'01' SERIES

DUAL HIGH RESOLUTION™ POWER AMPLIFIER

SAE
Scientific Audio Electronics, Inc.

SERVICE MANUAL

2401 SERVICE MANUAL

INTRODUCTION

This manual provides all technical information required for the 2401 Power Amplifier. Sections 2 and 3 are intended as the basis of the service guide for this product. Any questions or addendums should be referred to the SAE Engineering or Technical Services Departments.

SECTION 1

CIRCUIT DESCRIPTION AND SCHEMATICS

- CONTENTS -

2401 CIRCUIT DESCRIPTION

GENERAL DESCRIPTION

The 2401 Power Amplifier is a true fully complementary symmetric audio power amplifier employing high current output stages. The amplifier utilizes both wide and restricted frequency input options, modular construction, and independent power supply rectification and filtering for each channel. Protection is provided for overload on either the input or output as well as DC output and turn on and off isolation via a high current relay. The 2401 is a convection cooled heat sink system employing the SAE Turbo-flow system.

GAIN MODULE

The Gain Module provides all the voltage gain and drive for the amplification stage. Input signal is coupled to the amplifier via J1. Capacitor C1 restricts the low end input with a 6dB per octave passive filter set at a roll-off point of 21Hz. R3 and C36 limit the high end response with a 6dB per octave roll-off at 800kHz. Capacitors C2 and C3 couple the input signal to the input differential transistors Q1 and Q2 whose A side bases are biased via resistors R4 and R6. The emitter of Q1 and Q2 are current sourced through R7 and R8 from the floating constant voltage source made up of R9 and R11, 51 volt zener CR3 and filter C4. Transistors Q3 and Q4 shift the audio signal's DC component to correctly bias the emitter followers Q5 and Q6. Q5 and Q6 then provide low impedance drive to the final gain stage devices Q7 and Q8 which are coupled to the output stage at pins 3,4,and 11,12.

Two feedback paths are provided from the output board to Q1 and Q2. The DC path is 100% feedback via R14 and R15 with DC blocking provided by C7 and C8. The AC gain setting feedback is via the resistor divider network R5 and R65 coupled to the bases of Q1 and Q2 inverting inputs through C7 and C8. The Gain Module provides 3 protection methods to handle a variety of input and output conditions. First diodes CR1 and CR2 provide input overload protection by preventing the inverting and non-inverting inputs from getting more than .6 volts apart at any time. Secondly, diodes CR4 and CR5 prevent reverse bias of Q7 and Q8 when the output is shorted. Finally, transistors Q9 and Q10 through their respective networks of CR6, CR8, R21, R22, R23, C15, and C17 along with CR7, CR9, R25, R26, R27, C18 and C16 will clamp the drive to the output stage when excessive current passes through the output transistors. In this process the voltage appearing across R35 and R46 will cause clamping of the positive or negative waveform respectively.

OUTPUT MODULE

The Output Module contains the driver and output devices along with the thermal tracking bias network, output network and reverse inductive spike protection.

Transistors Q11 and Q12 provide low impedance drive to the output transistors Q13 and Q24 respectively. The constant voltage bias network of Q25, R30, R32, C21 and C36 provide thermal tracking bias for the output stage and is adjusted via R31. Diodes CR14 and CR15 clamp the output to the power supply when an excessive inductive spike voltage appears on the output. The Zobell network of L1, R58, R59, and C24 provides feedback stability into capacitive loads at high frequencies.

RELAY PROTECTION MODULE

Output from the Output Module is passed through the Relay Protection Module to the output jacks on the back of the amplifier. The relays K1 and K2 are passed by C33 and C34 to eliminate high frequency contact distortion. Transistors Q25, Q26, Q27 and Q28 form a positive and negative comparator whose input filter C27, C28, C30 , R60 is coupled to the two inputs via R65 and R66. This filter eliminates all AC signals from the sense line and opens K1 and K2 when DC is present on the output. R63 and C31 provide delay for turn on as a back up to DC sensing to eliminate turn on thumps.

POWER SUPPLY

The primary side of the power supply employs S1 and S2 thermal switches which are attached to the Output Modules to provide over temperature shut down. Separate rectification bridges BR1 and BR2 along with respective capacitors C36, C37, C38 and C39 constitute isolated power supplies for CHA and CHB. An isolated power supply (CR12, CR13 and C35) for the LED display is powered from the power transformer T1 and physically located on the upper forward end of the channel A Output Module.

DISPLAY MODULE

The Display Module consists of 14 comparators for each channel in a ladder array. Resistors R83 and R96 provide stepped reference voltage established by diodes CR32 through CR37. The input signal is rectified and filtered by CR31 with R80, R97, C41 and C43. R30 and R113 set the scaling for the display.

2401 POWER AMPLIFIER SPECIFICATIONS

(As per IHF Standard Methods of Measurement)

(-1979-)

(Both channels driven)

1. CONTINUOUS AVERAGE POWER OUTPUT (C.A.P.O. is the minimum power available over the rated frequency range of 20Hz to 20kHz at less than a specified distortion level IHF 3.1).

LOAD	C.A.P.O.	DISTORTION
8 Ohms	250	0.025 THD
4 Ohms	375	0.025 THD

2. DYNAMIC HEADROOM is the ratio between the Continuous Average Power Output and the maximum power output before clipping (about 3% THD) at a frequency of 1KHz and is 1dB (IHF 3.2.3.).

3. FREQUENCY RESPONSE is the change in output vs. the change in frequency with a 1KHz frequency used as an "0" dB reference point and is the rated frequency range noted in Specification 1. (IHF 3.13.1). +0, -0.5dB, 20Hz to 20KHz for 250 watts onto 8 Ohms.

4. SENSITIVITY is the input voltage level at 1KHz required to produce an output of 1 watt into 8 Ohms (2.83 V.R.M.S.) which is 0.15 Volts R.M.S for a unit gain of 25.5dB (IHF 3.7).

5. "A" WEIGHTED SIGNAL TO NOISE RATIO is the ratio between a 1 watt into 8 Ohms (2.83 Volts R.M.S.) output and the output available with the input shorted with a 1 K-Ohms resistor when weighted with a standard "A" type filter and is 110dB (IHF 3.12.2.).

6. OUTPUT IMPEDANCE is the highest output impedance value over the rated frequency response range of 20Hz to 20KHz. The output impedance is measured as follows:

$$\text{Output Impedance} = \frac{E \text{ (switch open)}}{E \text{ (switch closed)}} - 1$$

The greatest output impedance is 0.12 Ohms at 20KHz (IHF 3.10.5).

7. WIDE BAND DAMPING FACTOR is the ratio between a 8 Ohm load impedance and the rated Output Impedance and is 66.6 at 20KHz (IHF 3.11.1.).

8. LOW FREQUENCY DAMPING FACTOR is the ratio of an 8 Ohm load impedance and the 50Hz output impedance of 0.114 Ohms and is 70 (IHF 3.11.2.).

9. FILTER CUTOFF FREQUENCY is the 3dB down points of the user adjustable filter and is 20Hz for the high pass (low end cutoff). (IHF 3.13.2.2.1.).

10. FILTER SLOPE is the filter slope rate beyond the 3dB down points of specification 9 and is 6dB per octave for the high pass (low-end roll-off) (IHF 3.13.2.2.2.).

11. CROSS TALK is the ratio of the worst cross channel leakage over a range of 100Hz to 10KHz and is 72dB at 10KHz (IHF 3.14.1.).

12. S.M.P.T.E. INTERMODULATION DISTORTION is the distortion resulting from the amplification of a signal consisting of a 4 to 1 mixture of 60Hz and 7KHz and is 0.025% for an output of 250 watts into an 8 Ohm load (IHF 1.18 and 3.15.4.).

13. TRANSIENT OVERLOAD RECOVERY TIME is the time required for the amplifier to recover from a 10dB overload of a 1KHz signal for 20 msec and is 1.5 micro-seconds (IHF 3.18.).

SECTION 2

SERVICE INFORMATION

CONTENTS

SECTION 2 EQUIPMENT AND SET UP

A- GENERAL CONSIDERATIONS

The entire "01" Series of SAE amplifiers has the characteristics of both low distortion and wide band-width. These qualities require the use of precision test equipment and good connections. SHOULD EITHER OF THESE CONDITIONS NOT BE MET, SERVICE SHOULD NOT BE ATTEMPTED.

The most practical path to servicing these products is outlined in this manual. The technician is advised to read this manual and the appropriate section before attempting to service the unit.

B- EQUIPMENT

Servicing the "01" Series will require the following equipment. We have included recommended manufacturers and models for each where appropriate.

1. Distortion Meter - Accurate to 0.002% Total Harmonic Distortion (residual) with an input capability to 100 Volts R.M.S. and a frequency range of 10Hz to 100KHz (Sound Tech 1701A and Hewlett Packard 339A).

2. Audio Generator - Less than 0.002% residual Total Harmonic Distortion from 20Hz to 20KHz and a 3 volt R.M.S. output capability (included in the Sound Tech 1701A and Hewlett Packard 330A).

3. Ocilliscope - 30 millivolt vertical sensitivity, trigged sweep, and 10MHz bandwidth.

4. - Volt Meter - Greater than 20K Ohm per volt input impedance with a sensitivity of at least 2 millivolts for both AC and DC. AC frequency response of at least 200KHz. (included in Sound Tech 1701A and Hewlett Packard 339A).

5. Load - A two channel system of 8 Ohm non-inductive, resistive loads capable of dissipating 250 watts each. This load should be interfaced to the amplifier with at least #14 wire and terminated with standard MDP (dual banana) connectors.

6. Tools - Screwdriver - Phillips #2 (preferably pneumatic or electric); Soldering Iron (35-70 watt), Solder wick or sucker, Diagonal cutters, Pliers.

7. Line Controller - 0 to 120 Volt, 25 amp, variable auto transformer (variac) (All IHF performance specifications require a 120 Volt power line source) (Staco, General Radio, General Electric, Superior Electric, etc.)

C - SET UP

Performance testing of the "01" Series will require FIRST CLASS grounding and load connections. Secure all test equipment grounds as well as the amplifier output grounds through a heavy (#12) buss. Take the test output from the amplifier at the dual banana (MDP) connection on the amplifier, not from the load. (See Diagram I A&B)

TROUBLE SHOOTING WITHOUT OPENING THE UNIT

With all due respect to the customer, many amplifier problems are the result of "operator error". Any amplifier should be powered up without opening the unit for an initial examination. We suggest the following:

1) Check the fuse - replace it if needed. Fuse failure can occur from other than amplifier failure. It is not unrealistic to assume that it may be a defective fuse and nothing else.

2) With the fuse operational, place a 100 watt light bulb in the power line (in series) and slowly bring up the line voltage to the amplifier without load or input. Upon power-up the bulb will glow brightly and then;

A - It may continue to glow brightly - this means something is shorted and the unit will have to be opened.

B - It may dim to a dull glow - This indicates that no short exists in the power supply and that most likely the outputs are O.K. The bright period was due to inrush current charging the capacitors. Within 15 seconds of the lamp dulling a distinct relay click should be heard. This closure of the speaker relay indicated that all DC conditions in the amplifier are alright. Failure of this relay closure means either DC offset beyond the normal level or possibly oscillation.

DISASSEMBLY

Disassembly of the 2401 is as follows - use a pneumatic or electric #2 Phillips screwdriver and:

1. Remove the 16 screws from end panel on the side of the amplifier suspected as defective. Full access to the power supply can be obtained via either end bell. Each bell has:
   2 top screws, 2 bottom screws, 3 rear screws and 9 end screws
2. Remove the 2 top screws and 2 upper rear screws of the end bell that remains on the unit.
3. Remove all 22 screws on the top cover and slide the cover to the side and remove.

REMOVING THE GAIN MODULE

1 - Using a #2 Phillips screwdriver, remove the screws around the input sockets on the channel to be serviced.
2 - Unsolder the ground wire from the Gain Module to its termination at the chassis ground lug next to the input sockets.
3 - Work the board off the pins by shallow rocking and pulling of the board to the open side.
4 - Lift the board vertically, tilt the top to the rear of the amplifier and pull free.

REMOVING THE POWER MODULE

After removing the Gain Module.

1 - Place the unit on its side with the Power Module to be removed facing up.
2 - Remove the 6 Phillips screws securing the Power Module to the bottom of the chassis.
3 - Lay the amplifier back down on its bottom.
4 - Apply a steady gentle pull to the rear portion of the heat sink in an outward direction. It may be necessary to

gently rock the sink as you pull on it. As you pull it free note the red and grey leads soldered to the main board. These leads are long enough to allow service to the module without being unsoldered.

REMOVING THE POWER AND RELAY MODULE

In the rare case of the need to remove the Power Supply and Relay Module do the following:

1. Remove both end bells and the top of the amplifier.
2. Remove both Gain Modules.
3. Remove both Output Modules.
4. Remove the exposed nut on the output jacks.
5. Remove the 2 #10 machine screws securing the bridge rectifiers.
6. Remove the 4 #6 screws securing the Copper ground plate from the bottom of the amplifier.

REMOVING THE DISPLAY MODULE

1. Remove an end bell and the top of the chassis.
2. Remove the 3 forward most Phillips screws from the remaining end bell.
3. Remove the 3 Phillips screws along the forward most edge of the bottom of the amplifier.
4. Remove the 2 Phillips screws from the display board at the end with all the wire connections.
5. Remove the single Phillips screw from the display board at the end displaying maximum power.

REMOVING THE POWER SWITCH

1. Remove the front plate with display as noted in "removing the Display Module" steps 1 to 3.
2. Remove the 1/8" Allen head screws afixing the handles to the face plate and overlay from the sub-chassis side.

REMOVING AN OUTPUT TRANSISTOR

1. Once the defective output transistor has been located remove the two Phillips screws from the cover over it.
2. Remove the 2 Phillips screws from the output transistor and use either the SAE transistor extractor tool or long nose pliers to reach down into the Turbo-Flow heat sink and pull the transistor free. Do not use a screwdriver to pry the transistor loose - this will scar the heat sink and insulator.
3. Be careful to clean the power transistor pad and recoat with thermal transfer compound. Watch out for metal chips, dust or debris when replacing the device.

D - BIAS AND OTHER ADJUSTMENTS

The 2401 employs 2 bias networks, one fixed and the other variable.

1. Fixed bias - The quiescent current through the final voltage gain stage Q7 and Q8 is biased via a factory selected Resistor R16. This resister is chosen to cause a DC voltage drop of 900 mv across R18 or R20. This will yield a quiescent current of 14ma through Q7 and Q8. This resistor will not need an alteration under most repair situations. If any of Q1 through Q8 are replaced the voltage drop across R18 or R20 should be checked to be within 20% of 900 mv.
2. Variable Output Bias - Once all service has been performed on the 2401 and the amplifier module has been re-installed in the unit the following technique should be employed to set the final output bias.

A - Set up the unit for distortion measurement.
B - Pre-heat the unit to a warm state by running at 40% power (25 volts into 8 Ohms) at 20KHz for 4 to 5 minutes.

3. Reduce power level to 1 watt (2.83 volts across an 8 Ohm load) at 20KHz.
4. Set bias control located on the component side of the output module next to the plug-in to the Gain Module to yield no less than 0.02% THD. This typically will cause a 1.5mv drop across any output emitter resistor (R25, R26, R27, or R28) and indicates an idle current of 4ma per output.
5. Remove signal and let unit idle. The temperature of the heat sink should drop and be just perceptably warm or at room temperature. Failure to achieve this state would indicate:

A - Bias too high - Strong possibility that non-linear drivers or outputs require too much bias - check low signal gain of driver or output with curve tracer or by substitution.
B - The amplifier is still processing signal or oscillating at a very high frequency. Attach oscilliscope to the emitter of any output transistor rather than the amplifier output. The Zobell network will mask an internal oscillation so the output examination should be before the network.

TROUBLE SHOOTING NOTES

The Output Transistors - Here is a way of assessing the state of the Output Module that is rather straight forward and is greatly expedited by using a light bulb in series with the power line. It goes like this:

1. Remove the Gain Module of the channel in question.
2. Remove the Output Module and tilt the Module card up. The power leads are still attached.
3. With a jumper with clips, jump ground (18) pin on the Output Module to a ground point such as the Copper Power Supply Bracket.
4. Power up the amplifier with a 100 watt light bulb in series in the power line. If there is a shorted Output or driver the lamp will glow brightly.
5. If it glows, proceed as follows:

A-Measure the voltage between pin 1 and pin 3. This is the C-B voltage of the positive driver. If it is within 1 volt of the rail (B+) voltage it is most likely shorted and in need of replacement. The same applies for pin 13 and pin 11 on the negative half.

B-Once the drivers are known to be good, measure the drop across the emitter resistor R35 through R56. Replace any transistor that is leaking or is shorted. Once all shorted driver or output transistors have been replaced, the lamp in the power line will dim and the rails (B+ and B-) will come up in voltage. Turn off the unit and jump the output capacitors with a 100 Ohm, 10 watt resistor for a few seconds to dump the rail voltages.

C-Now plug the Output Module back into the power

supply and Relay Module. After turn on, the bulb should dim and power should be shut off and the rail voltages dumped. If the bulb remains on, repeat steps 5a and 5b.

THE GAIN MODULE

Attach the Gain Module to the unit, and with the lamp still in series with the power line, power up the unit. If the lamp dims, then remove the lamp with reasonable assurance the amplifier is DC stable. Test audio performance and continue from there.

If the lamp glows there is probably a short in a driver, level shifter or differential pair. It is also possible that the amplifier is oscillating. In either event, the test is a scope probe to an output emitter resistor. A DC offset to one rail would indicate which side is shorted. An open transistor will probably DC stabilize but may not pass signal. Oscillation will be obvious.

Should any questions arise, call the SAE Customer Service Department, (213) 489-7600.

CLIPPING

Clipping in the 2401 is symmetric and as such, a diagnostic tool. Asymmetric clipping, especially at high frequencies indicates a loss of gain and ft in one side of the amplifier. Try a 4 Ohm load. An increase in asymmetry would imply an open or low gain output. If the asymmetry is similar, the problem may be in the Gain Module.

DISTORTION

Examine the monitor output of your distortion set. What you see is the difference between the input and output scaled to each other. Superimpose the output over this trace and the non-linearity of the positive and negative halves of the amplifier may be observed. Consider this a picture of what the symmetric amplifiers are doing.

RELAY

The relay will close only when a successful DC power up is accomplished. Listen for the sound of the relay closing as a clue to internal DC conditions. Off-set greater than 600 mv will cause the relay to open.

TROUBLE SHOOTING

PROBLEM	CHECK
General	A. Check all resistors for possible burnt or overheated condition which may have already altered the valve. Examine electrolytics for bulges or shape damage. View the board with an eye for variations in color on both sides. Watch for solder errors and connector integrity.

TROUBLE SHOOTING, CONT'.

PROBLEM	CHECK
Protection Relay Cycles on and off	A. Check at output emitter resistors for ocillation. B. Check for DC offset at output transistors. C. Check Relay Circuit
No delay at output	A. Check for shorted relay contacts. B. Check relay circuit
Relay fails to close	Check for offset at output. Check for shorted or open outputs or drivers. 0 volts at output emitters means a failure in the relay circuit.
Excess Heat	A. Bias too high B. Oscillation - Scope probe to output emitters.
Asymmetric Clipping	Open output transistor or open output emitter resistor on orror side. (+ for NPN's, - for PNP's)
Asymmetric Slewing or distortion	Q1 or Q2
High distortion	Bias through Q1 and Q2 (2.3ma) or Q7 and Q8 (14 ma)
Intermittant output	Check relay, check board interconnects and check input connector.
Full DC at outputs	Both the relay circuit and the output have failed.

FLOW CHART FOR AMPLIFIER EXAMINATION

OBSERVE — Power to amplifier with light bulb in line.

WATCH BULB → BULB → glows → Short in amplifier open unit up*

BULB → glows then dulls

LISTEN FOR RELAY CLICK 5-15 SEC. → RELAY → fails to close → DC on output or oscillation, open unit up*

RELAY → closes

attach load

WATCH BULB → BULB → glows without input signal → Short---------- open unit up*

BULB → bulb remains dim

apply low level input signal

WATCH BULB → BULB → remains dim as input is increased → Amplifier is DC OK AC not amplified open unit up*

BULB → blub glows with increased input

USE TEST EQUIPMENT → REMOVE BULB PERFORMANCE TEST UNIT → Fail specs- open unit up*

REMOVE BULB PERFORMANCE TEST UNIT → meets specs - return to customer

*Proceed to appropriate manual section.

RECOMMENDED TEST SET-UP

THD DIAGRAM

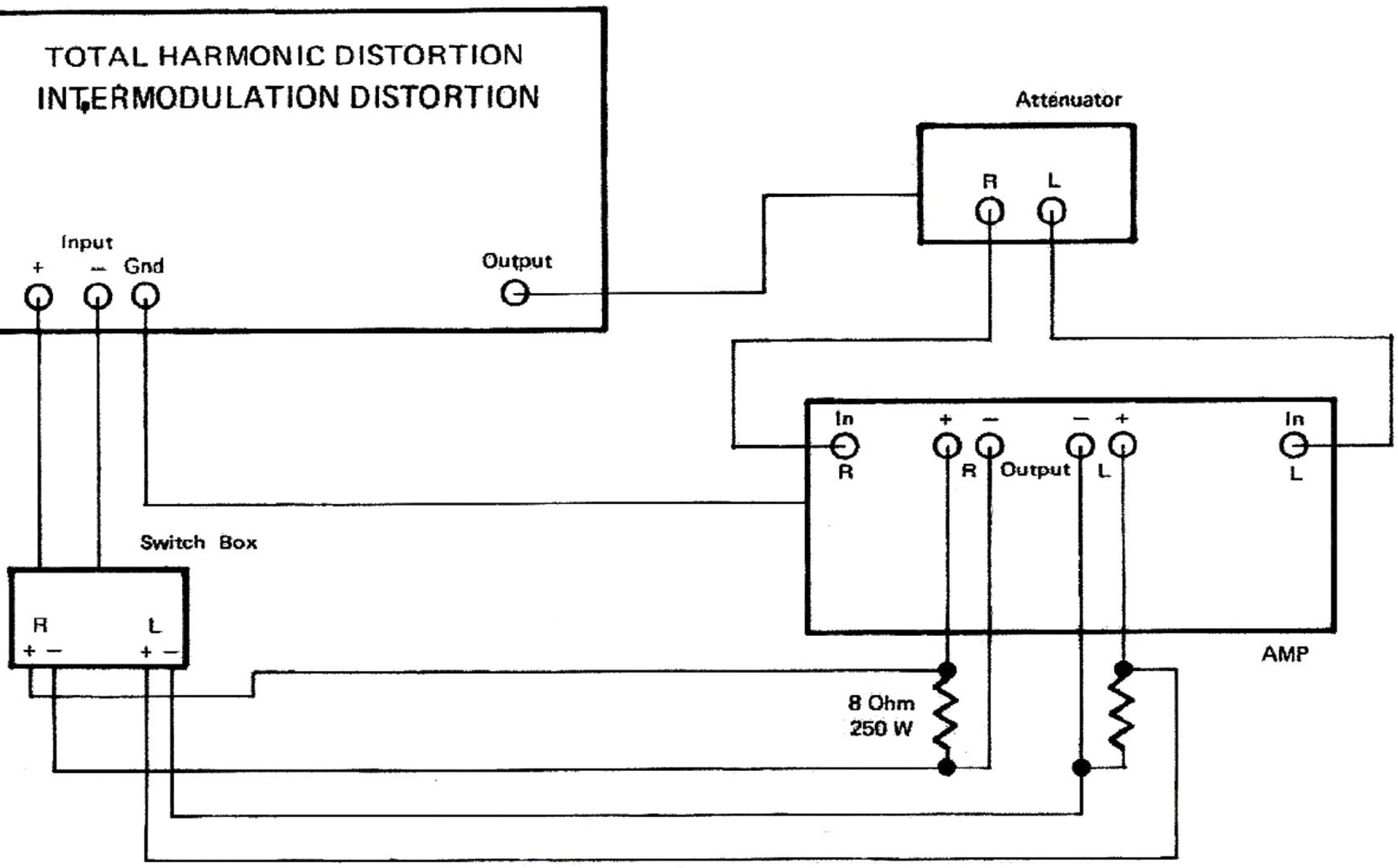


DIAGRAM 1-A TYPICAL SET-UP

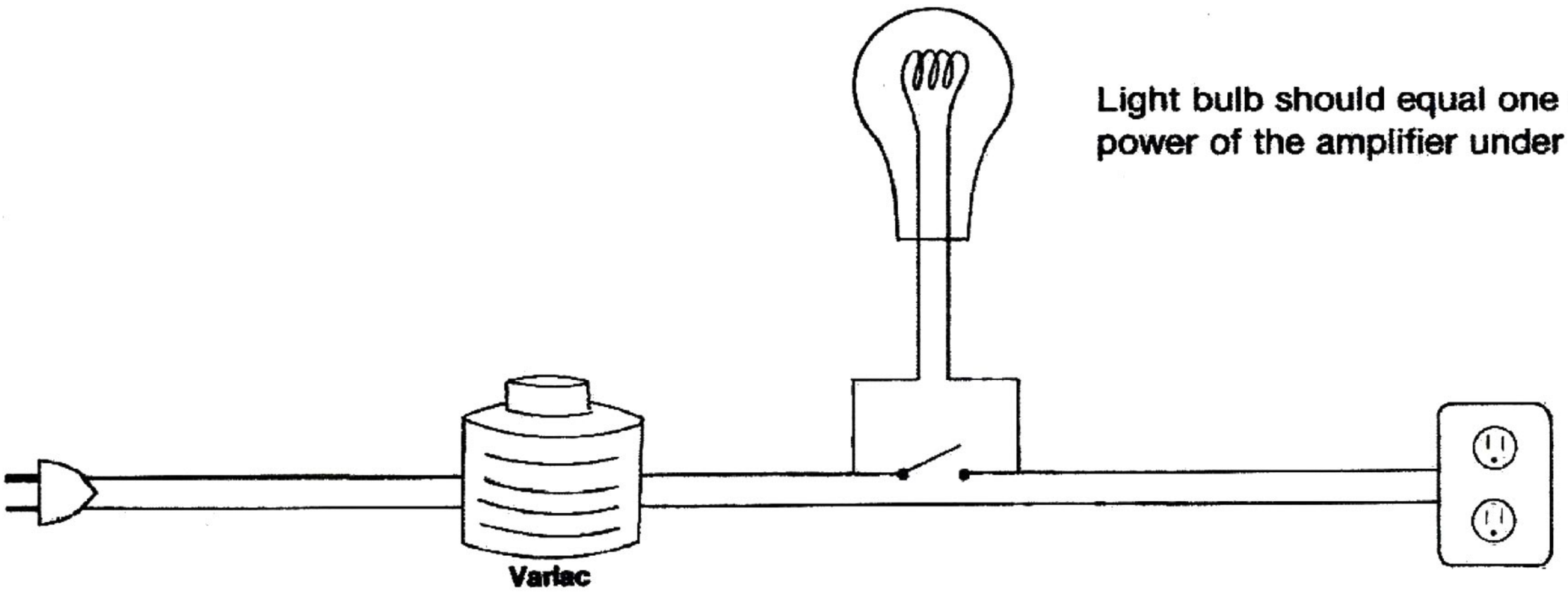
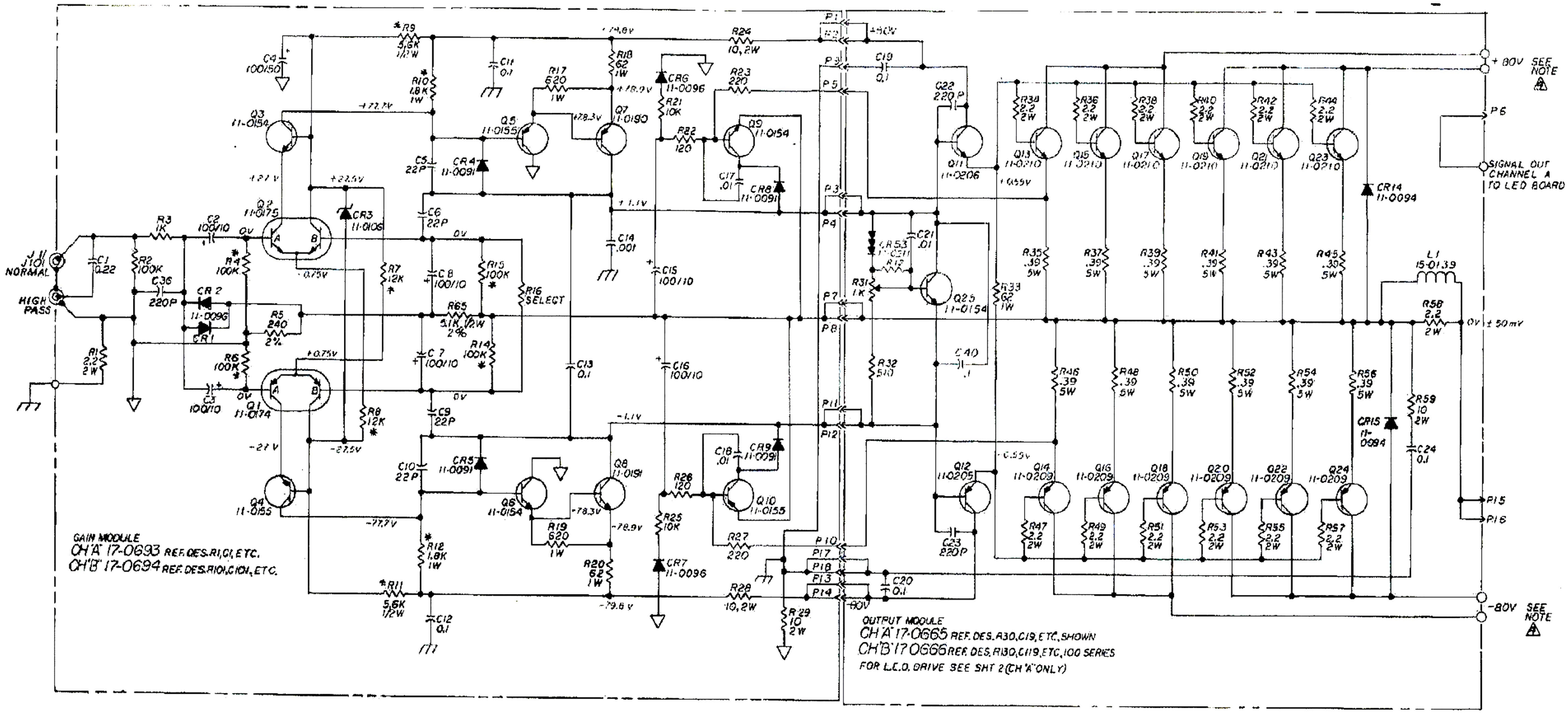
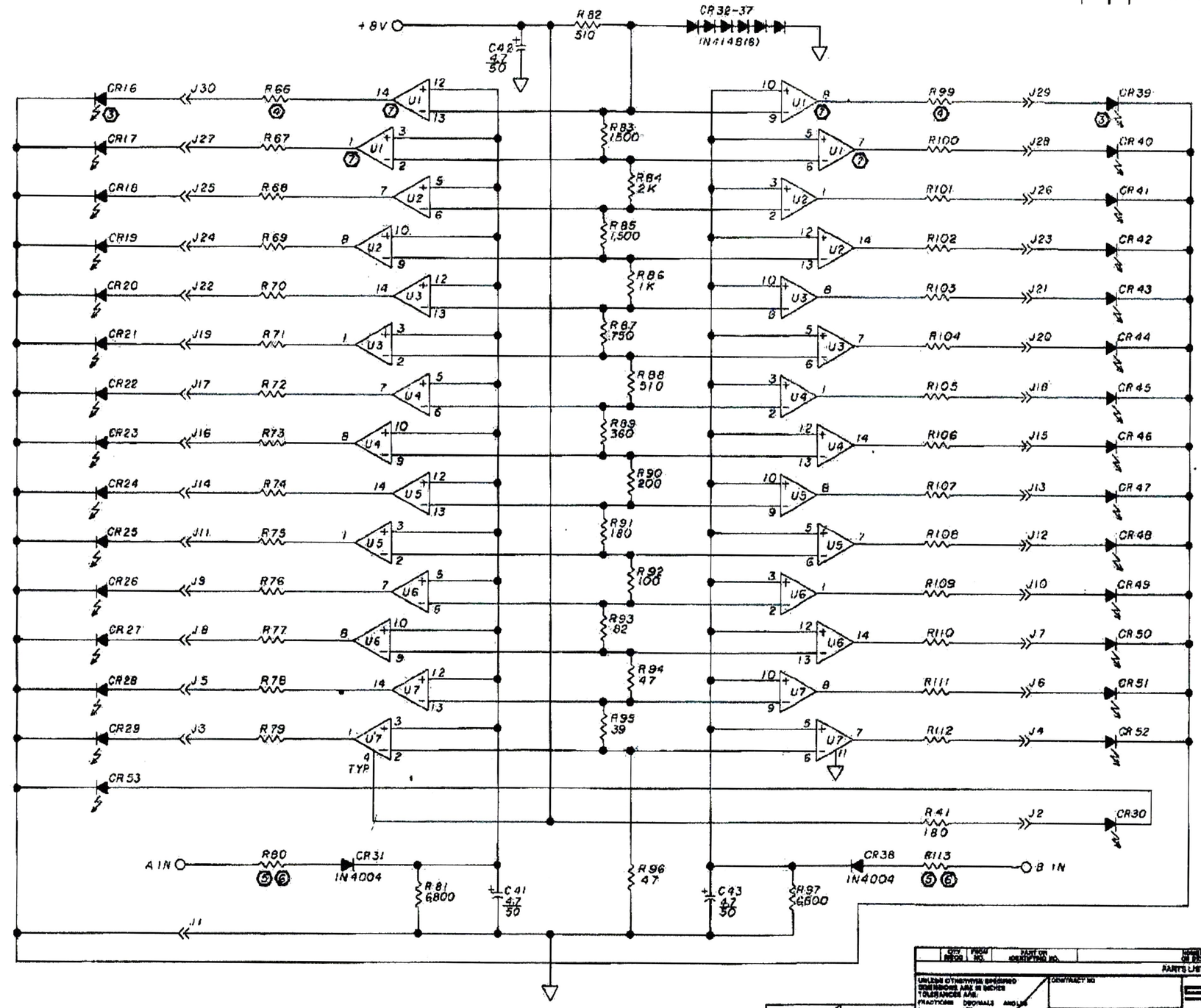


DIAGRAM 1-B MAIN POWER SET-UP



6. VOLTAGES ARE ± 10% AT 120V AC LINE VOLTAGE.
5. CHANNEL 'A' SHOWN, CHANNEL 'B' IDENTICAL.
4. OUTPUT TRANSISTORS ARE CONNECTED IN GROUPS OF THREE DIRECTLY TO THE APPROPRIATE PWR/SUP CAPACITORS VIA MAGA HARD WIRE BUSSING.
3. * = MATCHED RESISTORS
2. CAPACITOR VALUES IN MICROFARADS
1. RESISTOR VALUES IN OHMS, 1/4 WATT, 5%

NOTES: UNLESS OTHERWISE SPECIFIED



7. U1-U7=SAE 11-0163.
6. 33K FOR MODEL 2401.
5. 27K FOR MODEL 2301.
4. R66-79, 99-112=200 OHMS.
3. CR16-30, 39-53= SAE 16-0020.
2. CAPACITORS IN MICROFARADS.
1. RESISTORS IN OHMS, 1/4 W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED.

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED

PARTS LIST

NEXT ASSY	USED ON
	2401
	2301
APPLICATION	

DO NOT SCALE DRAWING

SAE SCIENTIFIC ACOUSTIC ELECTRONICS, INC. LOS ANGELES, CALIF.

SCHEMATIC, 2301, 2401, LED POWER DISPLAY

DRAWN	R. LIN	10-17-79
ISSUED		10-19-79

SIZE D | SHEET 1 OF 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

F1
10A-120V
5A-240V
SLO-BLO

C1
100°C
12-0052

P1
120 VAC
50/60 HZ

POWER SWITCH S2

T1
115-0119 (120)
115-0120 (240)

100°C
12-0052

RED 56.5V

BRN 0V

RED 56.5V

SEC
56.5 AC

TO POWER SUPPLY BOARD
-80
-80

BR1 (CH A)
2.5A
11-0085
+80

BR2 (CH B)
2.5A
11-0085
+80

LED DISPLAY
22-0208

YELLOW — SIG OUT CH A P6

ORANGE — SIG OUT CH B P106

CH A POWER MODULE
17-0665
SEE SHT 1

WHT 5.5V
CR12
11-0094(2)
CR13

WHT 5.5V

RED +8V

C35
1000
10V

GRN 0V

BLK GND

TO CH A MODULE SEE NOTE 4

TO RELAY BOARD CH A
B+ +80
B- -80

TO RELAY BOARD CH B
B+ +80
B- -80

+80
-80
+80
+80

C36 10,000 80V
C37 10,000 80V

C38 10,000 80V
C39 10,000 80V

+80
+80
TO CH B MODULE SEE NOTE 4
-80

17-0669

+80 -80 CH A POWER SUPPLY BR 3

+80 -80 CH B POWER SUPPLY BR 2

17-0700
RELAY BRD

Q25 11-0044
Q26 11-0117
Q27 11-0044
Q28 11-0191 +22.5V

R60 10K
R62 150
R61 100K
R63 100K
R64 680 2W

+2V
+19.5V

C27 4.7 50V
C28 4.7 50V
C29 100 10V
C30 100 10V
C31 220 16V

OUTPUT CH B +
P106
OUTPUT CH A +
P6

R65 100K
R66 100K

K1 12-0066
C33 0.1
K2 12-0066
C34 0.1

CR10 11-0094
+68.5V
C32 10 100V

CR11 11-0094

P17
P18
P115
P117
P113
P114
P101
P102
P13
P14
P1
P2

P15 P16 FROM CH A MODULE
P115 P116 FROM CH B MODULE

SEC 56.5 AC
B- -80 CH B
B+ +80
B- -80 CH A
B+ +80

NOTES SEE SHEET 1 OF 2.

PARTS LIST			
QTY REQD	ITEM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION / MATERIAL SPECIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO.	APPROVALS	DATE
MATERIAL		DRAWN R. LIN	10/9/75
FINISH		CHECKED	10/15/75
NEXT ASSY	USED ON	ISSUED	
APPLICATION	DO NOT SCALE DRAWING		

SAE SCIENTIFIC AUDIO ELECTRONICS, INC.

SCHEMATIC, 2401
POWER SUPPLY AND PROTECTION RELAYS

2401

SIZE D | FSCM NO | DWG NO | REV

SCALE | SHEET 2 OF 2

PART	ASSY	DESC	U/M	NS
22-0210		PC ASSY: DRIVE RIGHT CH (2401)		
01-XXXX		SELECTED VALUE 5% 1/4W CF		
01-0009-S		R: 240 OHM 2% 1/4W		
01-0021		R: 1K OHM 5% 1/4W CF		
01-0041		R: 10K OHM 5% 1/4W CF		
01-0041-M		R: 10K 1/4W 2% MATCHED		
01-0042-S		R: 12K OHM 2% 1/4W CF		
01-0059		R: 100K OHM 5% 1/4W CF		
01-0059-M		R: 100K OHM 5% 1/4W CF MATCH		
01-0098		R: 120 OHM 5% 1/4W MOF		
01-0108		R: 220 OHM 5% 1/4W MOF		
03-0020		R: 62 OHM 5% 1/2W MO		
03-0038		R: 620 OHM 5% 1/2W MO		
03-0047-M		R: 1800 OHM 2% 1/2W MO		
03-0115		R: 5.1K OHM 2% 1/2W MO		
03-0121-2		R: 5.6 KOHM 2% 1/2W CF		
04-0023		R: 10 OHM 5% 2W MO		
04-0064		R: 2.2 OHM 5% 2W MO		
07-0007		C: CER D 22 PF 10% 500V GP		
07-0014		C: CER D 200 PF 10% 500V GP		
07-0019		C: CER D .001 MF GMV 500V GP		
07-0023		C: CER D .01 MF +80-20% 100V		
08-0012-2		C: MY .22MF 50V 2% RA MLD		
08-0024		C: MY .1MF 50V 10% RA MLD		A
09-0027		C: EL 100 MF 10V RA		
09-0028		C: EL 100 MF 50V RA		
11-0091		DI: 200V 100MA 1N3070		A
11-0094		DI: 400V 1AMP 1N4004		
11-0096		DI: 100V 500 MW 1N4148		
11-0106		DI: 51V 5% 1/2W ZENER 1N5262B		
11-0154		TR: NPN SM SIGNAL MPSA06		
11-0155		TR: PNP SM SIGNAL MPSA56		
11-0174		TR: PNP 2SA798 DUAL MATCHED		
11-0175		TR: 2SC1583 DUAL MATCHED		
11-0190		TR: MATSUCHITA PNP 2SA913		
11-0191		TR: MATSUSHITA NPN 2SC1913		
17-0691		HEAT SINK: OR BD (2301, 2401)		
17-0694		PC BD: DRIVE RT CH (2301, 2401		
18-0122		INSULATOR: MICA DF103B		
18-0132		JACK: 2 POLE PC-MT, STHT PHONO		
18-0137		CONN:RT.AN.9PIN GOLD(MOLEX2144		
19-0040		SCREW #4X5/16" PHIL BLK OX		
19-0199		SCREW 4-40 X 3/8" PHIL NP		
19-0200		WASHER NYLON TR. MOUNT (3100)		
19-0205		NUT PRESS: S-440-2		
21-0024-02.5		#18 GA STRD BLK		
21-0178		#22 GA SLD PVC JUMPER .5" BLK		A
21-0207		#22 GA SLD PVC JUMPER .5" BL		

SLBT 22-0212 100 C

JAN 31 1980

PART	ASSY	DESC	U/M	NS
22-0212		SUB ASSY: PWR MOD RT CH (2401)		
01-0081		R: 510 OHM 5% 1/4 W MOF		
04-0023		R: 10 OHM 5% 2W MO		
04-0048		.39 OHM 10% 5W PW		
04-0064		R: 2.2 OHM 5% 2W MO		
04-0070		R: 62 OHM 5% 1W MO		A
06-0004		POT: 1K OHM PC SER BLK		
07-0014		C: CER D 200 PF 10% 500V GP		
07-0023		C: CER D .01 MF +80-20% 100V		
08-0024		C: MY .1MF 50V 10% RA MLD		A
11-0094		DI: 400V 1AMP 1N4004		
11-0154		TR: NPN SM SIGNAL MPSA06		
11-0205		TR: 2SB755		
11-0206		TR: 2SD 845		
11-0209-O		TR: 2SB554 "O"		
11-0210-O		TR: 2SD424 "O"		
11-0211		DI: STV-3H-Y		
12-0052		THERMOSTAT: 100 DEG		A
15-0139		CHOKE: OUTPUT (P-50)		
17-0656		HEAT SINK: MAIN (2401)		
17-0658		HEAT SINK: (2401)		
17-0666		PC BD: OUTPUT CH B (2401)		
18-0073		RELIEF: HEYCO SB-375-4		
18-0075		TO-3 INSULATOR		
18-0105		PIN: TERMINAL MALE .063 DIA		A
18-0159		CONN: WFR 9 PIN GOLD		
18-0189		SOCKET: TR - EMUIDEN M1629		
18-0190		MICA: TWO HOLE (TOSHIBA)		
19-0009		SCREW 6-32X3/8" PHIL SEMS NP		
19-0177		SCREW 6-32X1/4 PHIL BLK OX REV		
19-0185		STANDOFF 1/4 HEX 6-32X7/16 NP		
19-0198		NUT PRESS 4-40 (3100)		
19-0199		SCREW 4-40 X 3/8" PHIL NP		
19-0226		SCREW: M3X16MM PH BH NP		
19-0227		SCREW: 6-32X3/8 PH BLK OX REV		
21-0005-11		#14GA STRD PVC RED		
21-0005-13		#14 GA STRD RED		
21-0007-08		#14GA STRD PVC GRY		
21-0007-10		#14GA STRD PVC GRY		
21-0174		TIE WRAP NYLON 3/4" DIA TYB23M		A
21-0192		#22 GA SLD PVC JUMPER 1.0" BLK		
21-0193-02		#20 GA TUBING TEFLON CLR		

SLBTR\ 22-0208 100 C JAN 31 1980

PART	ASSY	DESC	U/M
22-0208		PC ASSY: LED/DRIVE (2401)	
01-0005		R: 47 OHM 5% 1/4W CF	
01-0012		R: 360 OHM 5% 1/4W CF	
01-0016		R: 510 OHM 5% 1/4W CF	
01-0021		R: 1K OHM 5% 1/4W CF	
01-0024		R: 1.5K OHM 5% 1/4W CF	
01-0026		R: 2K OHM 5% 1/4W CF	
01-0038		R: 6.8K OHM 5% 1/4W CF	
01-0078		R: 120 OHM 5% 1/4W CF	
01-0079		R: 200 OHM 5% 1/4W CF	
01-0082		R: 750 OHM 5% 1/4W CF	
01-0088		R: 39 OHM 5% 1/4W CF	
01-0089		R: 82 OHM 5% 1/4W CF	
01-0090		R: 180 OHM 5% 1/4W CF	
01-0094		R: 39K OHM 5% 1/4W CF	
09-0055		C: EL 4.7 MF 50V RA	
11-0094		DI: 400V 1AMP 1N4004	
11-0096		DI: 100V 500 MW 1N4148	
11-0163		IC: OP-AMP LM324A	
16-0026		DI: LED SLP-141B (RED)	
17-0416		PC BD: LED DRIVE (2400L)	
17-0417		PC BD: LED DISPLAY (2400L)	
18-0106		CONNECTOR: FEMALE MOLEX .0630	A
18-0115		WFR CONNECTOR MOLEX 09-67-1153	A
19-0003		SCREW 6-32X1/4" PHIL NP	
19-0082		STANDOFF 1/4 HEX 6-32X1/2" NP	
21-0116-07		#22 GA STRD BLK 1KV	
21-0118-07		#22 GA STRD RED 1KV	
21-0134-11		#22 GA STRANDED ORANGE 1KV	
21-0135-07		#22 GA STRD YLW	
21-0174		TIE WRAP NYLON 3/4" DIA TYB23M	A
21-0178		#22 GA SLD PVC JUMPER .5" BLK	A

*** PARENT COST = 1,247.35 TOTAL CO

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PART	ASSY	DESC	U/M	NS
22-0209		PC ASSY: DRIVE LEFT CH (2401)		
01-XXXX		SELECTED VALUE 5% 1/4W CF		
01-0009-S		R: 240 OHM 2% 1/4W		
01-0021		R: 1K OHM 5% 1/4W CF		
01-0041		R: 10K OHM 5% 1/4W CF		
01-0041-M		R: 10K 1/4W 2% MATCHED		
01-0042-S		R: 12K OHM 2% 1/4W CF		
01-0059		R: 100K OHM 5% 1/4W CF		
01-0059-M		R: 100K OHM 5% 1/4W CF MATCH		
01-0098		R: 120 OHM 5% 1/4W MOF		
01-0108		R: 220 OHM 5% 1/4W MOF		
03-0020		R: 62 OHM 5% 1/2W MO		
03-0038		R: 620 OHM 5% 1/2W MO		
03-0047-M		R: 1800 OHM 2% 1/2W MO		
03-0115		R: 5.1K OHM 2% 1/2W MO		
03-0121-2		R: 5.6 KOHM 2% 1/2W CF		
04-0023		R: 10 OHM 5% 2W MO		
04-0064		R: 2.2 OHM 5% 2W MO		
07-0007		C: CER D 22 PF 10% 500V GP		
07-0014		C: CER D 200 PF 10% 500V GP		
07-0019		C: CER D .001 MF GMV 500V GP		
07-0023		C: CER D .01 MF +80-20% 100V		
08-0012-2		C: MY .22MF 50V 2% RA MLD		
08-0024		C: MY .1MF 50V 10% RA MLD		A
09-0027		C: EL 100 MF 10V RA		
09-0028		C: EL 100 MF 50V RA		
11-0091		DI: 200V 100MA 1N3070		A
11-0094		DI: 400V 1AMP 1N4004		
11-0096		DI: 100V 500 MW 1N4148		
11-0106		DI: 51V 5% 1/2W ZENER 1N5262B		
11-0154		TR: NPN SM SIGNAL MPSA06		
11-0155		TR: PNP SM SIGNAL MPSA56		
11-0174		TR: PNP 2SA798 DUAL MATCHED		
11-0175		TR: 2SC1583 DUAL MATCHED		
11-0190		TR: MATSUSHITA PNP 2SA913		
11-0191		TR: MATSUSHITA NPN 2SC1913		
17-0691		HEAT SINK: DR BD (2301, 2401)		
17-0693		PC BD: DRIVE LT CH (2301, 2401		
18-0122		INSULATOR: MICA DF103B		
18-0132		JACK: 2 POLE PC-MT. STHT PHONO.		
18-0137		CONN:RT.AN.9PIN GOLD(MOLEX2144		
19-0040		SCREW #4X5/16" PHIL BLK OX		
19-0199		SCREW 4-40 X 3/8" PHIL NP		
19-0200		WASHER NYLON TR. MOUNT (3100)		
19-0205		NUT PRESS: S-440-2		
21-0024-02.5		#18 GA STRD BLK		
21-0178		#22 GA SLD PVC JUMPER .5" BLK	A	
21-0207		#22 GA SLD PVC JUMPER .2" BL		

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SLBT 50-0222 100 C

PART	ASSY	DESC	U/M
50-0222		FINAL ASSY: 2401	
21-0121		CABLE: DUAL RCA 6' LG MOLD	
32-0001		SERVICE CONTACT REGES CARD	
32-0002		SAE RETURN ENVELOPE	A
32-0003		WARRANTY CERTIFCATE 90 DAY	A
32-0004		SAE PRODUCT FOLDER	A
32-0005		ORDER ENVELOPE: CABINETS	A
32-0006		ORDER ENVELOPE AUDIO MAG	A
32-0015		ORDER CARD PRODUCT INFORMATION	A
32-0039		TAG SAE 5 YR. BLUE	
32-0056		SERVICE INFORMATION BROCHURE	
32-0057		ORDER ENVELOPE HI FIDELITY	
32-0082		OWNERS MANUAL: 2401	
33-0030		POLY BAG 6X8 3 MIL THK	A
33-0032		POLY BAG 10X16 2 MIL THK	A
33-0035		POLY BAG 26X30 3 MIL THK	A
33-0045		STAPLE-CARTON NO.34	A
33-0117		PAD: TOP (2401)	
33-0118		CARTON: SHIP (2401)	
33-0120		PAD: BOTTOM (2401)	
34-0057		SERIAL PLATE: 2401	
46-0066	A	DESTINATION FINAL (2401)	

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SLBT 22-0215 100 C

PART	ASSY	DESC	U/M	NS
22-0215		PC ASSY: RELAY (2401, 2301)		
01-0007		R: 150 OHM 5% 1/4W CF		
01-0041		R: 10K OHM 5% 1/4W CF		
01-0059		R: 100K OHM 5% 1/4W CF		
04-0032		R: 680 OHM 5% 2W MO		
08-0024		C: MY .1MF 50V 10% RA MLD	A	
09-0027		C: EL 100 MF 10V RA		
09-0033		C: EL 220 MF 16V RA		
09-0055		C: EL 4.7 MF 50V RA		
09-0071		C: EL: 10MF 100V RA		
11-0044		TR: NPN BC237B		
11-0094		DI: 400V 1AMP 1N4004		
11-0117		TR: PNP BC307B		
11-0191		TR: MATSUSHITA NPN 2SC1913		
12-0096		RELAY: 48V FRL-264-0048/02CK		
17-0700		PC BD: RELAY (2401)		
18-0137		CONN:RT.AN.9PIN GOLD(MOLEX2144		
21-0174		TIE WRAP NYLON 3/4" DIA TYB23M	A	
21-0192		#22 GA SLD PVC JUMPER 1.0" BLK		

DEC 14 1979

SLBT 22-0224 100 C

PART	ASSY	DESC	U/M	NS
22-0224		PC ASSY: PWR SPLY (2401)		
09-0076		C: EL 10000MF 100V RA		
17-0699		PC BD: PWR SPLY (2401, X-25A)		
21-0118-06		#22 GA STRD RED		
21-0139-06		#22 GA STRD GRY 1KV		

JAN 14 1980

SLBT 46-0066 100 C

PART	ASSY	DESC	U/M
46-0066		DESTINATION FINAL (2401)	
12-0012		FUSE: 10 AMP MDL 250V	
15-0144		TRANS: 2401, -C	
18-0030		FUSE HOLDER: 30 AMP	
34-0019		LA CITY APPROVAL LABEL	A
45-0023	A	PRODUCTION FINAL (2401)	

TOTAL CO

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JAN 31 1980

SLBT 45-0023 100 C

PART	ASSY	DESC	U/M
45-0023		PRODUCTION FINAL (2401)	
11-0085		RT: 200V 25 AMP 3-PHASE BRIDGE	
12-0022		SWITCH: PUSH-POWER AC	
17-0636		BRKT: XFMR MTG (2401, X-25-A)	
17-0653		PANEL: FRONT (2401)	
17-0659		HANDLE: (2401)	
17-0661		OVERLAY: (2401)	
17-0662		SUB PANEL: FRONT (2401)	
17-0671		COVER: TRANSISTOR (2401)	
17-0701		PLATE: GROUND PWR SPLY (2401)	
17-0702		COVER: BOTTOM (2401)	
17-0703		COVER: R & L SIDE (2401)	
17-0704		COVER: TOP (2401)	
17-0714		SPACER: DISPL (2401, 2301)	
18-0028		SOCKET: CONECTOR AMP #61117-1	
18-0031		POST: TERMINAL HEX-BLACK	
18-0032		POST: TERMINAL HEX-RED	
18-0050		LUG: SOLDER #6	
18-0053		LUG: 16-14	
18-0069		CONNECTOR: TER. 10-18 GA	
18-0074		RELIEF: HEYCO SR-33-1	
18-0093		TERM: SPADE LUG AMP #41274	
18-0161		BUSHING: SNAP SB-1000-12 (HEYC	
18-0168		BUSHING: SNAP SB-500-6 (HEYCO)	
18-0192		BUSHING: HEYCO 2166	
19-0003		SCREW 6-32X1/4" PHIL NP	
19-0004		SCREW 6-32X1/4" PHIL BLK OX	
19-0007		SCREW 6-32X3/8" PHIL NP	
19-0009		SCREW 6-32X3/8" PHIL SEMS NP	
19-0032		SCREW 10-32X5/8" PHIL NP	
19-0034		SCREW: 10-32 X 3/4" PHIL BLK O	
19-0040		SCREW #4X5/16" PHIL BLK OX	
19-0051		NUT 6-32X1/4" NP	
19-0055		NUT HEX 10-32 ZP	
19-0057		NUT PRESS 10-32-2	
19-0066		WASHER LOCK #6 INT STAR NP	
19-0069		WASHER LOCK #10 INT STAR NP	
19-0122		FEET: PLASTIC 1" BLACK	
19-0149		WASHER .203 .39X3/32 ZP	A
19-0177		SCREW 6-32X1/4 PHIL BLK OX REV	
19-0225		SCREW: 10-24X1" SOC H SS	
20-0022-01		WEATHER STRIP:3/8 X 3/8 FOAM	
21-0005-07		#14GA STRD PVC RED	
21-0007-02		#14GA STRD PVC GRY	
21-0024-08		#18 GA STRD BLK	
21-0110-12		#14 GA STRD GRY UL1015	
21-0110-14		#14 GA STD GRAY UL1015	
21-0113		LINE CORD 8 FT 3 COND	
21-0137-06		#22 GA STRD BLU	
21-0174		TIE WRAP NYLON 3/4" DIA TYB23M A	
21-0211-02		TUBING 1/2" RNF-100 SHRINK	
22-0208	A	PC ASSY: LED/DRIVE (2401)	
22-0209	A	PC ASSY: DRIVE LEFT CH (2401)	
22-0210	A	PC ASSY: DRIVE RIGHT CH (2401)	
22-0211	A	SUB ASSY: PWR MOD LT CH (2401)	
22-0212	A	SUB ASSY: PWR MOD RT CH (2401)	
22-0215	A	PC ASSY: RELAY (2401, 2301)	
22-0224	A	PC ASSY: PWR SPLY (2401, X-25A	

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