aim the compressed air directly into the heat sinks. Should the air stream strike the thin aluminum fins obliquely, they may be bent and damaged. Use care!

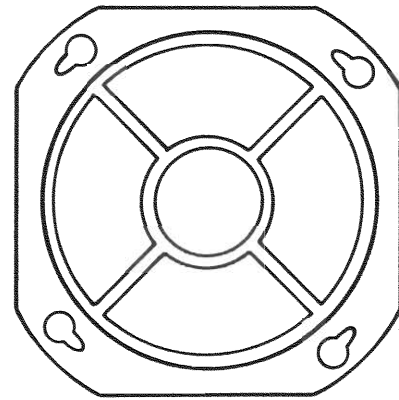


Fig 3.19 Dust Filter



SECTION 4

TECHNICAL INFORMATION

4.1 Theory of Operation (of the Delta Omega™ used as a voltage amp)

Refer to the block diagram, Fig. 4.1. The diagram does not show all circuit connections or feedback loops due to circuit complexity, but there is sufficient data to grasp the function of each circuit.

The Delta Omega™ 2000 is a high power direct coupled (option) amplifier with protection circuitry for the power output transistors. It is basically a bridge of four power amplifier elements powered by a floating power supply.

Two quasi-complementary (Class AB+B) amplifiers connected in a bridge make up the power section of the amplifier. One side of the bridge is grounded and the other side is powered. The floating power supply powers both sides of the bridge. This allows the load to be driven in reference to ground.

The main quiescent bias current is carried by the driver transistors. The power transistors sense when the drivers are giving a significant current to the load and boost the load current, taking the current load away from the drivers.

The SPACE circuit (Signal Programmed Automatic Current Executor) provides protection for the bridge by acting as an automatic current limiter at sonic frequencies, and a VI limiter at subsonic frequencies. The SPACE circuit remembers the history of the output signal and adjusts the threshold of current limiting. The no signal threshold of current limiting is high enough to allow full power tone bursting.

An input signal is fed to the input amplifier section. The input bias current is offset by the temperature compensated Input Bias Compensator. The input amp amplifies the signal and feeds it to the Signal Translator which divides the signal into two complementary signals. From there the two signals are sent to the last voltage amplifiers which are conventional amplifiers. The signal now feeds into the positive and negative predriver and driver sections which drive the high side power sections. The main bias servo corrects the bias on the driver stage according to the temperature sensed from a positive power section heat sink.

The signal now enters the load from the power sections and is referenced to ground. The feedback signal is taken from the signal terminal of the load and returns to the input amp, signal translator and last voltage amp. The feedback signal also is the input to the Bridge Balance Amp. The amplifier also uses the common point between the positive and negative power supply (V_{cc} common) as its feedback signal and feeds the BBA buffers which in turn drive the low side power sections. The protection circuit measures the current in the power transistors and stores voltage and current information from the output signal, signals from the last voltage amplifiers and the bridge balance amp buffers to provide power transistor protection. The Power Control senses high line voltage, high temperature, low frequency output (feature is switched selected) and time delay (also switch selected) and controls the main supply voltage through a relay. Operation is monitored by a red and an amber light on the front panel.

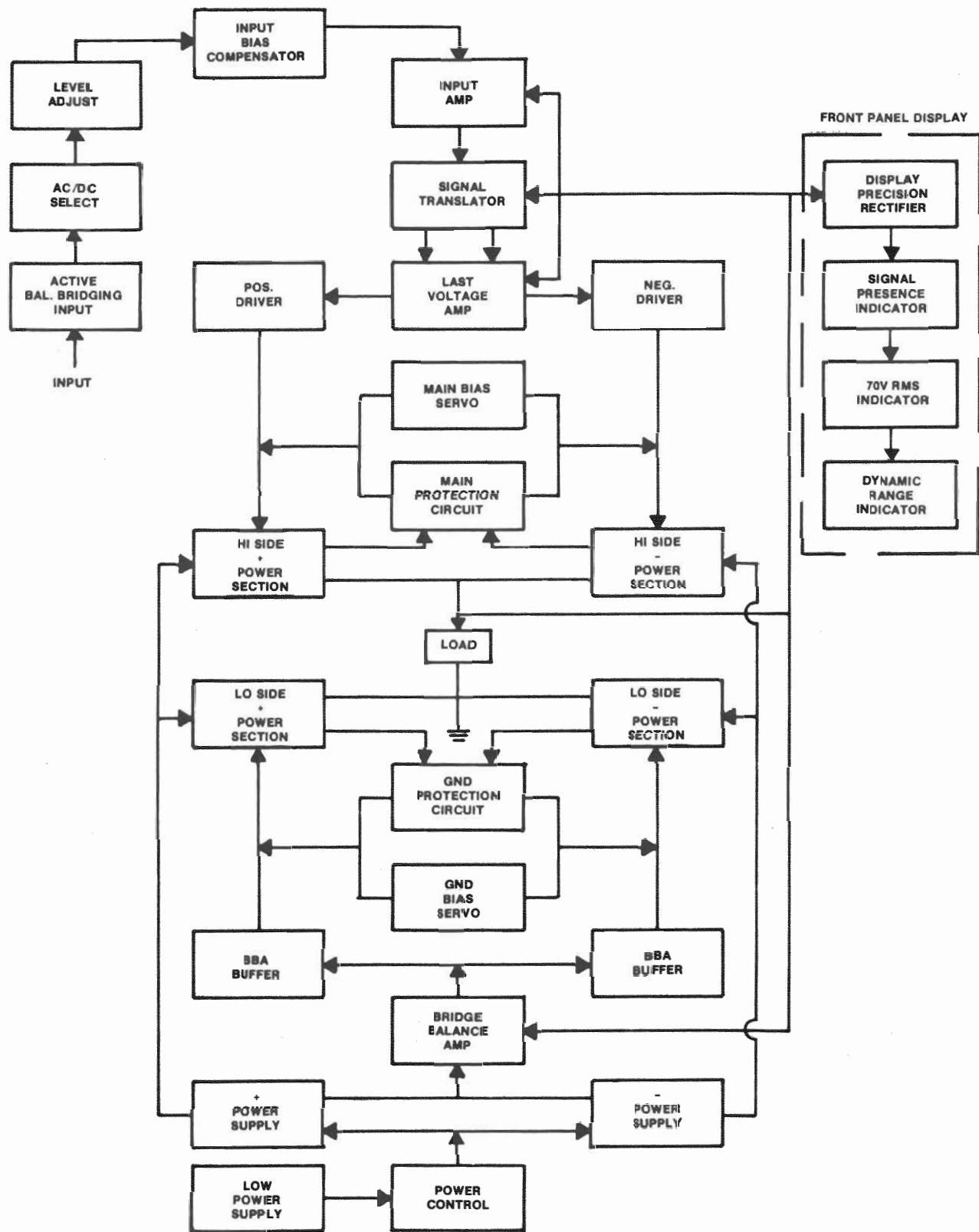


Fig. 4.1 Block Diagram