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9444B and 9444B/SA Anniversary Series Power Amplifier

Operating and Service Instructions

ALTEC LANSING® CORPORATION

a MARK IV company

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1 ELECTRICAL

Two amplifier models are available. One model has a 50/60 Hz power transformer with two 120 V ac primary windings. These windings may be wired in parallel or series for operation at either 120 V ac or 220/240 V ac. The other amplifier model is for export into countries where the ac line voltage is 100 volts, 50/60 Hz. The next two sections refer to the first model with the dual 120 V ac primary windings.

1.1 120 V ac, 50/60 Hz Power Connections

The amplifier is provided with the primary of the power transformer strapped for 120 V ac operation from the factory. Refer to Figure 2a for the wiring details.

WARNING: Verify that the power transformer's primary circuit configuration is correct for the intended ac line voltage BEFORE applying power to the amplifier.

1.2 220/240 V ac, 50/60 Hz Power Connections

The power transformer has two 120 volt primary windings which can be connected in parallel for 120 V ac line voltages, or in series to meet 220/240 V ac requirements. Use the following procedures to re-strap the primary of the power transformer for 220/240 V ac applications.

1. Make sure the amplifier is not connected to any power source.
2. Remove and save the eleven screws securing the top cover. There are three screws on each side and three along the top-rear edge of the chassis. In addition, you must remove the two innermost screws inset into the top bumper strip. Refer to Figure 1 for the exact screw locations.

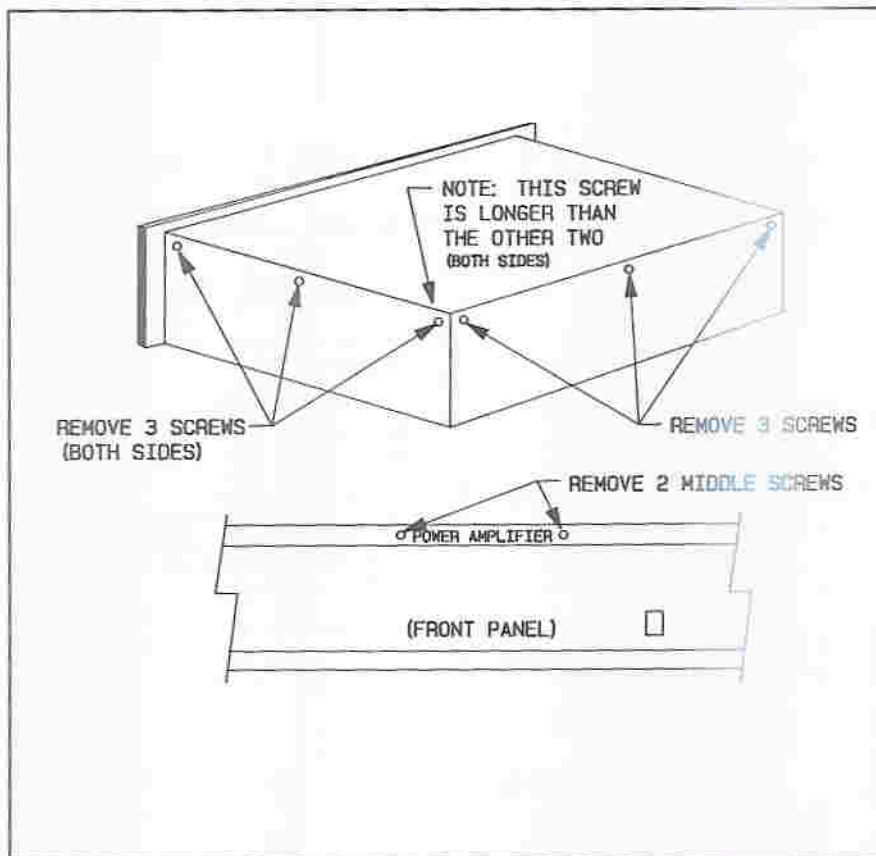


Figure 1 Top Cover Removal

3. Locate terminal blocks TB1 and TB2 on the side of the chassis near the rear input PC board. Reconnect the leads as shown in Figure 2b.
4. Install the top cover with the eleven screws previously removed. Two screws are longer than the others removed from the sides and rear. These longer screws install into the rearmost position on each side of the chassis.
5. Install an 5A fuse, Littelfuse Type 3AB 5A/250V slo-blo 326-series ceramic body or equiv.

2 INSTALLATION

2.1 Rack Mounting

The amplifier may be installed in a standard 19 inch equipment rack. It requires 5 1/4 inches of vertical rack space and secures to the rack cabinet with the four rack mount screws and cup washers provided in the hardware kit.

2.2 Ventilation

The amplifier must be adequately ventilated to avoid excessive temperature rise. It should not be used in areas where the ambient temperature exceeds 60 °C (140 °F). To determine the ambient air temperature, operate the system in the rack until the temperature stabilizes. Measure the ambient air with a bulb-type thermometer held at the bottom of the uppermost amplifier. Do not let the thermometer touch the metal chassis because the chassis will be hotter than the ambient air. If the

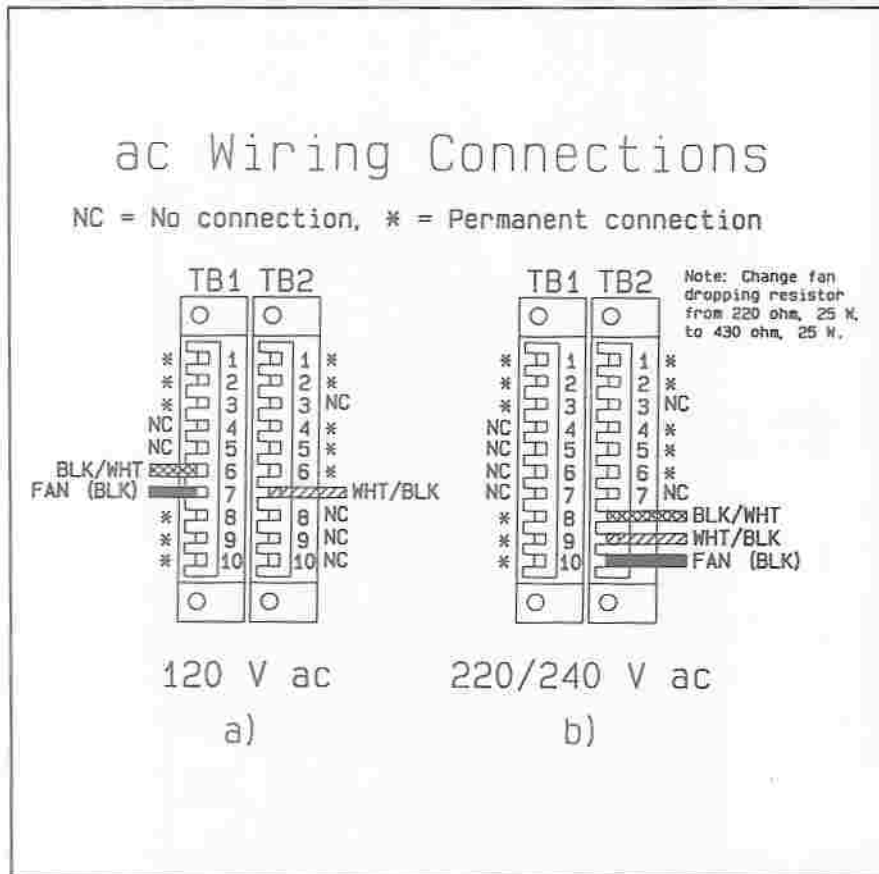


Figure 2 Primary Wiring Configuration for 120 V ac and 220/240 V ac

air temperature exceeds 60 °C (140 °F), the equipment should be spaced at least 1.75 inches apart or a blower installed to provide sufficient air movement within the cabinet.

WARNING: Do not operate the amplifier within a completely closed unventilated housing.

3 SIGNAL CONNECTIONS

3.1 Input Connections

Balanced input connections may be made to either the barrier strip or the female XLR connectors. For single-ended inputs, strap the low (—) input to ground (pin 3 on XLR). Otherwise, the electronically-balanced input stage will see 6 dB less input signal level than with a balanced input. Refer to Figure 3 for

typical input connections.

3.2 Line Output Connections

The XLR and barrier strip connectors are wired in parallel. Pin 2 of the XLR is the (+) input on the barrier strip, and pin 3 is the (—) input. Since the input impedance of the electronically-balanced input stage is high (15 kohms), there is minimal loading on the signal source. When the input connections are made to one connector, the other may be used as an auxiliary line output to feed other high input impedance equipment. Refer to Figure 3 for possible applications.

3.3 Output Connections

Output connections are made to the four terminal barrier strip connector located on the rear of the unit. Refer to Figure 4 for

typical output connections.

3.4 Output Cable Selection

Speaker wire size plays an important part in quality sound systems. Small wire gauges can waste power and reduce the damping factor at the speaker terminals. This can add coloration and muddiness to the sound. To help offset this problem, Table I has been assembled to enable you to calculate the power losses in the speaker cable.

3.4.1 Calculating Power Losses with 8 ohm Loads

To calculate the total power loss in the speaker cable, multiply the power loss per foot (or meter) of the 2-wire cable selected from Table I by the length of the cable in feet (or meters). For example, suppose an installer uses 160 feet of 10 GA 2-wire cable with an 8 Ω speaker system. The total power loss in the cable is:

Total Power Loss in cable

$$= 0.0509 \text{ watts/foot} \times 160 \text{ feet}$$

$$= 8.1 \text{ watts}$$

Does this mean that whenever the amplifier produces 200 watts of output power, 191.9 watts (200 watts minus 8.1 watts) will be delivered to the 8 ohm load? NO! The actual load impedance is 8 ohms plus the resistance of the cable (0.00204 ohms/foot times 160 feet) for a total load impedance of 8.3264 ohms. At the 8 Ω rated output power, the output voltage is 40 V rms. Therefore, the amplifier produces 192.2 watts with this load instead of 200 watts. This was calculated by squaring the voltage and dividing by the load impedance (40² divided by 8.3264 ohms). As a result, the actual power delivered to the load is 184.1 watts (192.2 watts minus 8.1 watts).

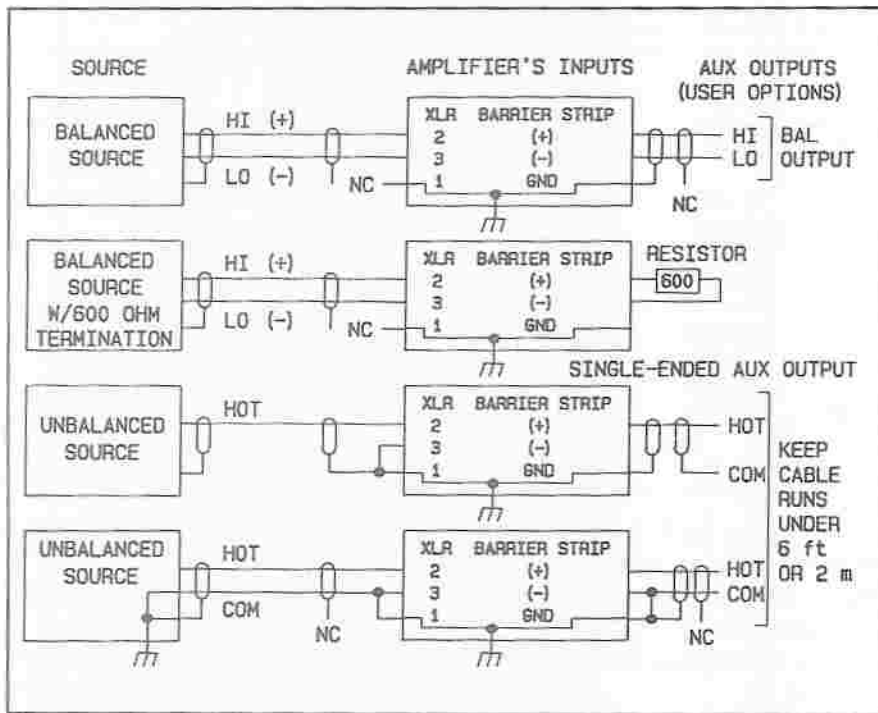


Figure 3 Typical Input Connections

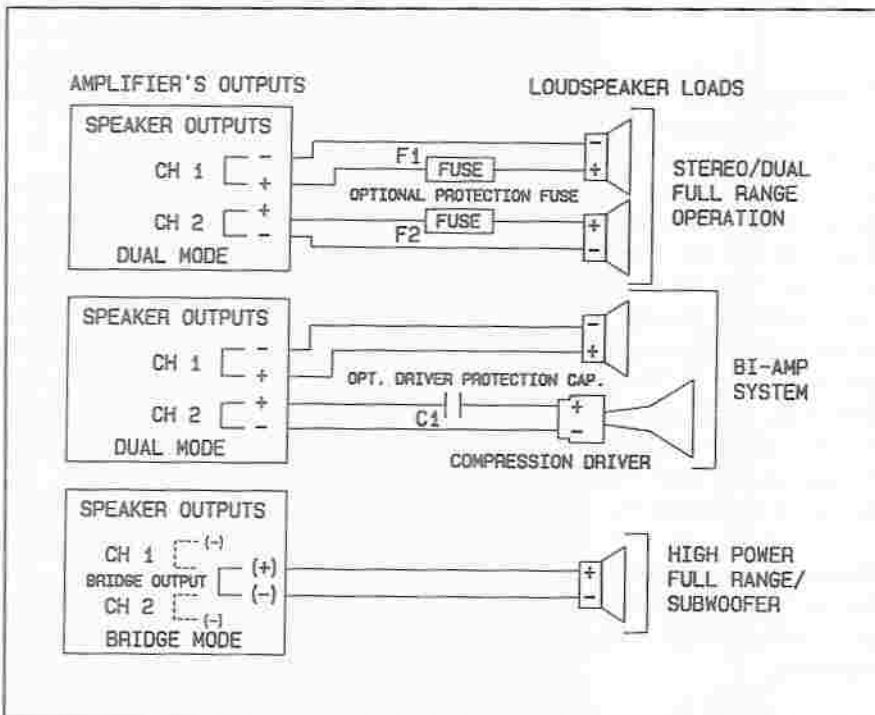


Figure 4 Typical Output Connections

Had 18 GA wire been used in the above example, the loss in the cable would have been 51.9 watts. This example illustrates the im-

portance of using the proper wire size.

3.4.2 Calculating Power

Losses with 4 ohm Loads

To calculate the losses when using a 4 ohm speaker system, multiply the loss at 8 ohms by 3. In the above example, the 10 GA wire would consume 24.3 watts of power while the 18 GA wire would waste 155.7 watts - more than half of the amplifier's 4 ohm power rating.

3.5 Damping Factor

The higher the damping factor rating of an amplifier, the greater the ability of the amplifier to control unwanted speaker cone movements. When a signal drives a woofer, current flowing through the voice coil creates a magnetic field. This field interacts with the permanent magnetic field in the gap and forces the combination cone and voice coil assembly to move outward. When the signal is removed, the assembly moves inward but its momentum causes it to overshoot its resting point. This overshoot will dampen itself out eventually but the unwanted movements can add considerable distortion products to the sound.

In the process of moving inward through the magnetic field, the voice coil assembly generates a current of opposite polarity to the original signal. This current induces a voltage or "back EMF" which travels through the speaker wire to the amplifier's output. The lower the amplifier's output impedance, the faster the overshoot of the voice coil will dampen out. The output impedance of an amplifier can be calculated by dividing the rated output impedance, typically 8 ohms, by the damping factor. The 9444B has a damping factor rating of 200 which corresponds to an output impedance of 0.04 ohms.

3.5.1 Calculating the Maximum Length of Cable for a Specified

Damping Factor Specification at the Load

The damping factor rating is typically never realized at the load because of the resistance of the cable (and other factors such as the contact resistance of an output relay or the resistance of an output fuse). The damping factor at the load should be 30 for general paging systems and 50 for high fidelity music systems. Economics usually dictate, however, that these numbers are cut-in-half. The resulting damping factor at the load should be based on experience and customer satisfaction. Once a minimum damping factor is determined for a particular type of installation, the following equation can calculate the maximum length of 2-wire cable which can be used to achieve the minimum damping factor specified at the load:

Max. Length of 2-wire cable in feet

$$= \frac{ZL - Zo}{DF \cdot DCR/ft}$$

where

- ZL is the load impedance to connect to the amplifier;
- Zo is the amplifier's output impedance (0.04 ohms for the 9444B);
- DF is the minimum permissible damping factor at the load; and
- DCR/ft is the DC resistance of the 2-wire cable per foot from Table I.

The same equation can be used to calculate the maximum cable length in meters by substituting the DCR per meter value from Table I.

Let's use the equation. Suppose ZL equals 8 ohms, Zo = 0.04 ohms, and the minimum damping

Table I 9444B Power Losses in 2-wire Speaker Cable

AWG (GA)	DCR/ft. (Ω/ft)	Power Loss/ft. (watts/ft)	Cable Cross-Sectional area (mm ²)	DCR/meter (Ω/m)	Power Loss/meter (watts/m)
6	0.00081	0.0201	13.30	0.00264	0.0661
8	0.00121	0.0302	8.36	0.00421	0.1051
10	0.00204	0.0509	5.26	0.00669	0.1669
12	0.00324	0.0809	3.31	0.01063	0.2650
14	0.00515	0.1286	2.08	0.01691	0.4210
16	0.00819	0.2043	1.31	0.02685	0.6667
18	0.01302	0.3244	0.82	0.04289	1.0609
20	0.02070	0.5148	0.52	0.06764	1.6627
22	0.03292	0.8163	0.33	0.10658	2.5950

factor at the load is 25. In addition, 18 GA cable is preferred. Then, the maximum length of 18 GA cable which can be used to achieve a damping factor of 25 at the load is:

$$\frac{8 - (0.04)}{25 \cdot 0.01302 \text{ } \Omega/\text{ft}} = 21.5 \text{ feet}$$

Sometimes it may be necessary to locate the speaker 100 feet or more away from the amplifier. In this situation, a much larger gauge cable is required. However, this may not be practical or economical. The size of the 2-wire cable can be greatly reduced by stepping up the output voltage of the amplifier to 70, 100, 140, or 210 volt, using an output transformer, then stepping down the voltage at the load. Such a system is shown in Figure 5.

The maximum length of 2-wire cable in this situation can be approximated from the following equation:

Max. Length of 2-wire cable in feet

$$\frac{V^2}{(P_{out})(DCR/ft)} - \frac{1}{DF} - \frac{Z_o}{ZL}$$

where

- V is the stepped-up voltage of the system;
- P_{out} is the rated output power of the amplifier;
- Z_o is the output impedance of the amplifier (0.04 ohms for the 9444B);
- Z_L is the load impedance;
- DCR/ft is the DC resistance of the 2-wire cable per foot from Table I; and
- DF is the minimum permissible damping factor at the load.

Suppose a 210 volt system were used at a 600 watt power level to drive an 8 ohm load with a minimum damping factor of 25. Using the same 18 GA cable as before, the maximum length can now be 198 feet. Power companies use this technique to transfer large amounts of power over great distances.

3.6 Speaker Protection Fuse Selection

Sometimes it may be desirable to use in-line fuses (fuses in series with the output) to protect loudspeaker systems (or the amplifier). It is difficult, however, to determine the proper fuse value with the correct time lag and overload characteristics to match the limitations of a speaker system. The values shown in Table II should serve only as a guide. To

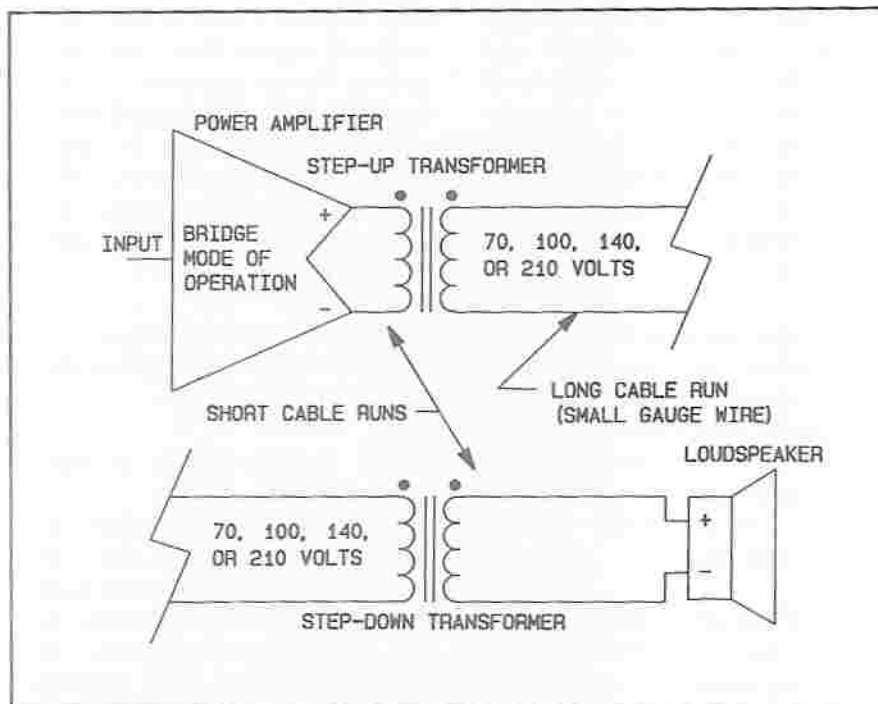


Figure 5 High-voltage Distribution System

use, determine the power rating and load value. Then, select a standard value fuse of the next smaller value to the one listed in the table.

Table II Calculated Output Fuse Values

Power (watts)	4 Ω Load	8 Ω Load	16 Ω Load
100	3.70	2.62	1.85
150	4.54	3.21	2.27
200	5.24	3.70	2.62
300	6.42	4.54	3.21
400	7.41	5.24	3.70
600	9.07	6.42	4.54

The values are calculated for fast-blow fuses which carry 135% of their current rating for an hour but will blow within 1 second at 200%. Other fuse values may be calculated for different power levels from the following equation:

$$\text{Fuse value} = \frac{(P_{out} \times ZL)^{1/2}}{ZL \times 1.35} \text{ amps}$$

where

P_{out} is the output power rating of the amplifier; and
 ZL is the load impedance.

Use 32 volt fuses if possible; they typically have the lowest internal resistance which will help minimize deterioration of the damping factor at the load. Refer to the example in Figure 4.

3.7 Compression Driver Protection Capacitors

Compression drivers, used for mid to high frequency sound reproduction, are much more susceptible to damage from low frequencies than large cone loudspeakers. Even though an electronic crossover may be employed, problems may arise in the cables between the crossover and the power amplifier, or from misadjustment of the crossover. Either of these situations could apply low frequency signals or hum to the driver and cause damage. To prevent a potential mishap, Altec

Lansing recommends using a capacitor between the amplifier and the compression driver to suppress low frequencies and possible DC. Refer to the example in Figure 4.

In choosing a value, one must be careful not to interfere with the crossover frequency. As a general rule, select a capacitor whose break frequency, with respect to the load, is 3 dB down at approximately 1/2 of the high pass corner frequency.

Mylar capacitors with at least a 100 volt ac rating are recommended. Table III shows the recommended capacitor values for use with 8 and 16 ohm drivers at popular crossover frequencies.

Table III Compression Driver Protection Capacitors

Crossover Frequency	8 Ω Driver	16 Ω Driver
500 Hz	80 μF	40 μF
800 Hz	50 μF	25 μF
1000 Hz	40 μF	20 μF
1250 Hz	33 μF	16 μF
2000 Hz	20 μF	10 μF
3150 Hz	12 μF	6 μF
6300 Hz	6 μF	3 μF

4 OCTAL ACCESSORY SOCKETS

Two octal sockets permit a variety of plug-in accessories to be used with the amplifier. Normally, one "U" jumper is inserted between octal socket pins 8 and 1, and another between pins 7 and 6. These jumpers must remain in place for the amplifier to operate when not using any accessory modules. To use with an accessory module, remove (and save) the jumpers and install the module making sure the key on its center post aligns with the groove in the female socket. For operation, refer to the instructions provided with

the module. Schematically, the module will be inserted between the input connector and the balanced input stage.

Electronic modules are powered from a bipolar 15 volt supply in the amplifier. The supply is capable of supplying up to 25 ma DC of current. Currents in excess of 25 ma DC may prevent the amplifier from disengaging from its built-in protection mechanisms.

5 PROTECTION SYSTEMS

5.1 Load Protection Circuitry

Each channel independently protects its load from startup/shutdown transients, DC, and large subsonic signals.

5.2 Amplifier Protection Circuitry

A unique current-limiting circuit was designed specifically for the amplifier. It features a variable current limit which is a function of the output signal voltage. As a result, the amplifier can deliver the rated currents into rated loads but substantially limits the current into low impedance or shorted loads (shorted output terminals). Once the short is removed, however, the amplifier will resume normal operation.

A dual speed fan is also incorporated to provide efficient cooling under the most demanding conditions. When the heatsink temperature at the fin tips reaches approximately 88 °C (190 °F), the fan automatically switches to high speed operation. As the temperature cools to approximately 78 °C (172 °F), low speed operation is once again resumed.

The heatsink is also thermally equalized to prevent the output devices nearest the fan from operating at a cooler temperature

than the devices at the opposite end. This minimizes the thermal gradient across the heatsink and forces the devices to operate at more nearly the same temperature. This equalizes the lifetimes and reliability characteristics of the output devices so that no one device becomes the weak link in the chain.

Should the heatsink temperature of a channel remain excessively high, the affected channel will shut down automatically. When the output devices cool to a safe operating temperature, the channel will automatically resume normal operation.

5.3 Protect Indicator

The "PROTECT" LED does not turn-on abruptly as others may do; its intensity is allowed to vary. As a result, its degree of brightness serves as a relative indicator of the severity of the current operating conditions e.g., the brighter the LED, the greater the stress on the channel(s). This provides a visual notification well in advance of any impending shutdown.

Although the channel may still operate with the LED apparently at full brightness, a total shutdown will occur within a few seconds unless the operating conditions improve. If a shutdown does occur, the channel will resume normal operation as soon as its devices have cooled to an acceptable temperature.

6 OPERATION

6.1 Dual Mode of Operation

In the dual mode of operation, the channels may be operated independently. After installation and hookup, verify that the mode switch, located on the rear panel, is in the "DUAL" position and rotate the level controls fully

counterclockwise (full attenuation). Input a 0 dBu (0.775 V rms) nominal signal level and apply power. Slowly increase the level controls until the desired output power is obtained. If either "CLIP" LED illuminates, reduce the output with the channel level control or reduce the input signal level at its source.

WARNING: Never attempt to connect the outputs of the two channels in parallel.

6.2 Bridge Mode of Operation

After installation and hookup, verify that the mode switch, located on the rear panel, is in the "BRIDGE" position. Rotate both level controls fully counterclockwise (full attenuation). Input a 0 dBu (0.775 V rms) nominal signal level into channel 1 only and apply power. Slowly increase the level control of channel 1 until the desired output power is obtained. If either "CLIP" LED illuminates, reduce the output level with the level control or reduce the input signal level at its source.

CAUTION: Be sure that no input connections are made to channel 2 and that its level control is fully counterclockwise (OFF).

WARNING: The bridged output mode provides a true balanced-to-ground output. Do not use any test equipment to test or evaluate this amplifier which does not have floating grounds.

7 In Case of Problems

Please check the following items:

1. Verify that the amplifier is properly connected to an ac power source and that the source is active.
2. Verify that the input connections are properly

- made. Refer to Figure 3.
3. Verify that the output connections are properly made. Refer to Figure 4.
 4. Check the input and output cables for proper wiring and continuity.
 5. Check the signal source and the load.
 6. Insure that the two jumpers for each octal socket are properly installed (if not using optional plug-in modules).
 7. Insure that any accessory modules installed do not draw more than 25 ma DC of current.
 8. Check that the mode switch is in the desired position.

NOTICE: Repairs performed by other than authorized warranty stations (Dealers) or qualified personnel shall void the warranty period of this unit. To avoid loss of warranty, see your nearest Altec Lansing authorized dealer, or call Altec Lansing Customer Service directly at (405) 324-5311, FAX (405) 324-8981, or write:

**Altec Lansing Customer
Service/Repair
10500 W. Reno
Oklahoma City, OK 73128
U.S.A.**

8 SPECIFICATIONS

Conditions:

1. 0 dBu = 0.775 volts rms.
2. Dual mode ratings are for each channel.
3. Both channels operating at rated output power unless noted.
4. 120 volt ac line input voltage maintained for all tests unless noted.

Continuous Rated Output Power:

(20 Hz - 20 kHz at less than 0.1% THD)

Dual mode, 4 Ω:	300 watts/ch
Bridge mode, 8 Ω:	600 watts
Dual mode, 8 Ω:	200 watts/ch
Bridge mode, 16 Ω:	400 watts

Continuous Rated Output Power to Subwoofer:

(20 Hz - 1 kHz at less than 0.1% THD)

Dual mode, 4 Ω:	375 watts/ch
Bridge mode, 8 Ω:	750 watts
Dual mode, 8 Ω:	225 watts/ch
Bridge mode, 16 Ω:	450 watts

Maximum Midband Output Power:

(Ref. 1 kHz, 1% THD, @120 volts ac line voltage)

Dual mode, 4 Ω:	>400 watts/ch
Bridge mode, 8 Ω:	>800 watts
Dual mode, 8 Ω:	>250 watts/ch
Bridge mode, 16 Ω:	>500 watts

(Ref. 1 kHz, 1% THD, @108 volts ac (10% sag))

Dual mode, 4 Ω:	>325 watts/ch
Bridge mode, 8 Ω:	>650 watts
Dual mode, 8 Ω:	>200 watts/ch
Bridge mode, 16 Ω:	>400 watts

(Ref. 1 kHz, 1% THD, @100 volts ac (17% sag))

Dual mode, 4 Ω:	>230 watts/ch
Bridge mode, 8 Ω:	>460 watts
Dual mode, 8 Ω:	>175 watts/ch
Bridge mode, 16 Ω:	>350 watts

Headroom (Before clip): ≥1 dB

(Ref. 1 kHz, 1% THD, any mode)

Frequency Response: 10 Hz - 90 kHz

(Ref. 1 kHz, 1 watt output, +0/-3 dB)

Power Bandwidth: 20 Hz - 20 kHz

(Ref. 1 kHz, +0/-1 dBr where 0 dBr = rated output power in any mode)

Voltage Gain:

(Ref. 1 kHz)

Dual mode, 4 Ω or 8 Ω:	33 dB
------------------------	-------

Bridge mode, 8 or 16 Ω: 39 dB

Input Sensitivity for Rated Output Power:

(Ref. 1 kHz, ±0.15 dB)

Dual mode, 4 Ω:	+0.1 dBu (0.78 V rms)
Bridge mode, 8 Ω:	+0.1 dBu (0.78 V rms)
Dual mode, 8 Ω:	+1.2 dBu (0.89 V rms)
Bridge mode, 16 Ω:	+1.2 dBu (0.89 V rms)

Maximum Input Level: +20 dBu (7.75 V rms)

(Ref. 1 kHz)

Input Impedance:

(Ref. 1 kHz)

Balanced:	15 kΩ
Unbalanced:	15 kΩ

Polarity:

Positive-going signal applied to pin 2 of XLR or (+) of barrier strip produces positive-going signal at (+) output terminal.

Phase Response:

(Any mode)

20 Hz:	<+25°
20 kHz:	>-15°

THD:

<0.1% (Typ. <0.01%)
(Any mode, 30 kHz measurement bandwidth)

IMD (SMPTE 4:1):

<0.05% (Typ. <0.01%)
(Any mode)

TIM (DIM 100):

<0.05%
(Any mode)

Rise Time:

<6 μsec
(Any mode, 10% to 90%)

Slew Rate:

Dual mode, 4 or 8 Ω:	>30 V/μsec
Bridge mode, 8 or 16 Ω:	>60 V/μsec

Damping Factor:

(Dual mode, 8 Ω)

20 Hz - 1 kHz:	>200
20 kHz:	>75

Crosstalk:

<75 dBr
(Ref. 1 kHz, 0 dBr = rated output power into 8 ohms, single channel operating)

Noise:

>100 dB
(Below rated output power, A-weighting filter, 8 Ω)

	dual mode, 50/60 Hz ac line frequency)		volts DC at 25 ma.
Amplifier Protection:	Shorted output terminals, Over-temperature, RF interference	Output:	Barrier strip
Load Protection:	Startup/shutdown transients, DC faults, Subsonic signals	Power:	6 ft (1.83 m), 3-wire, 16 GA power cord with NEMA 5-15 plug/IEC
Cooling:		Fuse Type:	Littelfuse Type 3AB 10 A/250 V Slo-Blo® 326-series ceramic cartridge body, or equivalent (for 120 V ac use)
Heatsink:	Thermally equalized 3/16 in aluminum black anodized heatsink	Power Requirements:	120 V ac, 50/60 Hz, 1000 watts (configurable to 220/240 V ac). 100 V ac, 50/60 Hz model available.
Fan:	Thermostatically controlled dual speed fan. Approximately 50 CFM at low speed and 100 CFM at high speed. Ball bearing fan has minimum life rating of 50,000 hours at 25 °C ambient temperature	Operating ac Voltage Range:	Operates from line voltages as low as 90 volts (at reduced output power) assuming a 120 V ac nominal line.
Output Topology:	True complementary symmetry with grounded collectors (no mica insulators means better heat transfer)	Power Consumption/Heat Produced:	(Both channels operating in dual mode with 1 kHz sinewave input signal at stated output power into 4 Ω loads)
Output Type:		idle:	72 watts/0.245 kBTU/h
Dual mode:	Unbalanced, each channel	1/8th max midband power:	720 watts/2.100 kBTU/h
Bridge mode:	Balanced	1/3rd max midband power:	1,068 watts/2.702 kBTU/h
Output Devices:		Rated output power:	1,464 watts/2.938 kBTU/h
Total number:	16 devices	Max midband power:	1,680 watts/2.873 kBTU/h
Pdmax rating:	250 watts		
Vceo:	250 volts DC	Operating Temperature Range:	Up to 60 °C (140 °F) ambient
Ic:	16 amps DC		
Tjmax:	200 °C	Dimensions (Rear of rack ears to max depth):	5.25 in H x 19 in W x 13 in D (13.3 cm H x 48.3 cm W x 33 cm D)
Controls and Switches:			
Rear:	Mode switch, Two input level controls		
Front:	Power switch		
Front Panel Indicators:	Power LED, Clip LED (x 2), Protect LED (x 2)		
Connections:			
Input:	6 terminal barrier strip, Female XLR (x 2), Octal accessory socket (x 2), powered with ±15		

Shipping Weight:	42 lbs (19.1 kg)
Net Weight:	34 lbs (15.5 kg)
Color:	Black
Enclosure:	Rack mount chassis, 16 GA steel, 3/16 in 5052 aluminum alloy front panel
Standard Accessories:	4 - "U" jumper plugs for octal sockets (2 per socket, installed) 1 - Operating Instructions and Service Manual 1 - 5 A/250 V fuse (for 220/240 V ac use)
Optional Accessories:	14712A Power Limiter 15515A Input Bridging Transformer with Pad 15524A 300 watt 70 volt Transformer 15525A 600 watt 70 volt Transformer 15567A 300 watt Auto-former 15581A 24 dB/oct Linkwitz-Riley Crossover 15594A-xxx 18 dB/oct Low Pass Filters 15595A-xxx 18 dB/oct High Pass Filters

The "-xxx" represents various corner frequencies available for the corresponding filter.

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