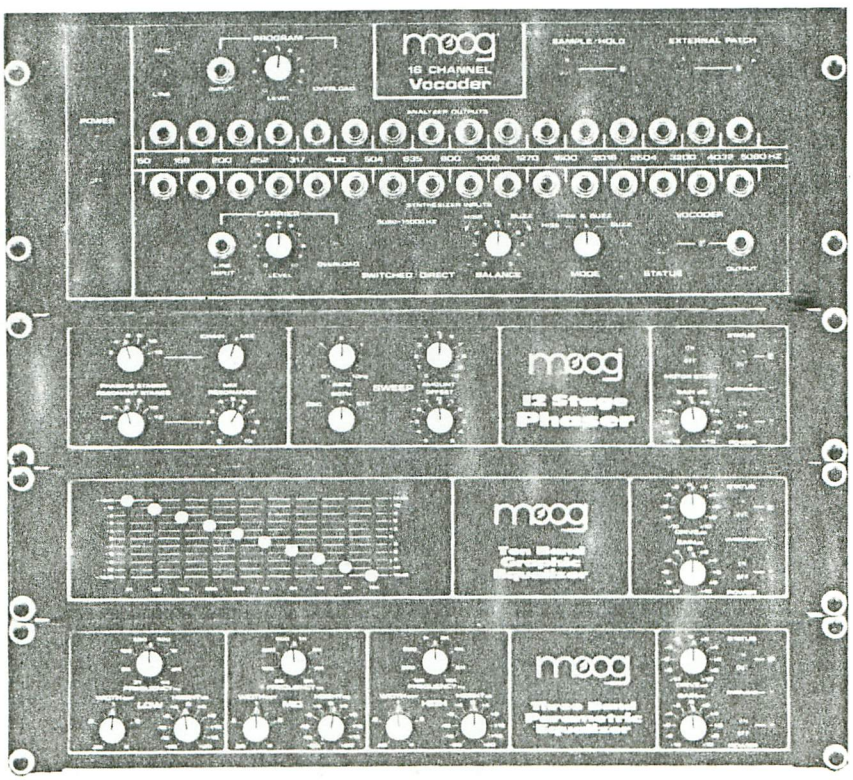
PRELIMINARY

MANUAL NO. 993-043289-001

SERVICE MANUAL
for
moog SIGNAL PROCESSORS



Norlin

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NORLIN MUSIC
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CIRCUIT DESCRIPTION 12 STAGE PHASER

The 12 Stage Phaser is a studio quality device designed for use on keyboards, guitars, bass and sound systems. When in the effects feed of a mixer board, it can be used on vocals, drums, accoustic guitar and piano. Its primary features are wide dynamic range, variable number of phasing stages, variable number of resonance stages, voltage controlled phase sweep, voltage controlled sweep rate, and stereo outputs. Like the rest of the Signal Processors, the 12 Stage Phaser has an overload indicator, insertion gain control, and electronic switching, but eliminates the drive control with a built-in compandor. The unit is housed in a sturdy metal case with reversable side handles for 19 inch rack mounting or free standing operation.

The circuitry of the 12 Stage Phaser is separated into three sections. A main audio processing board, the front panel control circuitry and a regulated power supply. The main board contains the compandors, phasing stages, motor start VCA s, electronic audio switches, overload detector, and output amplifiers. The control circuit contains the status drive, exponential current sources, current controlled rate oscillator and, of course, all the front panel controls and indicators. The power supply consists of a dual primary transformer, full wave bridge rectifier, and a preset ± 15 volt regulated power supply with pass transistors.

The input signal is fed to a compressor-limiter which reduces the dynamic range of the input signal to reduce distortion and noise. The compressed signal is fed to the phaser shift chain. The PHASING STAGES switch selects the desired number of stages used and feeds that to the CHAIN/MIX switch. The RESONANCE STAGES switch selects the number of phasing stages connected in a positive feedback loop. The MIX RESONANCE control varies the amount of feedback and, therefore, resonance.

The CHAIN/MIX switch selects either the direct output of the phase shift chain or mixes that output with the compressed input signal to produce the characteristic phasing notches. The selected signal goes through motor start VCA, which will be discussed later. The signal is then routed to the expander to restore the dynamic range and fed to the INSERTION GAIN control, the electronic switches and the + output amplifier.

The -output is synthesized fron the expanded phasing signal. The expanded signal s fed to an inverting summer and the original inputsignal is fed to the other half of the CHAIN/MIX switch. In the CHAIN position, the resulting outputis a 180° out-of-phase expanded version of the phsing chain. In the MIX position, the summation ofthe input and the phasing signal result in phasing notches spaced between the notches of the +phasing output. This output goes to the other half of the INSERTION GAIN control, the electronic switches and to the - output amplifier.

The phasing chain is current controlled and driven by a linear voltage to exponential current converter. The input of the converter is the OFFSET control, the internal triangle rate oscillator, or an external source. The OFFSET control varies the standing current in the phasing chain whichsets the center point phase shift. The SWEEP SELECTOR switch chooses the triangle oscillator and/or the external source. The triangle oscillator is voltage controlled and its rate (frequency) is controlled by the front panel RATE control or an external source. A flashing red LED indicates the rate of the internal oscillator.

The STATUS switch or a foot switch can activate the electronic switches putting the phaser in line and lighting the yellow STATUS LED. The use of the foot switch disconnects the front panel STATUS switch.

A motor start simulation circuit is also provided. Phasers are often used to simulate a rotating speaker used with organs. A speaker has inertia and when started from a stop, it takes time to reach operating speed. In the phaser, this effect is produced electronically. The motor start waveform generator produces a slowly increasing ramp voltage which controls two separate circuits; the rate oscillator and the motor start VCA s. The ramp slowly increases the frequency of the rate oscillator to simulate the increase in rpm's of the speaker. The ramp also slowly turns off the VCA feed from the input signal and slowing turns on the signal feed from the phaser. When the STATUS switch is turned off, the ramp decreases slowly and all the functions are reversed, simulating the stopping of a rotating speaker. The total effect is a good imitation of a rotating speaker starting, coming up to speed, and slowing to a stop.

Starting on the main audio processor board, we now take a more detailed look at the phaser circuitry. The input signal from J1 is first processed by the compressor-limiter which is a closed-loop design based on a conventional technique with modifications. The gain control amplifiers are followed by a full wave rectifier and an envelope detector which converts the input signal into a DC gain control signal. This signal is applied to the gain control elements forming a negative feedback gain control loop. As signal level increases, the DC control signal increases, causing the gain to decrease. Therefore the circuit acts as an automatic gain control. At low levels, the first gain control amplifier has gain to boost the signal level. At high levels, the second gain control amplifier has attenuation to reduce gain. Therefore, the amplifiers compress the dynamic range of input signal and hence the name compressor.

The input signal from J1 is applied to A4 and the gain of A4 is controlled by one-half of RAT1, an encapsulated module consisting of a LED and a center tapped photo resistor. A4 has a maximum gain of 20dB and a minimum gain of 0dB. R15, RAT2, and A5A form a linear limiter with a maximum gain of unity and a minimum gain of approximately -20dB. The limiter feeds inverter A25 and full-wave rectifier A8. A8 amplifies the signal by 26dB and applies it to rectifier diodes CR11 and CR12 which feed a special envelope detector comprised of R49, CR13, and C26. A conventional envelope detector has a fast attack and a slow exponential decay. This modified envelope detector has a 6.8ms attack, a 50msec zero decay band, and a relatively fast 68msec decay.

A9B compares the voltage stored on C26 with the pulsating DC feed across R46. When the level on C26 is higher, A9B's output jumps negative indicating that attack phase is complete and starts a 50msec timer composed of CR14, C27, R4, Q5, and Q6. R54 discharges C27 and Q5 follows that voltage. In approximately 50msec, the voltage on Q5 reaches zero volts, Q6 saturates, Q7 turns on and C26 is discharged through R52.

The timer has a reset capability through A9B and CR14. If the voltage on R46 rises equal to or above the voltage stored on C26, A9B will jump positive and reset the timer through CR14. Q7 will remain off and the voltage on C26 will n the new level or hold at the old stored va fore, in the case of a sinewave input above timer will be reset with every cycle and C2 its stored value with no ripple.

The voltage on C26 is level shifted and by A9A and applied to Q3 and Q4. At ir levels below -50dBm, C26 stays at 0 volts stays at -7.5 volts. Q3 is turned on and Q off. The current from Q3 is fed to RAT1 the maximum gain of A4. R59 sets th +20dB. RAT2 receives no current, there has a gain of 0dB. As signal levels increase age on A9A approaches 0 volts, the curren Q3 decreases, causing RAT1 resistance t which reduces the gain of A4.

At an input level of -20dB, the voltag is at 0 volts. Both Q3 and Q4 are shut off a fore, A4 and A5A have a gain of 0dB. An i of -10dBm turns Q4 on and reduces the gai At -5dBm and above, the current through (itself to keep the output level at appr -5dBm which results in the limiting acti CR3, CR4 and CR5 clip fast peaks to redu distortion.

A7B combines the compressed signal resonance signal and feeds the sum to shift chain. A13 to A24 form a 12 sectic controlled all-pass filter. Each section ha shift which equals 180° at DC and decreas 0° with increasing frequency. The contr fed into pin 5 of each device changes the p to frequency relationship. For example 100 microamperes of control current resu of phase shift at 1kHz. If the control c creases to 200 microamperes the 90° p occurs at 2kHz. If the current drops to amperes, then the 90° phase shift occurs and so forth. The outputs of every two p elements are routed to two switches; the STAGES selector SW7 and the RES STAGES selector SW6. SW7 selects the n stages of phasing and feeds that outp CHAIN/MIX switch SW8. SW6 selects the r stages in the positive feedback loop aro The positive feedback produces a resonan every frequency where the phase is a

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The timer has a reset capability through A9B and CR14. If the voltage on R46 rises equal to or above the voltage stored on C26, A9B will jump positive and reset the timer through CR14. Q7 will remain off and the voltage on C26 will move up to the new level or hold at the old stored value. Therefore, in the case of a sinewave input above 20Hz, the timer will be reset with every cycle and C26 will hold its stored value with no ripple.

The voltage on C26 is level shifted and amplified by A9A and applied to Q3 and Q4. At input signal levels below -50dBm, C26 stays at 0 volt and A9A stays at -7.5 volts. Q3 is turned on and Q4 is turned off. The current from Q3 is fed to RAT1 which sets the maximum gain of A4. R59 sets this gain at +20dB. RAT2 receives no current, therefore A5A has a gain of 0dB. As signal levels increase the voltage on A9A approaches 0 volts, the current through Q3 decreases, causing RAT1 resistance to increase which reduces the gain of A4.

At an input level of -20dB, the voltage on A9A is at 0 volts. Both Q3 and Q4 are shut off and, therefore, A4 and A5A have a gain of 0dB. An input level of -10dBm turns Q4 on and reduces the gain of A5A. At -5dBm and above, the current through Q4 adjusts itself to keep the output level at approximately -5dBm which results in the limiting action. CR2, CR3, CR4 and CR5 clip fast peaks to reduce overall distortion.

A7B combines the compressed signal with the resonance signal and feeds the sum to the phase shift chain. A13 to A24 form a 12 section current controlled all-pass filter. Each section has a phase shift which equals 180° at DC and decreases toward 0° with increasing frequency. The control current fed into pin 5 of each device changes the phase shift to frequency relationship. For example suppose 100 microamperes of control current results in 90° of phase shift at 1kHz. If the control current increases to 200 microamperes the 90° phase shift occurs at 2kHz. If the current drops to 0 microamperes, then the 90° phase shift occurs at 500Hz and so forth. The outputs of every two phase shift elements are routed to two switches; the PHASING STAGES selector SW7 and the RESONANCE STAGES selector SW6. SW7 selects the number of stages of phasing and feeds that output to the CHAIN/MIX switch SW8. SW6 selects the number of stages in the positive feedback loop around A7B. The positive feedback produces a resonant peak at every frequency where the phase is an integral multiple of 360°. Four stages give one peak with each additional two stages resulting in one additional peak. MIX RESONANCE control R42 controls the height of the peaks.

The CHAIN/MIX switch selects between two outputs. In the CHAIN position, the output is the phasing chain. In the MIX position, the phasing chain output is summed with the output of A7B, resulting in the familiar frequency response notches associated with phasing. At every odd integral multiple of 180°, a notch in the frequency response occurs. There is one notch associated with each two phasing stages. Therefore, the Phaser has a minimum of 1 notch (2 stages) and a maximum of 6 notches (12 stages). The +Output Null trimmer, R21, adjusts the relative amplitudes of the summed signals to obtain the maximum notch depth. The selected signal is routed to the motor start VCA A1. A1 is part of the motor start effect that will be discussed later. For the moment we will assume that A1 just passes the signal to A5B.

A5B and half of RAT2 form the limit restorer. The first half of RAT2 is a current controlled attenuator and forms the heart of the limiter. The second half forms a mirror image gain stage. If the limiter attenuates the signal by 10dB, A5B amplifies the signal by 10dB to restore it. The limit restored signal goes to the expander A6. A6 is a mirror-image of compressor A4. A6 has attenuation equal to the gain added by A4. The total effect of A5B and A6 is to restore the dynamic range of the phased signal to that of the original input signal.

The output of A6 is routed through half of the INSERTION GAIN control R60A and to electronic switch IC1. IC1 selects between the phaser output (STATUS IN) and the original input signal (STATUS OUT). With +7.5V on pin 6 of IC2, the phaser signal is routed through IC1 to A10, and the original signal feed is shorted to ground by IC2. A10 is selected for 600 ohm drive capability and supplies the +outputs.

CIRCUIT DESCRIPTION 12 STAGE PHASER (continued)

R60A controls the level of the phaser output. With -7.5V on pin 6 of IC2, the phaser feed to IC1 is shorted out by IC2 and the original signal from buffer A3 is fed to A10. The original signal appears at J2 at unity gain regardless of the setting of the Insertion Gain control.

The – output signal is synthesized from the expanded version of the +output. The output of A6 is fed through summing resistors to inverter A7A. The other end of the summing resistors goes to the other half of the CHAIN/MIX switch. In the CHAIN position, the output of A7A is the +output phasing signal shifted in phase by 180°. In the MIX position the output of A6 is summed with the original input signal. This results in phasing notches where the phase shift chain has 0° of phase shift. This occurs at the same frequencies as the resonant peaks. With no resonance feedback, the output of A7A has frequency notches that occur in between the notches of the +output. The -Null Trimpot R31 sets the notch depth to a maximum.

The output of A7A is routed through the INSERTION GAIN control R60B to electronic switch IC3. When pin 6 of IC2 is at +7.5V, IC3 passes the -phasing signal through A11 and to the -output J3. When pin 6 of IC2 is at -7.5 volts, IC3 shorts the INSERTION GAIN control feed which removes any signal from J3.

A12 detects overloads at selected points through the entire audio processing chain. A12's output changes from -15V to +15V whenever the voltage at any of the sampled points exceeds ± 10V. The output of A12 drives Q2 which lights L2 overload signifying an overload has occured.

In the process of describing the audio path, we have also covered some switches, controls and indicators located in the front panel control circuits. We will now cover the rest of the circuits on the front panel.

IC1 is a dual voltage to exponential current converter that supplies control current to the phase shift elements on the main audio board and the triangle rate oscillator located on the front panel control board. For the description of how the voltage to current converter operates, we will focus on transistor T1 and T3 and for the moment foret about T2. The converter takes a linear input voltge change and converts that into an exponential output current change by utilizing the exponential characteristics of silicone transistors. The converter consists of two parts; T1, an exponential current sink nd T2, a reference current sink. The reference currnt through T3 is regulated by A3B at precisely 15 microamperes. Any input voltage change on T1 also tries to change the current through T3, but A3B automatically sinks the correct current to hold he current through T3 constant. The current throgh T1 then follows the following relationship:

$$I^{O} = I_{REF}\, E^{\frac{Vin}{VT}}$$

Where I^{O} = current through T1.
I_{REF} = current through T3 or in our case 15 microamperes
VT = 26mV at room temperature.

This equation states that for every 18mV of input voltage (V_{in}) increase, the output current, (I^{O}), doubles. CR3 prevents reverse biasing of the emiter base junctions of the transistors which could leadto avalanche breakdown. C3 and R34 phase compenste A3B to prevent oscillations, while R33 limits output current to a safe value.

The current through T1 is pulled out of a amplifying current mirror. This current mirror, comprised of A2 and Q3, converts a current sink into a much larger current source. The current pulled through R37 causes the output of A2 to rise. This causes 12 times the current to flow through Q3 and, therefore, feeds that amplified current into the phse shift chain. C4 and C5 prevent oscillations and C14 prevents reverse breakdown of Q3 during POWR turn-on.

The input to the exponential converter usedto control phase shift is the summed output of many internal sources and one external source. The Swep Offset trimpot sets the standing current in T1 and thereby sets the static phase shift. The OFFST control allows the user to adjust the static phase slft over a 4 octave range. The SWEEP selector swith SW5 selects either the internal triangle rate oscillator and/or an external input applied to J6. The triangle oscillator's level is controlled by the SWEP AMOUNT control R54 which adjusts the range of the sweep. R4, R3, C1, and R61 roll off the oscillator amplitude at higher sweep rates to maintain smooth phasing. The External Sweep input is scaled by R1, R2 and R31 to provide approximately 1 volt/octave control.

The other half of IC1 drives the rate oscillator. T2 is identical to T1 and produces the same exponential characteristics. It pulls current from a unity gain current mirror which sources current to the control node of A4. A4 and A5A form a current controlled oscillator. A4 and C10 form a current controlled integrator. A ramp voltage appears on C10 and is followed by the internal Darlington transistors. That voltage is fed to Schmitt trigger A5A which will change states at + or -7.5 volts of input voltage. If C10 is charging, the voltage on pin 6 will rise until it reaches 7.5 volts. A5A will then jump negative causing C10 to discharge until the output of pin 6 reaches -7.5V. Then the output of A5A jumps positive and C10 charges again. The charge and discharge time are identical resulting in a triangle wave. The control current changes the charging time and, thereby, the frequency. R54 controls the output amplitude fed to A5B. A5B buffers the signal and applies it to J5 and the SWEEP selector switch.

The rate of the triangle oscillator is controlled through IC1 by the SWEEP RATE control, the RATE trimpot, the motor start waveform generator or the external rate input. The RATE trimpot sets oscillator rate to 10Hz with the SWEEP RATE control set to 10. The SWEEP RATE control adjusts the frequency of oscillator over a 100 to 1 range. The RATE EXT input disables the sweep rate control and allows the triangle frequency to be varied at 1 volt/octave.

The motor start waveform generator is activated by the STATUS switch and the MOTOR START switch. When the MOTOR START switch is off, the output of A1 is held at +12 volts and the STATUS switch drives the electronic switches on the main audio processing board. With the STATUS switch in the IN position, Q1 saturates, STATUS L1 lights, and 7.5 volts appears on the junction of R13 and R14, the IN position, Q1 saturates, STATUS L1 illuminates, and 7.5 volts appears on the junction of R13 and R14. This voltage activates the electronic switches and and the electronic switches puts the input signal on the +OUTPUT and kills the -OUTPUT.

When the MOTOR START switch is ON, the STATUS switch functions change form. The electronic switches are frozen in the phasing mode leaving the + and -OUTPUT live. With the STATUS switch in the OUT position, Q1 is off, and the output of A1 is sitting at -12 volts. The -12 volts shuts down the triangle oscillator. The output of A4 is also routed to the main board to the motor start VCA composed of A1, A2, and Q1 and Q2 located on the main board. The -12 volts turns Q3 off and Q2 on which turns A2 on. A2 feeds the compressed input signal from A25 (main board) to the limit restorer. The summation of the input signal and the 180° out-of-phase output of the expander results in almost total cancellation, which kills the -OUTPUT. The results are that the original compressed and expanded signal is routed through the INSERTION GAIN control and to the +OUTPUT and the -OUTPUT is dead.

When the STATUS switch is pushed to IN, changes occur. STATUS L1 illuminates and a positive input appears on A1. A1 charges C2 and the voltage appears on pin 6. This causes the rate oscillator to slowly increase in speed. On the main board, Q2 starts shutting down and Q1 starts turning on, causing A2 to shut down and A1 to turn on. Gradually, both the + and -OUTPUTS change from the bypass mode to the phasing mode. The effect is an imitation of a motorized speaker coming up to speed. When the STATUS switch is pushed to OUT, the process reverses and the oscillator slows down, and the + and -OUTPUTS revert back to the previous stage. The Motor Start trim R26 adjusts the charging time of C2 which sets the duration of the effect.

The regulated power supply is the same used on the other Moog Signal Processors. The AC line is coupled to voltage line SELECTOR SW1 which selects the correct transformer taps for 115V or 230V operation. The transformer steps down the line voltage to a center tapped 54 volts. CR1, CR2, CR3, and CR4 bridge rectify the AC voltage and C1 and C2 filter the output to reduce ripple. IC1, with pass transistors Q1 and Q2, forms a preset dual ± 15V regulator which supplies the voltage outputs. Q1 and Q2 increase the current capability of the regulator chip, C3 and C4 prevent parasitic oscillations and R1 and R2 set the current limit to approximately 200 microamperes.

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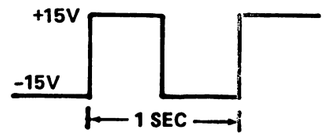
ADJUSTMENTS

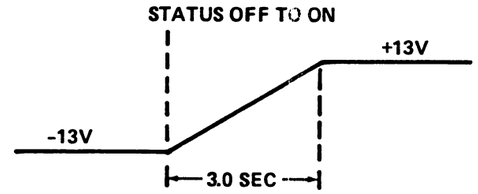
RATE TRIM R24 (BOARD 2) ADJUSTMENT

1. Set RATE Hz control (front panel) full clockwise to 10Hz.
2. Connect oscilloscope to A5A, pin 1.
3. Adjust Rate Trim R24 until 30 volt square wave has a total period of 0.1 seconds (= 10Hz).

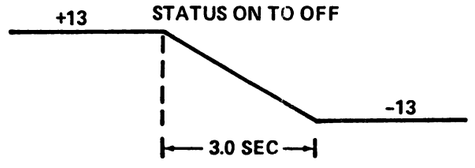


MOTOR START TRIM R26 ADJUSTMENT (BOARD 2)

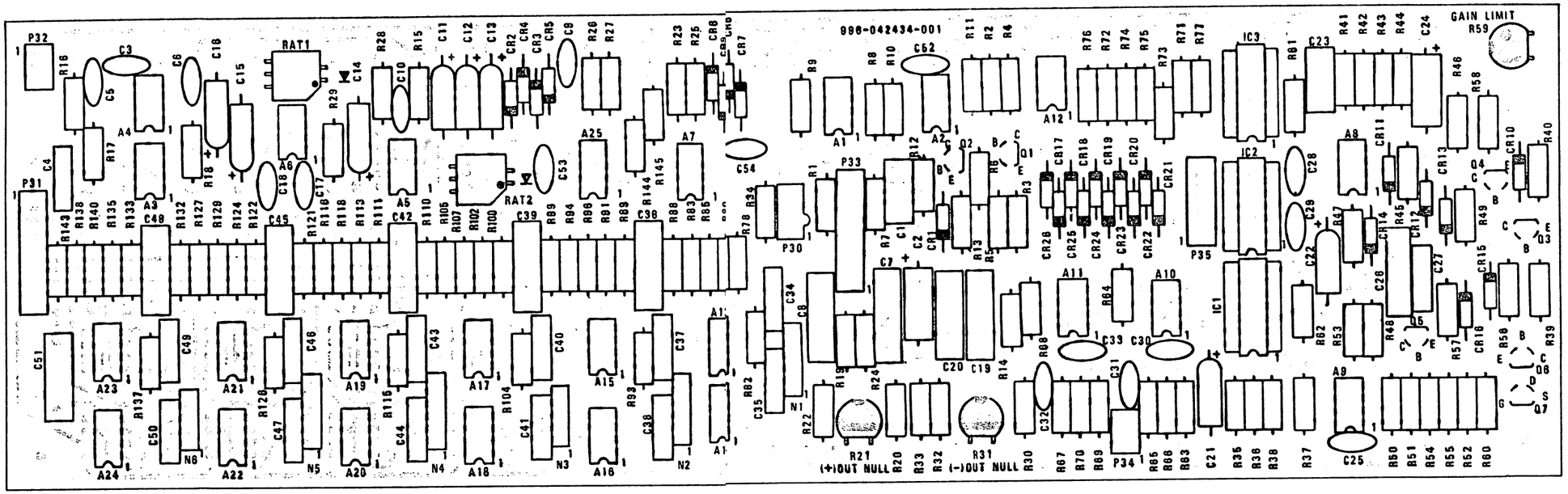
1. Push STATUS switch to OUT (front panel).
2. Connect oscilloscope (OC, 5 volts/div) to A1, pin 6.
3. Push STATUS switch to IN and observe following waveform.



4. Adjust Motor Start Trim R26 for a rise of 3.0 seconds.
5. Fall time check. Push STATUS switch to OUT and observe waveform.



Adjustments continued on page 3 of 6



MAIN AUDIO PROCESSING PRNTED CIRCUIT BOARD ASSEMBLY (BOARD 3)

NOTE:

⚠1

MAIN BOARD PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 3)
REPLACEMENT PARTS LIST

REF DESIG	PART NUMBER	DESCRIPTION	QTY
	996-042434-001	Printed Circuit Board Assembly consisting of:	1
A1,A13 thru A24	991-041210-002	Integrated Circuit, Operational Amplifier, 36V, CA3094A	13
A2	991-041089-004	Integrated Circuit, Operational Amplifier, FET, LM3080AN	1
A3,A4,A6,A25	991-041951-001	Integrated Circuit, Operational Amplifier, FET, LF356N	4
A5,A7	991-041146-001	Integrated Circuit, Operational Amplifier, Dual, 4558	2
A8,A9	991-042661-001	Integrated Circuit, Operational Amplifier, Dual, TL082	2
A10,A11	991-042793-001	Integrated Circuit, Operational Amplifier, JFET, Selected	2
A12	991-041101-001	Integrated Circuit, Operational Amplifier, 741	1
C1,C23	946-041978-224	Capacitor, Polyester, 0.22uf	2
C2,C24	945-040209-036	Capacitor, Aluminum, Electrolytic, 10uf, 35V	2
C3,C5,C17, C18,C28,C29, C31,C32,C53, C54	947-040200-103	Capacitor, Disc, 0.01uf	10
C4,C27	946-041978-104	Capacitor, Polyester, 0.1uf	2
C6	947-042020-180	Capacitor, Disc, 18Pf	1
C7,C8,C19, C20,C36,C39, C42,C45,C48, C51	946-041978-334	Capacitor, Polyester, 0.33uf	10
C9	947-042020-221	Capacitor, Disc, 220Pf	1
C10,C52	947-042020-470	Capacitor, Disc, 47Pf	2
C11 thru C16, C21,C22	946-040231-002	Capacitor, Tantalum, 10uf, 20V	8
C25	947-042020-100	Capacitor, Disc, 10Pf	1
C26	946-041978-684	Capacitor, Polyester, 0.68uf	1
C30,C33 C34,C35,C37, C38,C40,C41, C43,C44,C46, C47,C49,C50,	947-042020-101	Capacitor, Disc, 100Pf	2
CR1 thru CR26	946-041978-102	Capacitor, Polyester, 0.001uf	12
IC1 thru IC3	919-041075-001	Diode, Signal, 1N4148	26
N1 thru N6	991-041086-001	Integrated Circuit, CD4007	3
P30	949-042425-001	Resistor Network (5 Resistors), 20K Ohm, ±1%	6
P31,P33	910-040303-003	Connector, Header, 3 Pin, CIS, Keyed (0.15 Centers)	1
P32,P34	910-040299-010	Connector, Header, 10 Pin, CIS, (0.1 Centers)	2
P35	910-040299-003	Connector, Header, 3 Pin, CIS, (0.1 Centers)	2
Q1,Q2,Q3, Q5,Q6	910-040299-007	Connector, Header, 7 Pin, CIS, (0.1 Centers)	1
Q4	991-041052-001	Transistor, PNP, Small Signal, 2N3908	5
Q7	991-041051-001	Transistor, NPN, Small Signal, 2N3904	1
R1	991-041055 001	Transistor, FET, E112	1
R2,R5,R13, R26	852-312183-001	Resistor, 18K Ohm, ±5%, 1/4W	1
R3,R73,R75	852-312623-001	Resistor, 62K Ohm, ±5%, 1/4W	4
R4,R16,R35 thru R39,R49, R51,R53,R56	852-312273-001	Resistor, 27K Ohm, ±5%, 1/4W	3
	852-312103-001	Resistor, 10K Ohm, ±5%, 1/4W	11

MAIN BOARD PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 3)
REPLACEMENT PARTS LIST (Continued)

REF DESIG	PARTNUMBER	DESCRIPTION	QTY
R6,R8,R10, R11,R20,R22, R30,R32,R41, R43,R44,R45, R55,R60,R144, R145	852-31104-001	Resistor, 100K Ohm, ±5%, 1/4W	16
R7,R9,R12, R50,R82,R93, R104,R115, R126,R137	852-31203-001	Resistor, 20K Ohm, ±5%, 1/4W	10
R14,R66,R70	852-31332-001	Resistor, 3.3K Ohm, ±5%, 1/4W	3
R15,R18	852-31204-001	Resistor, 200K Ohm, ±5%, 1/4W	2
R17,R19,R24, R33,R57,R61, R62,R88,R99, R110,R121, R132,R143	852-31105-001	Resistor, 1 Megohm, ±5%, 1/4W	13
R21,R31	925-04275-003	Resistor, Trimmer, 50K Ohm, (+) OUT NULL and (-) OUT NULL	2
R23,R25	853-42002-031	Resistor, 20K Ohm, ±1%, 1/4W	2
R27,R34	852-31124-001	Resistor, 120K Ohm, ±5%, 1/4W	2
R28,R29	852-31224-001	Resistor, 220K Ohm, ±5%, 1/4W	2
R40⚠1	852-31102-001	Resistor, 1K Ohm, ±5%, 1/4W	1
R42	852-31472-001	Resistor, 4.7K Ohm, ±5%, 1/4W	1
R46	852-31512-001	Resistor, 5.1K Ohm, ±5%, 1/4W	1
R47	852-31475-001	Resistor, 4.7 Megohm, ±5%, 1/4W	1
R48,R76	851-11106-000	Resistor, 10 Megohm, ±10%, 1/4W	2
R52	852-31683-001	Resistor, 68K Ohm, ±5%, 1/4W	1
R54	852-31684-001	Resistor, 680K Ohm, ±5%, 1/4W	1
R58	852-31392-001	Resistor, 3.9K Ohm, ±5%, 1/4W	1
R59⚠1	925-04275-013	Resistor, Trimmer, 2.5K Ohm, MAX GAIN TRIM COMPRESSOR	1
R63,R67	852-31153-001	Resistor, 15K Ohm, ±5%, 1/4W	2
R64,R68	852-31202-001	Resistor, 2K Ohm, ±5%, 1/4W	2
R65,R69	852-31621-001	Resistor, 620 Ohm, ±5%, 1/4W	2
R71,R72, R74,R77	852-31473-001	Resistor, 47K Ohm, ±5%, 1/4W	4
R78,R83,R89, R94,R100,R105, R111,R116, R122,R127, R133,R138	852-31331-001	Resistor, 330 Ohm, ±5%, 1/4W	12
R80,R85,R91, R96,R102, R107,R113, R118,R124, R129,R135, R140	852-31303-001	Resistor, 30K Ohm, ±5%, 1/4W	12
RAT1,RAT2	948-04791-001	Isolator, Dual	2

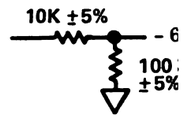
ADJUSTMENTS (Continued from page 2 of 6)

INITIAL CONTROL SETTINGS

PHASING STAGES	= 12	RATE	= .1 Hz
RESONANT STAGES	= 12	AMOUNT	= 0
CHAIN/MIX	= MIX	OFFSET	= 0
RESONANCE	= 0	MOTOR START	= ON

MAXIMUM GAIN TRIM COMPRESSOR ADJUSTMENT R59

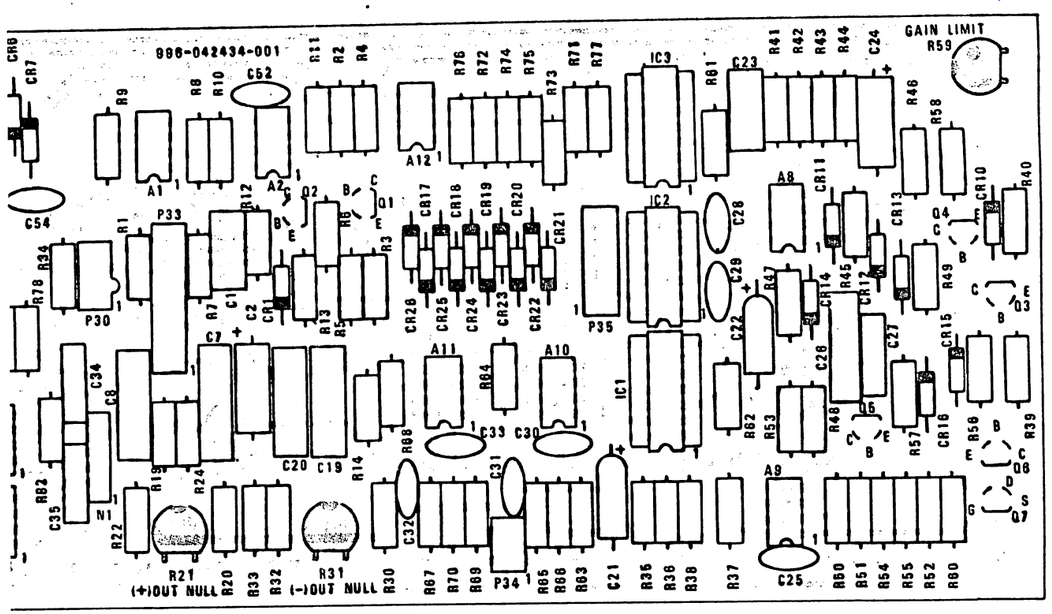
1. Apply a 2kHz sine wave at -60dBm (2mV peak-to-peak) oscilloscope does not go down to 1mv/div, apply a -20 sine wave to this resistive attenuator.



2. Connect oscilloscope probe to A4, pin 6.
3. Adjust R59 for -40dBm (20mV peak-to-peak) output le

PHASING CHAIN OFFSET TRIM R8 (BOARD 2), + OUTP NULL R31 (BOARD 3) ADJUSTMENT.

1. Apply a -20dBm (200mV peak-to-peak) 2.8kHz sine w
2. Connect oscilloscope probe to the + OUTPUT jack J2.
3. Set PHASING STAGES selector switch to 2.
4. Adjust Offset Trim R8 for null.
5. Change generator to 2kHz and PHASING STAGES sele
6. Readjust Offset Trim R8 for null.
7. Adjust + Output Null R21 for maximum notch depth.
8. Repeat steps 6 and 7 until maximum null is obtained. Not
9. Check for nulls at approximately 350Hz, 1.1kHz, 2k Tolerance ± 10%.
10. Connect oscilloscope to - OUTPUT J3.
11. Change audio oscillator frequency to 1.5kHz and the obtained.
12. Adjust - Output Null R31 for maximum notch depth
13. Repeat steps 11 and 12 until maximum notch depth exceed 20dB.



NOTE:

⚠ LATER VERSIONS CHANGE R40 TO 2.2K AND R59 TO 5K FOR IMPROVED COMPRESSOR GAIN SET UP.

VTED CIRCUIT BOARD ASSEMBLY (BOARD 3)

MAIN BOARD PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 3)
REPLACEMENT PARTS LIST (Continued)

NUMBER	DESCRIPTION	QTY
1104-001	Resistor, 100K Ohm, ± 5%, 1/4W	16
1203-001	Resistor, 20K Ohm, ± 5%, 1/4W	10
1332-001	Resistor, 3.3K Ohm, ± 5%, 1/4W	3
1204-001	Resistor, 200K Ohm, ± 5%, 1/4W	2
1105-001	Resistor, 1 Megohm, ± 5%, 1/4W	13
1275-003	Resistor, Trimmer, 50K Ohm, (+) OUT NULL and (-) OUT NULL	2
1002-031	Resistor, 20K Ohm, ± 1%, 1/4W	2
1124-001	Resistor, 120K Ohm, ± 5%, 1/4W	2
1224-001	Resistor, 220K Ohm, ± 5%, 1/4W	2
1102-001	Resistor, 1K Ohm, ± 5%, 1/4W	1
1472-001	Resistor, 4.7K Ohm, ± 5%, 1/4W	1
1512-001	Resistor, 5.1K Ohm, ± 5%, 1/4W	1
1475-001	Resistor, 4.7 Megohm, ± 5%, 1/4W	1
1106-000	Resistor, 10 Megohm, ± 10%, 1/4W	2
1683-001	Resistor, 68K Ohm, ± 5%, 1/4W	1
1684-001	Resistor, 680K Ohm, ± 5%, 1/4W	1
1392-001	Resistor, 3.9K Ohm, ± 5%, 1/4W	1
1275-013	Resistor, Trimmer, 2.5K Ohm, MAX GAIN TRIM COMPRESSOR	1
1153-001	Resistor, 15K Ohm, ± 5%, 1/4W	2
1202-001	Resistor, 2K Ohm, ± 5%, 1/4W	2
1621-001	Resistor, 620 Ohm, ± 5%, 1/4W	2
1473-001	Resistor, 47K Ohm, ± 5%, 1/4W	4
1331-001	Resistor, 330 Ohm, ± 5%, 1/4W	12
1303-001	Resistor, 30K Ohm, ± 5%, 1/4W	12
1791-001	Isolator, Dual	2

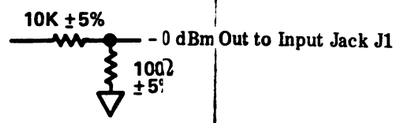
ADJUSTMENTS (Continued from page 2 of 6)

INITIAL CONTROL SETTINGS

PHASING STAGES	= 12	RATE	= .1 Hz	STATUS	= IN
RESONANT STAGES	= 12	AMOUNT	= 0	GAIN	= 0
CHAIN/MIX	= MIX	OFFSET	= 0	POWER	= ON
RESONANCE	= 0	MOTOR START	= ON		

MAXIMUM GAIN TRIM COMPRESSOR ADJUSTMENT R59(BOARD 3)

1. Apply a 2kHz sine wave at -60dBm (2mV peak-to-peak to INPUT jack J1. Observe that if oscilloscope does not go down to lmv/div, apply a -2dBm (200mV peak-to-peak) 2kHz sine wave to this resistive attenuator.



2. Connect oscilloscope probe to A4, pin 6.
3. Adjust R59 for -40dBm (20mV peak-to-peak) output lel.

PHASING CHAIN OFFSET TRIM R8 (BOARD 2), + OUTPUT NULL R21 AND - OUTPUT NULL R31 (BOARD 3) ADJUSTMENT.

1. Apply a -20dBm (200mV peak-to-peak) 2.8kHz sine wve to INPUT jack J1.
2. Connect oscilloscope probe to the + OUTPUT jack J2
3. Set PHASING STAGES selector switch to 2.
4. Adjust Offset Trim R8 for null.
5. Change generator to 2kHz and PHASING STAGES seltor switch to 12.
6. Readjust Offset Trim R8 for null.
7. Adjust + Output Null R21 for maximum notch depth
8. Repeat steps 6 and 7 until maximum null is obtained. Nch depth should exceed 20dB.
9. Check for nulls at approximately 350Hz, 1.1kHz, 2lz, 3.5kHz, 6.6kHz and 20kHz. Tolerance ± 10%.
10. Connect oscilloscope to - OUTPUT J3.
11. Change audio oscillator frequency to 1.5kHz and th "rock" generator until null is obtained.
12. Adjust - Output Null R31 for maximum notch dept
13. Repeat steps 11 and 12 until maximum notch depths obtained. Notch depth should exceed 20dB.

12 STAGE PHASEREYBOARD MODIFIER FINAL ASSEMBLY
RPLACEMENT PARTS LIST

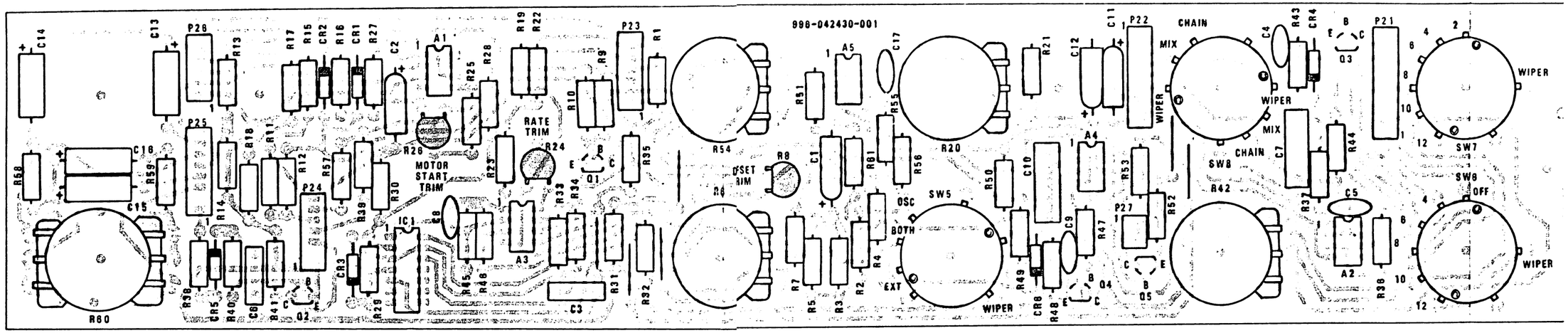
REF DESIG	PART NUMBER	DESCRIPTION	QTY
	997-042347-001	12 StaiPhaser Keyboard Modifier consisting of:	
	996-041659-001	Prind Circuit Board Assembly, KB Mod. Power Supply	1
	996-042430-001	Prind Circuit Board Assembly, Control, No. 2	1
	996-042434-001	Prind Circuit Board Assembly, Main, No. 3	1
F1	939-041620-004	Fui3AG, 1 Amp., Slo-Blo	1
F2,F3	939-041620-002	Fui3AG, 1/4 Amp., Slo-Blo	2
J1,J4	910-041306-002	Jac Phone, 1 Circuit, Shorting, Switchcraft 112A	2
J2,J3,J5,J6	910-041306-001	Jac Phone, 1 Circuit, Switchcraft 111	4
J7	910-041306-004	Jat Phone, 2 Circuit, Stereo, Switchcraft 112B	1
L1	939-041850-003	LE, Yellow, Opcoa LSM-26L	1
L2,L4	939-041850-001	LE, Red, Opcoa LSM-6L	2
L3	939-041850-002	LE, Green, Opcoa LSM-16L	1
P1	910-041739-001	Reptacle, 250V AC, Ga. Switchcraft EAC-31	1
P2,P3	910-041314-004	Plt, 4 Position, Univ. Mate-N-Lok, AMP1-480702-0	2
S2,S3	910-041315-004	Ca 4 Position, Univ. Mate-N-Lok, AMP1-480703-0	2
S4,S5,S6,S7	906-040298-002	Hasing, 2 Pin, CIS, 0.100 Centers, AMP350091-2	4
S11	906-040302-005	Hasing, 5 Pin, CIS, Keyed, 0.150 Centers, AMP640117-1	1
S12	910-041717-003	Hasing, Socket Connector, 3 Pin, 0.2 Centers, Mate-N Lok	1
S21,S31,S33	906-040298-010	Husing, 10 Pin, CIS, 0.100 Centers, AMP350091-10	3
S22	906-040298-009	Husing, 9 Pin, CIS, 0.100 Centers, AMP350091-9	1
S23,S24,S35	906-040298-007	Husing, 7 Pin, CIS, 0.100 Centers, AMP350091-7	3
S25	906-040298-008	Hasing, 8 Pin, CIS, 0.100 Centers, AMP350091-8	1
S26	906-040298-006	Hasing, 6 Pin, CIS, 0.100 Centers, AMP350091-6	1
S27,S32,S34	906-040298-003	Husing, 3 Pin, CIS, 0.100 Centers, AMP350091-3	3
S30	906-040302-003	Husing, 3 Pin, CIS, Keyed, 0.150 Centers, AMP640115-1	1
SW1	960-041303-001	Sitch, Selector, DPL Wipe, 115-230V, Switchcraft 46256LFE	1
SW2,SW4	960-041311-003	Sitch, Rocker, DPDT Legend, ON-OFF, Carling SGD0410-TB-B	2
SW3	960-041311-002	Sitch, Rocker, SPDT, Legend, IN-OUT, Carling SGB0410-TB-B	1
T1	954-041647-002	Tinsformer, 250 Ma, Shielded	1
	801-055446-000	Nt, Hexagon, 8-32	1
	806-045039-005	Srew, Pan Hd., Phillips, 6-32 x 5/16 in., Black Oxide	2
	806-045039-007	Srew, Pan Hd., Phillips, 6-32 x 7/16 in., Black Oxide	6
	806-045039-010	Srew, Pan Hd., Phillips, 6-32 x 0.625 in., Black Oxide	4
	806-055039-006	Srew, Pan Hd., 8-32 x 3/8 in., Black Oxide	1
	811-040039-008	Srew, Self Tapping, 6A x 1/2 in.	14
	811-040039-010	Srew, Self Tapping, Pan Hd., Type A, 6A x 5/8 in., Black Oxide	8
	816-040239-006	Srew, Self Tapping, Flat Hd., Type B, 6B x 3/8 in., Black Oxide	6
	902-040500-001	Nt, Speed, No. 6A	22
	902-040504-007	Nt, 3/8-32	12
	902-041394-009	Nt, 6-32, Hexagon	8
	904-040495-016	Vasher, Lock, No. 6	16
	904-040495-021	Vasher, Lock, 3/8 in.	12
	904-041390-017	Vasher, No. 6	12
	904-042026-001	Vasher, Flat, Conical, 3/8 in.	12
	905-040498-034	Fivet, Pop, 1/8 in. Dia.	6
	906-041331-003	Fuse Block, Littlefuse Series 357-003	1
	910-040308-001	Contact, Female, CIS, AMP350090-1	85
	910-040310-001	Rug, Keying	9
	910-041313-001	Contact, Socket, Univ. Mate-N-Lok, AMP350570-1	8
	910-041316-001	Contact, Pin, Univ. Mate-N-Lok, AMP350699-1	8
	910-042049-001	Connector, Mate-N-Lok, Crimp Socket	3
	911-040189-002	Lug, No. 8, AMP61436-1	1
	913-042007-001	Decal, Fuse	1
	913-042422-001	Overlay, Front Panel	1
	913-042459-001	Label, Instruction	1
	916-041834-001	Machine Screw Bumper	4
	957-041794-001	Power Cord, Belden 17250-8	1
	963-042801-001	Cover, Rear	1
	964-041896-001	Insert, Molded Foam	2
	967-040734-001	Cover, Top	1
	967-040734-004	Cover, Bottom	1
	967-042545-001	Bracket, Transformer	2
	968-040733-003	Front Extrusion	1
	973-040508-058	Spacer, 6-32 x 0.312 in., 1/4 Hex., Brass	4
	973-041308-018	Standoff, PEM, 6-32 x 1/4 in., PEMSO-632-8	2
	973-041308-020	Standoff, PEM, 6-32 x 3/8 in., PEMSO-632-12	6
	976-041851-001	Grommet and Ring, Opcoa OC-1	4
	997-041867-001	Knob Assembly, Pointer	9
	997-041886-001	End Plate Subassembly, L.H.	1
	997-041886-002	End Plate Subassembly, R.H.	1

SIGNAL PROCESSORS

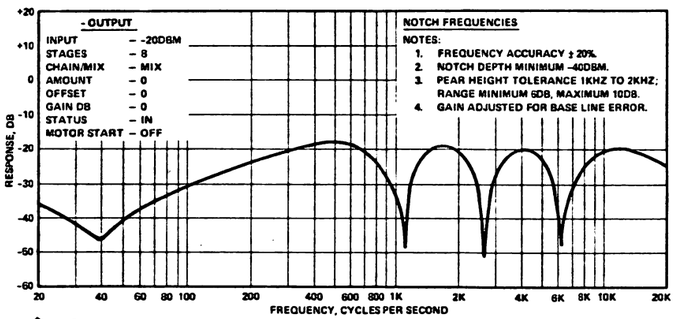
moog® MUSIC INC. BUFFALO, N.Y.

12 STAGE PHASER MAIN AUDIO PROCESSING PRINTED CIRCUIT BOARD PARTS LOCATION, REPLACEMENT PARTS LIST AND FINAL ASSEMBLY REPLACEMENT PARTS LIST

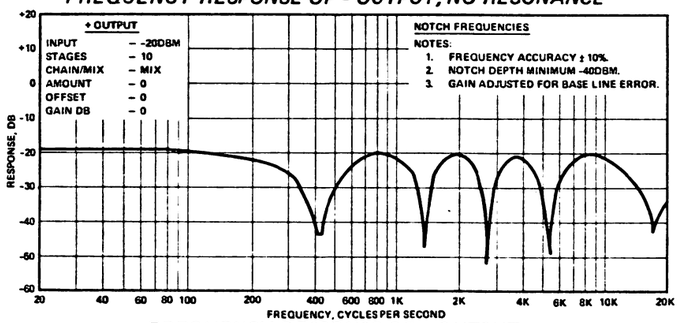
MODEL 307A **993-042931-001**



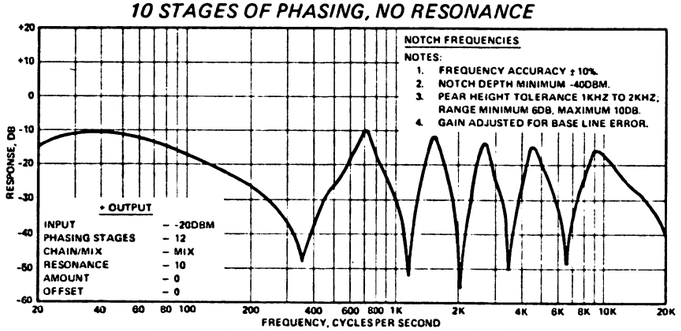
CONTROL BOARD PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 2)



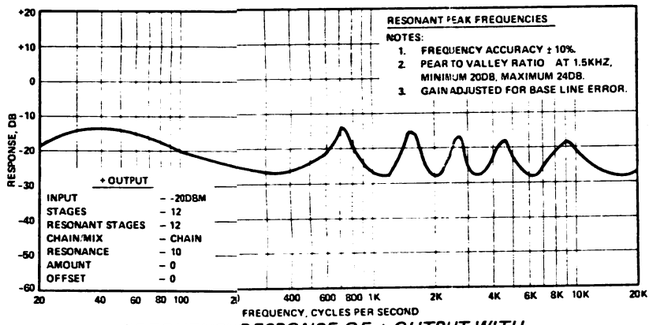
FREQUENCY RESPONSE OF - OUTPUT, NO RESONANCE



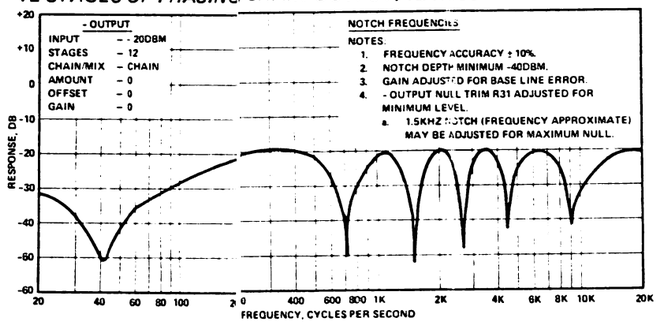
FREQUENCY RESPONSE OF + OUTPUT
10 STAGES OF PHASING, NO RESONANCE



FREQUENCY RESPONSE OF + OUTPUT
12 STAGES OF PHASING, 12 STAGES OF RESONANCE FULL



FREQUENCY RESPONSE OF + OUTPUT WITH
12 STAGES OF PHASING, CHAIN OUTPUT, 12 RESONANT STAGES



FREQUENCY RESPONSE OF - OUTPUT WITH
12 STAGES OF PHASING, NO RESONANCE

FREQUENCY RESPONSE OF + OUTPUT, NO RESONANCE

INPUT – -20DBM AMOUNT – 0 GAIN DB – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

NOTCH FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5	f 6
12	350HZ	1.1K	2K	3.5K	6.5K	20K
10	420HZ	1.3K	2.65K	5.1K	17K	—
8	520HZ	1.78K	4K	13.8K	—	—
6	720HZ	2.7K	10K	—	—	—
4	1.12K	6.6K	—	—	—	—
2	2.8K	—	—	—	—	—

NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.

FREQUENCY RESPONSE OF + OUTPUT
12 STAGES OF PHASING RESONANCE, RESONANCE FULL

INPUT – -20DBM AMOUNT – 0 GAIN – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

RESONANT PEAK FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5
12	720HZ	1.5K	2.6K	4.5K	9.5K

NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.
3. PEAR HEIGHT TOLERANCE 1KHZ TO 2KHZ; RANGE MINIMUM 6DB, MAXIMUM 10DB.

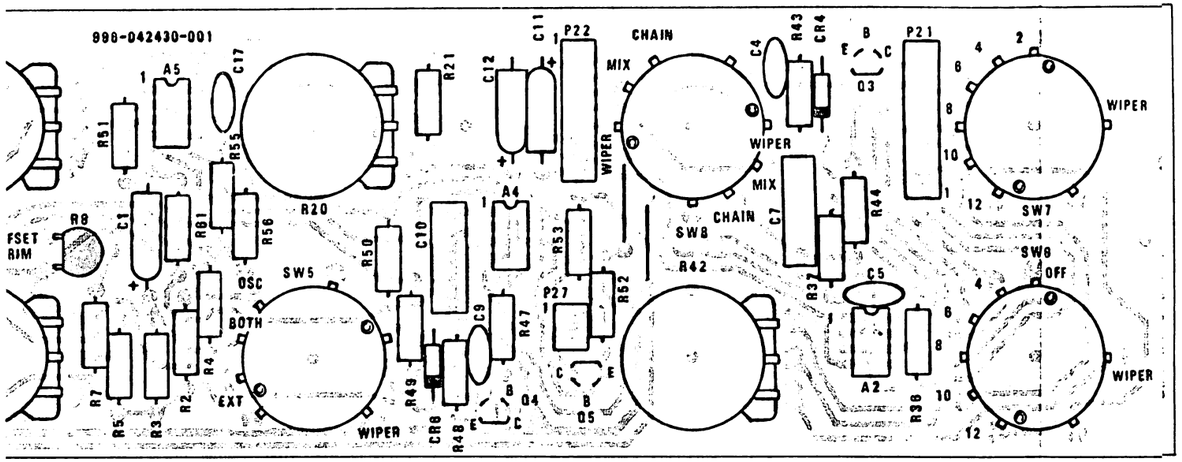
FREQUENCY RESPONSE OF -OUTPUT, NO RESONANCE

INPUT – -20DB AMOUNT – 0 GAIN – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

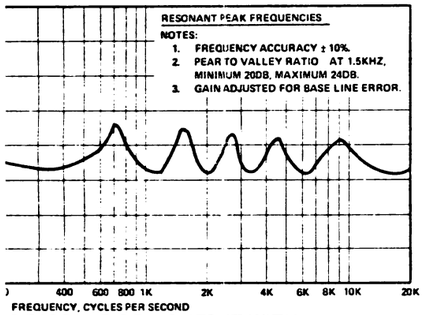
NOTCH FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5	f 6
12	42HZ	720HZ	1.5K	2.6K	4.5K	9K
10	35HZ	850HZ	1.9K	3.6K	7.8K	—
8	38HZ	1.1K	2.6K	6.1K	—	—
6	45HZ	1.5K	4.4K	—	—	—
4	55HZ	2.6K	—	—	—	—
2	80HZ	14K	—	—	—	—

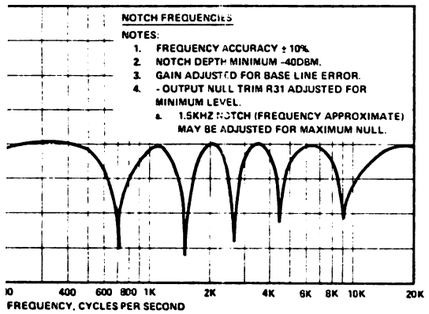
NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.



ED CIRCUIT BOARD ASSEMBLY (BOARD 2)



RESPONSE OF + OUTPUT WITH , CHAIN OUTPUT, 12 RESONANT STAGES



RESPONSE OF - OUTPUT WITH OF PHASING, NO RESONANCE

FREQUENCY RESPONSE OF + OUTPUT, NO RESONANCE

INPUT – -20DBM AMOUNT – 0 GAIN DB – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

NOTCH FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5	f 6
12	350HZ	1.1K	2K	3.5K	6.5K	20K
10	420HZ	1.3K	2.65K	5.1K	17K	—
8	520HZ	1.78K	4K	13.8K	—	—
6	720HZ	2.7K	10K	—	—	—
4	1.12K	6.6K	—	—	—	—
2	2.8K	—	—	—	—	—

NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.

FREQUENCY RESPONSE OF + OUTPUT 12 STAGES OF PHASING RESONANCE, RESONANCE FULL

INPUT – -20DBM AMOUNT – 0 GAIN – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

RESONANT PEAK FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5
12	720HZ	1.5K	2.6K	4.5K	9.5K

NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.
3. PEAR HEIGHT TOLERANCE 1KHZ TO 2KHZ; RANGE MINIMUM 6DB, MAXIMUM 10DB.

FREQUENCY RESPONSE OF -OUTPUT, NO RESONANCE

INPUT – -20DB AMOUNT – 0 GAIN – 0
CHAIN/MIX – MIX OFFSET – 0 STATUS – IN

NOTCH FREQUENCIES

NO. OF STAGES	f 1	f 2	f 3	f 4	f 5	f 6
12	42HZ	720HZ	1.5K	2.6K	4.5K	9K
10	35HZ	850HZ	1.9K	3.6K	7.8K	—
8	38HZ	1.1K	2.6K	6.1K	—	—
6	45HZ	1.5K	4.4K	—	—	—
4	55HZ	2.6K	—	—	—	—
2	80HZ	14K	—	—	—	—

NOTES: 1. FREQUENCY ACCURACY ± 20%.
2. NOTCH DEPTH MINIMUM -40DBM.

CONTROL BOARD PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 2) REPLACEMENT PARTS LIST

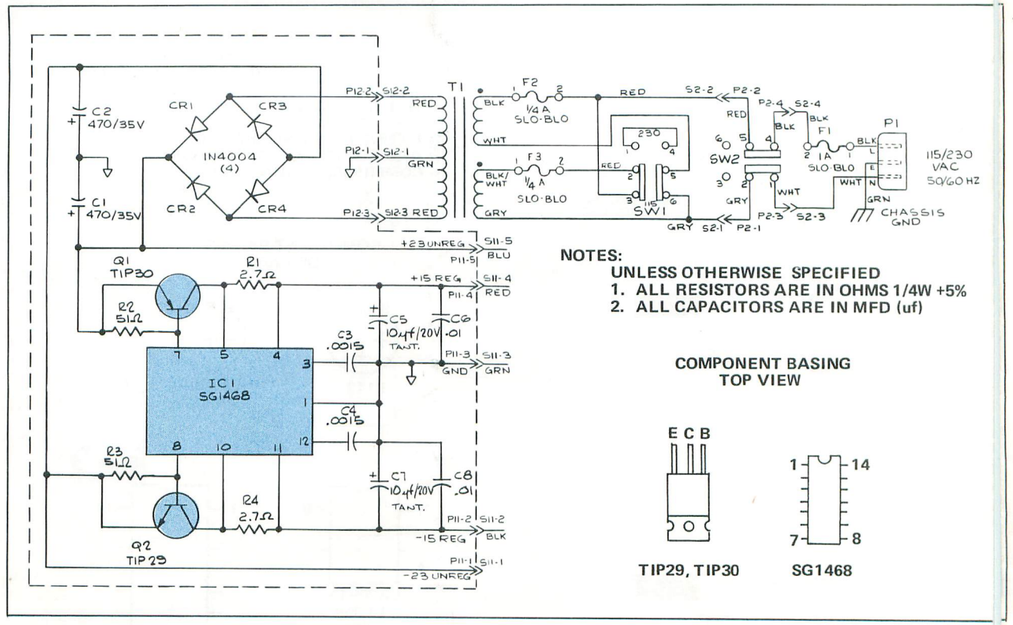
REF DESIG	PART NUMBER	DESCRIPTION	QTY
	996-042430-001	Printed Circuit Board Assembly, consisting of:	1
A1,A4	991-041210-002	Integrated Circuit, Operational Amplifier, 36V, CA3094A	2
A2	991-041951-001	Integrated Circuit, Operational Amplifier, LF356N	1
A3,A5	991-041146-001	Integrated Circuit, Dual Operational Amplifier, 4558	2
C1,C2,C11,C12	946-040231-002	Capacitor, Tantalum, 10uf, 20V	4
C3	946-041978-102	Capacitor, Polyester, 0.001uf	1
C4,C5,C8,C9	947-042020-501	Capacitor, Disc, 500Pf	4
C6	946-041978-104	Capacitor, Polyester, 510Pf	1
C7	946-041978-334	Capacitor, Polyester, 0.33uf	1
C10	946-041978-474	Capacitor, Polyester, 0.47uf	1
C13 thru C16	945-040209-001	Capacitor, Aluminum, electrolytic, 10uf, 25V	4
C17	947-042020-101	Capacitor, Disc, 100Pf	1
CR1 thru CR6	919-041075-001	Diode, Signal, 1N4148	6
IC1	991-041104-001	Integrated Circuit, Transistor Array, CA3046	1
P21	910-040299-010	Connector, 10 Pin, CIS, Printed Circuit	1
P22	910-040299-009	Connector, 9 Pin, CIS, Printed Circuit	1
P23,P24	910-040299-007	Connector, 7 Pin, CIS Printed Circuit	2
P25	910-040299-008	Connector, 8 Pin, CIS Printed Circuit	1
P26	910-040299-006	Connector, 6 Pin, CIS, Printed Circuit	1
P27	910-040299-003	Connector, 3 Pin, CIS, Printed Circuit	1
Q1,Q3,Q4	991-041052-001	Transistor, PNP, Small Signal, 2N3906	3
Q2	991-041265-001	Transistor, NPN, Small Signal, TIS97	1
Q5	991-041051-001	Transistor, NPN, Small Signal, 2N3904	1
R1,R2,R4	852-312513-001	Resistor, 51K Ohm, ± 5%, 1/4W	3
R3	852-312134-001	Resistor, 130K Ohm, ± 5%, 1/4W	1
R5	852-312474-001	Resistor, 470K Ohm, ± 5%, 1/4W	1
R6,R20	925-041870-003	Resistor, Rotary, Linear, 10K, SWEEP OFFSET and SWEEP RATE	2
R7	852-312824-001	Resistor, 820K Ohm, ± 5%, 1/4W	1
R8,R24,R26	925-040275-004	Resistor, Trimmer, 10K Ohm, OFFSET TRIM, RATE TRIM and MOTOR START TRIM	3
R9	852-312473-001	Resistor, 47K Ohm, ± 5%, 1/4W	1
R10	852-312472-001	Resistor, 4.7K Ohm, ± 5%, 1/4W	1
R11,R15,R16, R27,R37	852-312103-001	Resistor, 10K Ohm, ± 5%, 1/4W	5
R12,R29,R31, R52,R53	852-512202-001	Resistor, 2K Ohm, ± 5%, 1/4W	5
R13,R14,R17, R19,R22,R35, R40,R43,R49, R51	852-312104-001	Resistor, 100K Ohm, ± 5%, 1/4W	10
R18	852-312681-001	Resistor, 680 Ohm, ± 5%, 1/4W	1
R21,R25	852-312154-001	Resistor, 150K Ohm, ± 5%, 1/4W	2
R23,R41	852-312105-001	Resistor, 1 Megohm ± 5%, 1/4W	2
R28	852-312394-001	Resistor, 390K Ohm, ± 5%, 1/4W	1
R30,R55	852-312164-001	Resistor, 160K Ohm ± 5%, 1/4W	2
R32	852-312914-001	Resistor, 910K Ohm, ± 5%, 1/4W	1
R33	852-312512-001	Resistor, 5.1K Ohm, ± 5%, 1/4W	1
R34,R56	852-312102-001	Resistor, 1K Ohm, ± 5%, 1/4W	2
R36	852-312821-001	Resistor, 820 Ohm, ± 5%, 1/4W	1
R38	852 312101-001	Resistor, 100 Ohm ± 5%, 1/4W	1
R39,R57	852-512102-001	Resistor, 1K Ohm, ± 5%, 1/2W	2
R42	925-041870-005	Resistor, Rotary, 100K Ohm, 10% CCW Log, RESONANCE	1
R44	852-312515-001	Resistor, 5.1 Megohm, ± 5%, 1/4W	1
R45,R46	852-312273-001	Resistor, 27K Ohm, ± 5%, 1/4W	2
R47	852-312303-001	Resistor, 30K Ohm, ± 5%, 1/4W	1
R48	852-312132-001	Resistor, 1.3K Ohm, ± 5%, 1/4W	1
R50	852-312203-001	Resistor, 20K Ohm, ± 5%, 1/4W	1
R54	925-041870-004	Resistor, Rotary, Linear, 100K Ohm, SWEEP AMOUNT	1
R58,R59	852-312522-001	Resistor, 5.6K Ohm, ± 5%, 1/4W	2
R60	925-041869-004	Resistor, Rotary, Dual, 50K Ohm, 50K Ohm, 20% CCW Log, INSERTION GAIN	1
R61	852-312392-001	Resistor, 3.9K Ohm, ± 5%, 1/4W	1
SW5	960-042792-002	Switch, Rotary, 1P3T, SWEEP SELECTOR	1
SW6,SW7	960-042792-001	Switch, Rotary, 1P6T, RESONANT STAGES and PHASING STAGES	2
SW8	960-042792-003	Switch, Rotary, 2P2T, CHAIN MIX	1

SIGNAL PROCESSORS

moog® MUSIC INC. BUFFALO, N.Y.

12 STAGE PHASER CONTROL BOARD PRINTED CIRCUIT BOARD PARTS LOCATION, REPLACEMENT PARTS LIST AND FINAL ASSEMBLY REPLACEMENT PARTS LIST

MODEL 307A 993-042931-001

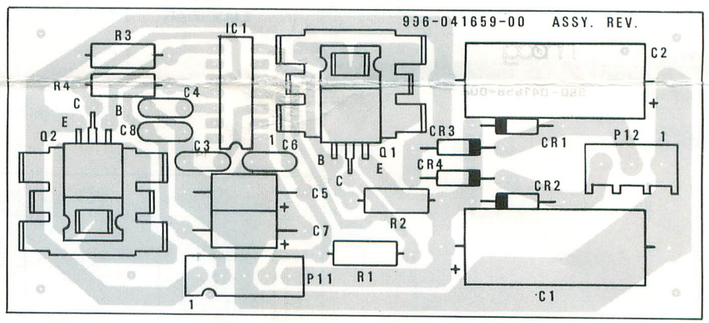


NOTES:
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS 1/4W +5%
2. ALL CAPACITORS ARE IN MFD (uf)

COMPONENT BASING
TOP VIEW

TIP29, TIP30 SG1468

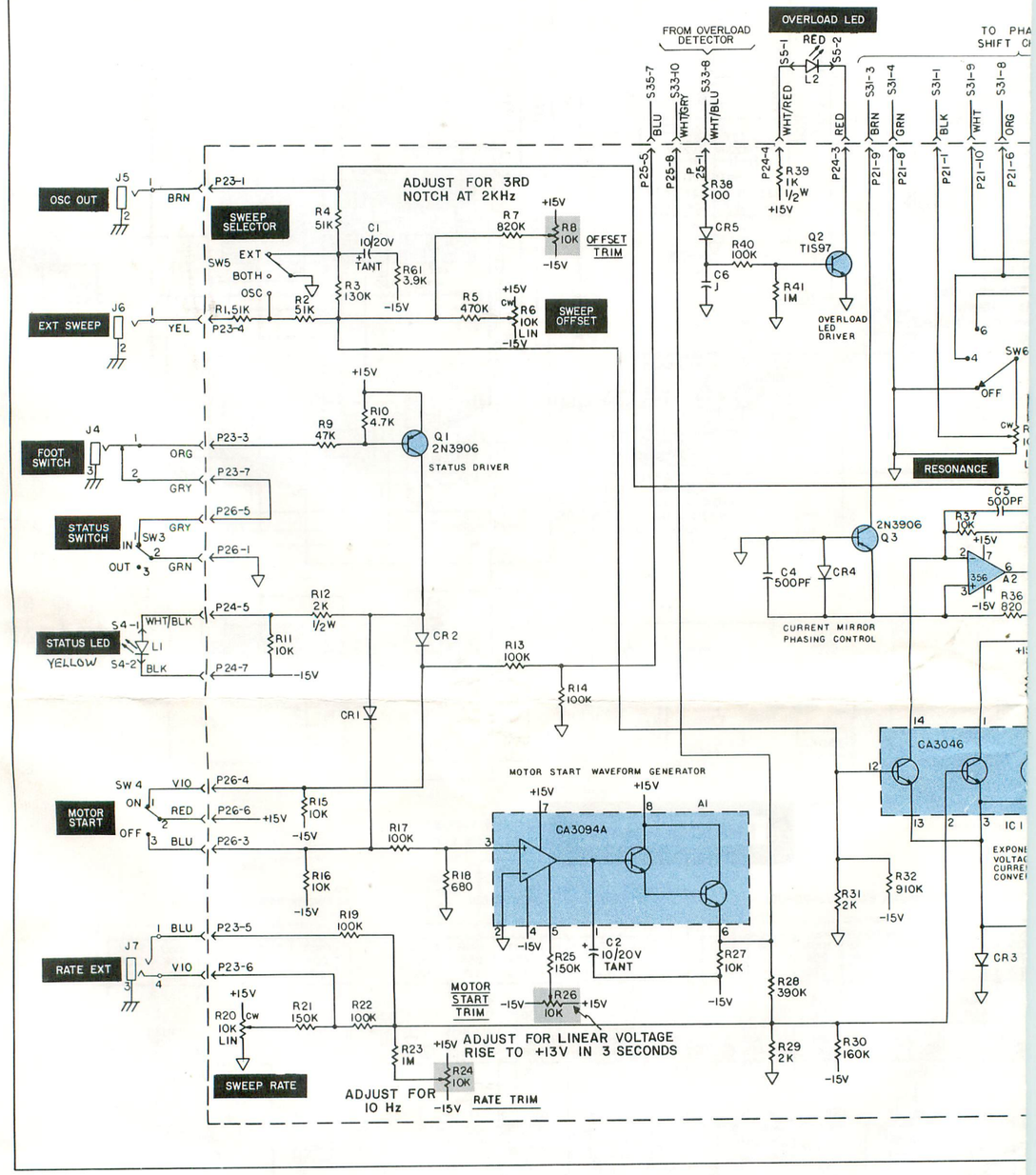
POWER SUPPLY SCHEMATIC DIAGRAM (BOARD 1)



POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 1)

POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY (BOARD 1)
REPLACEMENT PARTS LIST

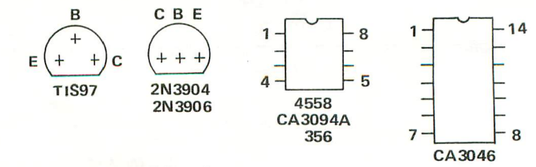
REF DESIG	PART NUMBER	DESCRIPTION	QTY
	996-041659-001	Printed Circuit Board Assembly consisting of:	1
C1,C2	945-040209-007	Capacitor, Aluminum, Electrolytic, 470uf, 35V	2
C3,C4	947-040194-152	Capacitor, Disc, 0.0015uf	2
C5,C7	946-040231-002	Capacitor, Tantalum, 10uf, 20V	2
C6,C8	947-040200-103	Capacitor, Disc, 0.01uf	2
CR1 thru CR4	919-010623-003	Diode, Rectifier, 1N4004	4
IC101	991-041111-001	Integrated Circuit, Dual Regulator, ± 15V, SG1468.	1
P11	910-040303-005	Header, Printed Circuit, 5 Pin, Keyed (0.150 Centers), AMP640242-5	1
P12	910-041716-003	Header, Printed Circuit, 3 Pin, AMP350210-1	1
Q1	991-041050-001	Transistor, PNP, TIP30	1
Q2	991-041049-001	Transistor, NPN, TIP29	1
R1,R4	852-312027-001	Resistor, 2.7 Ohm, ± 5%, 1/4W	2
R2,R3	852-312510-001	Resistor, 51 Ohm, ± 5%, 1/4W	2
	967-040935-001	Heatsink, TO-220 Device	2

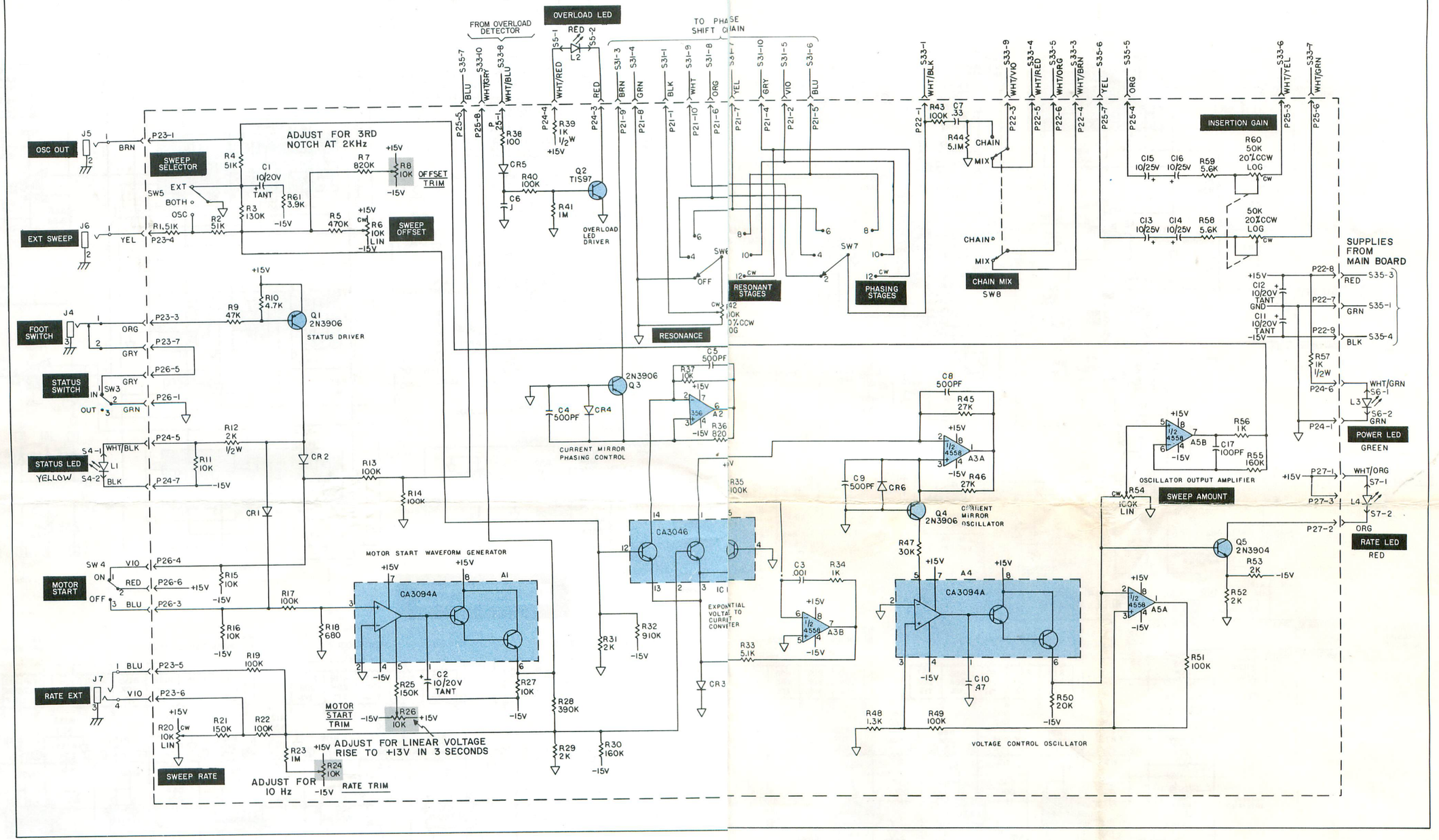


CONTROL BOARD SCHEMA

NOTES:
UNLESS OTHERWISE NOTED
1. ALL RESISTORS ARE IN OHMS 1/4W +5%.
2. ALL CAPACITORS ARE IN MFD (uf)
3. ALL DIODES ARE 1N4148

COMPONENT BASING
TOP VIEW

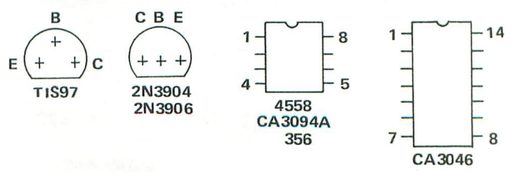




CONTROL BOARD SCHEMATIC DIAGRAM (BOARD 2)

NOTES:
UNLESS OTHERWISE NOTED
1. ALL RESISTORS ARE IN OHMS 1/4W +5%.
2. ALL CAPACITORS ARE IN MFD (uf)
3. ALL DIODES ARE 1N4148

COMPONENT BASING
TOP VIEW

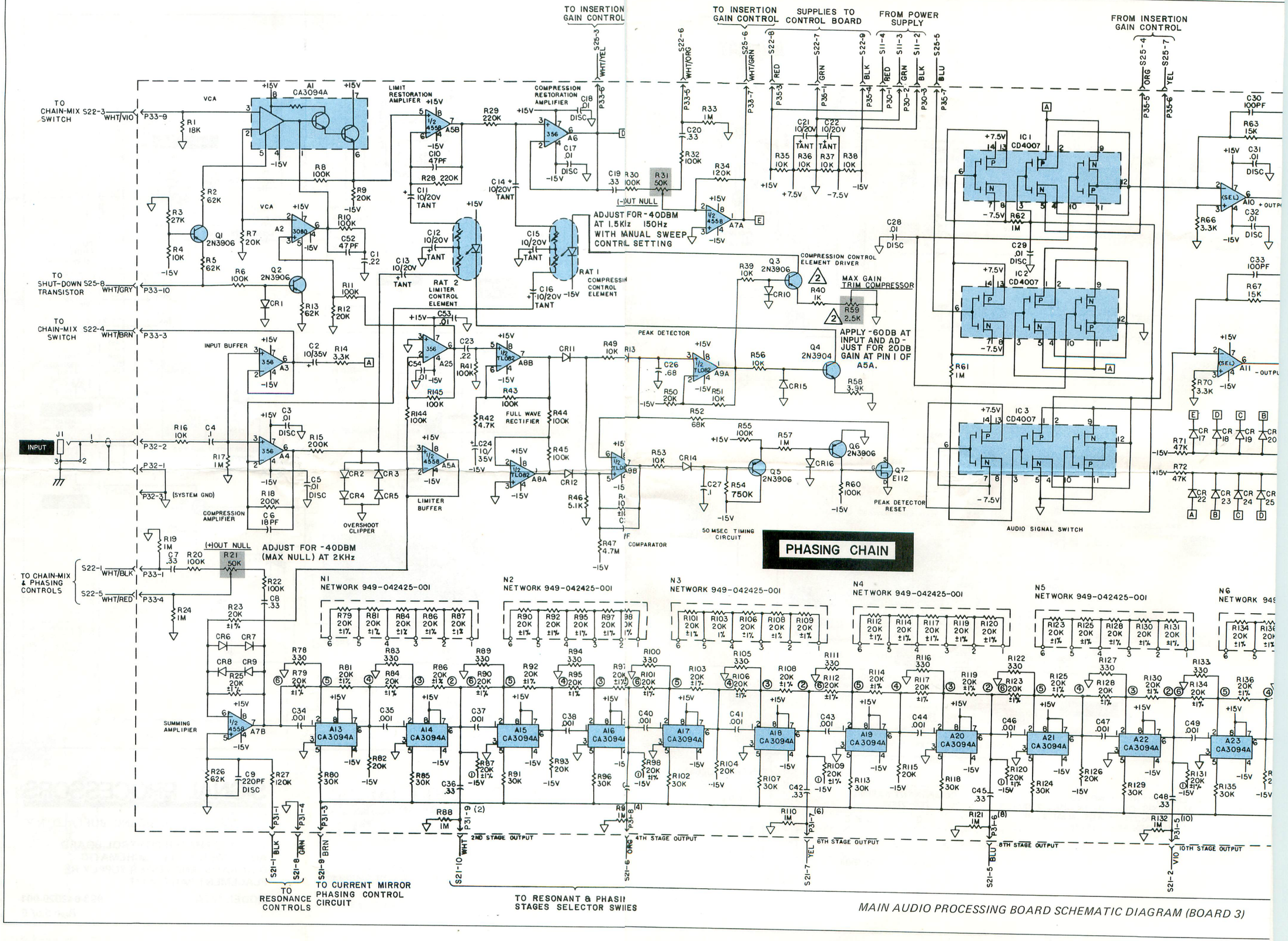


SIGNAL PROCESSORS

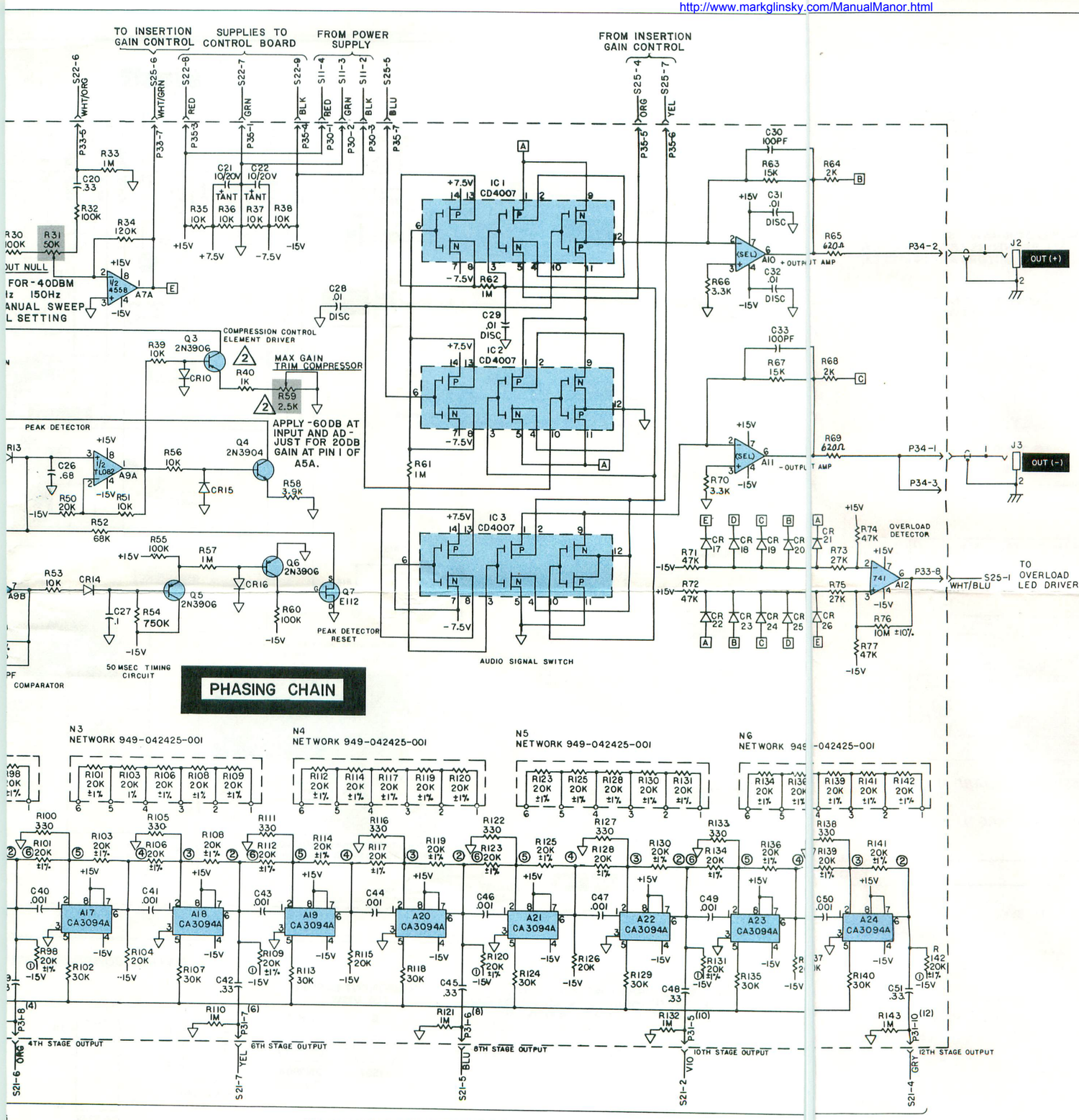
moog® MUSIC INC. BUFFALO, N.Y.

12 STAGE PHASER CONTROL BOARD AND POWER SUPPLY SCHEMATIC DIAGRAMS, AND POWER SUPPLY REPLACEMENT PARTS LIST

MODEL 307A 993-042929-001



MAIN AUDIO PROCESSING BOARD SCHEMATIC DIAGRAM (BOARD 3)

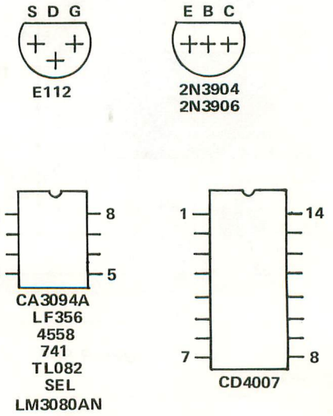


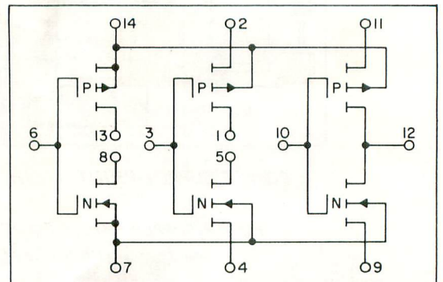
MAIN AUDIO PROCESSING BOARD SCHEMATIC DIAGRAM (BOARD 3)

NOTES:
1. UNLESS OTHERWISE SPECIFIED
   ALL RESISTORS ARE IN OHMS 1/4W ± 5%
   ALL CAPACITORS ARE IN MFD (uf)
   ALL DIODES ARE 1N4148

2 LATER VERSIONS CHANGE R40 TO 2.2K AND R59 TO 5K FOR IMPROVED COMPRESSOR GAIN SET UP.

COMPONENT BASING
TOP VIEW





SIGNAL PROCESSORS

MUSIC INC. BUFFALO, N.Y.

12 STAGE PHASER MAIN AUDIO PROCESSING BOARD SCHEMATIC DIAGRAM

MODEL 307A **993-042929-001**

PARTS LIST

POWER SUPPLY

REF. DESIG.	PART NUMBER	DESCRIPTION	QTY.
	996-041659-001	Printed Circuit Board Assembly consisting of:	1
C1, C2	945-040209-007	Capacitor, Aluminum, Electrolytic, 470uf, 35V	2
C3, C4	947-040194-152	Capacitor, Disc, 0.0015uf	2
C5, C7	946-040231-002	Capacitor, Tantalum, 10uf, 20V	2
C6, C8	947-040200-103	Capacitor, Disc, 0.01uf	2
CR1 thru CR4	919-010623-003	Diode, Rectifier, 1N4004	4
IC101	991-041111-001	Integrated Circuit, Dual Regulator, ±15V, SG1468	1
P11	910-040303-005	Header, Printed Circuit, 5 Pin, Keyed (0.150 Centers), AMP640242-5	1
P12	910-041716-003	Header, Printed Circuit, 3 Pin, AMP350210-1	1
Q1	991-041050-001	Transistor, PNP, TIP30	1
Q2	991-041049-001	Transistor, NPN, TIP29	1
R1, R4	852-312027-001	Resistor, 2.7 Ohm, ±5%, 1/4W	2
R2, R3	852-312510-001	Resistor, 51 Ohm, ±5%, 1/4W	2
	967-040935-001	Heatsink, TO-220 Device	2

CONTROL BOARD

REF. DESIG.	PART NUMBER	DESCRIPTION	QTY.
	996-042430-001	Printed Circuit Board Assembly, consisting of:	1
A1, A4	991-041210-002	Integrated Circuit, Operational Amplifier, 36V, CA3094A	2
A2	991-041951-001	Integrated Circuit, Operational Amplifier, LF356N	1
A3, A5	991-041146-001	Integrated Circuit, Dual Operational Amplifier, 4558	2
C1, C2, C11, C12	946-040231-002	Capacitor, Tantalum, 10uf, 20V	4
C3	946-041978-102	Capacitor, Polyester, 0.001uf	1
C4, C5, C8, C9	947-042020-501	Capacitor, Disc, 5500Pf	4
C6	946-041978-104	Capacitor, Polyester, 500Pf	1
C7	946-041978-334	Capacitor, Polyester, 0.33uf	1
C10	946-041978-474	Capacitor, Polyester, 0.47uf	1
C13 thru C16	945-040209-001	Capacitor, Aluminum, Electrolytic, 10uf, 25V	4
C17	947-042020-101	Capacitor, Disc, 100Pf	1
CR1 thru CR6	919-041075-001	Diode, Signal, 1N4148	6
IC1	991-041104-001	Integrated Circuit, Transistor Array, CA3046	1
P21	910-040299-010	Connector, 10 Pin, CIS, Printed Circuit	1
P22	910-040299-009	Connector, 9 Pin, CIS, Printed Circuit	1
P23, P24	910-040299-006	Connector, 7 Pin, CIS, Printed Circuit	2
P25	910-040299-008	Connector, 8 Pin, CIS, Printed Circuit	1
P26	910-040299-006	Connector, 6 Pin, CIS, Printed Circuit	1
P27	910-040299-003	Connector, 3 Pin, CIS, Printed Circuit	1
Q1, Q3, Q4	991-041052-001	Transistor, PNP, Small Signal, 2N3906	3
Q2	991-041265-001	Transistor, NPN, Small Signal, TIS97	1
Q5	991-041051-001	Transistor, NPN, Small Signal, 2N3904	1
R1, R2, R4	852-312513-001	Resistor, 51K Ohm, ±5%, 1/4W	3
R3	852-312134-001	Resistor, 130K Ohm, ±5%, 1/4W	1
R5	852-312474-001	Resistor, 470K Ohm, ±5%, 1/4W	1
R6, R20	925-041870-003	Resistor, Rotary, Linear, 10K, SWEEP OFFSET and SWEEP RATE	2
R7	852-312824-001	Resistor, 820K Ohm, ±5%, 1/4W	1
R8, R24, R26	925-040275-004	Resistor, Trimmer, 10K Ohm, OFFSET TRIM, RATE TRIM AND MOTOR START TRIM	3
R9	852-312473-001	Resistor, 47K Ohm, ±5%, 1/4W	1
R10	852-312472-001	Resistor, 4.7K Ohm, ±5%, 1/4W	1
R11, R15, R16, R27, R37	852-312103-001	Resistor, 10K Ohm, ±5%, 1/4W	5
R12, R29, R31, R52, R53	852-512202-001	Resistor, 2K Ohm, ±5%, 1/4W	5
R13, R14, R17, R19, R22, R35, R40, R43, R49, R51	852-312104-001	Resistor, 100K Ohm, ±5%, 1/4W	10
R18	852-312681-001	Resistor, 680 Ohm, ±5%, 1/4W	1
R21, R25	852-312154-001	Resistor, 150K Ohm, ±5%, 1/4W	2
R23, R41	852-312105-001	Resistor, 1 Megohm, ±5%, 1/4W	2
R28	852-312394-001	Resistor, 390K Ohm, ±5%, 1/4W	1
R30, R55	852-312164-001	Resistor, 160K Ohm, ±5%, 1/4W	2
R32	852-312914-001	Resistor, 910K Ohm, ±5%, 1/4W	1
R33	852-312512-001	Resistor, 5.1K Ohm, ±5%, 1/4W	1
R34, R56	852-312102-001	Resistor, 1K Ohm, ±5%, 1/4W	2
R36	852-312821-001	Resistor, 820 Ohm, ±5%, 1/4W	1
R38	852-312101-001	Resistor, 100 Ohm, ±5%, 1/4W	1
R39, R57	852-512102-001	Resistor, 1K Ohm, ±5%, 1/2W	2
R42	925-041870-005	Resistor, Rotary, 100K Ohm, 10% CCW Log, RESONANCE	1
R44	852-312515-001	Resistor, 5.1 Megohm, ±5%, 1/4W	1
R45, R46	852-312273-001	Resistor, 27K Ohm, ±5%, 1/4W	2
R47	852-312303-001	Resistor, 30K Ohm, ±5%, 1/4W	1
R48	852-312132-001	Resistor, 1.3K Ohm, ±5%, 1/4W	1
R50	852-312203-001	Resistor, 20K Ohm, ±5%, 1/4W	1
R54	925-041870-004	Resistor, Rotary, Linear, 100K Ohm, SWEEP AMOUNT	1
R58, R59	852-312522-001	Resistor, 5.6K Ohm, ±5%, 1/4W	2
R60	925-041869-004	Resistor, Rotary, Dual, 50K Ohm, 20% CCW Log, INSERTION GAIN	1
R61	852-312392-001	Resistor, 3.9K Ohm, ±5%, 1/4W	1
SW5	960-042792-002	Switch, Rotary, 1P3T, SWEEP SELECTOR	1
SW6, SW7	960-042792-001	Switch, Rotary, 1P6T, RESONANT STAGES and PHASING STAGES	2
SW8	960-042792-003	Switch, Rotary, 2P2T, CHAIN MIX	1

MAIN BOARD

REF. DESIG.	PART NUMBER	DESCRIPTION	QTY.
	996-042434-001	Printed Circuit Board Assembly consisting of:	1
A1, A13 thru A24	991-041210-002	Integrated Circuit, Operational Amplifier, 36V, CA3094A	13
A2	991-041089-004	Integrated Circuit, Operational Amplifier, FET, LM3080AN	1
A3, A4, A6, A25	991-041951-001	Integrated Circuit, Operational Amplifier, FET, LF356N	4
A5, A7	991-041146-001	Integrated Circuit, Operational Amplifier, Dual, 4558	2
A8, A9	991-042661-001	Integrated Circuit, Operational Amplifier, Dual, TL082	2
A10, A11	991-042793-001	Integrated Circuit, Operational Amplifier, JFET, Selected	2
A12	991-041101-001	Integrated Circuit, Operational Amplifier, 741	1
C1, C23	946-041978-224	Capacitor, Polyester, 0 22uf	2
C2, C24	945-040209-036	Capacitor, Aluminum, Electrolytic, 10uf, 35V	2
C3, C5, C17 C18, C28, C29, C31, C32, C53, C54	947-040200-103	Capacitor, Disc, 0 01uf	10
C4, C27	946-041978-104	Capacitor, Polyester, 0 1uf	2
C6	947-042020-180	Capacitor, Disc, 18Pf	1
C7, C8, C19, C20, C36, C39, C42, C45, C48, C51	946-041978-334	Capacitor, Polyester, 0.33uf	10
C9	947-042020-221	Capacitor, Disc, 220Pf	1
C10, C52	947-042020-470	Capacitor, Disc, 47Pf	2
C11 thru C16, C21, C22	946-040231-002	Capacitor, Tantalum, 10uf, 20V	8
C25	947-042020-100	Capacitor, Disc, 10Pf	1
C26	946-041978-684	Capacitor, Polyester, 0 68uf	1
C30, C31, C34, C35, C37, C38, C40, C41, C43, C44, C46, C47, C49, C50,	946-043070-102	Capacitor, Disc, 100Pf	2
CR1 thru CR26	946-041978-102	Capacitor, Polyester, 0 01uf	12
IC1 thru IC3	919-041075-001	Diode, Signal, 1N4148	26
N1 thru N6	991-041086-001	Integrated Circuit, CD4007	3
P30	949-042425-001	Resistor Network (5 Resistors), 20K Ohm, ±1%	6
P31, P33	910-040303-003	Connector, Header, 3 Pin, CIS, Keyed (0 15 Centers)	1
P32, P34	910-040299-010	Connector, Header, 10 Pin, CIS, (0 1 Centers)	2
P35	910-040299-003	Connector, Header, 3 Pin, CIS, (0.1 Centers)	2
Q1, Q2, Q3, Q5, Q6	910-040299-007	Connector, Header, 7 Pin, CIS, (0.1 Centers)	1
Q4,	991-041052-001	Transistor, PNP, Small Signal, 2N3906	5
Q7	991-041051-001	Transistor, NPN, Small Signal, 2N3904	1
R1, R2, R5, R13, R26,	991-041055-001	Transistor FET, E112	1
R3, R73, R75, R4, R16, R35, thru R39, R49, R51, R53, R56 R6, R8, R10, R11, R20, R22, R30, R32, R41, R43, R44, R45, R55, R60, R144, R145 R7, R9, R12	852-312183-001	Resistor, 18K Ohm, ±5%, 1/4W	1
	852-312623-001	Resistor, 62K Ohm, ±5%, 1/4W	4
	852-312273-001	Resistor, 27K Ohm, ±5% 1/4W	3
	852-312103-001	Resistor, 10K Ohm, ±5%, 1/4W	11
	852-312104-001	Resistor, 100K Ohm, ±5%, 1/4W	16
R50, R82, R93, R104, R115, R126, R137, R14, R66, R70 R15, R18, R17, R19, R24, R33, R57, R61, R62, R88, R99, R110, R121,	852-312203-001	Resistor 20K Ohm, ±5%, 1/4W	10
	852-312332-001	Resistor, 3 3K Ohm, ±5%, 1/4W	3
	852-312204-001	Resistor, 200K Ohm, ±5%, 1/4W	2
R132, R143	852-312105-001	Resistor, 1 Megohm, ±5%, 1/4W	13
R21, R31,	925-040275-003	Resistor, Trimmer, 50K Ohm, (+) OUT NULL and (-) OUT NULL	2
R23, R25	853-422002-031	Resistor, 20K Ohm, ±1%, 1/4W	2
R27, R34	852-312124-001	Resistor, 120K Ohm, ±5%, 1/4W	2
R28, R29	852-312224-001	Resistor, 220K Ohm, ±5%, 1/4W	2
R40	852-312102-001	Resistor, 1K Ohm, ±5%, 1/4W	1
R42	852-312472-001	Resistor, 4 7K Ohm, ±5%, 1/4W	1
R46	852-312512-001	Resistor, 5 1K Ohm, ±5%,1/4W	1
R47	852-312475-001	Resistor, 4 7 Megohm, ±5%, 1/4W	1
R48, R76	851-152106-000	Resistor, 10 Megohm, ±10%, 1/4W	2
R52	852-312683-001	Resistor, 68K Ohm, ±5%, 1/4W	1
R54	852-312684-001	Resistor, 680K Ohm, ±5%, 1/4W	1
R58	852-312392-001	Resistor, 3 9K Ohm, ±5%, 1/4W	1
R59	925-040275-013	Resistor, Trimmer, 2 5K Ohm, MAX GAIN TRIM COMPRESSOR	1
R63, R67	852-312153-001	Resistor, 15K Ohm, ±5%, 1/4W	2
R64, R68	852-312202-001	Resistor, 2K Ohm, ±5%, 1/4W	2
R65, R69	852-312621-001	Resistor, 620 Ohm, ±5%, 1/4W	2
R71, R72, R74, R77	852-312473-001	Resistor, 47K Ohm, ±5%, 1/4W	4
R78, R83, R89, R94, R100, R106, R111, R116, R122, R127, R133, R138	852-312331-001	Resistor, 330 Ohm, ±5%, 1/4W	12
R80, R85, R91, R96, R102, R107, R113, R118, R124, R129, R135, R140	852-312303-001	Resistor, 30K Ohm, ±5%, 1/4W	12
RAT1, RAT2	948-042791-001	Isolator, Dual	2

REPLACEMENT PARTS LIST

REF. DESIG.	PART NUMBER	DESCRIPTION	QTY.
	997-042347-001	12 Stage Phaser Keyboard Modifier consisting of:	
	996-041659-001	Printed Circuit Board Assembly, KB Mod, Power Supply	1
	996-042430-001	Printed Circuit Board Assembly, Control, No. 2	1
	996-042434-001	Printed Circuit Board Assembly, Main, No. 3	1
F1	939-041620-004	Fuse 3AG, 1 Amp., Slo-Blo	1
F2, F3	939-041620-002	Fuse 3AG, 1/4 Amp., Slo-Blo	2
J1, J4	910-041306-002	Jack, Phone, 1 Circuit, Shorting, Switchcraft 112A	2
J2, J3, J5, J6,	910-041306-001	Jack, Phone, 1 Circuit, Switchcraft 111	4
J7	910-041306-004	Jack, Phone, 2 Circuit, Stereo, Switchcraft 112B	1
L1	939-041850-003	LED, Yellow, Opcoa LSM-26L	1
L2, L4	939-041850-001	LED, Red, Opcoa LSM 6L	2
L3	939-041850-002	LED, Green, Opcoa LSM-16L	1
P1	910-041739-001	Receptacle, 250V AC, Ga, Switchcraft EAC-31	1

REF. DESIG.	PART NUMBER	DESCRIPTION	QTY.
P2 P3	910-041314-004	Plug, 4 Position, Univ. Mate-N-Lok, AMP1-480702-0	2
S2 S3	910-041315-004	Cap, 4 Position, Univ. Mate-N-Lok, AMP1-480703-0	2
S4, S5, S6, S7	906-040298-002	Housing, 2 Pin, CIS, 0.100 Centers, AMP350091-2	4
S11	906-040302-005	Housing, 5 Pin, CIS, Keyed, 0.150 Centers, AMP640117-1	1
S12	910-041717-003	Housing, Socket Connector, 3 Pin, 0.2 Centers, Mate-N-Lok	1
S21 S31, S33	906-040298-010	Housing, 10 Pin, CIS, 0.100 Centers, AMP350091-10	3
S22	906-040298-009	Housing, 9 Pin, CIS, 0.100 Centers, AMP350091-9	1
S23, S24, S35	906-040298-007	Housing, 7 Pin, CIS, 0.100 Centers, AMP350091-7	3
S25	906-040298-008	Housing, 8 Pin, CIS, 0.100 Centers, AMP350091-8	1
S26	906-040298-006	Housing, 6 Pin, CIS, 0.100 Centers, AMP350091-6	1
S27, S32, S34	906-040298-003	Housing, 3 Pin, CIS 0.100 Centers, AMP350091-3	3
S30	906-040302-003	Housing, 3 Pin, CIS, Keyed, 0.150 Centers, AMP640115-1	1
SW1	960-041303-001	Switch, Selector, DPL Wipe, 115-230V, Switchcraft 46256LFE	1
SW2 SW4	960-041311-003	Switch, Rocker, DPDT, Legend, ON-OFF, Carling SGD0410-TB-B	2
SW3	960 041314 002	Switch, Rocker, SPDT, Legend, IN-OUT, Carling SGB0410-TB-B	1
T1	954-041647-002	Transformer, 250 Ma, Shielded	1
	801-055446-000	Nut, Hexagon, 8-32	1
	806-054039-005	Screw, Pan Hd., Phillips, 6-32 x 5/16 in., Black Oxide	2
	806-045039-007	Screw, Pan Hd., Phillips, 6-32 x 7/16 in., Black Oxide	6
	806-045039-010	Screw, Pan Hd., Phillips, 6-32 x 0.625 in., Black Oxide	4
	806-055039-006	Screw, Pan Hd, 8-32 x 3/8 in., Black Oxide	1
	811-040039-008	Screw, Self Tapping, 6A x 1/2 in.	14
	811-040039-010	Screw, Self Tapping, Pan Hd., Type A, 6A x 5/8 in., Black Oxide	8
	816-040239-006	Screw, Self Tapping, Flat Hd., Type B, 6B x 3/8 in., Black Oxide	6
	902-040500-001	Nut, Speed, No. 6A	22
	902-040504-007	Nut, 3/8-32	12
	902-041394-009	Nut, 6-32, Hexagon	8
	904-040495-016	Washer, Lock, No. 6	16
	904-040495-021	Washer, Lock, 3/8 in.	12
	904-041390-017	Washer, No. 6	12
	904-042026-001	Washer, Flat, Conical, 3/8 in.	12
	905-040498-034	Rivet, Pop, 1/8 in. Dia.	6
	906-041331-003	Fuse Black, Littlefuse Series 357-003	1
	910-040308-001	Contact, Female, CIS, AMP350090-1	85
	910-040310-001	Plug, Keying	9
	910-041313-001	Contact, Socket, Univ. Mate-N-Lok, AMP350570-1	8
	910-041316-001	Contact, Pin, Univ. Mate-N-Lok, AMP350699-1	8
	910-042049-001	Connector, Mate-N-Lok, Crimp Socket	3
	911-040189-002	Lug, No. 8, AMP61436-1	1
	913-042007-001	Decal, Fuse	1
	913-042422-001	Overlay, Front Panel	1
	913-042459-001	Label, Instruction	1
	916-041834-001	Machine Screw Bumper	4
	957-041794-001	Power Cord, Belden 17250-B	1
	963-042801-001	Cover, Rear	1
	964-041896-001	Insert, Molded Foam	2
	967-040734-001	Cover, Top	1
	967-040734-004	Cover, Bottom	1
	967-042545-001	Bracket, Transformer	2
	968-040733-003	Front Extrusion	1
	973-040508-058	Spacer, 6-32 x 0.312 in., 1/4 Hex., Brass	4
	973-041308-018	Standoff, PEM, 6-32 x 1/4 in., PEMSO-632-8	2
	973-041308-020	Standoff, PEM, 6-32 x 3/8 in., PEMSO-632-12	6
	976-041851-001	Grommet and Ring, Opcoa OC-1	4
	997-041887-001	Knob Assembly, Pointer	9
	997-041886-001	End Plate Subassembly, L.H.	1
	997-041886-002	End Plate Subassembly, R.H.	1