

4000 Service Manual

Prepared 6/76

CONTENTS

- I. Specifications
- II. Circuit Description
- III. Schematics and Design History
- IV. Disassembly
- V. Test and Alignment Procedure
- VI. Troubleshooting Guide
- VII. Service Bulletins

I. TECHNICAL SPECIFICATIONS

Total Distortion: Less than .25%.

Typically .02%.

Total Noise: High Level: 95dB

below full output. Phono:

72dB below full output.

Input Impedance: Phono: No less

than 47k from 20 Hz to 20k Hz.

High Level: 50k.

Gain: Phono: 65dB. High Level:

15dB.

Output Voltage: Full output 8

volts R.M.S. Better than 2

volts into 4.7k or greater.

Frequency Response: Phono: Within

+ .5dB of RIAA from 20 Hz to

20k Hz. High Level: Within

.5dB from 20 Hz to 20k Hz.

Tone Controls: Bass: Monotonically

increasing and decreasing, dual hinge points, + 8dB

at 20 Hz. Hinge points

switch selectable beginning

at 40 Hz or 150 Hz. Treble:

Monotonically increasing and

decreasing, dual hinge points,

+ 8dB @ 20k Hz. Hinge points

switch selectable beginning at

2k Hz and 8k Hz.

Active Equalizer: 6dB/octave

boost below 50 Hz.

Peak Unlimiter: (Nominal peak un-

limit rate attack threshold,

front panel variable) .5dB/

microsecond for + 6dB peak un-

limit operation.

Nominal Amplitude Attack Threshold:

.2 volts peak at input to peak

unlimiter.

Downward Expander: Downward ex-

pansion commences at -- 35dB.

Ultimate limit is -- 41dB. Un-

limiter window is 35dB wide,

upper and lower thresholds are

simultaneously variable by

front panel unlimit threshold

control.

Four Channel Facilities: Built in

CBS SQ system with Phase Linear

developed differential logic

for enhanced four channel separ-

ation.

Semiconductor Complement: 45 tran-

sistors, 9 integrated circuits,

57 diodes, 2 zener regulators, 2

light emitting diodes.

Auto Correlator (Noise Reduction

System): High frequency noise

reduction commences at 2k Hz and

is 3 dB, reaching 10dB from 4k Hz

to 20k Hz. Low frequency noise

reduction begins at 200 Hz, ulti-

mately reaching 20dB @ 20 Hz.

Passive subsonic filter rejection

of -- 35dB @ 5 Hz. Weighted

overall noise reduction is -- 10

dB from 20 Hz to 20k Hz.

Tape Monitor: Two tape switches per-

mitting any input source to be re-

corded on either of two tape

machines, play back selection of

either machine, or copy of tape

machine to while listening to

a third source.

Power Switching Capability: Switched

outlets are capable of switching

up to 20 amperes.

Power Consumption: Preamplifier: 40

watts.

Size: 19" wide x 7" high x 10" deep.

Weight: 18 pounds. Warranty; three

years, parts and labor.

II. CIRCUIT DESCRIPTION

A. RIAA AMPLIFIER CIRCUIT BOARD

Q1 and Q2 form a high gain feedback pair equalized for the standard RIAA recording curve. A "cartridge loading" adjustment customer control is provided to vary the input impedance between 47K ohms and 147K ohms. This allows a slight tailoring of the high frequency response of the phono cartridge. Typically the higher impedance setting will result in a 2 or 3dB boost at 20k Hz and lower impedance settings will result in a 2 or 3dB cut at 20k Hz. (Counter clockwise is low impedance) NOTE: This variation will not be observed if the RIAA amplifier is driven with a low output impedance audio oscillator, but only with a phono cartridge and a stereo test record. The correct setting is a matter of listening preference.

B. TONE AMPLIFIER CIRCUIT BOARD

Q1 and Q2 form a high gain feedback pair normally equalized for flat response. Low and high frequency boost is provided by feedback network consisting of C7, and R8, C29 and R59. Front panel Active Equalization switch shunts C7 and disconnects C27 for flat response.

C. LOGIC CIRCUIT BOARD

The Logic circuit consists of four interdependent amplifier stages which serve to couple the S.Q. decoder to the main output jacks.

D. BANDPASS I CIRCUIT BOARD

BP I circuit board consists of a single integrated circuit which forms two multiple, sharply tuned amplifiers, each amplifier consisting of two "gain blocks". One amplifier is used for frequencies in the vicinity of 4k Hz. The other for those in the vicinity of 7K Hz. The (variable) resistors at the input set the gain of each tuned amplifier.

E. BANDPASS II CIRCUIT BOARD

BP II circuit board consists of a high pass amplifier, a low pass amplifier, rectifying circuitry to transform the A.C. output of the bandpass amplifier into D.C. control voltage and operational amplifier D.C. inverters. Z1 is a single integrated circuit used to form a low pass amplifier below 200 Hz and high pass amplifier above 12k Hz. Their input (from the Log amp output) is amplified, filtered, then buffered by Q1 and Q2. The output of Q1 and Q2 is rectified by D1, D2, D4, D5 and filtered by C7 and C17. This is the control voltage for the correlators. Z2 serves as the D.C. inverter.

The A.C. output of the BP I circuit board is applied to the bases of Q3 and Q4 (on BP II board) and rectified by D6, D7, D8, D9 and filtered by C19 and C22. This rectified signal is similarly used as the D.C. control voltage for the correlators. Z2 serves as the D.C. inverter.

CIRCUIT BOARD DESCRIPTION

Peak Unlimiter Cont'd (PL08A through D)

maximum voltage level of approximately 2 volts by clamp diodes D8, D9, and D10. When the voltage at the base of Q5 reaches the turn-on voltage of Q5, (.7 volts) it conducts and pulls the control pin of Z1 and Z2 towards ground through R4 and R10 respectively. This causes the gain of the VCA to increase in such a manner that the audio signal is passed through unattenuated.

If a sufficiently large signal from the summing junction appears at the base of Q6, it will conduct and cause a rectified control voltage to appear at the base of Q7. This causes Q7 to conduct, pulling the resistors R5 and R11 toward ground. This results in a further increase in gain through the two VCA's Z1 and Z2. The audio signal then passes through with its amplitude increased approximately 3dB. The transistor Q4 is used to rapidly discharge C13 when the control signal is removed. When a control voltage is present, D7 conducts, charges C12 and causes Q4 to remain off. The absence of a control voltage causes Q4 to conduct and discharge C13. The VCA's then reduce their gain by approximately 6dB.

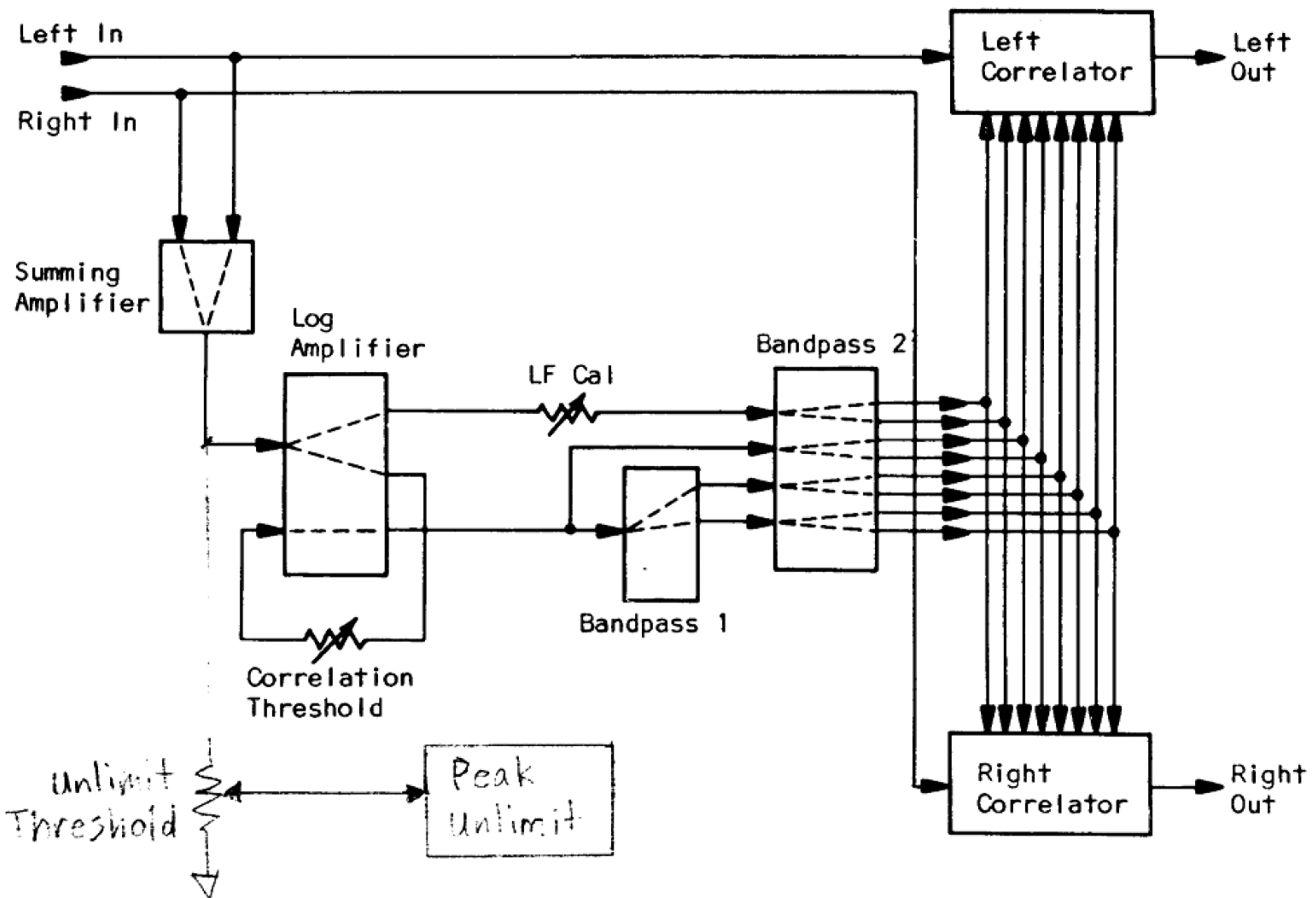
Peak Unlimiter Board PL08E

Audio signal is applied to pins 2 and 3, attenuated, and AC coupled to the first two stages of IC Z1. These stages serve as the voltage-controlled amplifier (VCA) for the Peak Unlimit and Downward Expand functions for each channel. The remaining stages of Z1 are the Linear Expander VCA's. Voltage-controlled gain change in these stages is accomplished through the forward biasing of diodes D1 through D24 by various DC control voltages. These diodes are AC coupled into the feedback networks of the Z1 stages such that a change in bias voltage from a control circuit causes the impedance of the diodes to change, altering the impedance ratio of the network and therefore changing the gain of the amplifier. Control voltages for the Peak Unlimit, Linear Expander and Downward Expand functions are derived as follows: Audio signal from both channels is summed and applied to pin #1 through the front panel threshold control. This control signal is then buffered and amplified by Q1 and rectified by the following diode and RC network. This DC voltage along with that inverted through Z2 serve as the control voltages for the Peak Unlimit function. Downward Expand control voltages are obtained similarly through Q3, Q4, rectifier network, and Z2 inverter, with the Q5 network determining the proper time constant. Linear Expander control voltages are derived through Q6, rectifier circuit and Z2 inverter.

J. AUTOCORRELATOR

The autocorrelator is a noise reduction system designed to remove noise from the signal source.

The autocorrelator system consists of 5 circuit boards. They are Bandpass I, Bandpass II, Log Amp and two (2) correlator boards. A block diagram is shown below:



Operation is as follows

The left channel and right channel correlator circuit boards consist of many voltage controlled notch filters (windows) placed throughout the audio band from 2K Hz to 20k Hz, each slightly overlapping its nearest neighbor. Upon receipt of wideband, noise contaminated musical material, the control circuits (consisting of BP I, BP II and Log amp) cause the windows in the correlator to open when a musical harmonic associated with a given window occurs, and to close when the harmonic is no longer present. Each window is a gate for a particular narrow band of frequencies, gating "on" in the presence of musical energy and "off" at all other times. The gating action is accomplished by D.C. control voltage from the correlator driver (see block diagram) which causes diode switches to bypass the filters that comprise each window.

The control voltages for the correlators are developed in several steps. First, the left and right channel audio signals are summed together to form a composite control signal. This signal is then applied simultaneously to a low pass filter (below 200 Hz) and a high pass filter (above 2k Hz). The signal components

CIRCUIT DESCRIPTION

Autocorrelator (Cont'd)

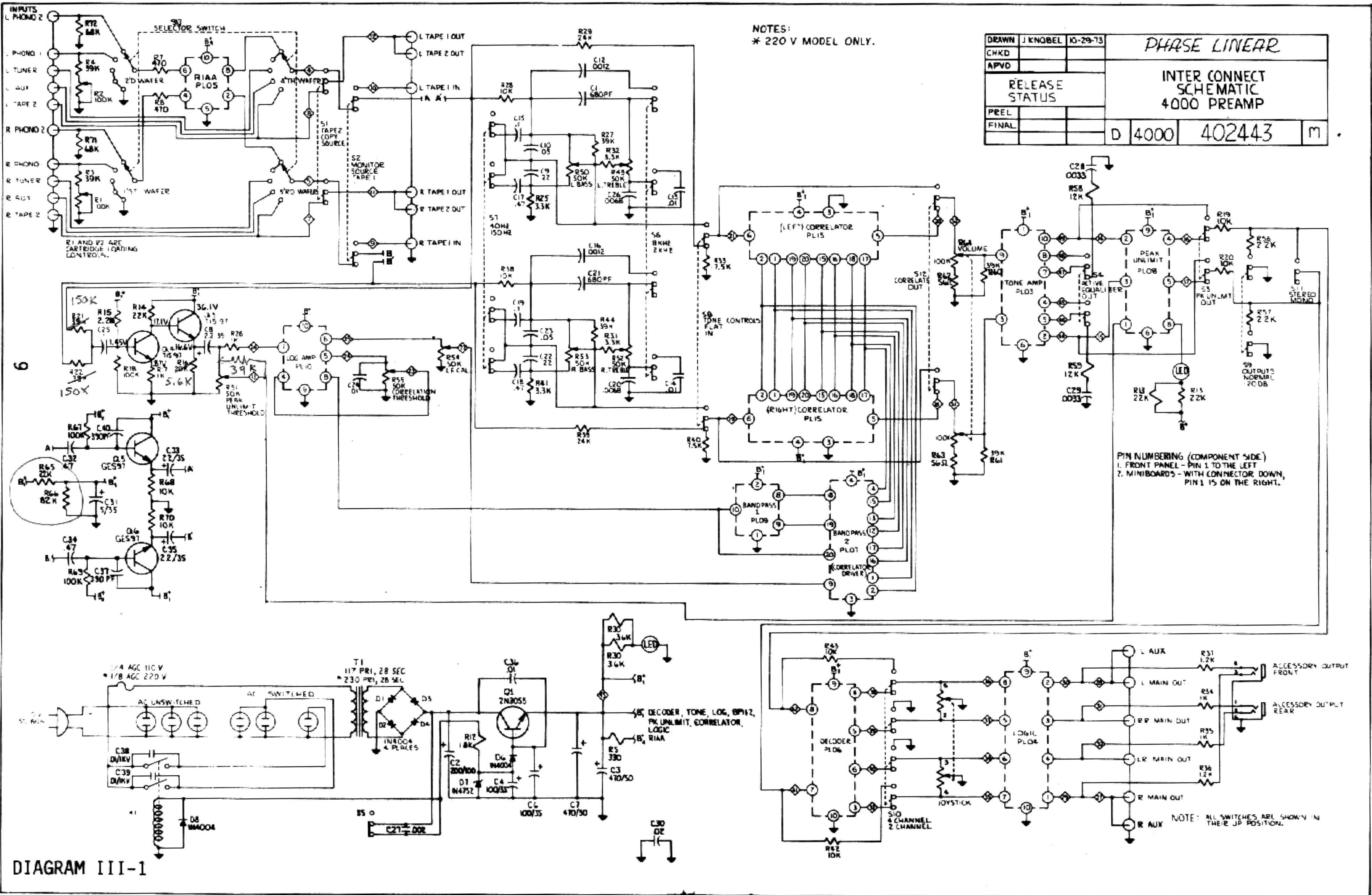
above 2k Hz are operated on by the Log amp, a logarithmic converter whose output is the logarithm of its input. The output of the Log amp is presented to a series of bandpass, sharply tuned amplifiers. (Located on BP I, BP II) For each tuned amplifier there exists a corresponding window in the two correlators. The output of each of these amplifiers is rectified, filtered and inverted to form a pair of D.C. control voltages of opposite polarity to operate the diode switches. The inversion is accomplished by integrated operational amps. Diode logic determines the simultaneous existence of higher order harmonics and lower frequency fundamentals and instructs the appropriate windows to open and/or close.

For frequencies below 200 Hz, a low pass filter amplifies the energy below 200 Hz. Those frequencies are detected by a pair of voltage doubling diodes and activate a low frequency dynamic filter. This filter opens whenever low frequency energy above the hum and rumble level exists. (The threshold is front panel variable.)

III. SCHEMATICS AND DESIGN HISTORY

This is a list of schematics of the various boards used in the 4000. Design changes and modifications are noted on the schematics. Also included is a compatibility schedule to show interchangeability of various plug in boards.

- Diagram III - 1) Interconnect
III - 2) Mother Board "C" Layout
III - 3) Front Panel "A" Layout
III - 4) Mother Board PL01 Layout
III - 5) Front Panel PL06 Layout
III - 6) RIAA Schematic and Layout
III - 7) Tone amp Schematic and Layout
III - 8) Peak Unlimit PL08A-D Schematic and Layout
III - 9) Peak Unlimit PL08E Schematic
III -10) Peak Unlimit PL08E Layout
III -11) Log amp Schematic and Layout
III -12) Bandpass I Schematic and Layout
III -13) Bandpass II Schematic
III -14) Bandpass II Layout
III -15) Correlator Schematic and Layout
III -16) Decoder Schematic and Layout
III -17) Logic Schematic and Layout



NOTES:
* 220 V MODEL ONLY.

DRAWN	J. KNOBEL	10-29-73	PHASE LINEAR		
CNVD			INTER CONNECT		
APVD			SCHEMATIC		
			4000 PREAMP		
PREL			D 4000	402443	M
FINAL					

PIN NUMBERING (COMPONENT SIDE)
1. FRONT PANEL - PIN 1 TO THE LEFT
2. MINIBOARDS - WITH CONNECTOR DOWN, PIN 1 IS ON THE RIGHT.

DIAGRAM III-1

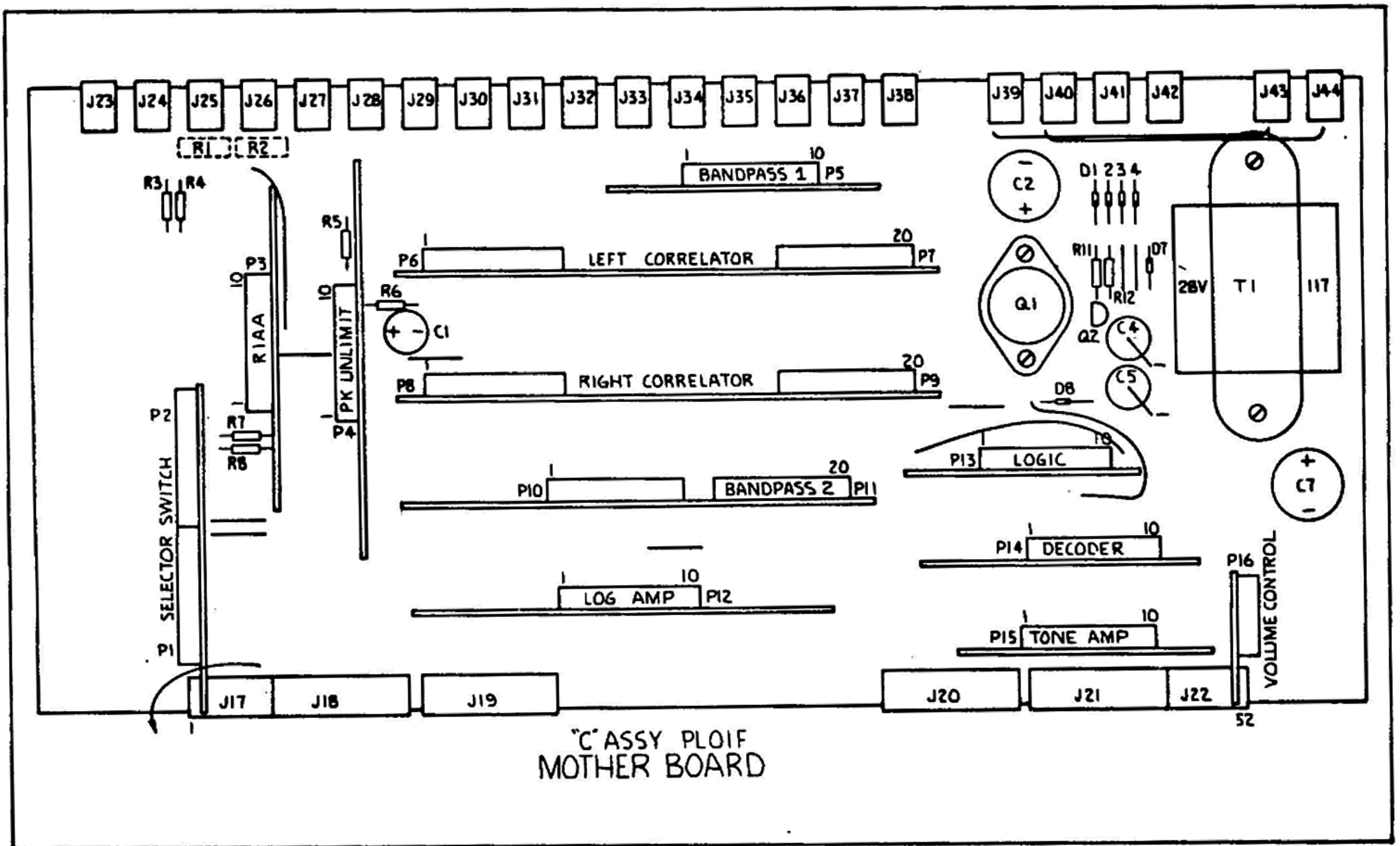


DIAGRAM III-2

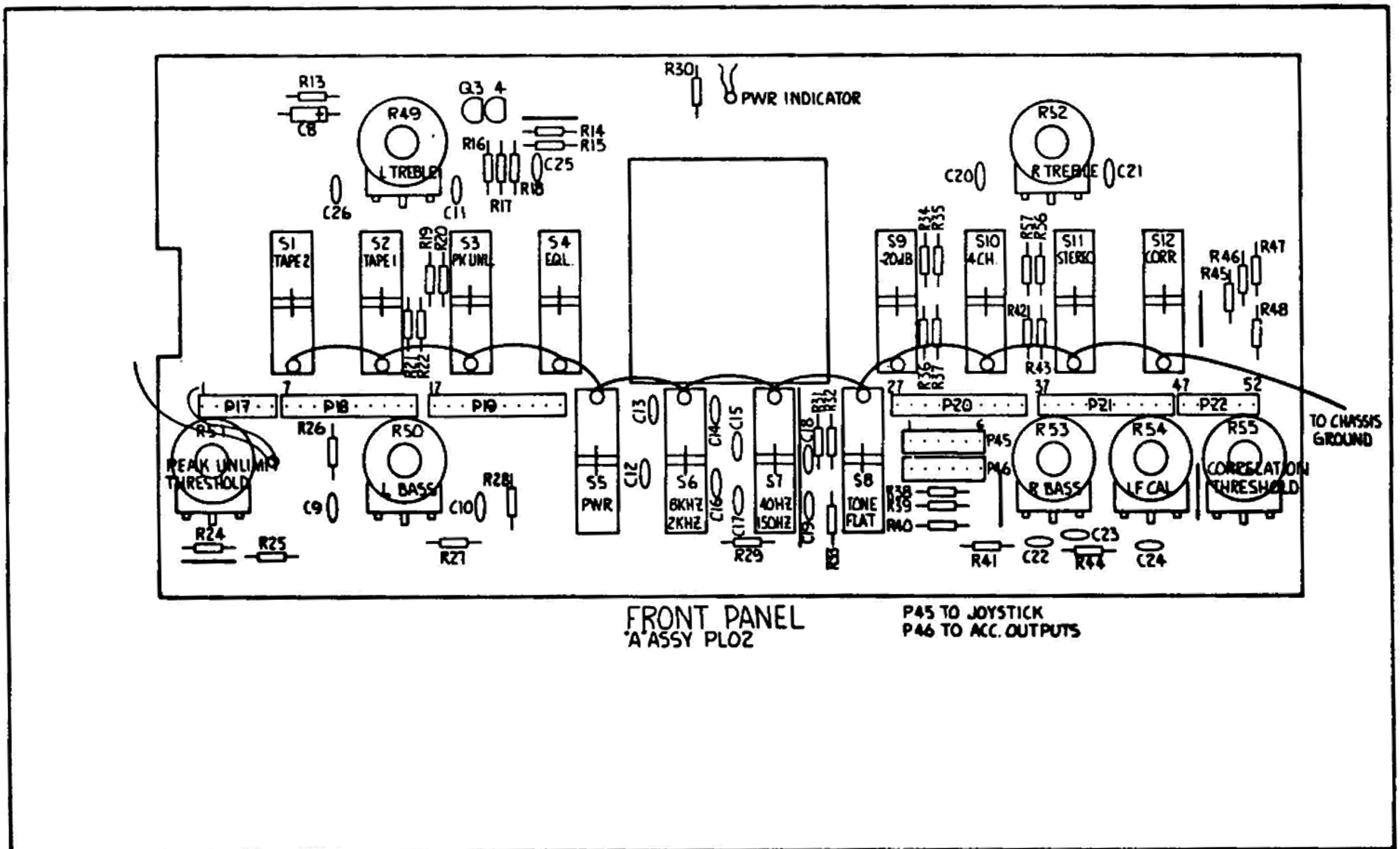
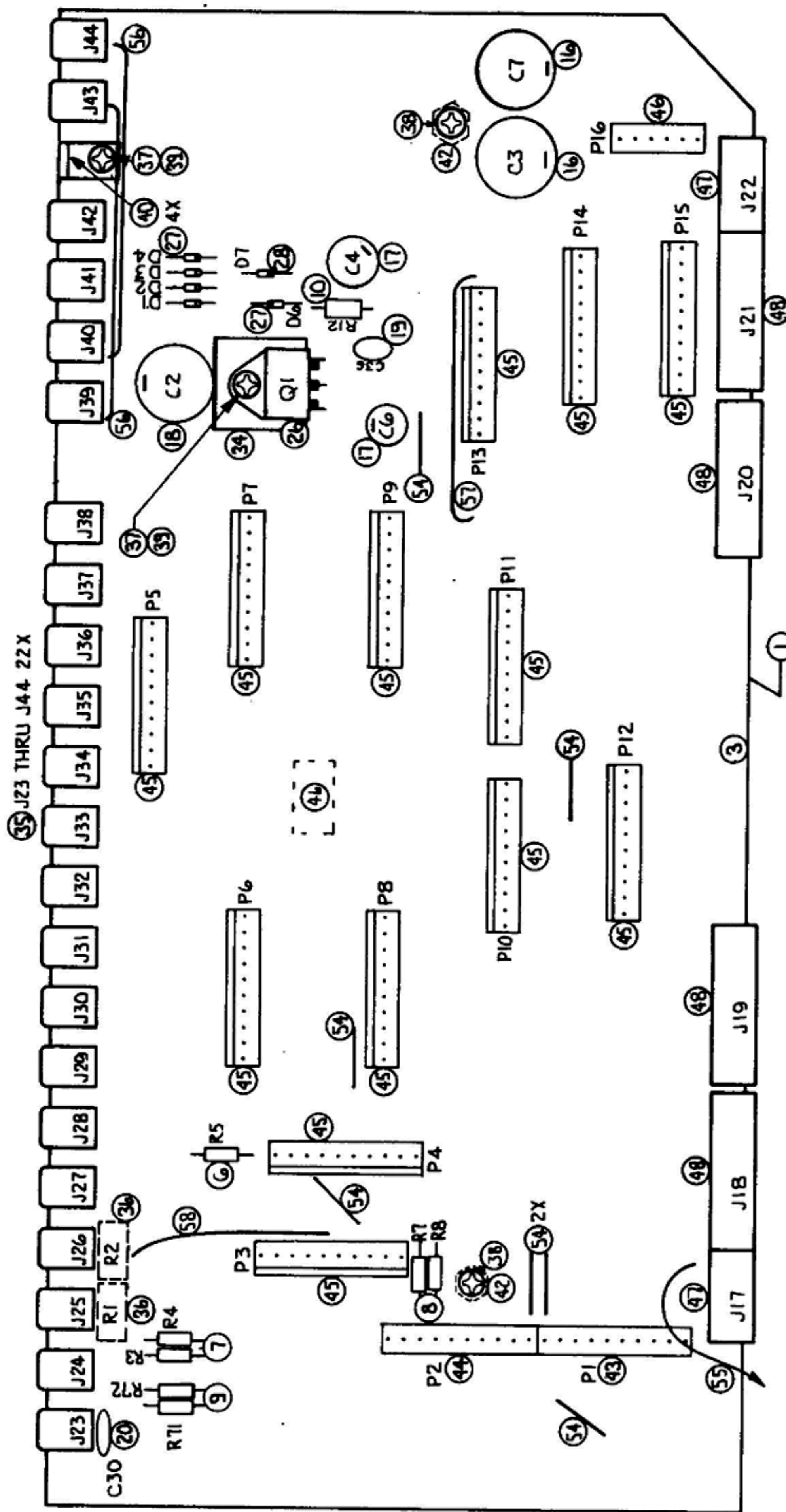


DIAGRAM III-3



03 ASSY MOTHER BOARD PLO1 75501

NOTE FOR SCHEMATIC SEE DWG. 402443

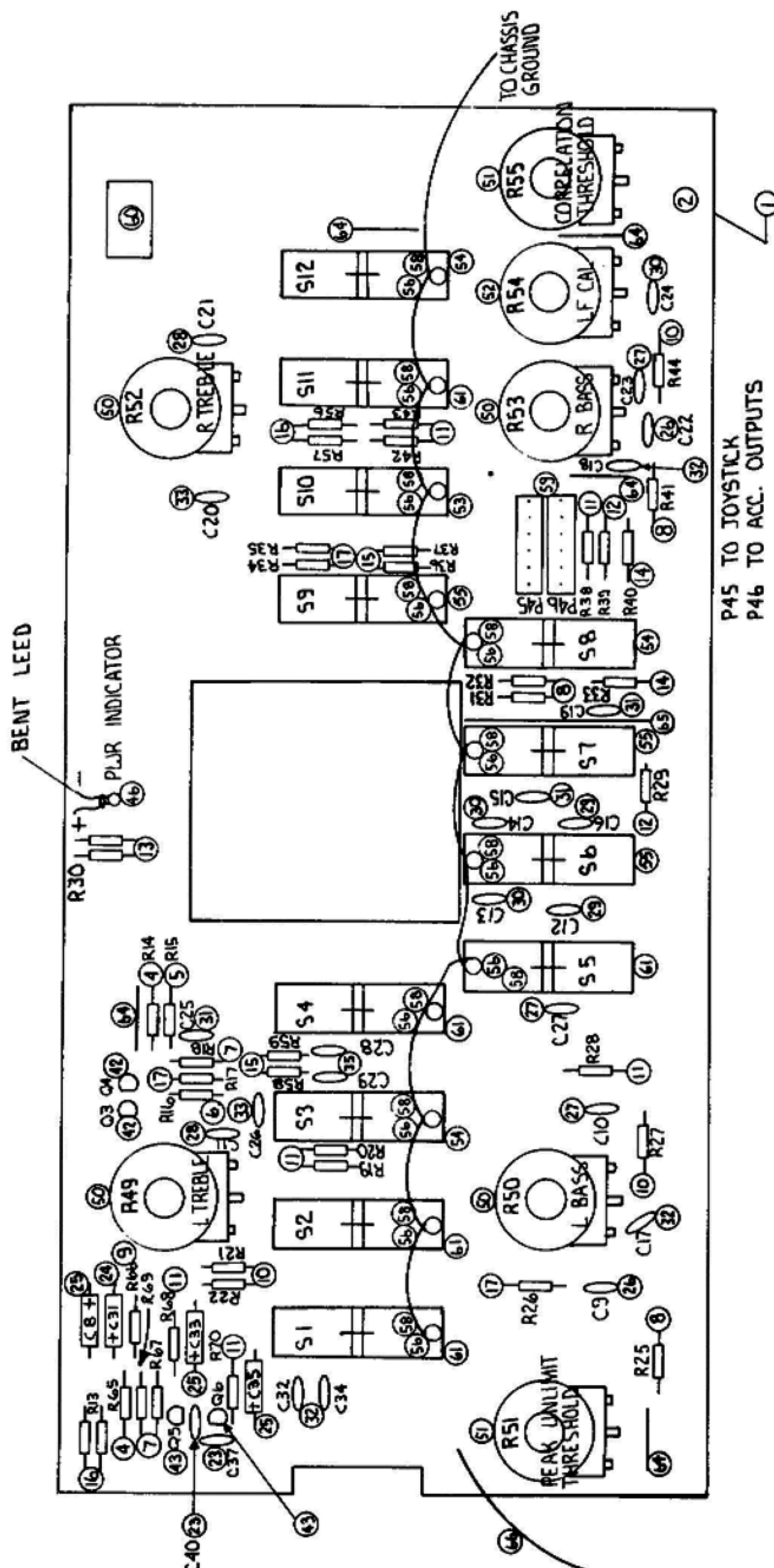
- F - SAME AS G EXCEPT DELETE C36.
R12 IS 2.7K, C6 IS 47/35.
ADD C5 WHICH WAS 100/35.
- G - SAME AS H EXCEPT P.C.B. NOT MODIFIED
TO ALLOW ON-OFF SWITCH TO BE
CONNECTED TO 2NDARY SIDE OF TRANSFR.
ECO 33
- H - SAME AS J EXCEPT DELETE R71 & R72
- J - SAME AS O1 EXCEPT ADD 4 TERM. LUGS / MOVE C36 / R12
- O1 - SAME AS O2 EXCEPT FEMALE CONNECTORS FOR J17 - J22.
- O2 - SAME AS O3 EXCEPT Q1 DOES NOT FIT PROPERLY & SCREW
FROM L BRACKET TO P.C.B. IS NOT ZINC PLTD.
- O3 - SHOWN

DRAWN	KNOBEL	S-22-74
CHKD	<i>Knobel</i>	5/23/74
	RELEASE	
	STATUS	
PREL		
FINAL		

PHASE LINEAR
CIRCUIT BOARD
MOTHER BOARD

C	PLO1	402454	REV	J
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REV. NO.	DESCRIPTION	BY	DATE	APPROVED



O6 ASSY PLO2 FRONT PANEL 77500

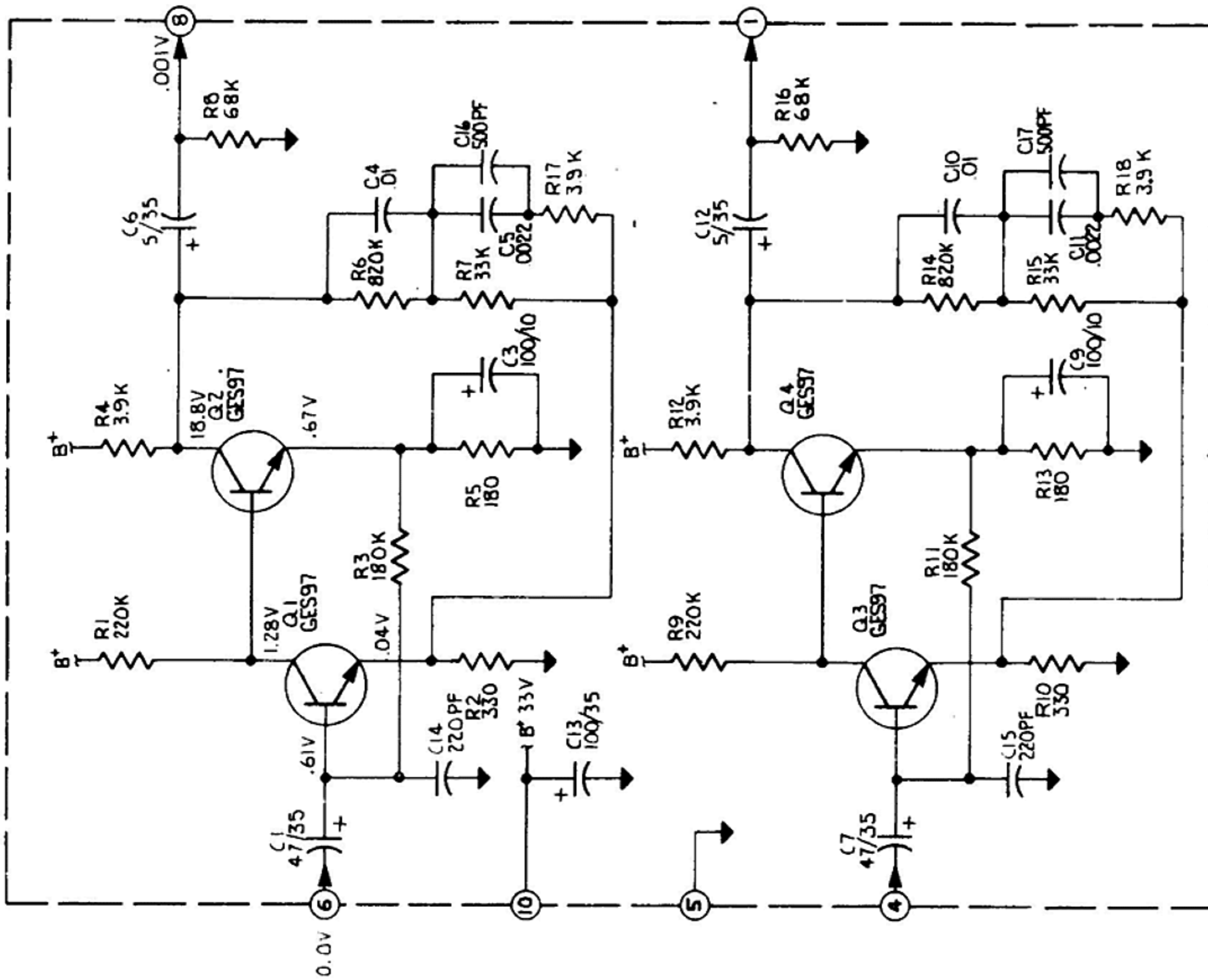
NOTE:
FOR SCHEMATIC SEE DLG. 402443.

ASSY REV.
O4 - SAME AS O5 EXCEPT Q5 & Q6 ARE TISS7, S5 IS ZTIP.
O5 - SAME AS O6 EXCEPT S1, S4, S5, S6, S7, S9, S11 ARE SHORTING SWITCHES
O6 - AS SHOWN

UNLESS OTHERWISE SPECIFIED DIM. AND TOL. ARE IN INCHES AND SHALL BE INTERPRETED PER (ANSI) Y14.5-1976.		DRAWN	PICKENS	10/2/75
TOLERANCES ARE:		CHECKED		
1 DEC ± .1 3 DEC ± .005		APPROVED		
2 DEC ± .01 4 DEC ± .0008		RELEASE STATUS		
ANGLES ± 0° 30'		PREL.		
REMOVE BURRS, BREAK SHARP EDGES MATCH SURFACES IF		FINAL		
MAT'L				
FINISH:				
MT. TREAT:				
		DO NOT SCALE DWG.	SCALE	
		SIZE	PLO2	DWG. NO. 402455
		REV.	L	SHEET 1 OF 1

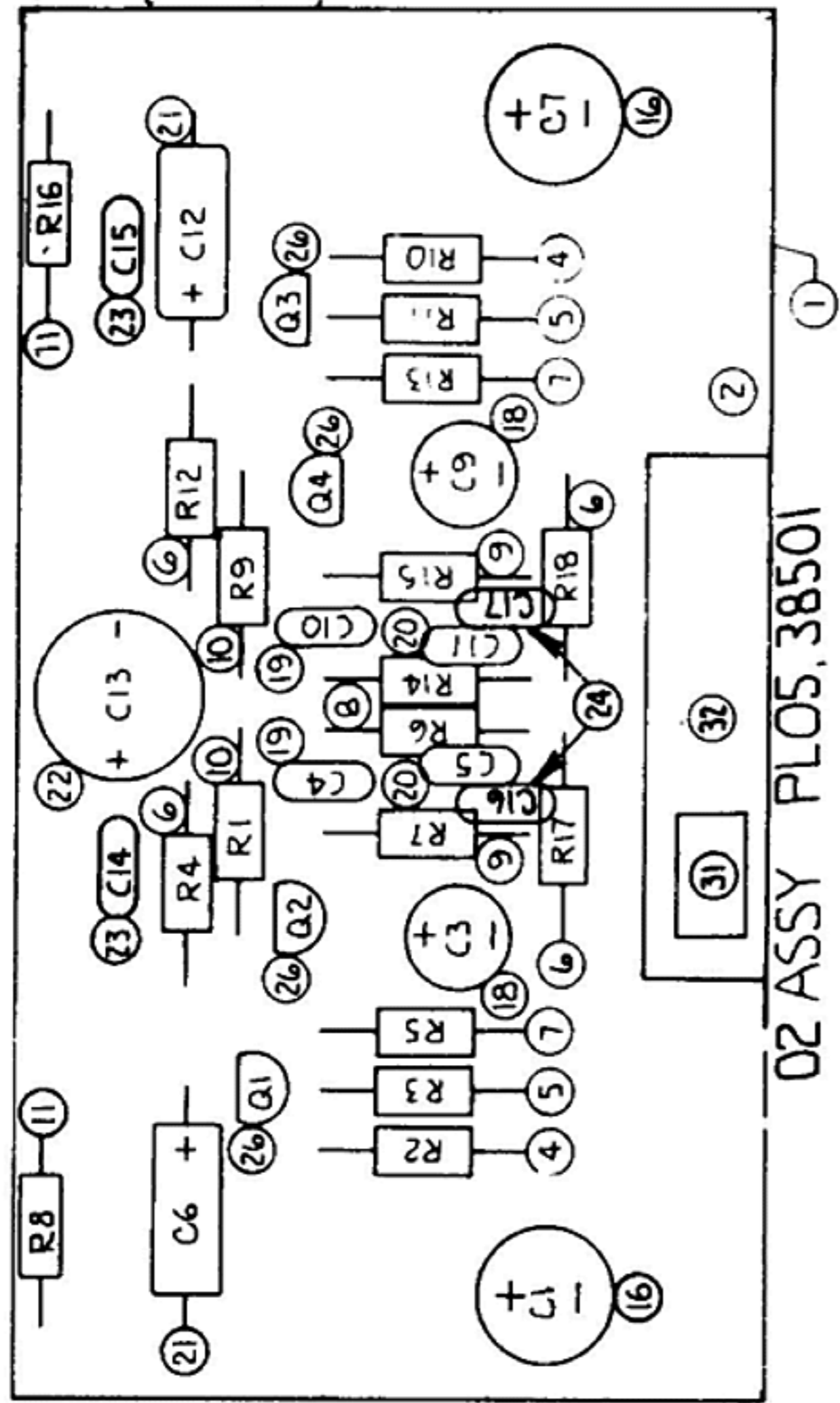
Phase Linear

PCB ASSY
FRONT PANEL



NOTE: BOTH CHANNELS HAVE SIMILAR VOLTAGES.
 ALL VOLTAGES SHOWN ARE D.C. AND MAY VARY ±10% FROM THE NOMINAL VALUES GIVEN.

SCHEMATIC PLO5
 A- SAME AS B EXCEPT R8 & R16 ARE 180K, C5 & C11 ARE .0015, OMIT R17 & R18.
 B- SAME AS C EXCEPT C4 & C15 ARE 150PF.
 C- SAME AS D EXCEPT R6 & R14 ARE 820K, C4 & C10 ARE .02, R7 & R18 ARE 5.6K.
 D- SAME AS E EXCEPT R2 & R10 ARE 270K.
 E- SAME AS F EXCEPT C14 & C15 ARE 390PF, R17 & R18 ARE 3.3K, R2 & R10 ARE 390K.
 F- SAME AS G EXCEPT OMIT C14 & C17, R6 & R14 ARE 560K, ADD 82PF B TO C OF Q2 & Q4.
 G- SAME AS H EXCEPT R17 & R18 ARE 1.5K, C16 & C17 ARE 68PF.
 H- SAME AS O1 EXCEPT EXTRA HOLES ARE ON P.C.B.
 O1- SAME AS O2 EXCEPT Q1 THRU Q4 ARE TS97.

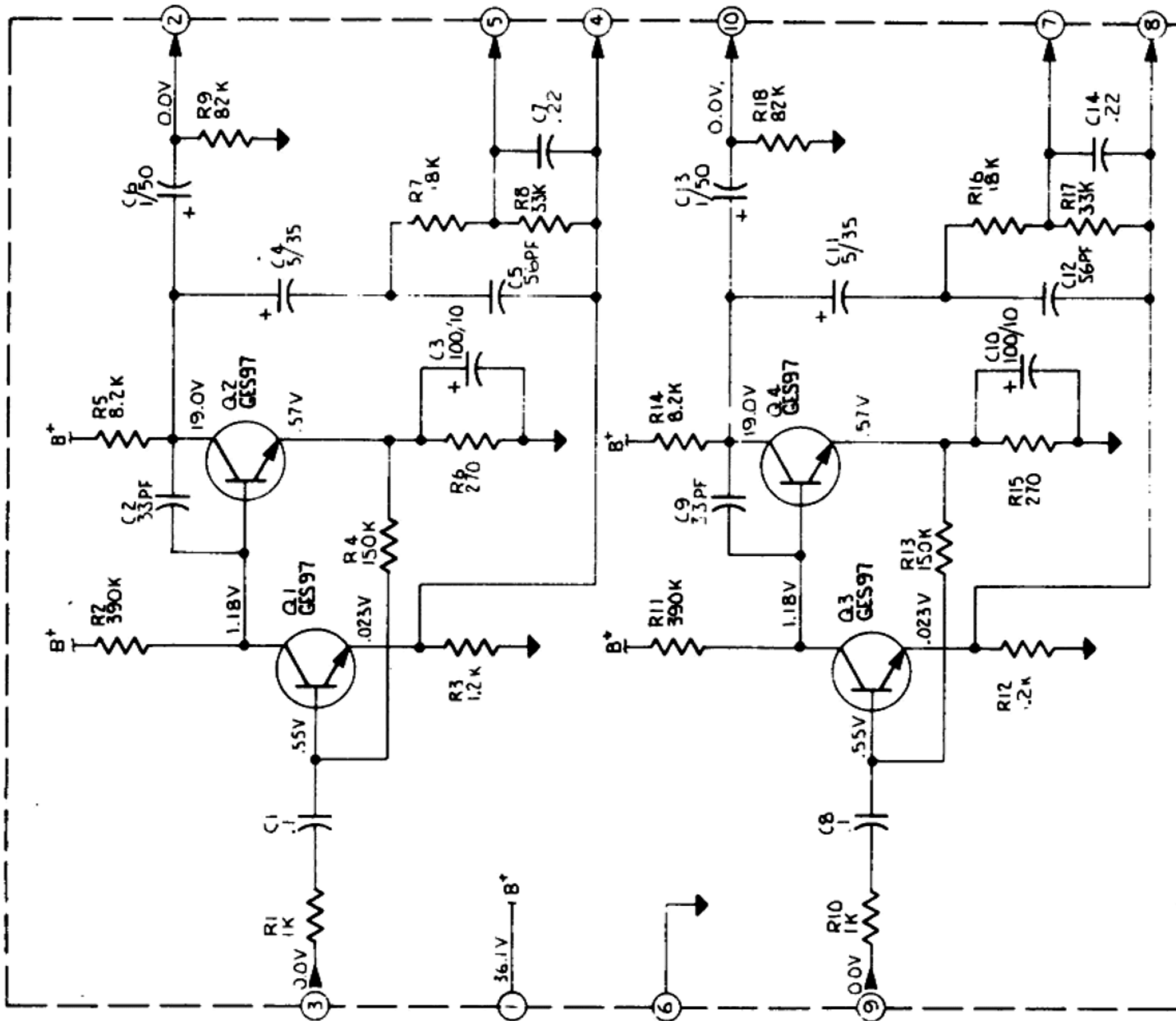


02-SHOWLN

DRAWN	KNOBEL	6/12/73
CHECKED
APVD
RELEASE STATUS		
PREL
FINAL
C	PLO5	402422
REV	J	SHEET 1 OF 1

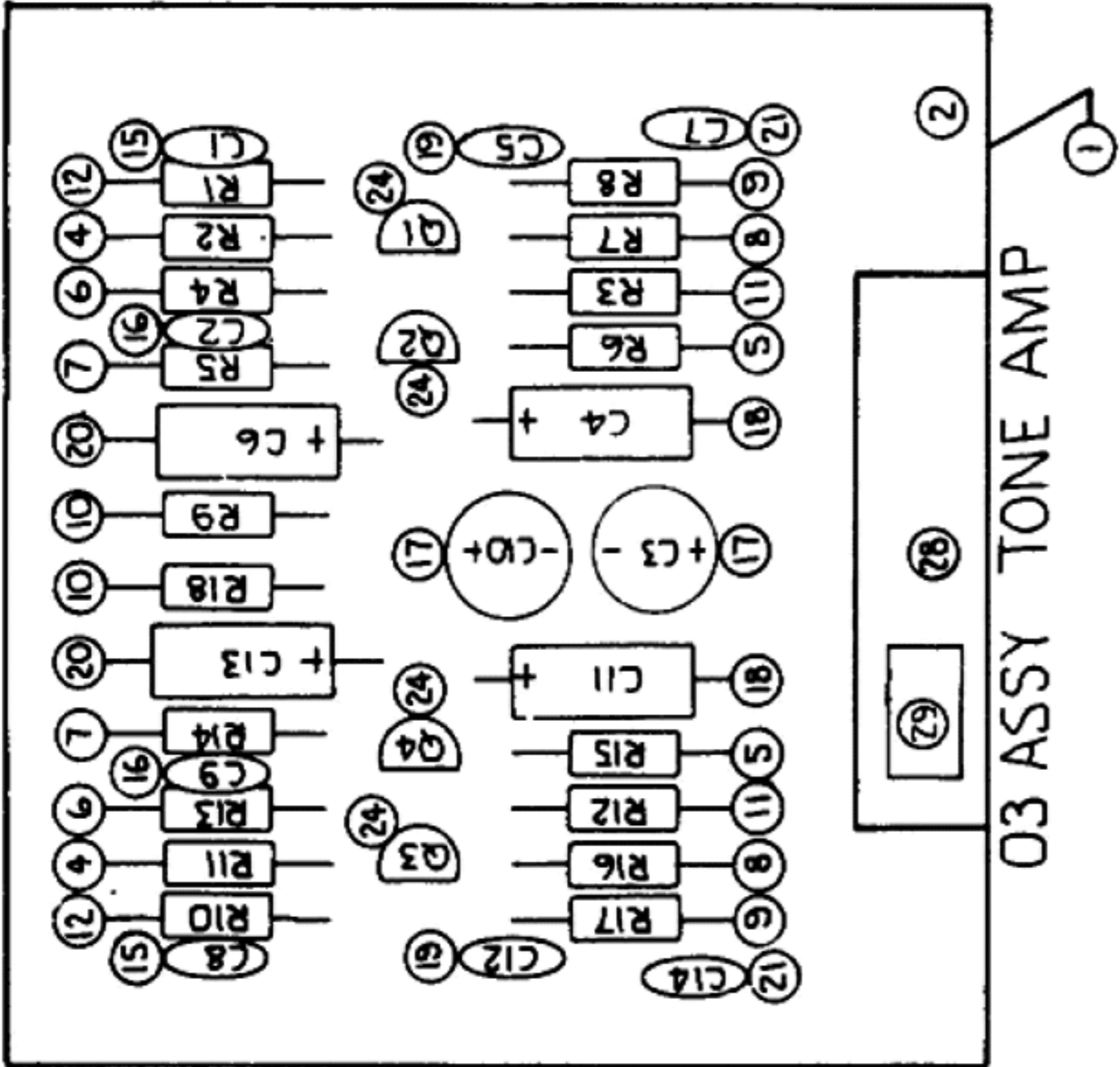
PHASE LINEAR CORP

CIRCUIT BOARD
 R1AA



SCHMATIC PLO3, 47501

- A - SAME AS B EXCEPT R4 & R13 ARE 120K, R6 & R17 ARE 15K, R7 & R16 ARE 6.8K, R3 & R12 ARE 270Ω, C7 & C14 ARE .47, C5 & C12 ARE 220 PF.
- B - SAME AS C EXCEPT C2 & C9 ARE 56PF
- C - SAME AS O1 EXCEPT EXTRA HOLES ADDED & PARTS 00 NOT FIT BOARD AS WELL.
- O1 - SAME AS O2 EXCEPT USES P.C.B. REV 38501.
- O2 - SAME AS O3 EXCEPT Q1 THRU Q4 ARE 1597.
- O3 - SHOWN

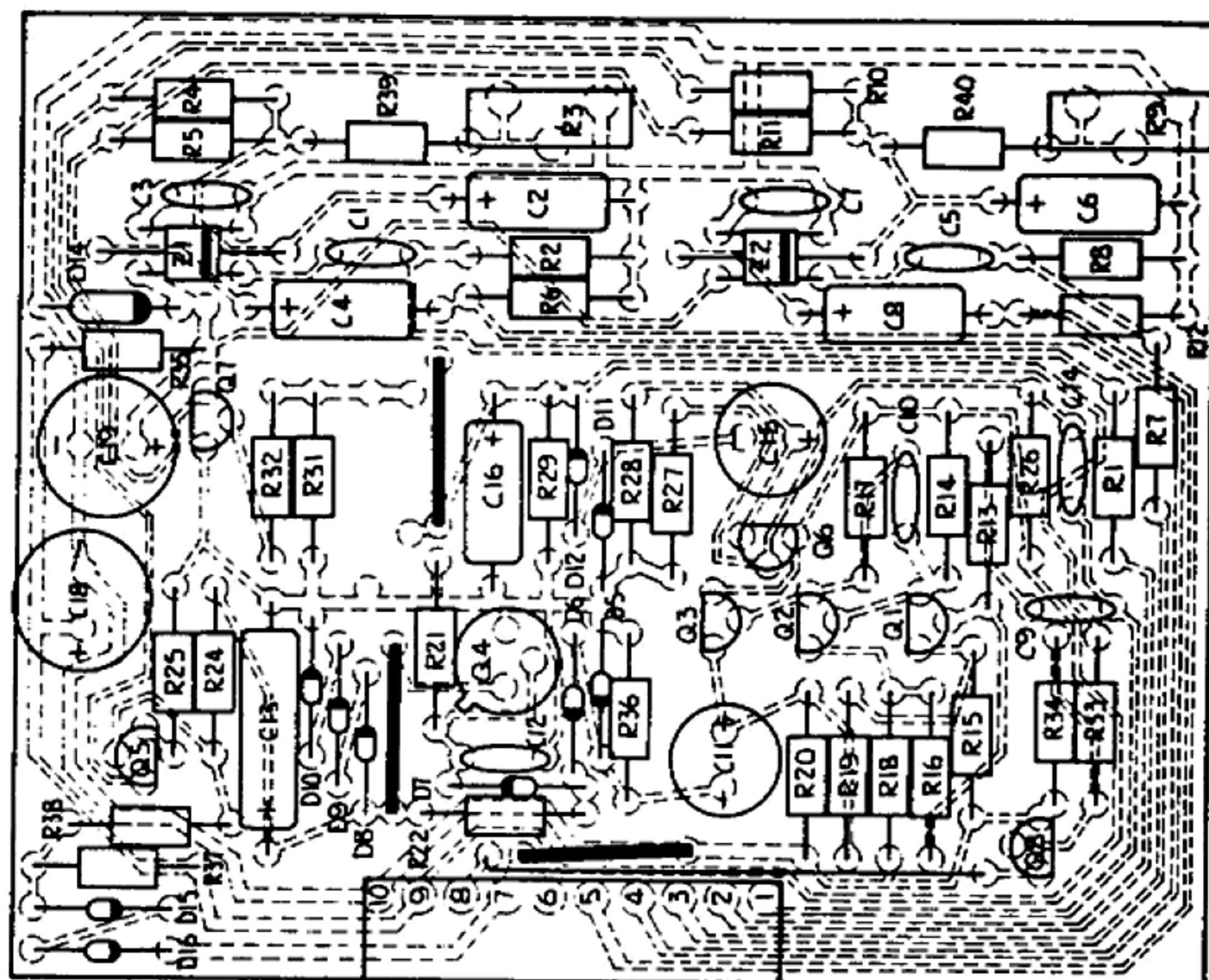
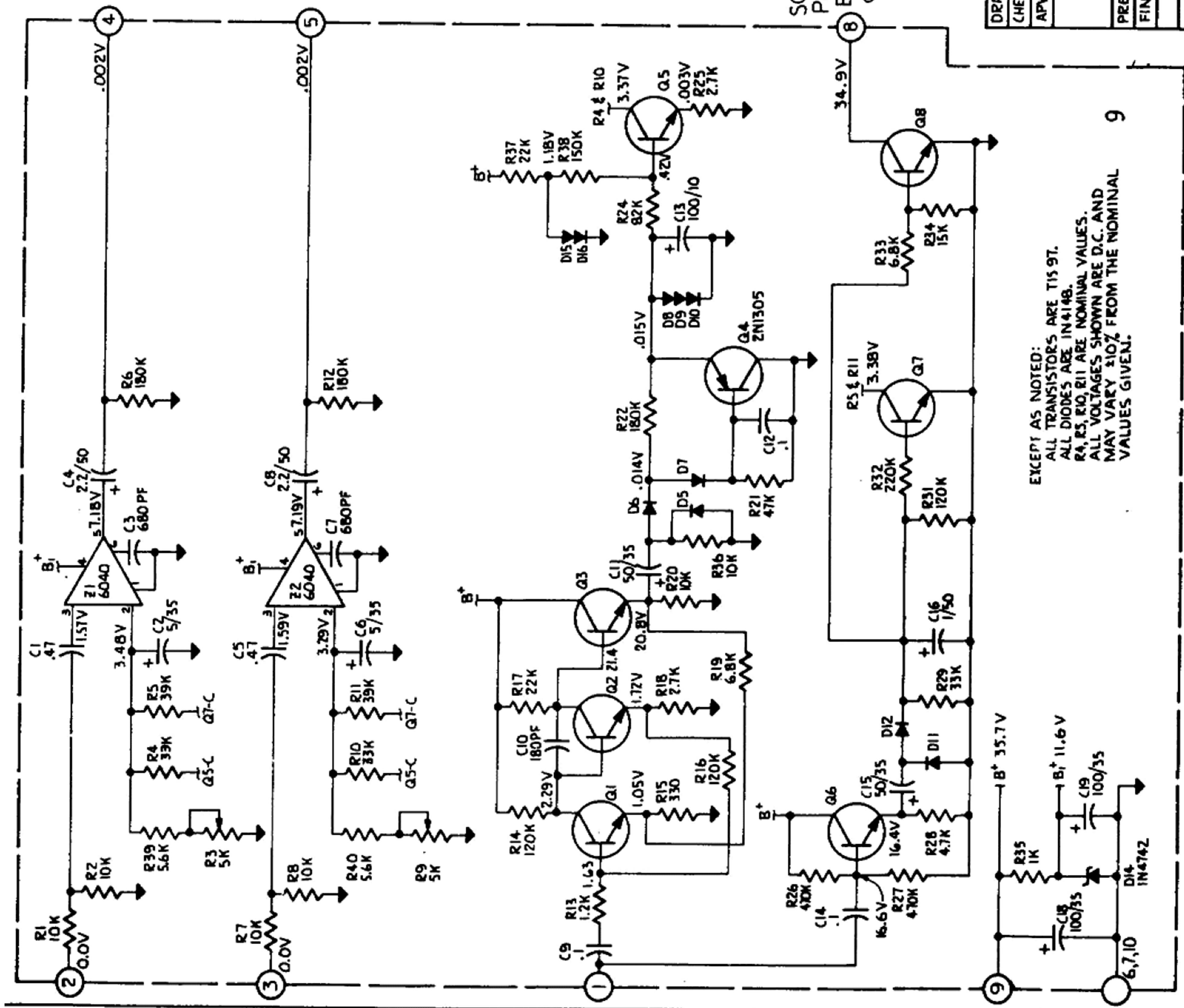


NOTE: ALL VOLTAGES SHOWN ARE D.C., AND MAY VARY ±10% FROM THE VALUES GIVEN.

DRAWN	KNOBEL	6/8/73
CHECKED	<i>[Signature]</i>	6/8/73
APVD	W.L.S.	6/8/73
RELEASE STATUS		
PREL.	W.L.S.	6/8/73
FINAL	/	/
C PLO3		402421
REV		F

PHASE LINEAR CORP

CIRCUIT BOARD
TONE AMPLIFIER



ASSEMBLY PLOBE

SCHEMATIC
PLOB
B SHOWN

C-22 & C10 IS 10/35, C16 IS 2.2/35.

DRAWN	J KNOBEL	10-9-73
CHECKED	W. Skinner	10/11/73
APVD	W. Skinner	10/11/73
RELEASE STATUS		
PREL	WOS	10/11/73
FINAL		

PHASE LINEAR

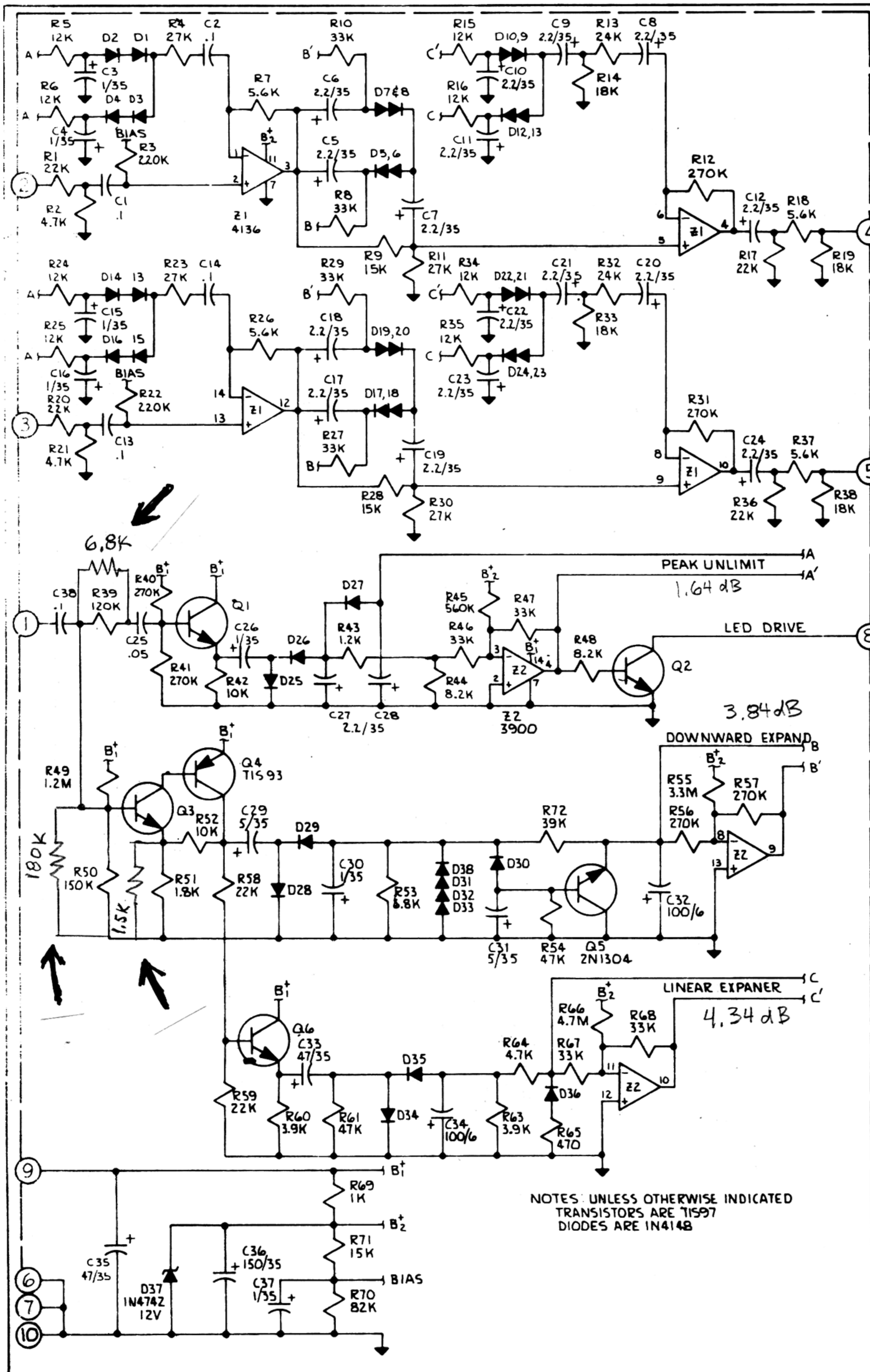
CIRCUIT BOARD
PEAK UNLIMITER

C PLOB 402442

REV

B

EXCEPT AS NOTED:
 ALL TRANSISTORS ARE T15 9T.
 ALL DIODES ARE 1N4148.
 R4, R5, R10, R11 ARE NOMINAL VALUES.
 ALL VOLTAGES SHOWN ARE D.C. AND
 MAY VARY 10% FROM THE NOMINAL
 VALUES GIVEN.

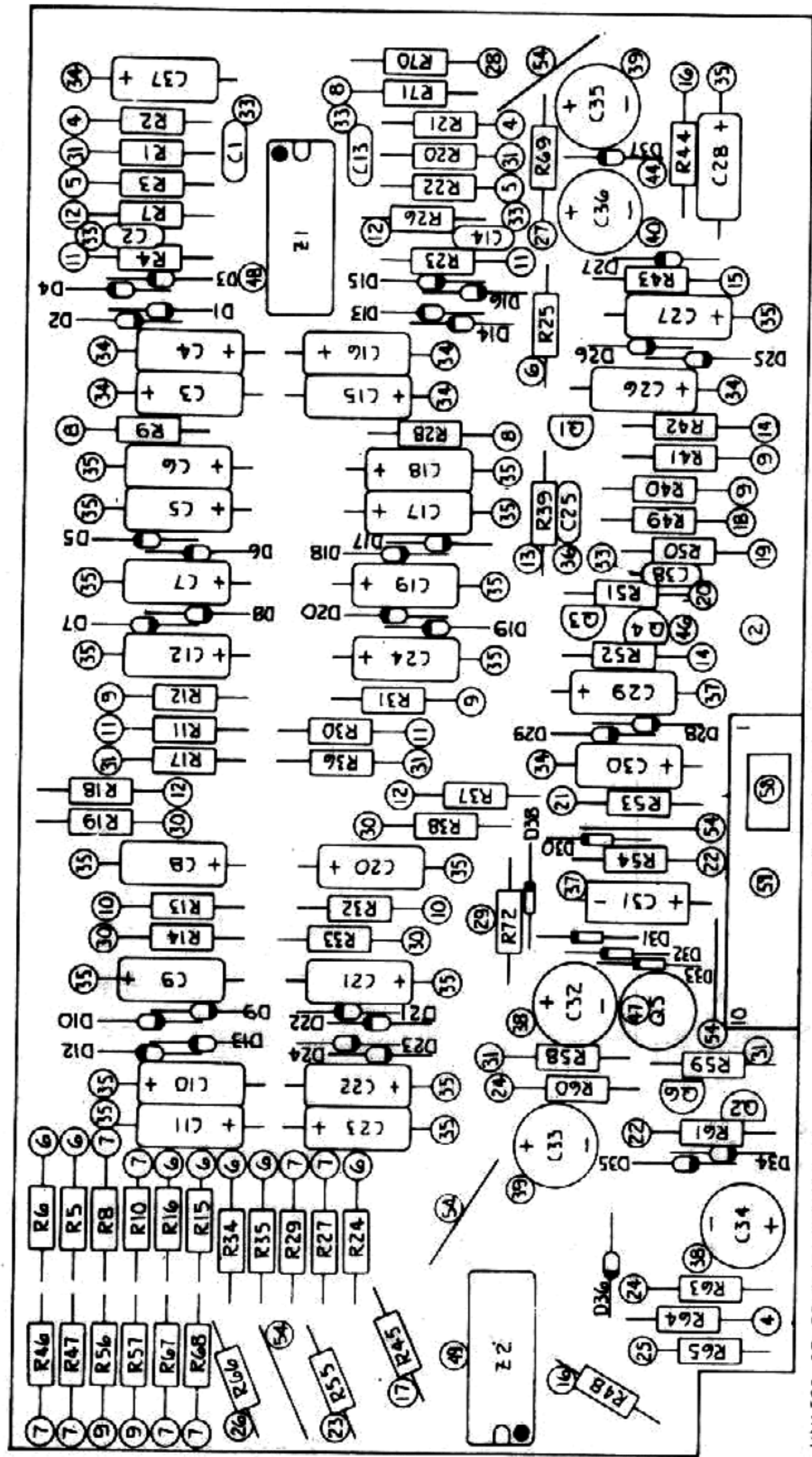


NOTES: UNLESS OTHERWISE INDICATED
 TRANSISTORS ARE T1S97
 DIODES ARE 1N4148

DRAWN		KNOBEL B/21/74		RELEASE STATUS	
CHKD				PREL	
APVD				FINAL	
				C	
				402442	
				REV F	
				SHEET 2 OF 2	

01 ASSY PEAK UNLIMIT

PHASE LINEAR
 PCB ASSY
 PEAK UNLIMIT



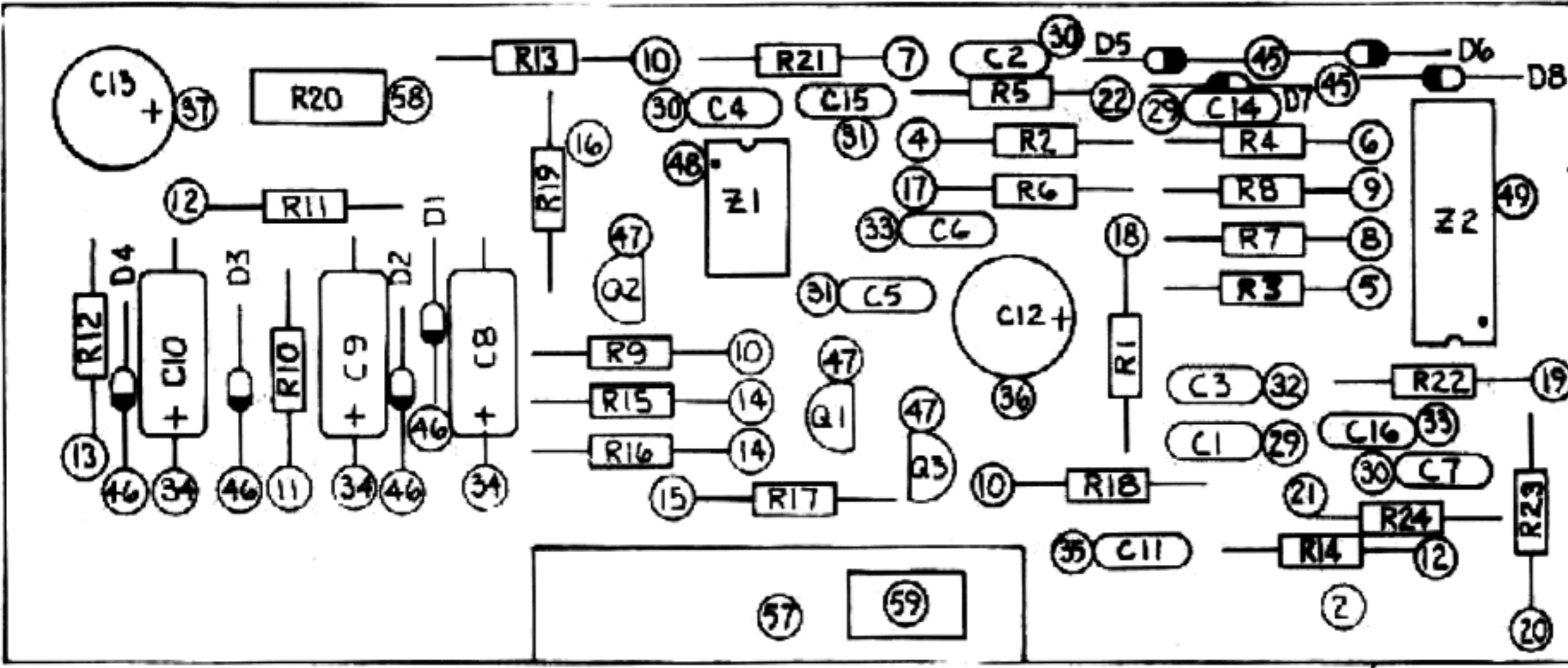
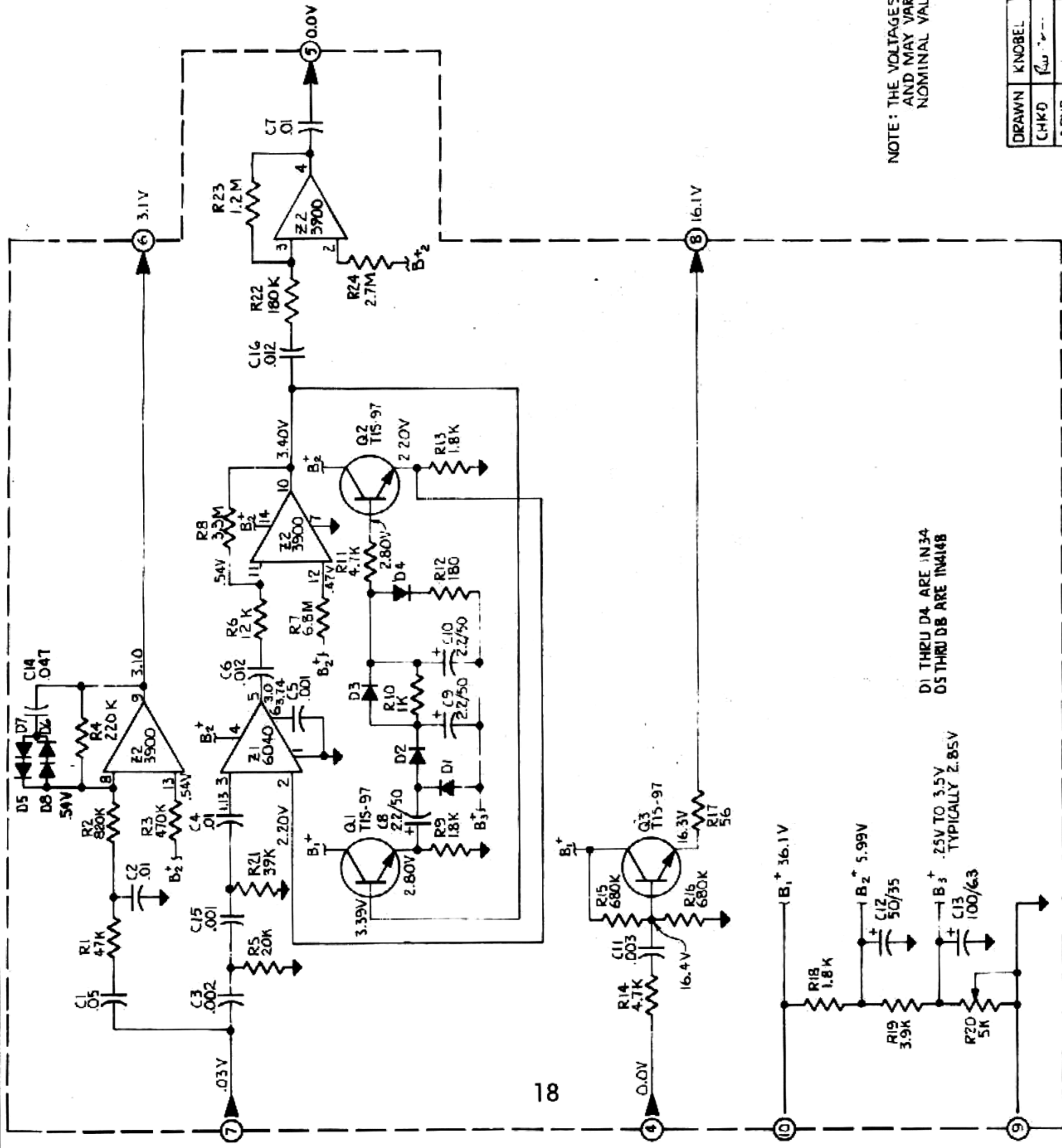
UNLESS OTHERWISE INDICATED
 TRANSISTORS ARE T1597
 DIODES ARE IN4148.

O1 ASSY PLO8 38501
 PEAK UNLIMIT

E- SAME AS O1 EXCEPT PARTS DO NOT FIT AS WELL.
 O1- SHOWN

DRAWN	KNOBEL	8/21/74
CHK'D		
APVD		
RELEASE STATUS		
PREL		
FINAL		

PHASE LINEAR	
PCB ASSY	
PEAK UNLIMIT	
C	REV F
40Z442	
SHEET 1 OF 2	



O1 ASSEMBLY PLIO

NOTE: THE VOLTAGES SHOWN ARE DC. AND MAY VARY ±10% FROM THE NOMINAL VALUES GIVEN.

DRAWN	KNOBEL	8/13/73
CHKD		
APVD		
RELEASE STATUS		
PREL		
FINAL		

PHASE LINEAR CORP

CIRCUIT BOARD
LOG AMP

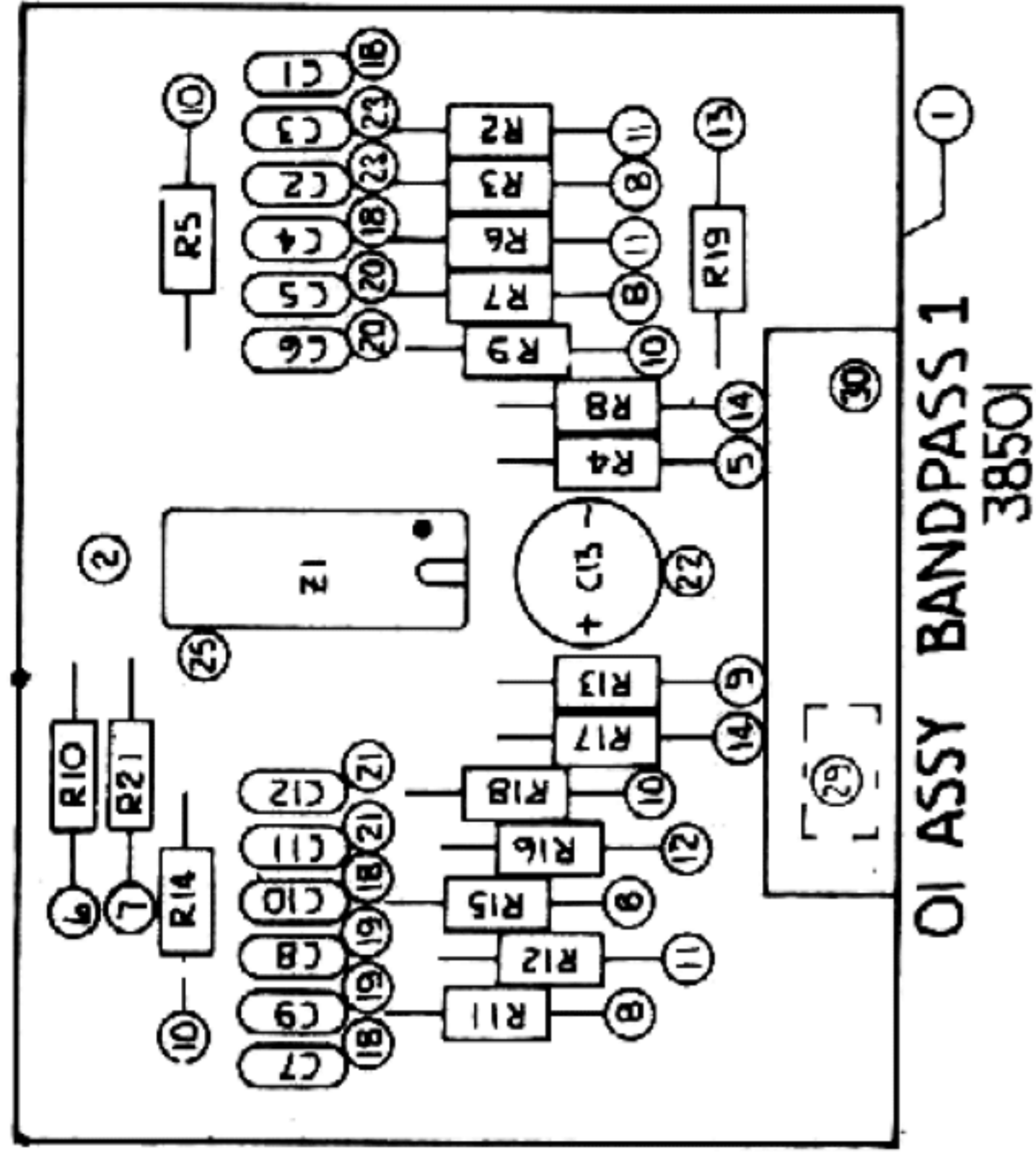
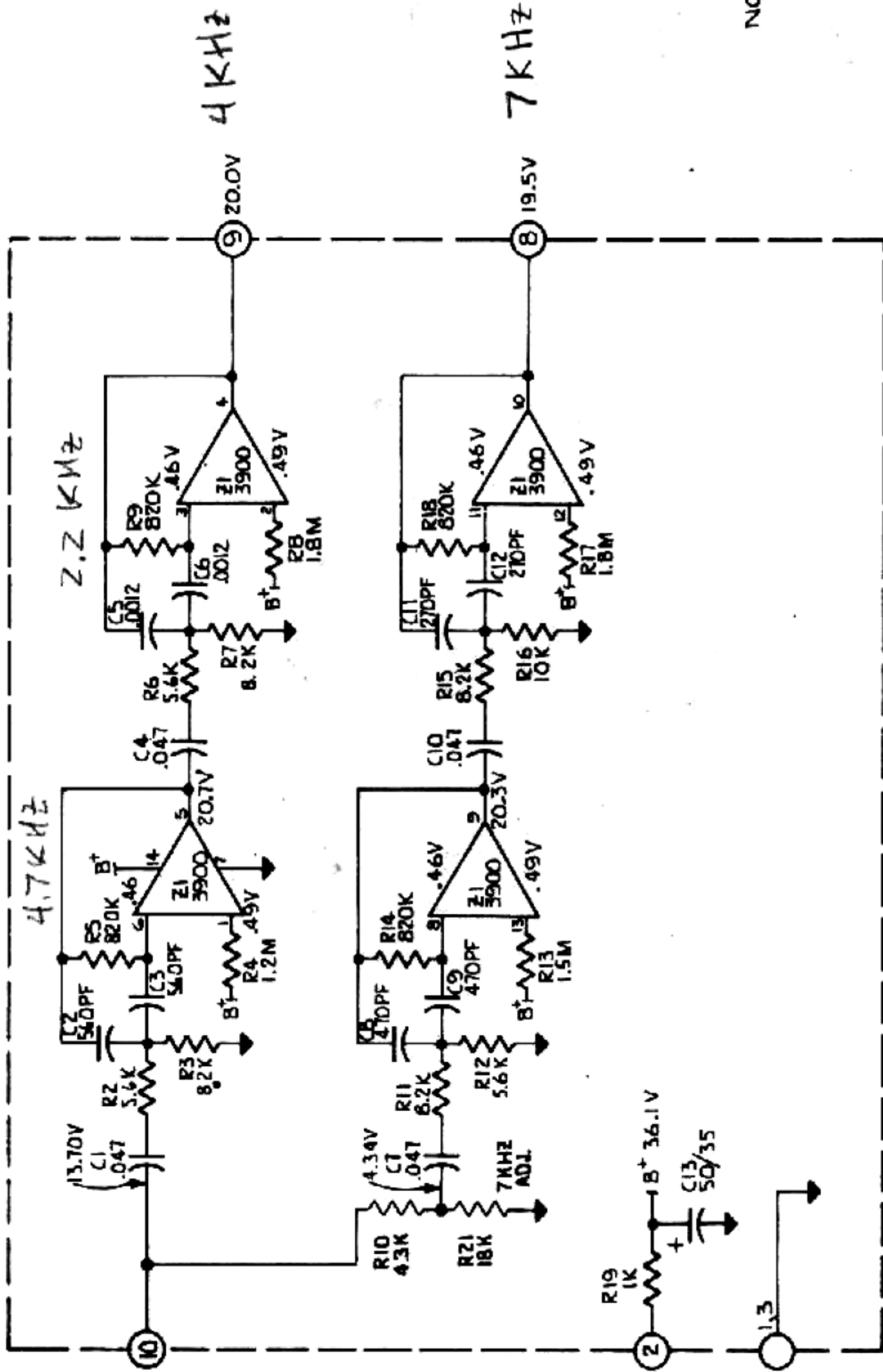
C	PLIO	402429	REV	F
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SCHEMATIC

- A- SAME AS B EXCEPT R2 IS 180K.
- B- SAME AS C EXCEPT R6 IS 39K.
- C- SAME AS D EXCEPT R8 IS 2.2K.
- D- SAME AS E EXCEPT C4 IS 820PF.
- E- SAME AS F EXCEPT OMIT D5, D6, C14.
- F- SAME AS O1 EXCEPT R5 IS 39K, C3 IS .001/100, C4 IS 390 PF/100, C13 IS 100/55.

- 1 JUMPER, Z1 IS MFC 6040 AND OMIT R21, R22, R23, R24, C15, C16, D7, D8 O1-SHOWN

D1 THRU D4 ARE IN34
D5 THRU D8 ARE INM48



NOTE: ALL VOLTAGES SHOWN ARE D.C. AND MAY VARY ±10% FROM THE NOMINAL VALUES SHOWN.

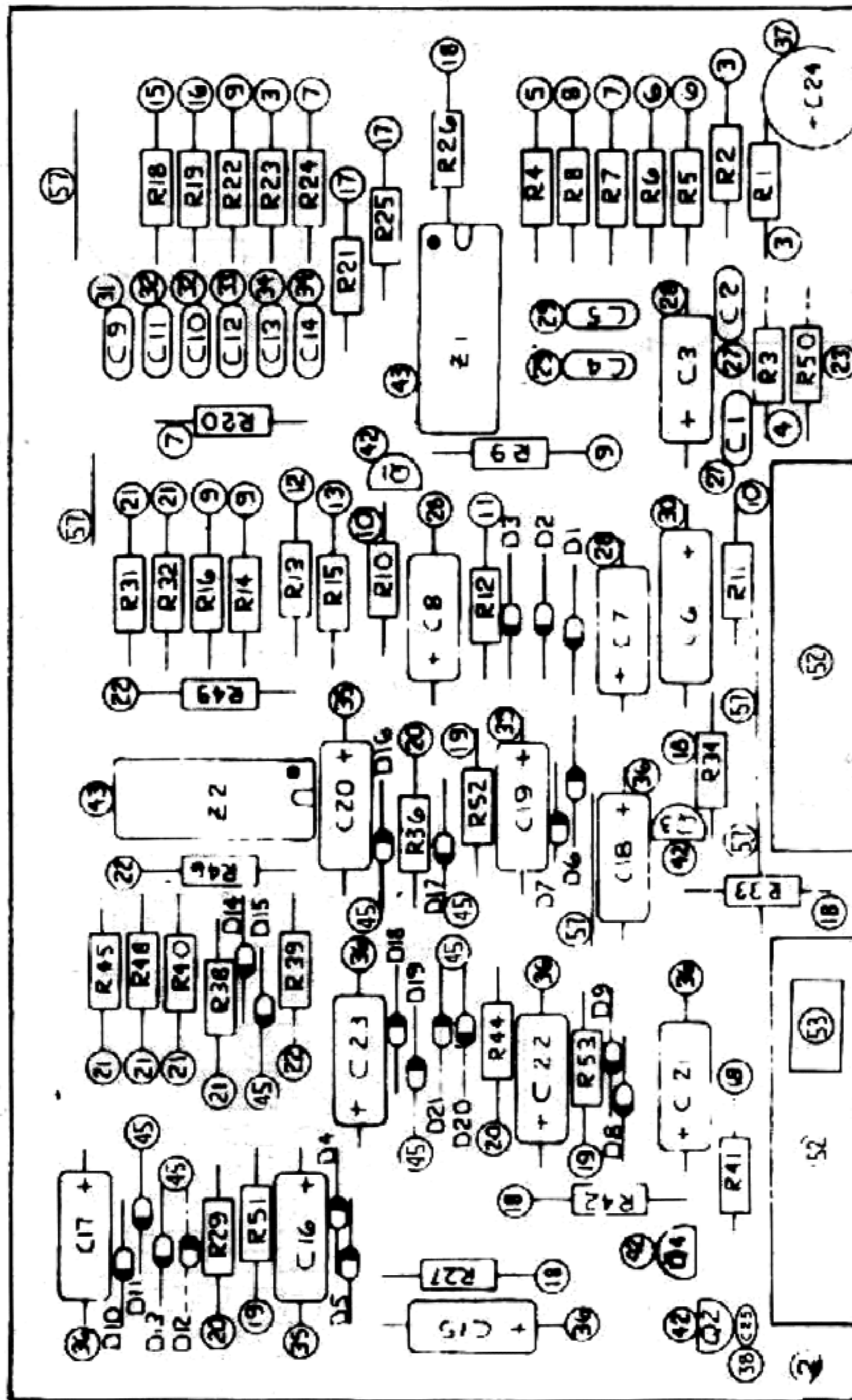
SCHEMATIC PLO9E

- A - SAME AS B EXCEPT OMIT R19 & C13.
- B - SAME AS D EXCEPT R8 & R17 ARE 15M.
- E - SAME AS F EXCEPT R1 & R20 ARE A 25K POT, R10 & R21 ARE A 25K POT.
- D - SAME AS E EXCEPT R19 IS 10Ω.
- F - SAME AS G EXCEPT R10 IS 13K, R20 IS 20K, R1 IS 5.6K, R21 IS 12K.
- G - SAME AS H EXCEPT R2 IS 75K, R5 IS 680K, R3 IS 20K, R6 IS 2.2K, C2 & C3 ARE 470PF.
- H - SAME AS J EXCEPT ADD DIVIDER TO TOP (4KHZ) INPUT.
- J - SAME AS K EXCEPT R10 IS 75K.
- K - SAME AS OI EXCEPT ADD 1 JUMPER.
- OI - SHOWN.

DRAWN	KNOBEL	8/28/73
CHECKED	W. S. ...	10/1/73
APVD	M.P.S.	10/8/73
RELEASE STATUS		
PREL	W.P.S.	10/1/73
FINAL		

PHASE LINEAR
CIRCUIT BOARD
BANDPASS 1

C	PLO9	402434	REV J
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D1 THROUGH D18 ARE IN4148

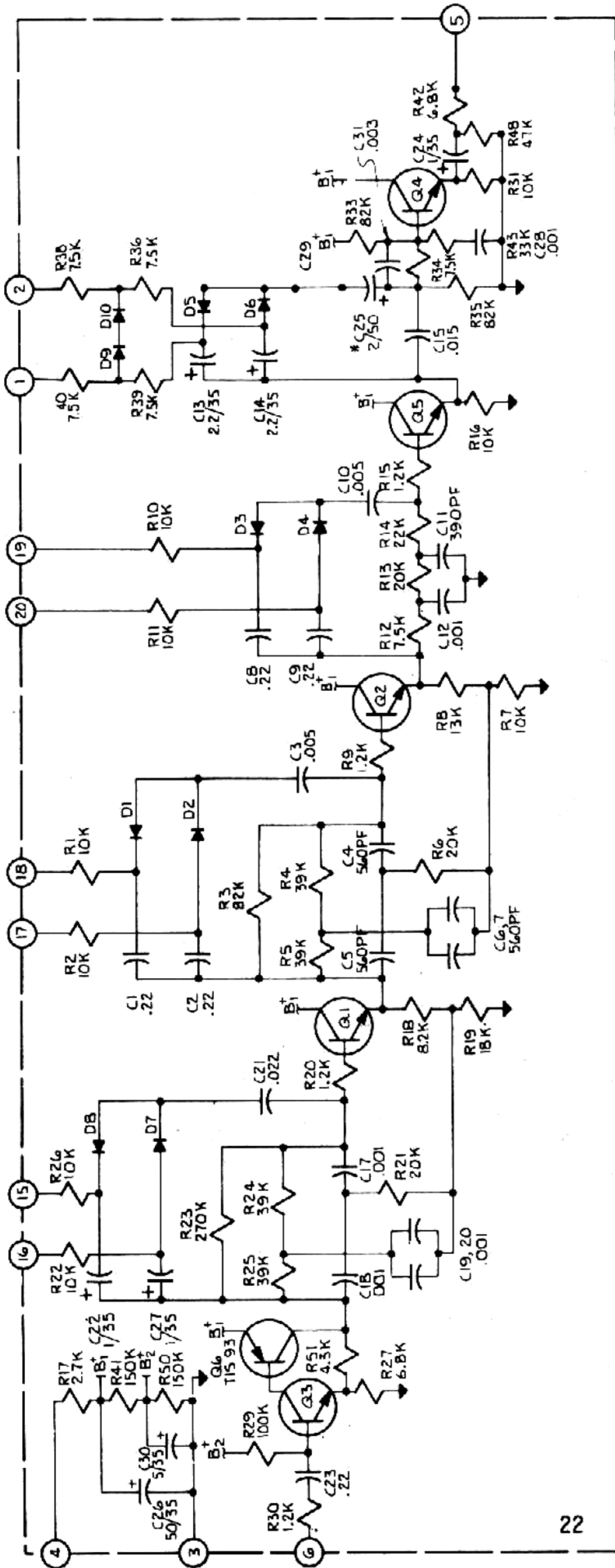
OZ ASSY BANDPASS 2 PLOT 84500

F - SAME AS G EXCEPT R18 IS 82K.
 ADD R17, A 25K LINEAR POTENTIOMETER.
 G - SAME AS OI EXCEPT DELETE C25
 OI - SAME AS OZ EXCEPT C25 IS MOD ON BACK OF PCB.
 OL - HOLDING

DRAWN PICKENS 7 24 74		CHECKED KNOBEL 7 25 74	
APPROVED		RELEASE STATUS	
DEC 1 1 DEC 008		PREL	
DEC 2 01 4 DEC 0088		FINA	
ANGLES - 0° 30'		REMOVE BURRS BRK SHARP EDGES	
MACH SURFACES		MACH	
MATERIAL		FINISH	
MOUNT TREAT		MOUNT TREAT	
SIZE	DWG NO	REV	SHEET OF
C	402430	H	2

Phase Linear

PCB ASSY
 BANDPASS 2



NOTE C25 MUST BE LOW LEAKAGE TYPE.
 Q1 THRU Q5 ARE 6ES9T

SCHEMATIC PL15
 F - SAME AS G EXCEPT C31 IS .005,
 R23 IS 470K R3 IS 150K.
 G - SAME AS H EXCEPT ADD 3 JUMPERS.
 H - SAME AS OI EXCEPT Q1 THRU Q5
 ARE 1T59T.
 OI - SHOWN

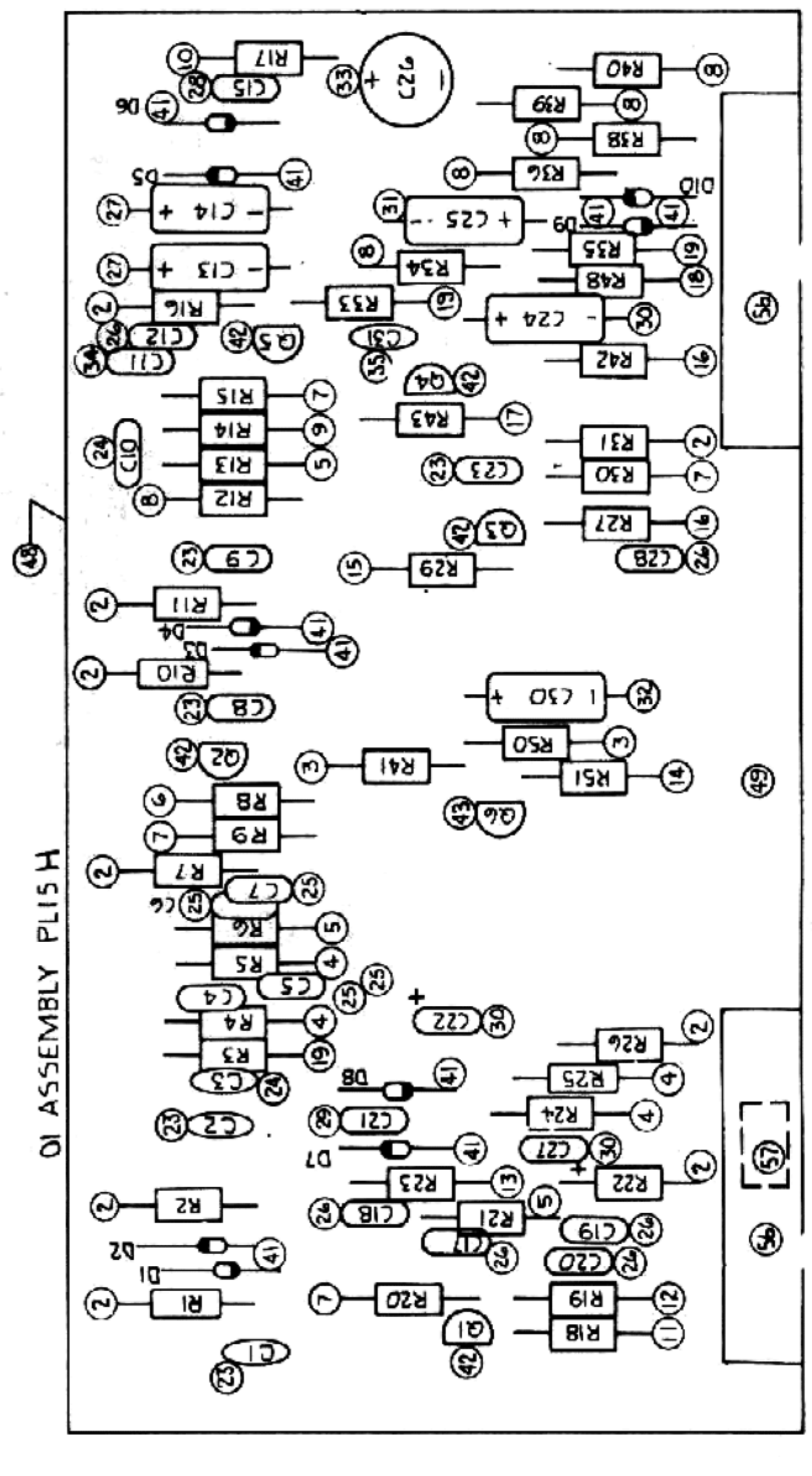


DIAGRAM III-15

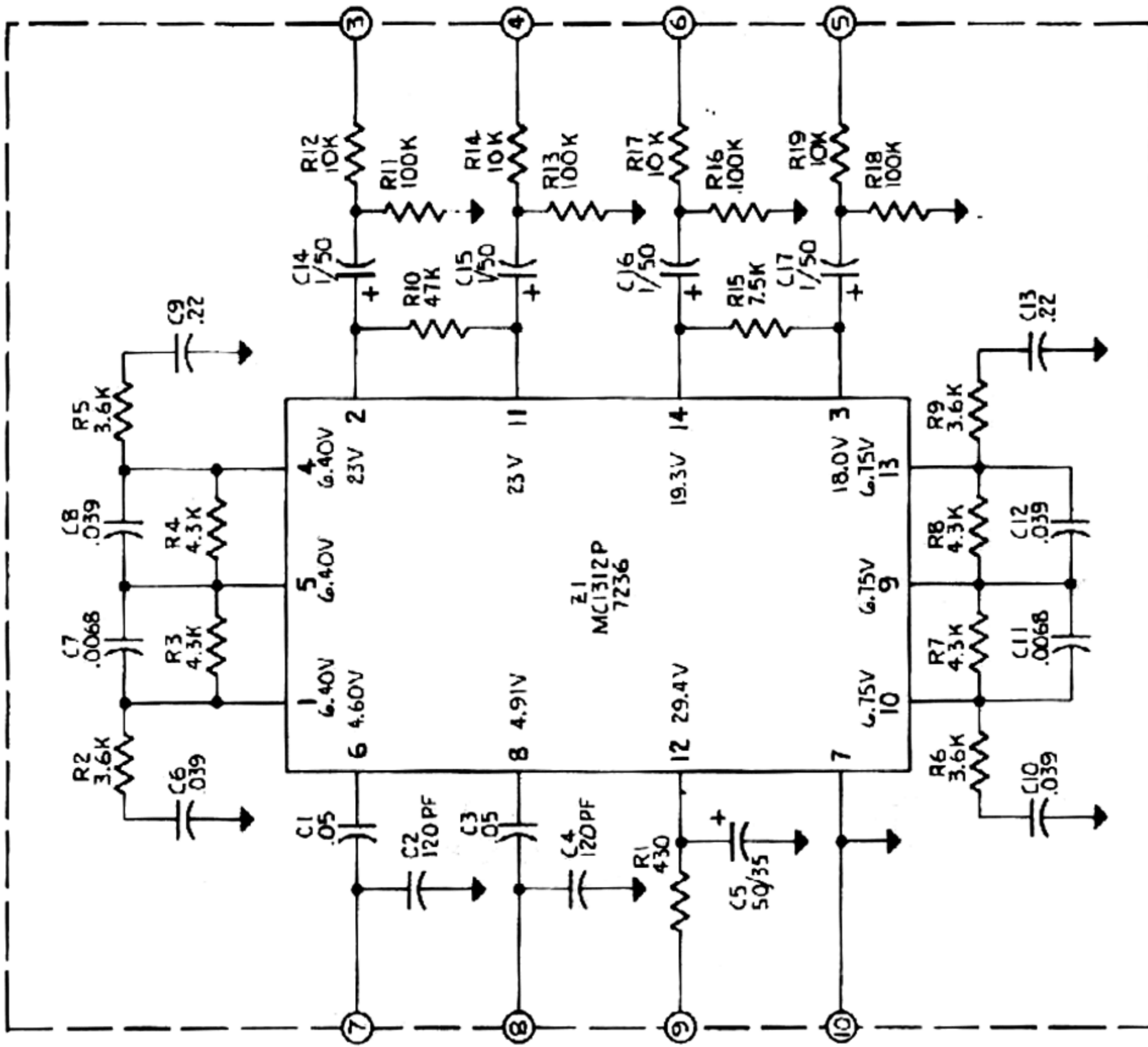
DRAWN	KNOBEL	4-16-74
CHKD	J.C.	4/17/74
APVD		
RELEASE STATUS		
PREL		
FINAL		

PHASE LINEAR
 CIRCUIT BOARD
 CORRELATOR

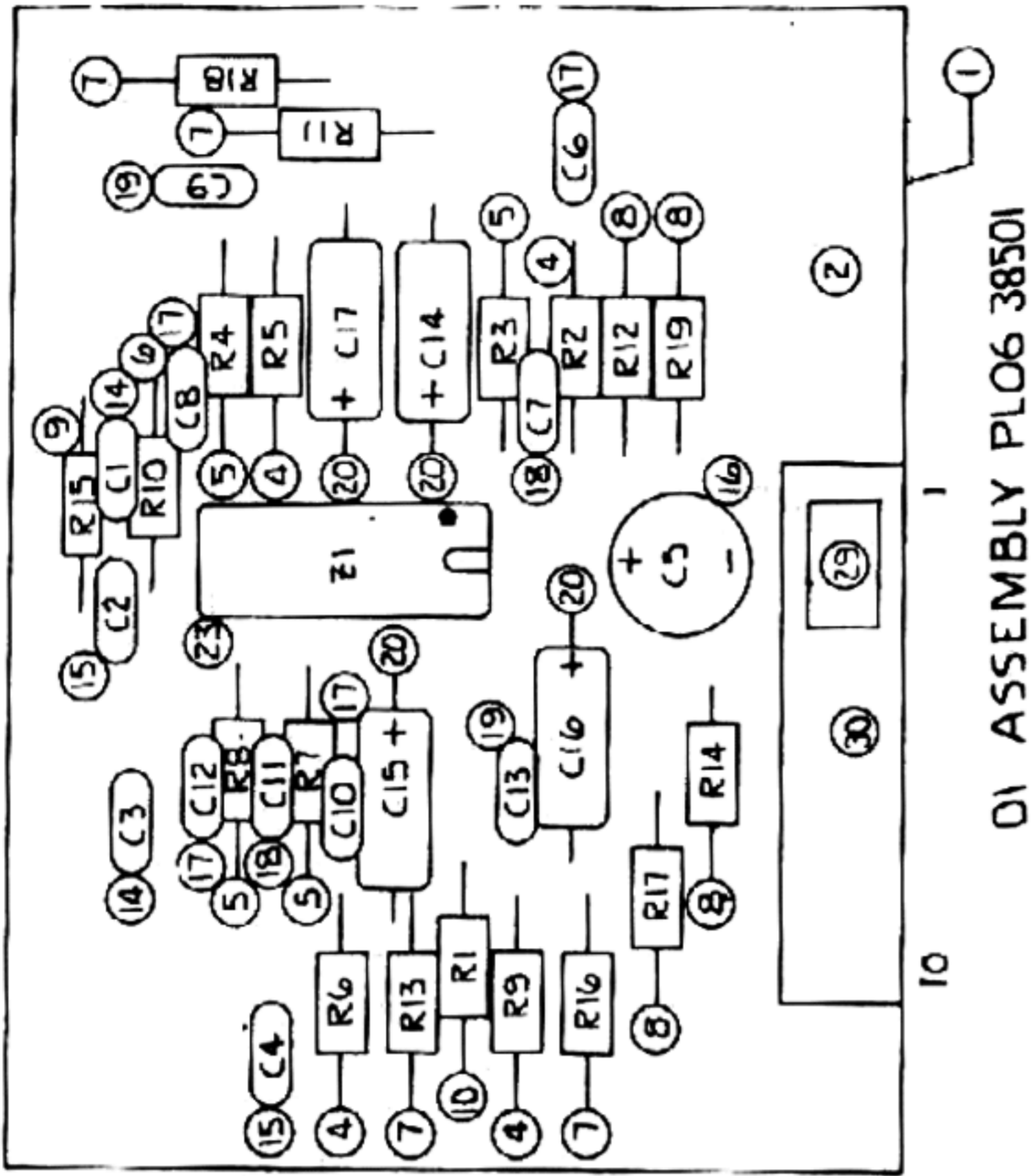
PL15 402441

REV F

PAGE 1 OF 1

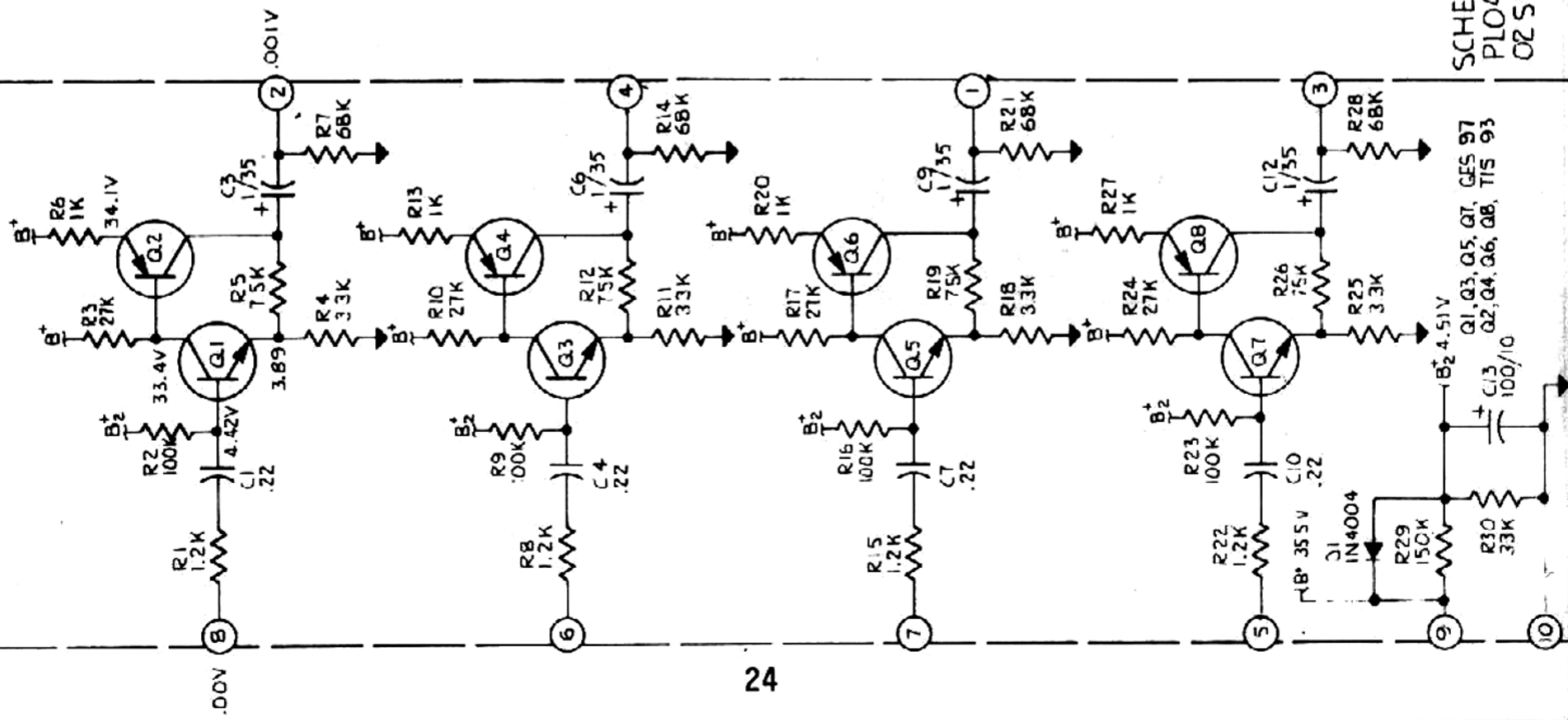


SCHEMATIC PLO6
 A - SHOWN EXCEPT R12, R14, R17, R19 ARE 22K
 B - SAME AS 01 EXCEPT PARTS DON'T FIT P.C.B. AS WELL.
 01 - SHOWN

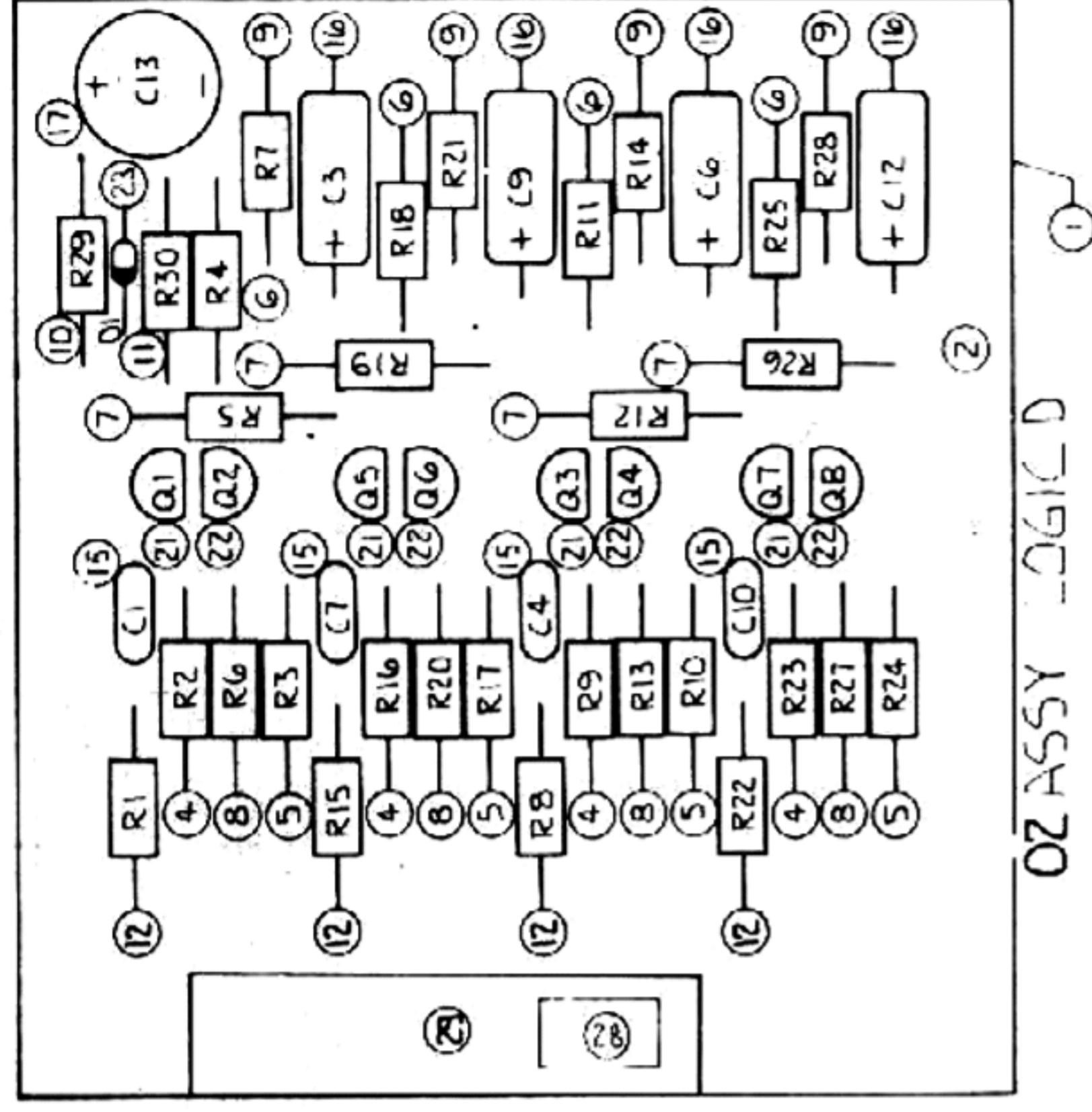


NOTE: VOLTAGES SHOWN ARE D.C. AND MAY VARY ±10% FROM THE NOMINAL VALUES GIVEN.

DRAWN	KNOBEL	6/13/73
CHECKED	W. Str...	8/8/73
APVD	WDS	10/1/73
RELEASE STATUS		
PREL	WDS	10/1/73
FINAL		
PHASE LINEAR CORP		
CIRCUIT BOARD DECODER		
SIZE	C	PLO6
DWG. NO.	402423	
REV	D	



SCHEMATIC
PLO4
02 SHOWN



NOTE: D.C. VOLTAGE FOR EACH AMPLIFIER PAIR ARE SIMILAR. ALL VOLTAGES SHOWN ARE D.C. AND MAY VARY 50% FROM THE NOMINAL VALUES GIVEN.

DIAGRAM III-17

DRAWN	J. KNOBEL	JAN 23, 74
CHECKED	J.C.C.	1/24/74
APVD		
RELEASE STATUS		
PREL		
FINAL		

NOTE:
FOR ASSY:
B- SAME AS C EXCEPT R4, 11, 18 & 25 ARE 27K, R5 12 19 & 26 ARE 10K, R29 IS 150K, R30 IS 22K.
C- SAME AS D EXCEPT R29 IS 160K.
D- SAME AS E EXCEPT 01.
E- SAME AS F EXCEPT C3, 6, 9, & 12 ARE 5/35.
F- SAME AS 01 EXCEPT EXTRA HOLES
01- SAME AS 02 EXCEPT Q1, Q3, Q5, Q7 ARE 1T53T
02- SHOWN

PHASE LINEAR
CIRCUIT BOARD
LOGIC

PLO4	402440	REV	G
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Schematics and Design History (Cont'd)

Compatibility Schedule:

The following boards are interchangeable in all units:

1. RIAA
2. Log Amp
3. Bandpass I
4. Bandpass II
5. Decoder

The following boards are not compatible in all units and should be modified as noted.

6. Correlator -- there are two types: 5-transistor and 6-transistor. The 6-transistor type may only be replaced with the same type. A 5-transistor board may be replaced by a 6-transistor board if it is modified as shown in diagram III - 18.
7. Logic -- some earlier units contain 4-transistor logic boards. These should be replaced by the present 8-transistor type. Only the 8-transistor type should be used in any unit, and these are all interchangeable.
8. Peak Unlimiter -- the new large peak unlimiter board (PL08E) is not interchangeable with the older, smaller sized board with trim pots (PL08A thru D).
9. Tone Amp -- the older tone amps (PL03A) have slightly more gain but may be replaced by newer tone amps (PL03B,C,D). Do not, however, use a (PL03A) in place of any other.

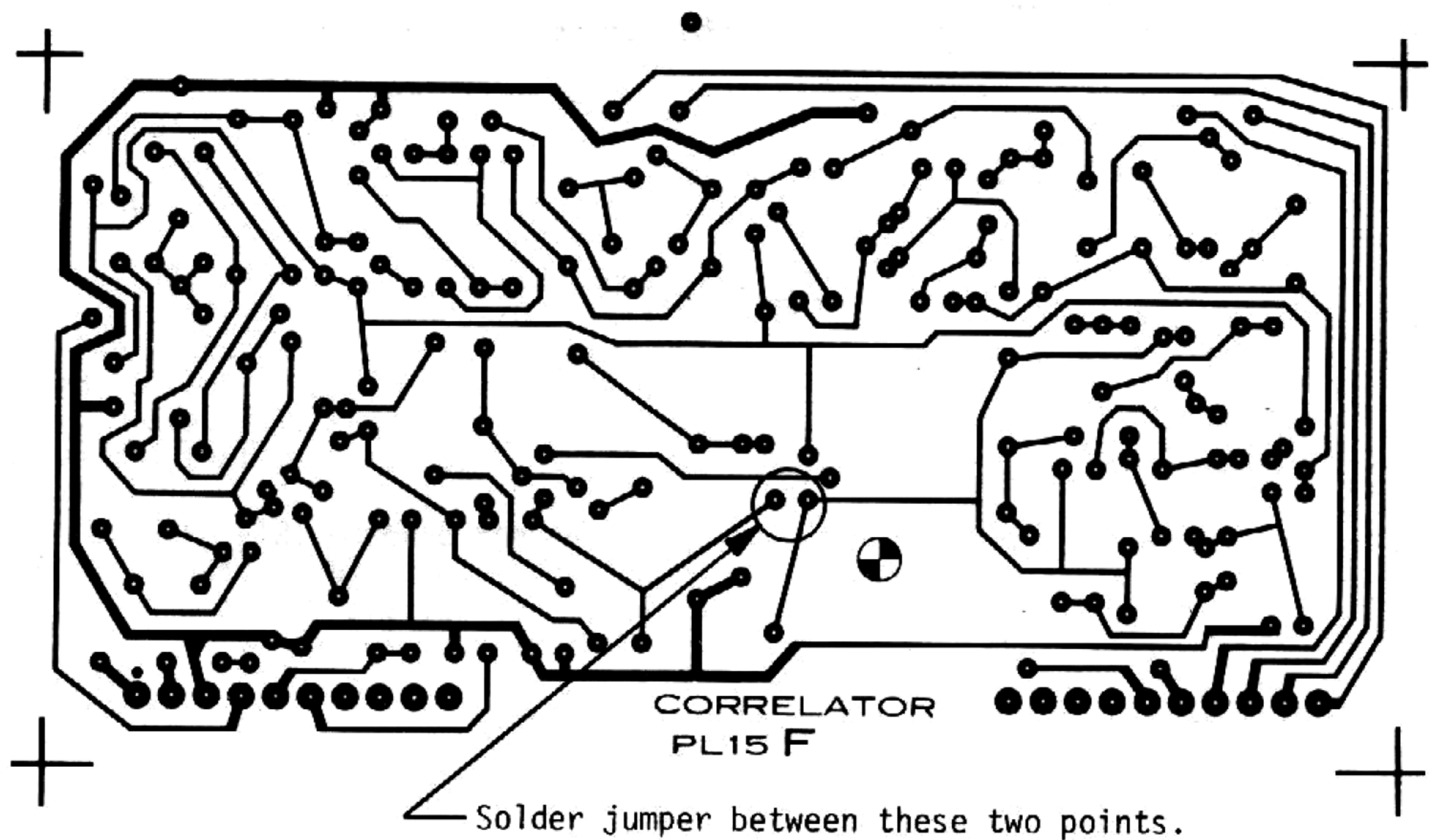


DIAGRAM III-18

IV. DISASSEMBLY

Although only the top cover need be removed for most repairs, the following steps outline the simplest procedure for any stage of disassembly.

Step #1. Remove 6 phillips screws on the top and 2 on each bottom lip of the top cover. Spring sides outward and pull up to remove top cover.

Step #2. To gain access to the bottom of the mother board, remove remaining 8 screws on the bottom of the unit and slide the bottom plate out either side. On older units (S. N. prior to 2000), the bottom plate is one piece with the front panel plate; to remove these:

- a) Remove remaining 5 screws on the bottom of the unit.
- b) Pull off the switch handles and remove all knobs with 1/16 inch and 5/64 inch allen wrenches.
- c) Remove six 1/2 inch nuts (some may be 9/16) from the control pot shafts.
- d) Pull front panel forward while grasping rear rail.
- e) Note the position of the joystick and accessory jack connectors and unplug these for complete separation.

Step #3. To gain access to input/output jacks, remove the three phillips screws on the bottom lip of the rear rail, then remove the three phillips screws which are in line with the input/output jacks. A service loop enables the panel to swing away from the jacks for complete access.

Step #4. Assembly procedure--reverse the above steps.

V. TEST AND ALIGNMENT PROCEDURE

The following is a test procedure for verifying proper operation of all functions of the 4000. If the unit being tested does not pass any of these tests, refer to Section VI, Troubleshooting Guide, for suggested repair procedure.

Step #1. With selector switch on AUX, drive the Aux input with 250 mv @ 2K Hz, all special circuits out. Observe main outputs with scope and voltmeter and verify sine wave when the volume control is turned up (some adjustment of the joystick may be necessary to balance the channels). Repeat for tuner and tape 2 inputs

Step #2. Turn up input level slowly and verify at least 5 volts RMS at output before clipping.

Step #3. With the selector switch at Phono 2, drive the Phono 2 input with 10 mv @ 2K Hz. Verify signal at output with volume control turned up. Repeat for Phono 1.

Step #4. With the selector switch at Tape 2, drive the Tape 2 inputs with 250 mv @ 2K Hz. Observe main outputs and turn up volume control to 1 volt RMS out. Rotate the Peak Unlimit Threshold knob fully clockwise and switch the Peak Unlimiter in. Verify that the signal has increased by 2.5 to 4dB. Verify also that the Peak Unlimit LED is lighted.

Step #5. Rotate Peak Unlimit Threshold knob fully counterclockwise and verify that the output signal has dropped 7 to 9dB both channels and that the LED is not lighted. Switch the Peak Unlimiter out.

Step #6. Switch the Active Equalizer in and verify less than 2dB change in output signal level @ 2K Hz.

Step #7. Repeat step #6 @ 20 Hz and verify increase of 7 to 10dB in output signal level.

Step #8. On models with serial number larger than 2500, repeat step #6 @ 20K Hz and verify increase of 2 to 4dB in output signal level.

Step #9. Switch Active Equalizer out.

Step #10. Put the -20dB switch in the down position. Verify that the output signal is attenuated 20 to 22dB on units prior to #2000 and 13 to 15dB on units above #2000. Flip the -20dB switch up.

Step #11. Put the 2 channel switch up to the 4 channel position and verify that there is less than 2.5dB gain difference in the output signal.

Step #12. Observe the rear left and right outputs and verify that the signal level is 6 to 8dB lower than the front channels. If dual trace scope is available, verify that the left and right rear channels are 180 degrees out of phase. Switch back to the 2 channel position.

Step #13. Observe signal at main outputs. Unplug one of the inputs and verify that the appropriate output signal is removed. Put the Stereo/Mono switch in the Mono position and verify that the signal is present in both outputs, attenuated approximately 6dB. Switch back to Stereo and reinsert input.

Step #14. With input level of 250 mv @ 2K Hz, rotate the Correlation Threshold knob fully clockwise and switch the correlator in. Now rotate the Correlation Threshold knob fully counterclockwise and verify 2 to 4dB attenuation of output signal.

Step #15. Repeat step #14 @ 4K Hz and then at 7K Hz; verify 8 to 10dB of attenuation.

Test and Alignment Procedures (Cont'd)

Step #16. Repeat step 14 @ 20K Hz. Verify increase of 1.5 to 2.5dB and attenuation of 6 to 8dB in output level.

Step #17. Switch the input signal to 20 Hz, 250 mv; with Correlator in, rotate the LF Cal adjustment fully counterclockwise from the full clockwise position. Verify attenuation of at least 12dB. Rotate LF Cal fully clockwise and switch Correlator out.

Step #18. With the generator still at 20 Hz, switch the tone controls in. Verify separate operation of the bass tone pots, with + 9dB @ the 150 Hz turnover position and + 7dB at the 40 Hz position.

Step #19. Switch the generator to 20K Hz, and with tone circuit still in verify separate operation of the treble pots with + 11dB at the 2K turnover position and + 7dB at the 8K Hz position.

Step #20. To verify proper operation of the tape monitor functions:

- a) Apply signal to Tape 2 inputs, selector switch at AUX.
- b) With Tape 2 copy switch up verify signal at the Tape 1 and 2 outputs.
- c) Put the Tape 2 copy switch down to Source and verify that the signal is removed from the Tape 1 and 2 outputs.
- d) Apply signal to Aux input and verify return of signal to the Tape 1 and 2 outputs (Tape 2 copy switch still down).
- e) Apply signal to Tape 1 inputs and verify signal at main outputs with the Monitor Source/Tape 1 switch down. Put this switch up in the Source position and verify that signal is removed from the main outputs.
- f) Apply signal to Aux with selector switch at Aux and verify return of signal to main outputs.

VI. TROUBLESHOOTING GUIDE

This section is presented as an aid to successful troubleshooting of the 4000. Probable causes and solutions are listed according to symptom, the main categories being:

- A. No Signal
- B. Distorted or Intermittent Signal
- C. Special Circuit Malfunctions
- D. Miscellaneous

This section will be continually updated to keep abreast with any design changes or new problems which are discovered. Should you encounter a problem which is not listed in this section we would appreciate hearing from you.

A. No signal.

1. LED not lighting:

- a) Check power supply fuse.
- b) Check power supply transistor(s).
- c) Check zener diode (D7).
- d) Check rectifier diodes.
- e) Check diode on relay.

2. LED lighting, but no signal:

- a) Check voltage on emitter of Q1 (2N3055) for 32 VDC.
- b) Put selector switch to Tape 2, drive Tape 2 inputs with 250 mv @ 2K Hz. Check for signal at Tape 2 outputs; if no signal, check selector and front panel connectors and solder joints on male pins. If signal is present at Tape 2, but not at main outputs, check connectors on logic and tone amps or replace these with test boards. Check volume control circuit.
- c) Clean all molex connectors as outlined in Section VI, B #3.

B. Distorted or intermittent signal.

- 1. Check emitter of Q1 (2N3055) for 32 VDC.
- 2. Check tone amp, logic and volume control boards for:

- a) Broken solder joints on molex connectors.
- b) Dirty connectors.
- c) Loose or unsoldered parts.
- d) Broken solder joints on mother board connectors.
- e) Replace tone and/or logic boards with test boards if they are available.

- 3. Check and clean the front panel-mother board connectors as follows:

First observe the line of connectors between the front panel board and mother board. If these are plug-in connectors proceed with step B. If these are soldered wire connectors, skip to step L.

- a) Remove top cover (10 phillips screws). Spring sides out then pull straight up.

Special Circuit Malfunctions (Cont'd)

- a) One channel dead: Replace correlator board or locate and replace defective correlator transistor or broken solder joint on connector. Check also the solder joints on the correlator connectors underneath the mother board.
 - b) Highs drop out when correlator switched in regardless of threshold position:
 - (1) Press down on all PCB's to be sure that they are firmly seated on connectors.
 - (2) Be sure that there is sufficient input voltage; 250 mv in line inputs. (Check for low-output cartridge).
 - (3) If test boards are available, replace BP I, BP II, and Log Amp. Verify normal operation of correlator. Now replace these boards one at a time with the original ones to determine which is the defective. Once the defective board(s) is located, replace one or both IC's on the board to restore normal operation.
 - (4) If test boards are not available, the following will help you to locate the defective board: Perform steps 14 thru 17 in Section V. Note which of the test frequencies remains fully attenuated regardless of the threshold rotation. If it is 4K or 7K, replace Z1 on BP I. If it is 20K or 20 Hz (LF Cal) replace Z1 and/or Z2 on BP II. If replacement of IC's on BP I and BP II does not yield results, then replace Z1 and/or Z2 on the Log Amp.
 - (5) Check solder joints under the mother board on all the 10-pin connectors--these may be cracked in rough shipment.
 - c) Excessive noise in one channel when correlator in: the cause of this is a defective (noisy) transistor on one of the correlator boards. The only way to locate the noisy transistor is to replace them one at a time until the noisy one has been eliminated. NOTE: Expect an increase in noise in both channels when the correlator is switched in--this is normal since there are active circuits involved.
 - d) Intermittent operation of correlator--sometimes sensitive to vibration: Check and resolder joints underneath the mother board on the 6 and 10 pin connectors. Spray the female connectors with tuner cleaner and press all boards firmly onto mother board.
2. Peak Unlimiter.
- a) One or both channels dead or noisy when Peak Unlimiter is switched in: Replace IC Z1 on Peak Unlimit board (IC #4136), or replace Peak Unlimit board. In some rare cases, one channel will exhibit excessive noise even after Z1 is replaced. This is due to a noisy diode, one of D1 thru D24. If a replacement board is not available, replace a group of four diodes at a time until the noisy one has been eliminated. On early Peak Unlimit boards matching diagram III- 8, replace Z1 and/or Z2 in case of noisy channel(s)

Peak Unlimiter (Cont'd)

- b) No Peak unlimit: First Check for proper operation of the correlator. If the correlator also does not work, then suspect problems with the summing amp, which is Q3 and Q4 on the front panel board. Connect scope input to the negative lead of C8 on the front panel board and check for presence of sine wave (drive any line input with 250 mv @ 2K Hz). If the correlator operates properly, either replace the Peak unlimit board or replace Z2, Q1.
- c) Peak unlimit LED will not flash when unit is in Phono 1 or 2 only: Verify that the Peak unlimit LED is lighted when Phono 1 or 2 is driven with 10 mv at 2K Hz. If it does not light up, replace the RIAA stage. If it does light up, check type of phono cartridge being used--some low output cartridges may not have sufficient output to drive the Peak unlimiter through the RIAA stage.
- d) Intermittent noise in both channels; noise dies away rapidly when signal is removed. The cause of this is a noisy Z2, which can be heard in the unlimit mode where there is increased gain. To eliminate this noise, replace Z2.

D. Miscellaneous.

1. Nuisance complaints.

These are complaints regarding certain idiosyncrasies of the Phase 4000 that should not be considered a failure:

- a) Volume control does not turn all the way off. This is normal. For increased volume range, use the muting switch. This feature allows a finer volume adjustment at low levels.
- b) Tone controls inoperative or not effective enough. The tone control action is extremely subtle. Malfunctions in the tone controls are extremely rare. If both channels behave the same way, it is safe to assume that they are operating properly.
- c) No signal at tape output jacks. Depress Tape 2. Copy switch. This function is different than most preamplifiers. Refer to Owner's Manual.
- d) Tape monitor switch pops. Contact us, we will send you a special switch. This only seems to happen with some tape machines.
- e) Excessive noise with muting switch in NORMAL position. This complaint will generally be with users of very high efficiency speaker systems. This is normal and the muting switch should be moved to the -20dB position. The -20dB position should be used at all times when the volume control is operated below the 12 o'clock position.
- f) Peak Unlimiter seems to have reduced effect when the muting switch is operated in the -20dB position. This is normal. In fact, the Peak Unlimiter operation has not changed at all. It is only its insertion gain that has been altered, i.e., reduced by approximately 3dB. This feature achieves maximum usefulness of the muting control.

Miscellaneous (Cont'd)

- g) Noisy 4 channel operation. The SQ circuitry is such that there is slightly more noise present in this mode than in the rest of the 4000. Trial and error substitution of the Motorola integrated circuit or complete circuit board may bring more satisfactory results.
2. Excessive turn-off thump. Eliminating turn-off thumping from earlier models requires modifying the power supply as follows: (Mother board matches diagram III-2)

Two-transistor power supply:

- a) Remove top cover and all screws on bottom of unit.
- b) Remove the three screws and nuts which are in line with the input/output jacks on the rear rail and then place unit upside-down with rear rail facing you.
- c) Pull the rear rail assembly away from the chassis to expose the back side of AC outlets and foil side of mother board.
- d) Locate the red and black twisted pair of 22 Ga. wires which lead from the power switch on the front panel. Cut both of these wires as close as possible to the AC outlets on the rear rail.
- e) Unsolder the remainder of the red wire from the fuse socket and discard this piece of wire.
- f) Locate the cut end of the remaining black wire which is connected to the transformer secondary, not to the power switch: Solder this end to the fuse socket terminal from which the red wire was removed in step e.
- g) Unsolder and remove capacitor C2, 470 or 500 mf capacitor closest to the main output jacks. Solder in its place a 220 mf, 50 volt (or greater) capacitor (be sure the negative lead of this cap is soldered to the ground land).
- h) Locate the solder terminal on the underside of the mother board which is bolted to the collector screw of Q1. Remove the blue wire from this terminal and solder in its place the free end of the black wire described in step d (running from the power switch).
- i) Run the blue wire from step h and the red wire from step d through the hole in the mother board near R9 and R10, so that the cut ends of these wire are now on the top side of the mother board.
- j) Locate the land running from the positive side of C5, diagram VI-1, and cut this land as shown in the diagram.
- k) Install a jumper wire (you can use the left over red wire from step e between the base of Q1 and the positive lead of C5 as shown in diagram VI-1.
- l) Obtain a diode 1N4004; solder the cathode end of the diode to the base of Q1 and the other end of the diode to the base of Q2 as shown in diagram VI-1, on the under side of the mother board.
- m) Turn the unit over so that it is right-side up with the front panel facing you. Locate transistor Q2 (plastic package) and clip it out of the unit completely; discard transistor.

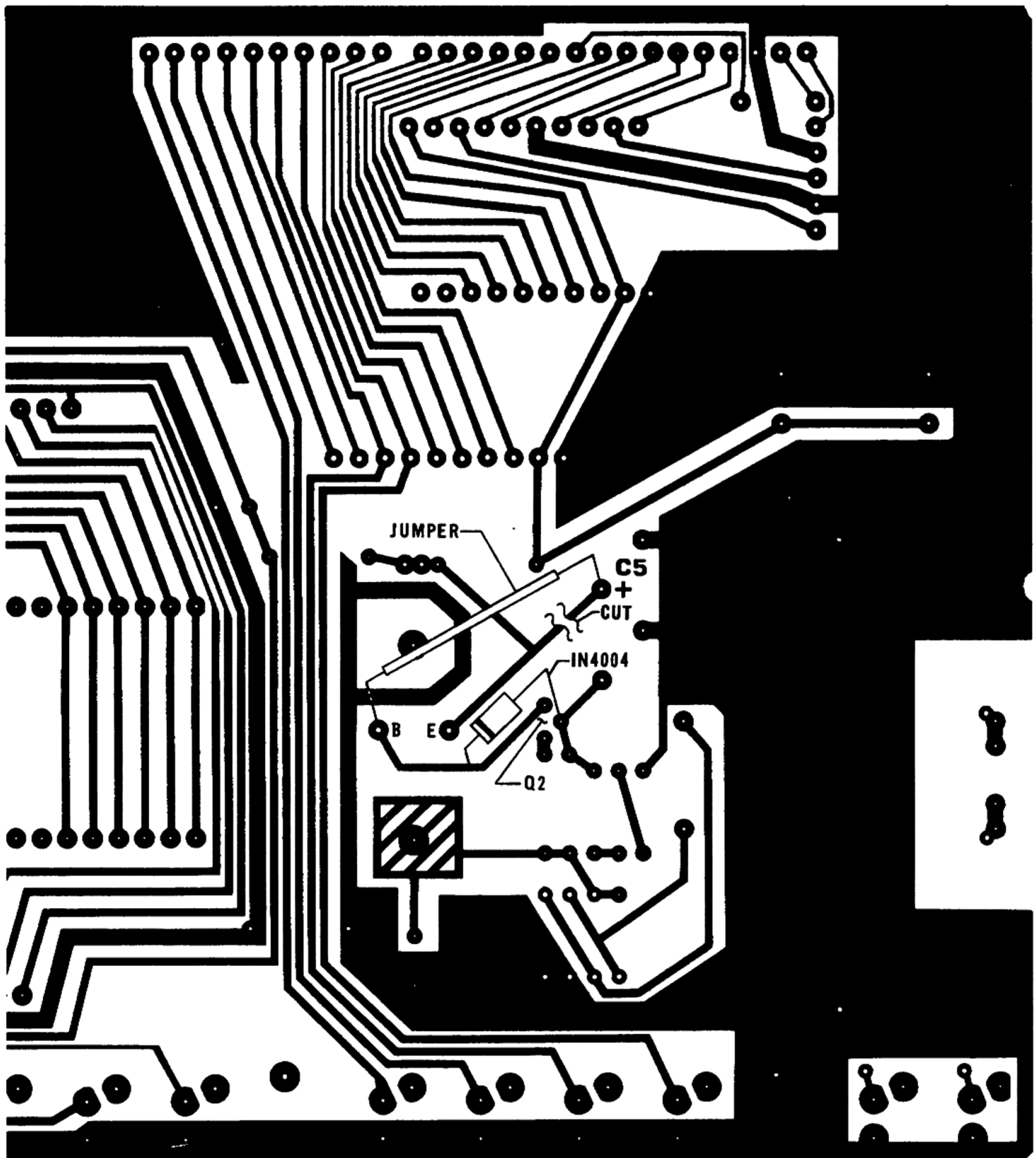


DIAGRAM VI-1

Miscellaneous (Cont'd)

- n) Locate R11, diagram VI-2 and clip this resistor completely out; discard.
- o) Locate R12, diagram VI-2; clip the end of this resistor nearest diode D2 as close to the mother board as possible. There must be enough lead left attached to the resistor to solder to. Lift this cut end of the resistor up and solder to it the red and blue wires from step i which are running up through the hole in the mother board. Tape this connection and the entire resistor so that both are well insulated.
- p) If there are two diodes between D7 and R12, install a jumper between them as shown in diagram VI-2. If there are jumper wires present already, instead of the diodes, then no additional jumper is necessary.
- q) Verify that diode D7 is a 33 volt 1N4752. If it is any other type, replace with a 1N4752.
- r) Solder a diode 1N4004 across the relay coil, cathode to positive (cathode to the left, facing relay from front).
- s) Double check all connections; with power switch off, plug in unit, turn power switch on: Verify that relay snaps in immediately and that there is +32.0 volts DC, + 1 volt, across zener diode D7.
- t) Turn unit off by means of the power switch; verify that the LED takes at least 5 seconds to turn off. Verify that there is also little or no audible thump.
- u) Reverse steps a, b and c to reassemble the unit. This completes the power supply modification.

Single-transistor supply: (Mother board matches diagram III-4)

The procedure for modifying a single-transistor power supply is the same as that previously described for the two-transistor supply, except for the following changes:

OMIT steps j, k, l, m, n and p.

3. Relay sticking, not turning switched outlets on and/or off:
 - a) Examine relay to make sure that the armature has not been jarred out of position--it should work back and forth freely. If the armature is up out of position, push it in toward the coil and downward until it snaps back into place. Be sure also that the return springs are in the proper position.
 - b) Examine the contacts. If they are badly burned or pitted, the relay should be replaced. In the case of repeated relay failure, perform the power supply modification as outlined in Section VI-D, #2. This will snap the relay in faster and reduce arcing and burning substantially. If more than one power amp is being switched, have the customer plug them into the outer two of the three switched outlets--this will ensure that they are on separate relay contacts.

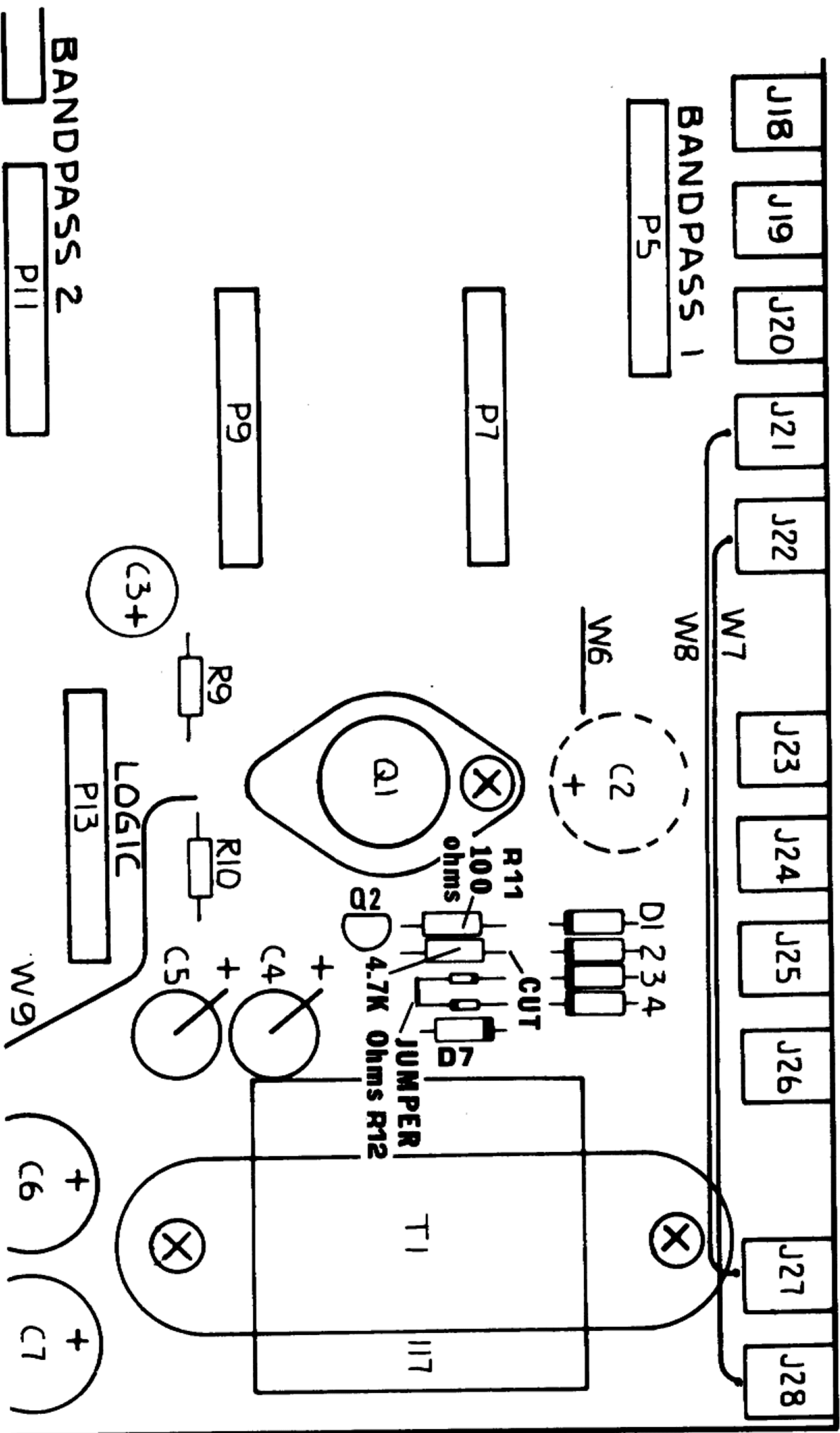


DIAGRAM VI-2

VII. SERVICE BULLETINS

This section contains copies of all past service bulletins dealing with the 4000. Any future service bulletins you receive which may apply to the 4000 should be placed in this section for your reference.

SERVICE BULLETIN

RE: MODEL 4000

Complaint: Intermittent buzzing, beeping or whistling in both channels, all selector positions.

Cause: This is actually an intermittent oscillation of one stage of Z2 on the log amp board.

Solution: This stage of Z2 can be stabilized by installing a .047 mylar capacitor in series with two 1N4148 diodes, back to back, in parallel with feedback resistor R4 (220K). Install the network on the back of the log amp board as shown in the diagram below. All 4000's with serial number higher than 3000 have this modification incorporated into the log amp board.

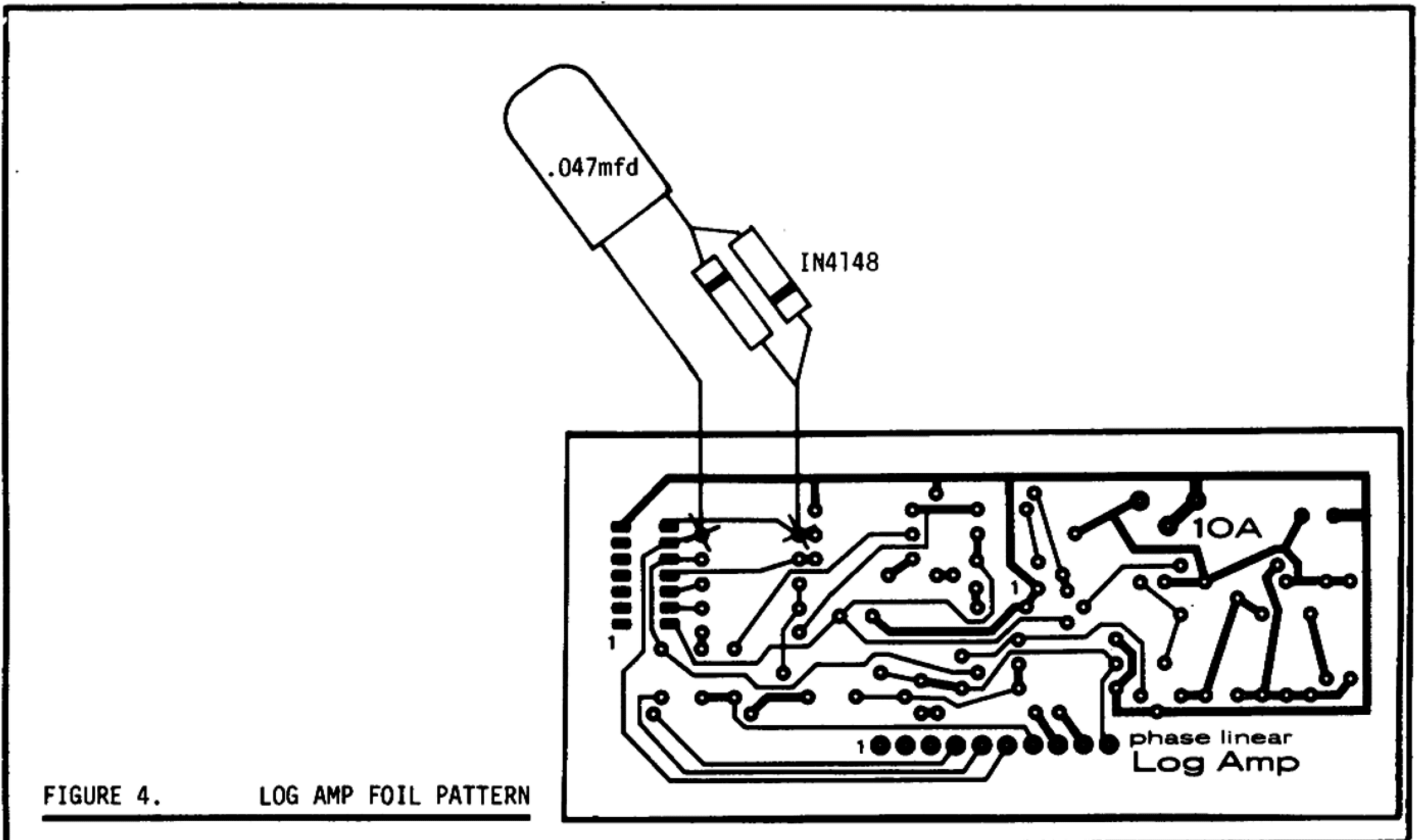


FIGURE 4. LOG AMP FOIL PATTERN