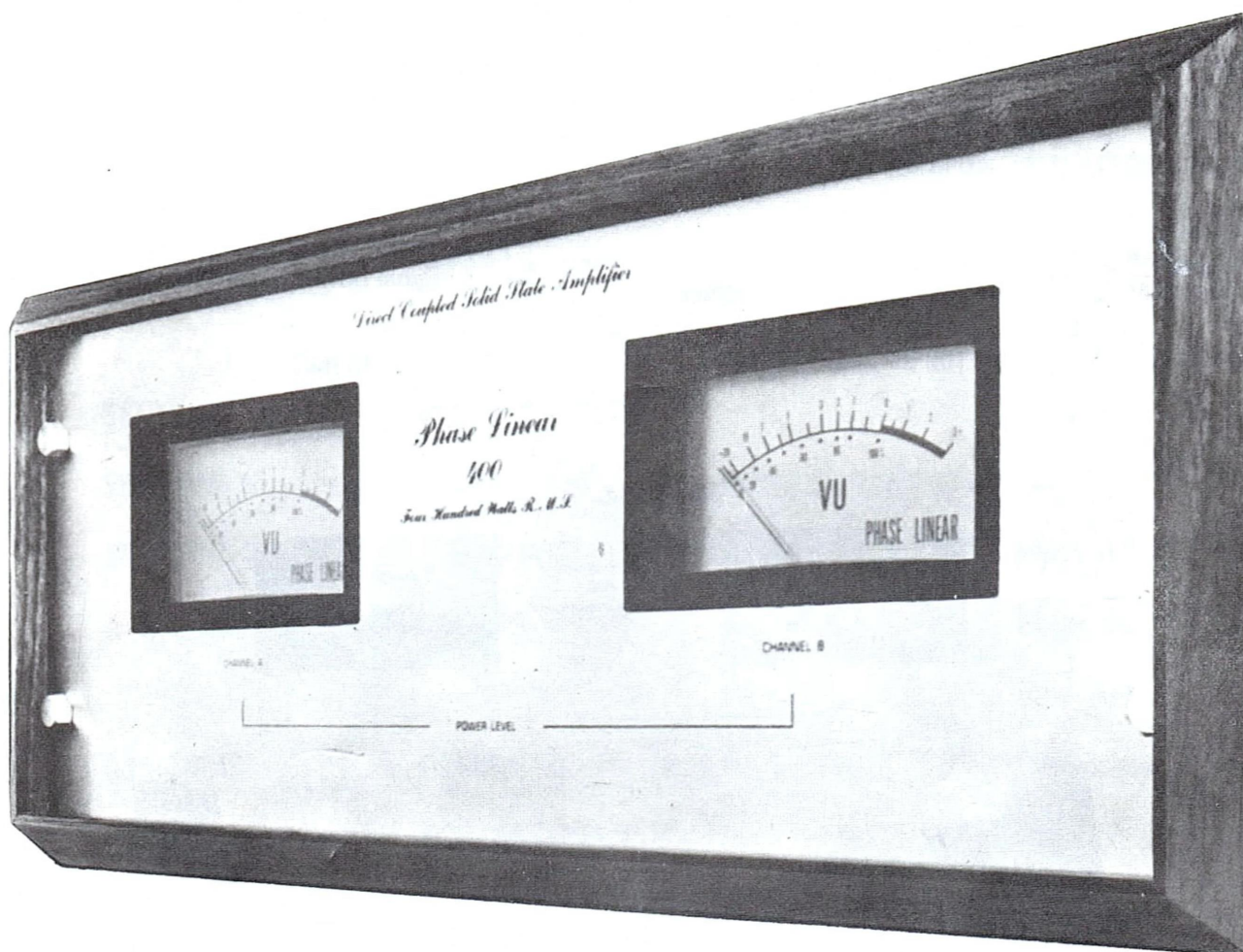


Phase Linear 400 **AMPLIFIER**



SERVICE INFORMATION

For Serial Numbers 000-000 thru 743-300

TECHNICAL SPECIFICATIONS

POWER AT CLIPPING: Typically 250 watts/channel R.M.S., into 8 ohms, 400 watts/channel R.M.S., into 4 ohms, 125 watts/channel R.M.S., into 16 ohms.

HARMONIC OR I.M. DISTORTION: Less than .25%.
Distortion is typically less than .05%.

POWER: Greater than 200 watts/channel R.M.S., both channels driven into 8 ohms, 5 to 20 kHz.

FREQUENCY RESPONSE: 5 Hz to .25 MHz @ 1 watt

INPUT IMPEDANCE: 47 kilohms

SQUARE WAVE RESPONSE: Undershoot: none
Overshoot: none

POWER BANDWIDTH: 5Hz - 40 kHz

PROTECTION: Electronic energy limiters, together with supply fuses prevent excursions into the unsafe operating region, regardless of load condition.

HUM AND NOISE: Better than 100 dB below 200 watts.

DAMPING RATIO: Greater than 1,000:1 @ 20 Hz.

RISE TIME: Less than 1.7 microseconds.

PHASE SHIFT: Leading 0 degrees @ 20 Hz.
Lagging 12 degrees @ 20 kHz.

SENSITIVITY: 1.75 volts for 200 watts into 8 ohms.

STABILITY: Absolutely stable with all loudspeaker loads including electrostatic units.

METER BALLISTICS: V.U. calibration is such that impulsive waveforms result in 0 V.U. at clipping.

DIMENSIONS: 19 inches wide, 7 inches high, and 10 inches deep.

FINISH: Light brushed gold, baked enamel, and black anodize.

POWER REQUIREMENTS: 122% of maximum R.M.S. signal power output. Stand-by power is 35 watts.

WEIGHT: 35 lbs.

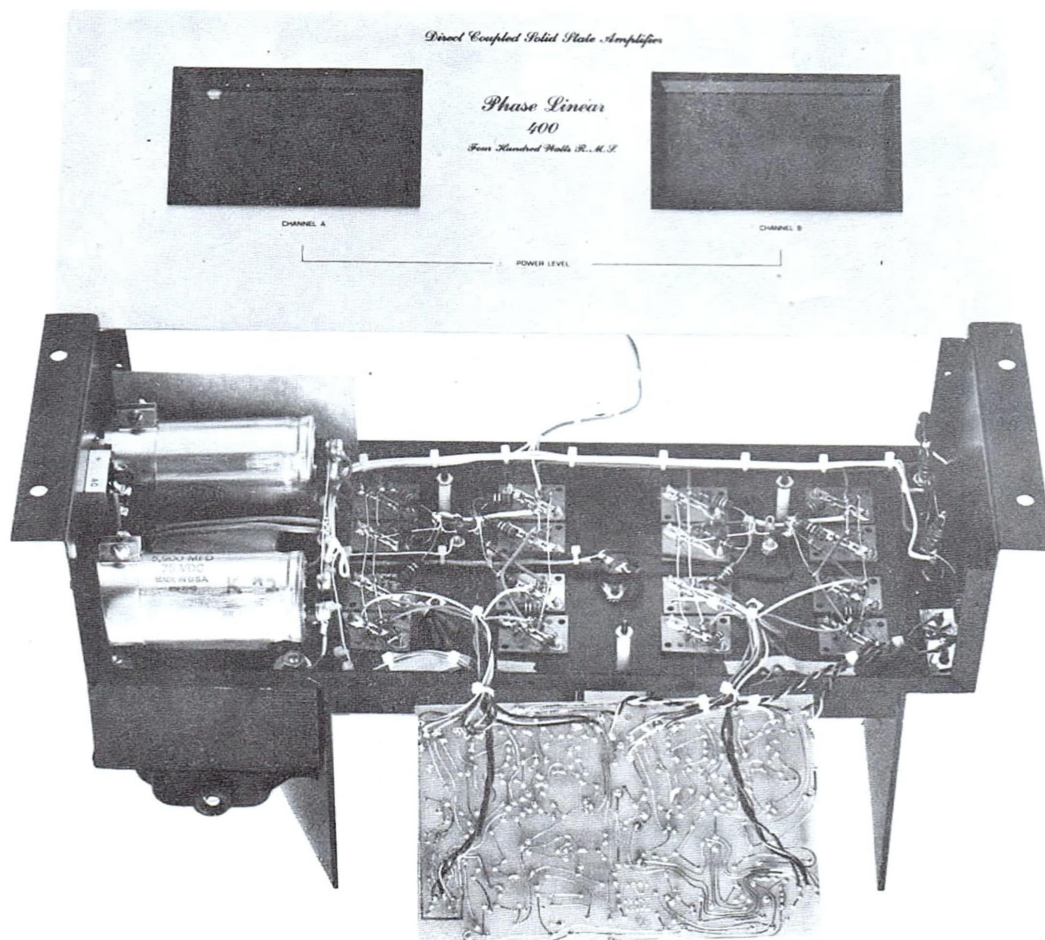


Figure 1

SECTION I

CIRCUIT DESCRIPTION

Input signal is applied to the base of Q_1 . The output of the differential pair comprised of Q_1 and Q_2 is applied to the base of Q_4 . Q_4 provides the final voltage gain to drive the predriver transistors Q_7 and Q_8 . The P.N.P. predriver Q_7 serves as a phase inverter to drive the negative output driver transistor Q_{13} . The emitter of Q_{13} drives the paralleled emitter follower output transistors Q_{14} , Q_{15} , and Q_{16} . The positive half of the signal is amplified by emitter follower Q_8 which in turn drives the paralleled outputs Q_9 , Q_{10} , and Q_{12} .

Forward bias is generated by bias regulator transistor Q_3 . R_{14} adjusts the slight amount of forward bias necessary to provide a few milliamps of idling current in the driver transistors. This prevents cross-over distortion.

The protection circuit consists of Q_5 , Q_6 , and their associated R-C and diode networks. If the output current flowing through R_{25} and R_{36} becomes dangerously large, capacitors C_{12} and C_{13} acquire a voltage through R_{23} and R_{35} to cause Q_5 and Q_6 to turn on. Q_5 and Q_6 then cause D_8 and D_9 to also turn on. Drive current is then shunted through D_6 and Q_5 around the predriver Q_8 , preventing an uncontrolled increase in output current. This prevents Q_9 from driving the load. D_{12} and D_{13} are flyback diodes which prevent overvoltage from appearing across the output transistors in the event an inductive load is switched. S_1 is a switch thermally attached to the heat sinks. It removes power if the heat sinks become too hot to touch.

SECTION II

ALIGNMENT

The following adjustment is necessary only for critical laboratory applications.

Step #1. Using a voltmeter, adjust the offset controls so that the meter indicates 0 (zero) volts at the speaker terminals between hot and ground. Adjust as follows: Adjust R_8 offset for 0 (zero) volts. This completes offset adjustments.

BIAS

The bias control is present at the factory and should not be adjusted or rotated needlessly. Adjustment is only required if it is rotated accidentally or if bias transistor Q_3 is replaced.

Step #1. Locate test point TP_1 on the circuit board. Connect a voltmeter positive lead to TP_1 (negative end of C_6) and the negative lead to the hot (red or white) speaker output terminal.

Step #2. Allow at least 5 minutes warmup! This is extremely important and cannot be overemphasized. Remove all input and output connections (no load), and have level controls fully counterclockwise. Adjust bias control to read 0.35 volts. This completes alignment.

SECTION III

TROUBLESHOOTING

Symptom: Blows output fuses.

If the output fuses blow immediately and repeatedly, one or more output transistors may have shorted. Generally, when one output transistor fails, it causes at least one other to fail. If a determination has been made that one or more output transistors has shorted, the following method is recommended to specifically locate the defective unit/units among the group of eight and to get the amplifier back into operation.

Step #1. Set up the amplifier on the test bench as shown in figure #1. The heat sink closest to the power transformer holds the left channel output transistors. Use a V.T.V.M. (RCA Volt-Ohmyst or equivalent) on the resistance R_{x1} range. Connect the negative lead to the collector bus wire of the suspected bank of output devices. Starting with the top transistor, measure the resistance at its emitter with the positive lead. If that transistor, or any in that bank of transistors is shorted, the meter will indicate a fraction of an ohm. If the transistors are good, the meter will indicate a high resistance circuit. If the meter indicates a fraction of an ohm, note the resistance and proceed from emitter to emitter, testing in turn each device. The meter will indicate a fraction of an ohm on each emitter because the transistors are connected in parallel through their emitter transistors. However, when the defective one is tested,

the meter will indicate slightly less than it did on tests of the good transistors. That is the clue which determines the defective device within its group of six. Typically, the meter will indicate .4 ohms on the good devices and .1 ohm on the defective one. Occasionally it will indicate 1 or 2 ohms on the good ones and .6 ohms or 1.6 ohms (.4 ohms less) on the defective one. This requires reading the meter with care to spot this small differential. If a high reading of 5 ohms or more is obtained, suspect that the driver transistor is shorted.

Step #2. Using an ordinary pair of pliers, grasp the defective device by its top hat and pull it out of its socket. Reverse the procedure to install the replacement.

Step #3. After the defective transistors have been replaced, check the driver transistors (the very bottom ones on each heat sink). If the drivers are good, the chances are 98% that the amplifier will perform normally if the above steps have been followed.

If the drivers are defective, some parts on the board may have to be replaced. (See step #4).

Step #4. To service the board, proceed as follows: Remove the phillips screws that secure the top and bottom plates. Place the amplifier flat on its back, with the front panel facing up. Remove the four bolts that secure the front panel. Do not use a wrench on the front panel or scratches will occur. Hold the bolts on the front panel with thumb and index finger, and remove the nut from the back of the panel with a nut driver or wrench. The front panel will lift off and fold over towards the back of the amplifier. It will then rest on the bench along one edge, held by cable bundles. Remove the four nuts holding the circuit board and "fold" the board out, away from the chassis, using its cable harnesses as hinges. This allows access to the front and back of the board. When the board is in the folded out position, it should be rested on a small support of some kind to relieve tension on the cable harnesses.

Step #5. If even one of the devices is found to be defective, you may prefer to replace Q₄, Q₅, Q₆, Q₇, Q₈, D₃, D₄, D₆, D₇, D₈, and D₉ on the circuit board. Not all of these parts will be defective, but they are inexpensive, and it may be easier to replace them all than to spend time checking and pondering which should not be replaced.

If Q₄ is found to be defective, diodes D₃ and D₄ will also be defective. Be certain that the protection circuit, consisting of Q₅, Q₆, D₆, and D₇ is good. If the unit is returned to the customer without checking these devices, the amplifier will certainly fail the first time someone shorts the speaker leads together.

Step #6. The final test is the short circuit test. Plug the amplifier A.C. line cord into a variac. Set the variac to 0 volts. Short circuit the output terminals with a jumper, and drive the input of the amplifier at 20 Hz. Slowly increase the variac from 0 (zero) volts to 117 volts. Remove the short circuit jumper and verify that the amplifier resumes normal operation.

CLEANING THE AMPLIFIER

Full strength sudsey ammonia soaked on paper towels should be used to clean the front panel occasionally. This removes dirt and oily films and will restore the original luster of the front panel.

SECTION IV

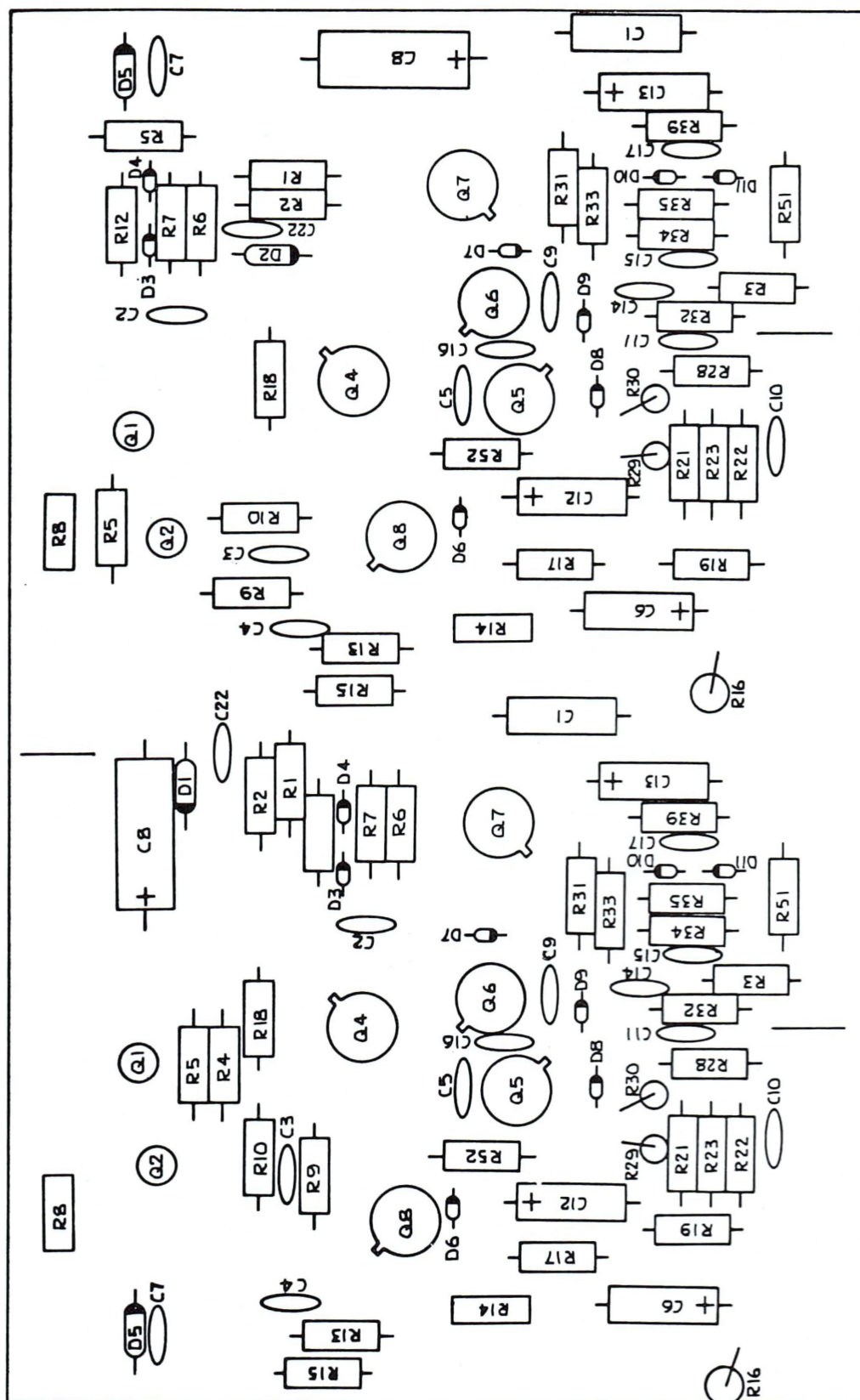
SERVICE HINTS

Analysis of amplifier service problems over the past two years has resulted in the following table of amplifier failure modes.

Typical repair problems: (In order of decending frequency of occurance.)

- 1.) Simple open fuse.
- 2.) Stuck or sticking V.U. meters. Burned out lamps.
- 3.) Bad solder connections on circuit board.
- 4.) Shorted out transistors.
- 5.) Defective zener diode on the circuit board.
- 6.) Defective transistors on circuit board.
- 7.) Shorted power rectifier.
- 8.) Mechanical failure of fuse holder.
- 9.) Open electrolytic capacitors.
- 10.) No known resistor failures.
No known mylar capacitor failures.

PHASE LINEAR 400
PCB ASSEMBLY



SECTION V

PARTS LIST

DESCRIPTION	PHASE LINEAR PARTS NUMBER	ORIGINAL MFR'S NUMBER	ORIGINAL MANUFACTURER
5900MF/85V	070-0119-0	Same	Sangamo
POWER TRANSFORMER 120V	050-0333-0	Same	Phase Linear
" " 240V	050-0334-0	Same	Phase Linear
4½" VU METER	030-0234-0	73T	Jewell
METER BEZEL	010-0235-0	Same	Phase Linear
BINDING POST			
RED	100-0076-0	111-0103-001	E.F. Johnson
WHITE	100-0075-0	111-0103-001	E.F. Johnson
BLACK	100-0077-0	111-0103-001	E.F. Johnson
THERMAL CUTOUT	100-0083-0	2455-087-090	Elmwood Sensor
DIODES			
IN4752	060-0109-0	IN4752	
IN4148	060-0055-0	IN4148	
IN4004	060-0056-0	IN4004	
BRIDGE RECTIFIER	060-0054-0	S25A20	Sensitron
	060-0054-0	MDA990-3	Motorola
TRANSISTORS			
PL909 (XPL909) (PL909A)	060-0085-0		Phase Linear
RCA410	060-0086-0	RCA410	RCA
MM4003 (RCA5415)	060-0061-0	MM4003	Motorola
RCA40327 (FPN60994)	060-0062-0	RCA40327	RCA
MPS5172	060-0066-0	MPS5172	Motorola
TIS93 (TIS93M)	060-0064-0	TIS93	T.I.
2N5401 (2N5400)	060-0067-0	2N5401	Motorola
2N1304 (40396N)	060-0059-0	2N1304	T.I.

SECTION VI

400 BOARD HISTORY

R5 47K
R9 1.5 Meg
R10 22K
R14 Trim pot---1k older amps and 250 Ohm in newer amps.
R15 1K before December 1972---820 Ohm since.
R13 2.2K to 3.9K resistor.value changes as needed.
R37 120hm-1 watt
R38 120hm--1 watt

Q3 5172 or 2N3403--Heat sink mounted.
Q9 Q13 Output driver--SJ2741, MJ1800, RCA410.
Output device--PL909, PL909A, XPL909.

METERS

PHASE LINEAR NOW USES JEWELL METERS. IN THE PAST, THE 400 UNIT USED ARGONNE METERS AND THESE ARE NOT INTERCHANGEABLE WITH THE JEWELL. THE TECHNIQUES USED TO LIGHT THE METERS HAVE BEEN CHANGED TO IMPROVE THE LIGHTING. IF YOU WISH TO REPLACE A METER, RETURN THE OLD METER TO THE FACTORY AND A NEW METER WILL BE SENT BY AIR THE SAME DAY.

NOTES

If you should have any questions, please contact:

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