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M-1.5
MAGNETIC FIELD POWER AMPLIFIER
SERVICE MANUAL
INCLUDING SCHEMATICS
FOR THE M-1.5t

M-1.5 SERVICE GUIDE

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INTRODUCTION

The magnetic-field power amplifier design incorporated in the M-1.5 allows a degree of efficiency and protection unequalled in conventional amplifiers.

The high efficiency and protection control are made possible by the triac-controlled primary of the M-1.5's transformer together with the supply's ability to "track" the audio signal.

These features greatly reduce size and cost per watt.

To better understand this design, which is far from conventional, the following circuit description should be read carefully.

Attempting to repair the unit without the following information may lead to severe damage to the unit.

The circuit description is followed by a Test Procedure and Troubleshooting Guide. Please read the Circuit Description and follow the Test Procedure, using the Troubleshooting Guide only if you run into trouble during the test procedure. It is very important that the "prestart" list at the beginning of the test procedure is followed when powering up a damaged unit on the bench. It will also be a very good idea to study the Troubleshooting Guide ahead of time so you are familiar with its contents.

AMPLIFIER BOARDS

Two standard phono plugs on the amplifier are capacitively coupled to the amp boards. On older units, the input was directly coupled to the amplifiers.

The input signal is processed by a clipping eliminator circuit which consists of a OPTO coupler (OC1), a "steering" bridge (D1, D2, D3, D4), and a filter network (R96, R98, C33). The clipping eliminator is driven by the error signal on the output of input buffer IC1. Distortion in excess of 1% will provide sufficient drive to attenuate input and light the headroom exhausted LED on the display. This circuit will prevent distortion in excess of 3% with up to 15 dB overdrive on the input (see figure 7).

NOTE: On older units, a dual op-amp was used in the front-end and the clipping eliminator was driven by a differential amp which was outside the signal path and independently compared input and output signals.

Input buffer IC1 (TLO-81 op-amp) provides a high impedance input to isolate the clipping eliminator circuit and provides a low impedance output for driving the clipping eliminator circuit and succeeding stages.

Local negative feedback from the output of IC1 via R90 and C25 is used for stability, and to reduce overall negative feedback.

The output of the input buffer is coupled to Q14 and Q15 which provide a current source for dc biasing and also provide dc-level shifting which is required for referencing the audio signal to the top dc supplies (\pm) to drive the next stage.

The output of the dc-level shifters drives a pair of predriver/voltage amplifiers (Q13 and Q20). This stage provides full voltage swing to the following current gain stages and supply "tracking" on commutator circuits.

The bias network of Q16 and Q17 provides adjustment of the dc idle current through outputs Q5 and Q6. Q16 is mounted on the heatsink and provides thermal feedback to prevent thermal runaway and helps maintain a constant idle current. RP1 on the amp boards, adjusts the idle current.

The predrivers drive the "driver" stage (Q8 and Q3) which provides current amplification for driving the outputs and supply commutating circuitry.

Available current to the base of the drivers is limited by limiter transistors Q18 and Q19 which are biased on by the voltage drop across the output emitter resistors R49 and R87. When Q19 is biased on, Q26 is also biased on, providing a shutdown pulse to the supply board.

Q26 will also be biased on by excessive high frequency. This is achieved with C30 and R102. As frequency increases, the current through R102 increases, sending a shutdown pulse to the supply board.

These are the only two shutdown signals that the supply will get from the amp cards--other than their output signals.

Current from drivers Q8 and Q3 provides drive for the two high gain, high-linearity output devices Q6 and Q5. These devices provide full voltage swing and current drive to the loads.

The active, local bias network of Q23, R86, and R85, provides variable "pull down" of the bases of Q6 and Q5 to help prevent common-mode conduction of the output transistors and reduce their turn-off time.

The first supply commutator transistors, Q7 and Q4, are used to increase the supply voltages on the collectors of Q6 and Q5 from 50V to 80V as required (see figures 5 and 6). The diode network of D31, D15, D16, and D17 (and their negative equivalents), in the base of Q6 and Q7, provides voltage "lead" for the first supply commutating transistors Q7 and Q4. This allows the supply voltages to stay ahead of the audio demand. As frequency increases, Q7 and Q4 require additional "lead" time to stay ahead of the audio. This is achieved by C13, R6, D14, and R47 (and their negative equivalents).

The second supply commutator pairs, Q9, Q10 and Q1, Q2, increase the supply voltages on the collectors of Q7 and Q4 from 80V to 125V as required. This, in turn, allows Q7 and Q4 to increase Q6 and Q5 collector voltages to 125V as required (see figures 3 and 4). D13 and D14 prevent the first commutator from dumping back into the supply.

The second commutators receive their drive from drivers Q8 and Q3. However, the current at this stage is insufficient to supply enough current to the output transistors and a bootstrap network and current gain stage are required.

The main bootstrap network consists of R33, R92, R34, and C9 (and their equivalents on the negative side). A second bootstrap network is used to provide additional "lead" voltage for the second commutator as required at higher frequencies. This circuit consists of R36, R35, and C10 (and their equivalents on the negative side).

The turn-on threshold for the second commutators is determined by the dc biasing on the base of Q12 and Q21. D12 and D23 provide supply steering which prevents the commutators from dumping back into the supply.

Power Supply 240V, 50 Hz

PRIMARY REGULATOR CARD

The M-1.5 is fused with an AGC8 amp fuse, and thermally protected by a 90°C thermal breaker--both of which are in series with the transformer primary.

An RC line filter network is used to suppress line noise generated by the triggering of triac TR1, and to reduce noise already present on-line.

The firing angle of triac TR1, which controls the voltage on the primary of the transformer, is determined by the active voltage divider formed by OC1 and R4 on the regulator card. D1, D2, D3, and D4 provide voltage "steering" for OC1 which makes it possible to use the bipolar device for ac control. This voltage divider drives the passive RC phase shift network composed of R3, C3, R2, and C2. When the voltage on C2 reaches the 40V trigger voltage of diac (DC1), the triac will be triggered (see figure 1). If OC1 is turned on hard enough, the voltage necessary to fire the diac will be unobtainable and the unit will turn off. If the triac is triggered at or before 90°C, the primary voltage will be at its maximum (see figure 2). If triggered later than 90°C but before zero crossing, the secondary voltage will be at some lower level determined by demand.

Since it is possible to turn the unit on or off with OC1 on the regulator card, this device is used for linear line and load regulation as well as protection shutdown. OC1 is used to provide electrical isolation between the primary and secondary circuits. The current through the LED portion of OC1 is inversely proportioned to the voltage available to the primary of the transformer. This means that as OC1 LED current increases, the transformer primary voltage will decrease.

MAIN POWER SUPPLY BOARD

Linear regulation control is achieved by controlling the current through the LED portion of OC1. This current is provided by Q5 and Q6 and their passive control circuitry. R21, R20, R23, and R24 are used to monitor the secondary supply voltages. RP1 is used for manual adjustment of the idle voltage, and R22 limits the range of control.

The Dynamic Headroom Control circuit provides a means of limiting the length of time the amplifier will run at its maximum dynamic power output. This feature is useful in limiting damaging, continuous high-power output. Over a period of 5 seconds, the output will be reduced from 625W down to 350W. The clipping eliminator circuit prevents clipping as the supply voltages are reduced.

The circuit works as follows. The right- and left-channel output signals are summed and rectified by D2 and D3 (on the supply board). This signal is fed to an RC network consisting of R29, R30, C18, R50, and C8. The output of IC1 Pins 10 and 14 provide the appropriate positive and negative headroom control signals to the regulator (Q5 and Q6). Diodes D20, D9, D21, and D10 isolate the

regulator from IC1 Pins 10 and 4 during normal operation. R49 and D19 allow the RC network of R50 and C8 to reset rapidly when the output signal is reduced.

Active shutdown protection is provided for the following faults.

- A) Over-voltage
- B) Over-current
- C) Excessive high frequency
- D) Integrator control
- E) dc offset - low frequency differential
- F) $\pm 12V$ fault

All shutdown signals are sensed by the differential comparator of Q2 and Q3. During normal operation, Q3 is biased on with a 1.3V reference on its base, and Q2 is off. Q2 will deliver current to the base of the shutdown drive transistor Q4 when the voltage on the base of Q2 exceeds that on the base of Q3. C5 extends the shutdown period by providing base current to Q4 after Q2 has turned off. C5 also helps prevent false triggering of Q4, as current through Q2 initially flows to C5. D32 and D33, in conjunction with R63, provide current limiting for Q4. This prevents excessive current through Q4 during initial shutdown, yet allows Q4 to maintain sufficient drive to OCL as the 80V supply collapses. The fault indicator LED is in series with Q4 and will light during all fault conditions. The fault LED will also light when the amplifier is switched off. The amplifier may not restart until the fault LED is off.

Over-voltage protection is achieved by comparing a portion of the +125V supply to a preset, regulated reference ($\approx 5.8V$). If the voltage on Pin 13 of IC1 exceeds the reference on Pin 14 of IC1, then Pin 12 will go positive and raise the voltage on the base of

Q2. This biases Q2 on and turns the amplifier off. Over-voltage shutdown should occur between +130 and +140V.

Over-current and high-frequency shutdown signals from the amplifier cards are sensed by Q1. When Q1 is biased on, the base of Q2 will exceed 1.3V and the amplifier will shut down.

An "integrator shutdown" circuit is provided for additional speaker protection. The output of the right and left channels is rectified and summed by D2 and D3. This voltage is averaged over approximately 3 minutes by the integrator network of R8 and C4. If the output exceeds 35V rms for too long a period, the amplifier is either clipping, or extremely-low dynamic material is being played at too high a level. Both of these conditions will damage speakers and need to be avoided. The rate of charge on C4 is determined by the output level of the right and left channels. When C4 is sufficiently charged to raise the base of Q2 above 1.3V, the amplifier will shut down. This circuit allows full dynamic range, yet limits long-term average output.

DC offset and excessive low-frequency differences are sensed by a low-pass differential amplifier (IC1 Pins 1, 2, and 3). C6 and C7 roll off the output in the audio spectrum while dc offset and single-channel, low-frequency signals (below 5 Hz) will be amplified. If Pin 3 goes positive, Q2 will be biased on when its base reaches 1.3V, turning the amplifier off. If Pin 3 goes negative, the base of Q3 will be pulled down. If pulled down to less than 0V, Q2 will turn on shutting the amplifier off.

The positive and negative 12V supplies are summed by R57 and R56, and compared by Q2 and Q3. If the negative 12V supply fails, the cathode of D6 will go positive, raising the voltage on the base of Q2 above 1.3V which will turn the amplifier off. If the positive

12V supply fails, the cathode of D6 will go negative. This will pull the base of Q3 below 0V and turn the amplifier off.

The M-1.5 transformer secondary consists of 3 pair of supply voltages ($\pm 125V$, $\pm 80V$ and $\pm 50V$), each having its own bridge rectifier and filter network. A stable $\pm 12V$ supply is obtained from the $\pm 50V$ supply via D13, Q7 and D14, Q8.

DISPLAY BOARD

The M-1.5's display consists of 2 columns of 7 LEDs which monitor the peak output of the right and left channels. The first, or bottom LED, is a power indicator and lets you know the amplifier is ready for operation. The second thru sixth LEDs indicate power level with a 1 msec attack and 500 msec decay. This display operates by incorporating a series of 4 comparators and a resistive ladder network which sets the appropriate reference voltages for each stage. D10 will light at 7V rms output, D9 at 10V, D8 at 13V, D7 at 21V, and D6 at 28V. See Table 1 for indicated wattage for 4-, 8-, and 16-ohm loads. The seventh LED is amber and indicates distortion in excess of $\approx 1\%$. It also indicates operation of the clipping eliminator circuit. It will accurately indicate clipping at any frequency, regardless of load impedance or line voltage.

TABLE 1

LED #	COLOR	V RMS OUTPUT	WATTS		
			4	8	16
7th	Amber	Headroom Exhausted	at	clipping	
6th	Red	28	196	98	49
5th	Red	21	110	56	27
4th	Red	13	42	21	10
3rd	Red	10	25	12	6
2nd	Red	7	12	6	3
1st	Red	Power On	-	-	-

Equipment List

Scope (isolated)
DA (with signal source)
22A variac
Line current monitor
Line voltage monitor
8 Ω load
Digital voltmeter
ACVM's

I) Presets

1. 8 Ω loads in
2. Input cables connected
3. Variac set @ min.
4. Line cord plugged into variac and line monitor meters (voltage and current).
5. Set RPI on supply board for min rail voltage (FCW).
6. Set RPI on left- and right-channel amp boards for min idle current. (FCCW)
7. Audio generator set to min.
8. Use 10A test fuse for bench test on 240V units.
Use 20A test fuse for bench test on 110V units.

CAUTION: Be sure to replace with factory fuse when test is completed.

- * II. Bring variac up slowly until triac just fires (\approx 120V ac line for 240V units \approx 60V ac line for 120V units).
1. Ready-lights on display should light.
 2. Fault LED should be out.
 3. No excessive current flow in line (less than 0.5A).
 4. Increase audio inputs to generate a 1V rms, 1 kHz signal on output.
 - A) Small crossover notches should be present on output wave form.
 5. Check triac firing for good symmetry (should be triggering @ about 90°. See figure 1).
 6. Check dc supply levels.
 - A) \pm 125V should be about \pm 57V.
 - B) \pm 80V should be about \pm 35V.
 - C) \pm 50V should read about \pm 16V.
 - D) \pm 12V should read about \pm 11.2V.
 7. Check dc offset @ output (should be less than 30 mV).
- III. Increase variac to 240/120V ac line (depending on unit type).
1. Check for excessive current draw (should be less than 0.5A).
 2. \pm 125V supply should read \approx 98V dc.
 3. Increase \pm 125V supply to \pm 122V dc by adjusting RPI on power-supply board.
 - A) Check for symmetrical triac triggering (figure 1).
- IV. Set idle current.
1. Remove 8 Ω loads.
 2. Adjust RPI on left amp card for 4 mV across emitter resistor R87 (5W sandbox by RPI) (\pm 0.5 mV).
 3. Repeat step 2 for right channel.
 4. Connect 8 Ω loads.

*Note: All primary waveforms must be viewed with isolated scope.

VI. Amp Cards

1. Check frequency response.
 - A) Set ref @ +10 dBm @ 1 kHz.
 - B) Check response @ 20 Hz (+0, -0.2 dB).
 - C) Check response @ 20 kHz (+0, -0.75).
2. Increase amplifier output to 40V rms (200W) @ 1 kHz and check commutators.
 - A) Refer to figures 3 & 4. Top commutators ($\pm 125V$) should be just starting to operate.
 - B) Refer to figures 5 & 6. Middle commutators ($\pm 80V$) should be full on.
3. Check full power with one channel at a time driven into 8Ω @ 1 kHz.
 - A) Min of 400W @ the clip point.
 - B) Distortion should be less than 0.1% @ 400W/channel, one channel driven.
 - C) Check commutators.
4. Check headroom controller.
 - A) Drive both channels @ 1 kHz with no load to the clip point.
 - B) Signal should drop 3 dB in ≈ 5 sec.
 - C) Remove signal and engage 8Ω loads.

VII.

1. Check 30 sec limit.
 - A) Make sure integrator cap (C-4) is fully discharged.
 - B) Drive both channels @ 350W out into 8Ω (53V rms).
 - C) Amp should shut down in ≈ 30 sec $\pm 20\%$.
 - D) Reduce input by 20 dB. Amp should restart in 40 sec $\pm 20\%$.

VII. (Continued)

2. Protection Circuitry

- A) Drive both channels @ 10V rms output @ 1 kHz.
- B) Short left-channel output to ground.
 - 1) amp should shut down immediately.
 - 2) right-channel output should cycle on and off.
- C) Remove left-channel short.
- D) Short right-channel output to ground.
 - 1) amp should shut down immediately.
 - 2) left-channel output should cycle on and off.
- E) Remove right-channel short.

3. Internal dc offset protection

- A) Remove input signal.
- B) The M-1.5t is capacitively coupled on the new amp board inputs, so offset must be generated on the amp board.
- C) Carefully short pin 3 to pin 2 on IC₁ (TLO-81) on left-channel amp board.
 - 1) amp should shut down immediately and cycle @ low level.
- D) Remove short from left channel op-amp.
- E) Repeat for right channel.

4. ±12V fault protection

- A) Disable +12V supply by grounding cathode of D13 on supply board.
- B) Amp should shut down immediately and cycle @ low level.
- C) Remove ground and amp should restart.
- D) Repeat for -12V supply via shorting anode of D14 to ground.

5. High frequency shut down
 - A) Drive right channel @ 20 kHz.
 - B) Amp should shut down @ ~30-35V rms output.
 - C) Reduce input and amp should restart.
 - D) Repeat for left channel.
6. Over-voltage shut down
 - A) With no input signal, increase secondary voltage by adjusting RPI on supply board until amp shuts down.
 - B) Should shut down between +130 & +140V and cycle.
 - C) DO NOT exceed 140V.
 - D) Reduce supply voltage and amp should restart.
 - E) Reset $\pm 125V$ supply to $\pm 122V$.

VIII. Amp boards

1. Drive left channel with 1 kHz signal
 - A) Check display LEDs.
 - B) Check clipping indicator and clipping eliminator circuit.
 1. With output @ the clip point, increase input by 6 dB.
 2. Distortion should not exceed 3%.
2. Repeat step 1 for right channel.
3. Drive right channel with 1 kHz signal to the clip point into 4 Ω .
 - A) Check for symmetrical clipping (± 0.25 dB).
 - B) Min output should be 570W.
 - C) Check commutators (figures 3, 4, 5, 6).
4. Repeat step 3 for left channel.
5. Reduce output to 1V rms and drive both channels.
 - A) With shorted inputs, check noise (should be less than 600 μV).
 - B) Turn amplifier off.
 - C) Turn-off "thumps" should not exceed 2V peak.

END OF TEST

If the amplifier indicates a fault condition (no power or fault LED lit), the technician should go through the check list located on pages 8 and 9 of the owners manual.

If the problem cannot be corrected and service is required, the following "hints" may be helpful.

- *I. No power (all LEDs fail to light).
 - A) Determine if ac line voltage is reaching the triac.
 - 1) Use ac meter from Main T1 to Main T2 on triac.
 - B) If ac is not present on triac:
 - 1) Check fuse and fuse holder.
 - 2) Check line cord.
 - 3) Check thermal breaker.
 - 4) Check primary winding of transformer for continuity.
 - 5) Check solder on primary wiring.
 - C) If ac is present across triac (MT1--Mt2) but triac is not firing:
 - 1) Check voltage waveform across diac (see fig. 1).
 - a. If diac is firing and the triac is not, then the triac is defective.
 - b. If diac voltage is exceeding 40V peak and not firing, then the triac gate or diac is open.
 - c. If the voltage across the diac fails to reach 40V peak, then the problem lies in the phaseshift network or regulator.
 - 1. Check OPTO coupler OC1 on primary regulator card.
 - 2. Check steering bridge of D1, D2, D3, D4

*Note: All primary waveforms must be viewed with a line triggered isolated scope with NO secondary ground reference.

II. Fault LED lights when power is applied.

- A) Disable shutdown drive by removing the yel/wht wire from anode of fault LED to power supply board.

NOTE: The amplifier is now totally unprotected except for the line fuse. Extreme caution should be used to prevent serious damage to the amplifier. At this point, it would be unsafe to increase line voltage until the triac fires as rail voltages would be too high (± 57 , ± 35 , ± 17). Therefore, when shutdown drive is removed, you should jumper MT1 and MT2 of triac and increase line voltage just enough to determine source of fault (about 10V on the ± 50 V supply).

- B) Determine source of shutdown drive.

- 1) If Q4 is turned on, the base of Q2 should be at a higher voltage than the base of Q3. If not, the shutdown drive circuit is defective.
- 2) If the voltage on the base of Q2 does exceed that on the base of Q3, then determine which shutdown sensor circuit is activated.
 - a. Check ± 12 V fault--if cathode of D6 is 0.6V, supplies are okay. If not, check ± 12 V supplies and R57 and R56.
 - b. Check DC OFFSET--LOW FREQUENCY DIFF. on Pin 3 of IC1. See section III.
 - c. Check HI-FREQUENCY OVER CURRENT TRIP on collector of Q1 on supply board. See section IV.
 - d. Over-voltage shutdown, check pin 12 on IC1. See section V, paragraph A.
- 3) When source of shutdown fault is located and repaired, reconnect fault LED and remove jumper on triac.

- *III. DC-OFFSET sensor is tripped (If amp is offset start @ A, if not, go to C).
- A) Check $\pm 12V$ supply.
 - 1) Defective Q7 or Q8 on supply board.
 - 2) Defective D13 or D14 on supply board.
 - 3) Burned R67 or R68.
 - B) Check Pin 6 on IC1 on amp board.
 - 1) If offset is in the same direction as the offset on the output of the amp, then:
 - a. IC1 is defective
 - b. Missing correct feedback
 - c. Missing correct supply voltages on IC1.
 - 2) If the offset on IC1 Pin 6 is in the opposite direction as the offset on the output of the amp, the problem is somewhere after IC1.
 - 3) If the offset is after IC1, its cause may be determined by measuring the base-emitter voltages on Q14, Q15, Q13, Q20, Q8, Q3, Q6 and Q5.
EXAMPLE: If IC1 Pin 6 is offset positive, then Q20 should be off and Q13 should be turned on. It follows that Q3 should be off and Q8 on, etc.
 - C) NO offset on the output of the amp but output present on Pin 3 of IC1 on supply board.
 - 1) Defective IC1 or missing $\pm 12V$ supply to IC1 on supply board.
 - 2) If tripped when audio is applied, check D2, D3, and passive elements of the differential amplifier.

*NOTE: Always remove loads when troubleshooting dc offset.

- IV) Over-current high frequency shutdown is activated (Q1 is turned on, on the supply board).
- A) Shutdown activated with no signal applied:
 - 1) Defective Q1 on power supply board.
 - 2) Defective D6, Q26, Q19 or D18 on one of the amp boards. You may determine which board by measuring the voltages across R26 on each board. If current flow is indicated through R26, then that limiter is activating the trip sensor.
 - 3) Oscillation on the output of either amp card.
 - B) Shutdown activates too early when signal is applied:
 - 1) Oscillation on output of either channel.
 - 2) Leaky D6, Q26, D18 or Q19.
 - 3) Defective R87, C30, or R102 on amp board.
 - 4) Defective C2 on supply board.
- V) Over-voltage sensor is on (positive) when variac is brought up toward full line with RP1 on supply board set at min.
- A) If $\pm 125V$ supply is exceeding 130V, go to step B.
If $\pm 125V$ supply is not exceeding 130V, go to step C.
 - B) NO primary transformer regulation.
 - 1) Shorted triac (check waveform MT1 to MT2--see figure 1).
 - 2) Incorrect regulator drive.
 - a. Check Q5 and Q6 on supply board (see test voltages on base of Q5 and Q6 on schematic).
 - b. Check R21, R20, R23, R24 on the supply board.
 - c. Check OPTO-Coupler OC1 on primary regulator card.
 - d. Check RP1, R22, in the base circuit of Q5 and Q6 on the supply board.
 - e. Check the passive phase shift network on the primary regulator card.

V) Continued

C) Defective sensor circuit:

- 1) Check reference voltage on Pin 14 of IC1 on the supply board, $\approx 5.8V$ when +125V supply is set @ +122V.
- 2) Check sample voltage on Pin 13 of IC1.
 - a. If the voltage on Pin 13 does not exceed that on Pin 14 of IC1, yet Pin 12 is positive, then IC1 is defective or missing a supply.

*VI) Excessive current draw with no signal applied (and before triac fires):

A) Transformer primary circuit.

- 1) Defective line filter.
- 2) Shorted triac--this will cause excessive primary current at idle. Check voltage waveform across triac (figure 1).

*NOTE: Always remove loads when checking for excessive idle current.

VII) Excessive current draw with no signal applied and after triac has fired.

A) Transformer primary circuit.

- 1) Triac firing unsymmetrically:
 - a. Defective steering bridge (D1, D2, D3, D4) on regulator board.
 - b. Defective diac. Check diac waveform (figure 1).
 - c. Defective triac. May be firing in only one quadrant.

B) Supply secondary:

- 1) Defective bridge rectifier (± 125 , ± 80 , ± 50).
- 2) Defective supply capacitor (± 125 , ± 80 , ± 50).
- 3) Defective $\pm 12V$ regulators Q7 and Q8 on supply board.

VII) Continued

C) Damaged amplifier drive circuitry:

- 1) Blown output transistors (Q6 or Q5).
- 2) Defective driver transistors (Q8 or Q3).
- 3) Defective predriver transistors (Q13 or Q20).
- 4) Defective level shifter transistors (Q14 or Q15).

NOTE: 1 through 4 may cause offset, depending on other faults, in which case, it may be easier to use the troubleshooting procedure in Section III. Be sure to remove loads when troubleshooting offset.

- 5) Defective bias network (Q17 or Q16).

D) Defective or missing mica insulators on any transistor device which is bolted to the heatsink.

VIII) Early clipping on + or - side of waveform, on one channel or the other.

- A) When troubleshooting early clipping, the clipping eliminator should be disabled by removing an end of D33 on amp board.
- B) First commutator not supplying sufficient drive to the outputs.
 - 1) Defective Q7 or Q4 on amp board.
 - 2) Shorted D13 or D24 (this causes commutator current to flow back into the supply rather than to the output transistors).
 - 3) Insufficient voltage lead for first commutator.
 - a. Defective D31, D15, D16, or D17.
 - b. Defective D14, R47, C13, R6, or their negative equivalents.

VIII) Continued

C) Second commutator not supplying sufficient current to the outputs.

1) Defective Q9, Q10, Q2, Q1.

a. To see if both Q9 and Q10 (or Q1 and Q2) are working, you may check the voltage drops across their emitter resistors R45 and R46 (or R78 and R79) to see that they are within 10% of each other.

2) Insufficient drive to Q9, Q10, Q1, or Q2.

a. Check drive transistors Q11, Q12, or Q21, Q22.
b. Check bootstrap network (see test voltages on schematic).

3) Shorted D12 or D23 (this causes second commutator current to flow back into the $\pm 80V$ supply instead of to the output transistors.

D) Defective current limiters.

1) Check D7, Q18 or Q19, D18 (depending on whether early clip is the positive or negative side of the waveform).

E) Defective drive circuitry:

1) Check drivers Q8 and Q3.

2) Check R21 and R57.

3) Check predrivers Q13 and Q20. Also check R24 and R55.

4) Check level shifters Q14 and Q15.

IX) Clips early, both channels:

A) Defective secondary supply circuitry:

1) Open supply cap. (Check ripple on supply while running a signal.)

2) Open bridge diode.

3) Open LAN between supply and amp boards.

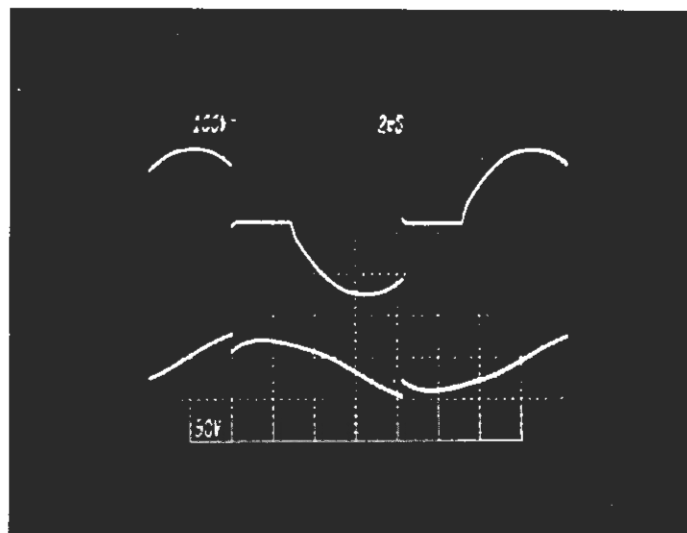
- IX) Continued
 - A) Continued
 - 4) Low secondary supply voltages.
 - a. Defective regulator circuit (OC1 on primary regulator card, Q5 or Q6 or associated circuitry).
 - b. Defective headroom controller (check voltage Pins 10 and 4 on IC1 on supply board; should be zero with no signal applied).
- X) Clipping eliminator not working:
 - A) Defective OC1 on amp board.
 - B) Defective D33, D1, D2, D3, D4 on amp board.
- XI) Excessive noise:
 - A) Noisy $\pm 12V$ supply
 - B) Triac misfiring will cause excessive noise.
 - C) Bad TLO 81 op-amp on amp board will cause "hiss" and "popcorn" noise.
 - D) Poor grounding "buzzing" and "hum".
 - E) Worn out or defective input jacks.
 - F) Loose connections will cause "crackling" and "scratching".
- XII) Excessive turn-off thumps:
 - A) Front end op-amp.
 - 1) TLO 81 on amp board.
 - B) Leaky drivers or predrivers.
 - C) Uneven $\pm 12V$ supply collapse.

#

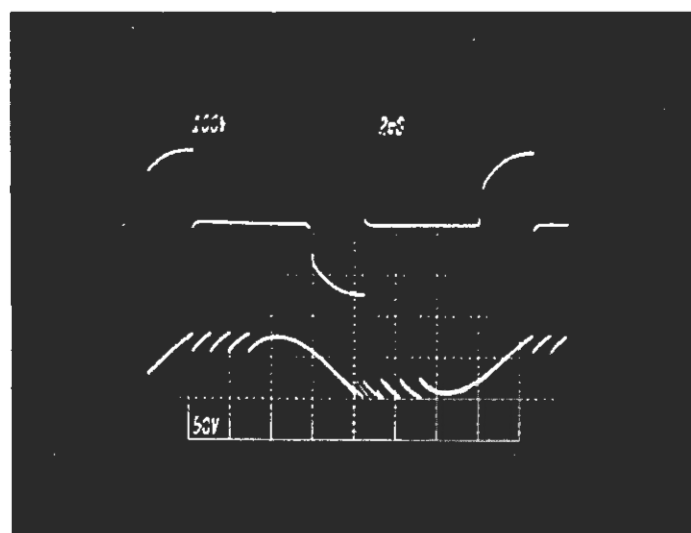
Figure Index

- Figure 1 Triac & diac @ idle
- Figure 2 Triac & diac @ full power into 8Ω @ 1 kHz
- Figure 3 +125V commutator @ full power @ 1 kHz into 8Ω .
- Figure 4 -125V commutator @ full power @ 1 kHz into 8Ω .
- Figure 5 +80V commutator @ full power @ 1 kHz into 8Ω .
- Figure 6 -80V commutator @ full power @ 1 kHz into 8Ω .
- Figure 7 Top trace is waveform driven 15 dB into clipping with
clipping eliminator out @ 1 kHz into 8Ω .
- Bottom trace is waveform driven 15 dB into clipping
with clipping eliminator in.

Note: All primary waveforms are for 120V units.
Waveforms for 240V units are identical except for amplitude.



1.57 FIG 1



1.57 FIG 2

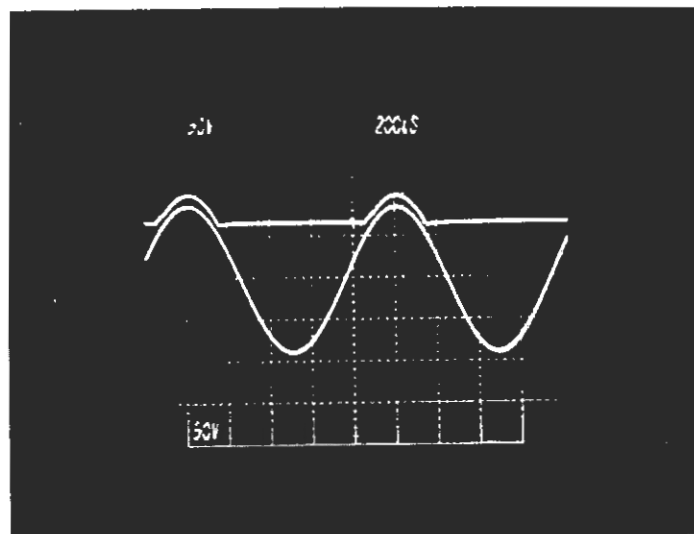


FIG 3

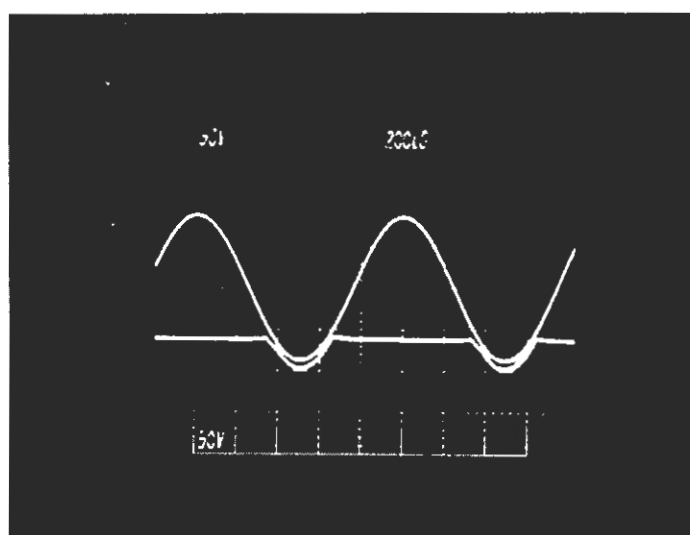


FIG 4

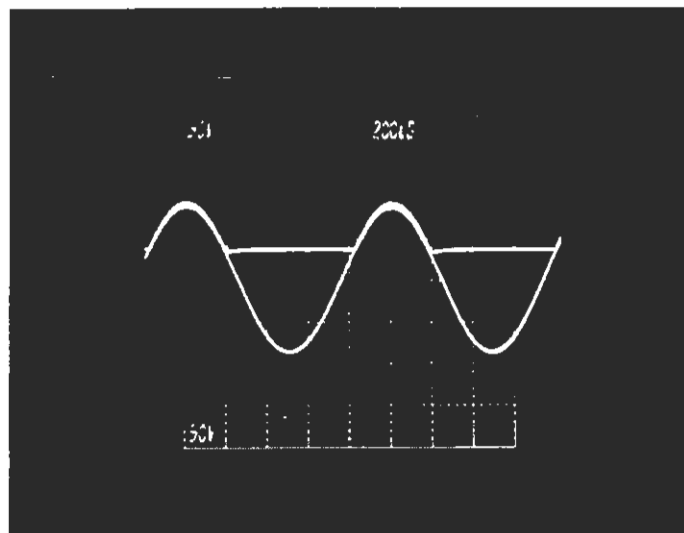


FIG 5

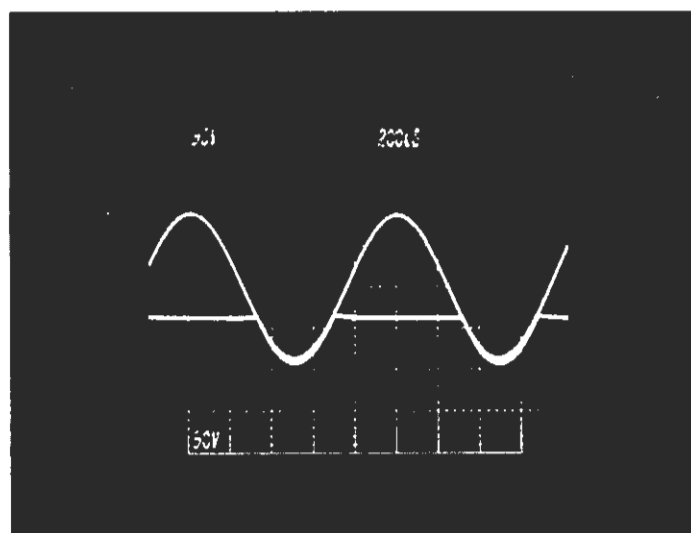


FIG 6

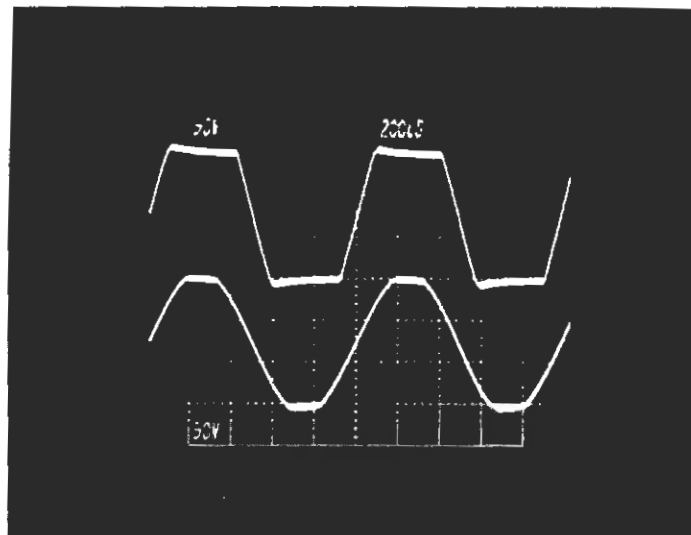


FIG 7

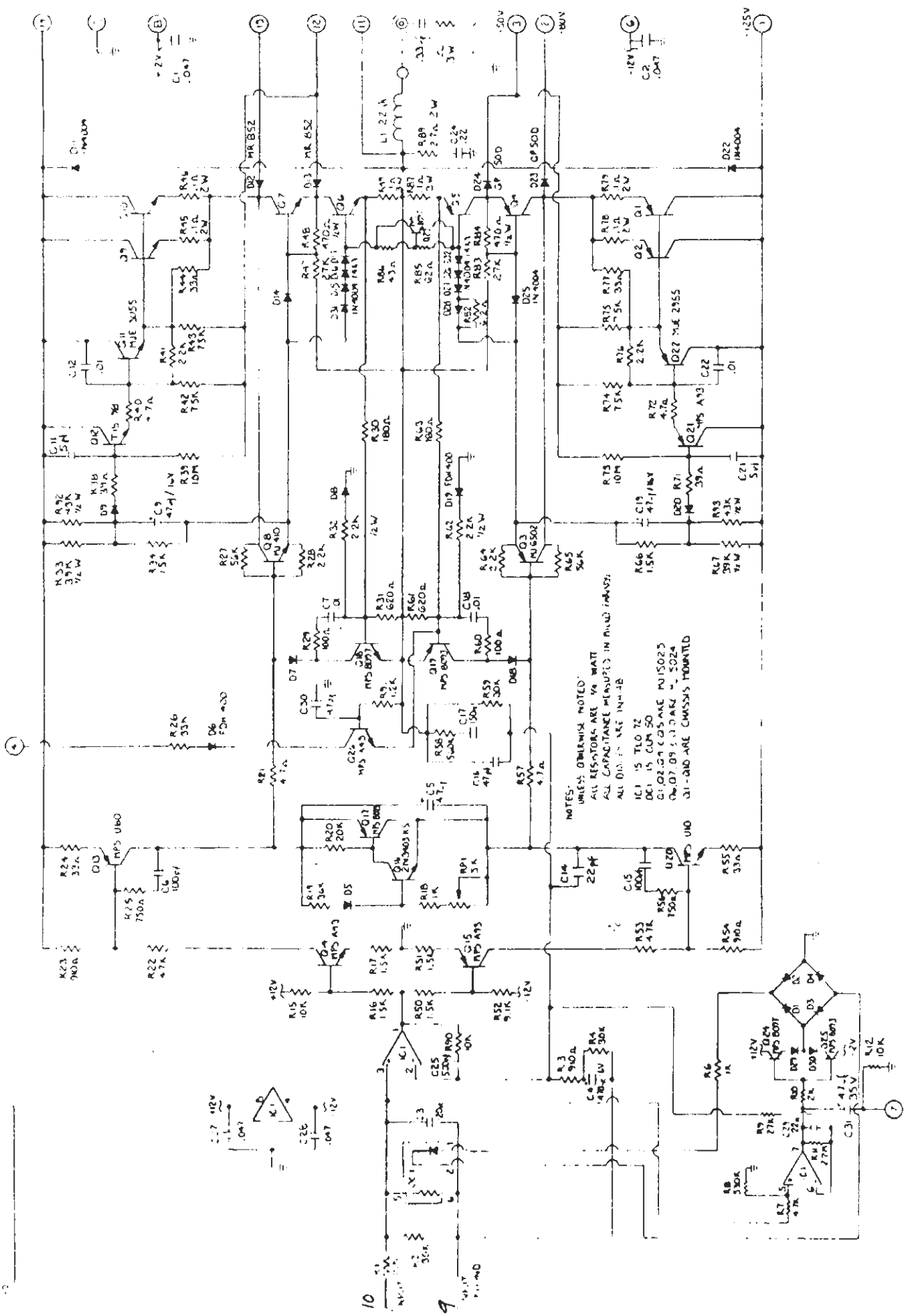
M-1.5 SCHEMATICS
AND BOARD LOCATORS

M-1.5 SCHEMATICS
AND BOARD LOCATORS

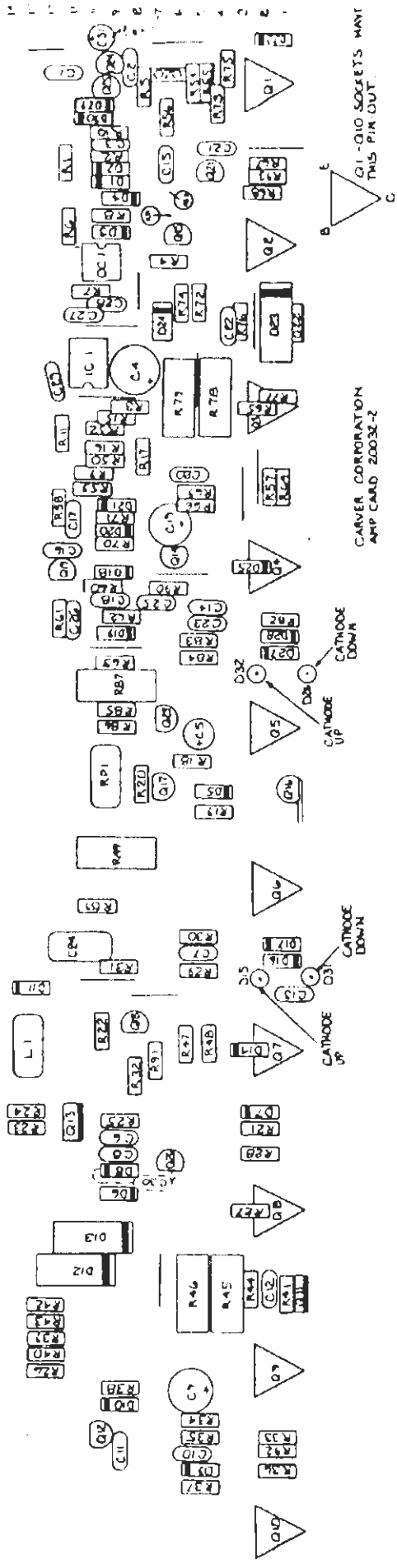
Table of Contents

- 1) Amp Card - - - - Board #20032-2, Rev. 2
- 2) Amp Card Locator - - - - Board #20032-2, Rev. 2
- 3) Amp Card - - - - Board #20032-3, Rev. 0
- 4) Amp Card - - - - Board #20032-3, Rev. 1
- 5) Amp Card Locator - - - - Board #20032-3, Rev. 1
- 6) Power Supply - - - - Board #20033-2, Rev. 2
- 7) Power Supply Locator - - - - Board #20033-2, Rev. 2
- 8) Power Supply - - - - Board #20033-3, Rev. 1
- 9) Power Supply - - - - Board #20033-3, Rev 1 (240V)
- 10) Power Supply Locator - - - - Board #20033-3, Rev. 1
- 11) Regulator Card Locator - - - - Board #20035-2
- 12) Regulator Card Locator - - - - Board #20035-6
- 13) Display Card - - - - Board #20034-2, Rev. 0
- 14) Display Card - - - - Board #20034-2, Rev. 2
- 15) Display Card Locator - - - - Board #20034-2

10
 9
 8
 7
 6
 5
 4
 3
 2
 1



NOTES:
 UNLESS OTHERWISE NOTED:
 ALL RESISTORS ARE 1/4 WATT
 ALL CAPACITANCE MEASURED IN P.P.M.F.
 ALL DIODES ARE 1N4148
 IC1 IS TL072
 DI1 IS CDM 50
 C1: 0.001 COS-ANAL. MUIS025
 C2: 0.01 COS-ANAL. MUIS024
 C3-D10 ARE CEMISS THROATED



Q1-Q10 SOCKETS HAVE THIS PIN OUT.

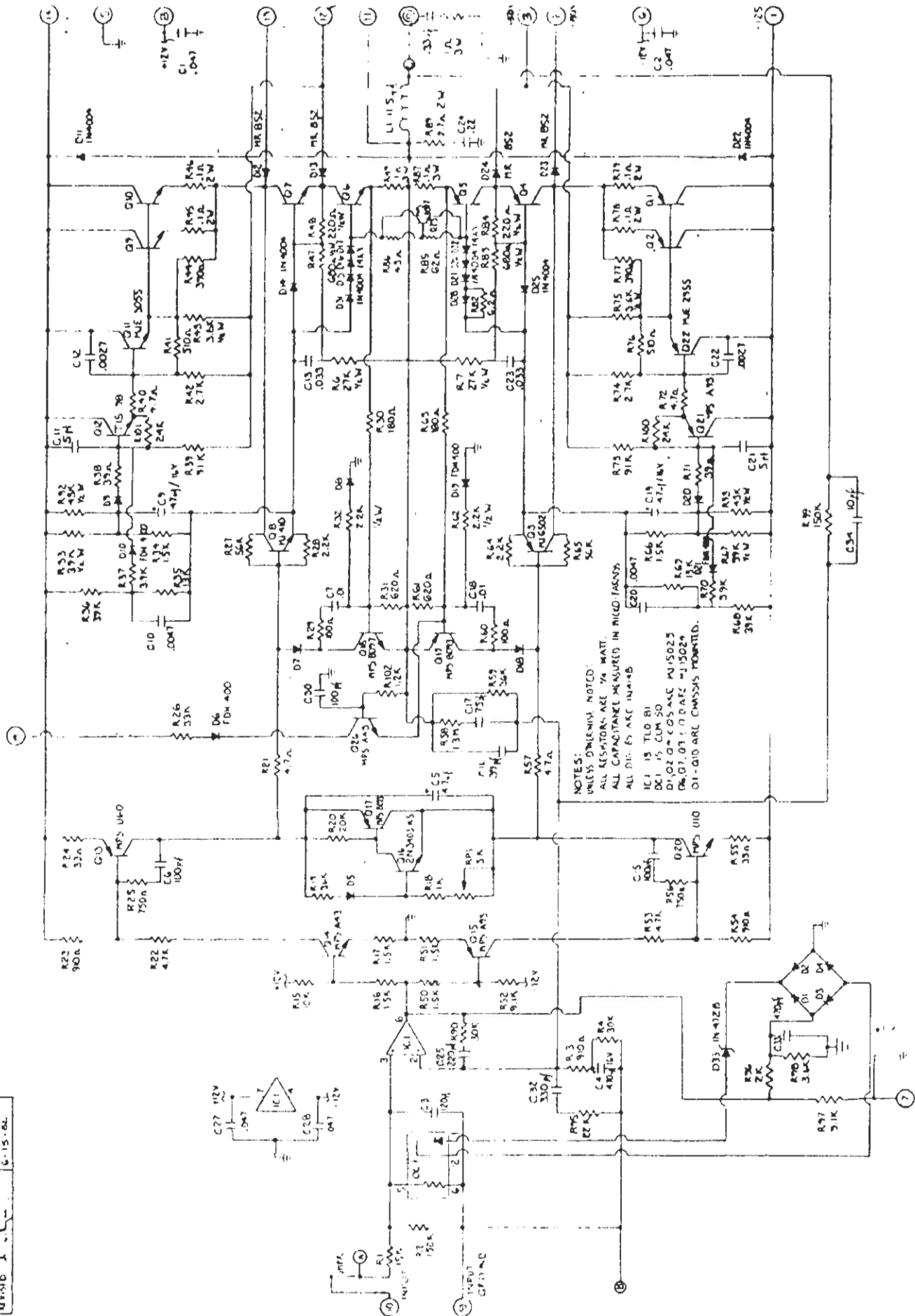
CARVER CORPORATION AMP CARD 2003A-2

CATHODE UP
CATHODE DOWN

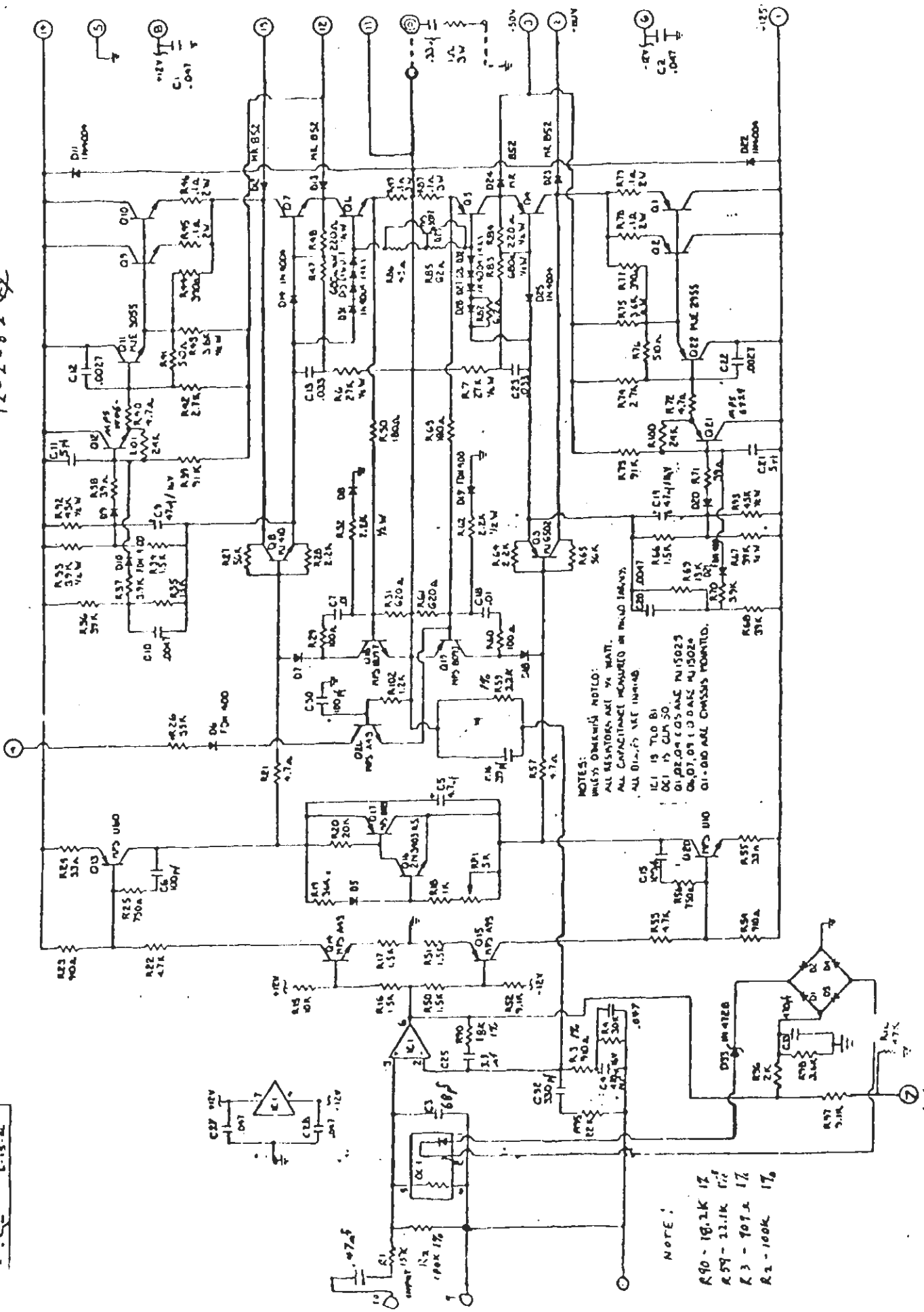
CATHODE UP
CATHODE DOWN

CARVER CORPORATION

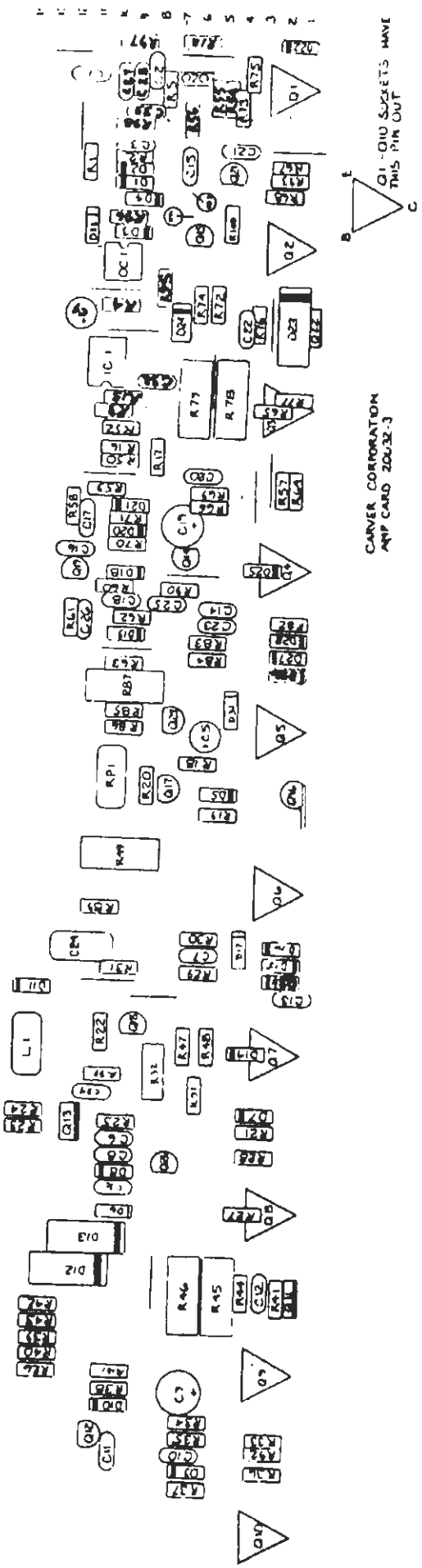
AMP CARD	ZB032-3	REV.0
DATE	1/10/62	2-0-8C
CHECKED	1/10/62	
DESIGNED	1/10/62	



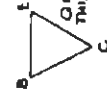
M157
 20032-3 Rev1
 12-2-82



20032-3	REV. 0
20032-3	REV. 0
20032-3	REV. 0
20032-3	REV. 0

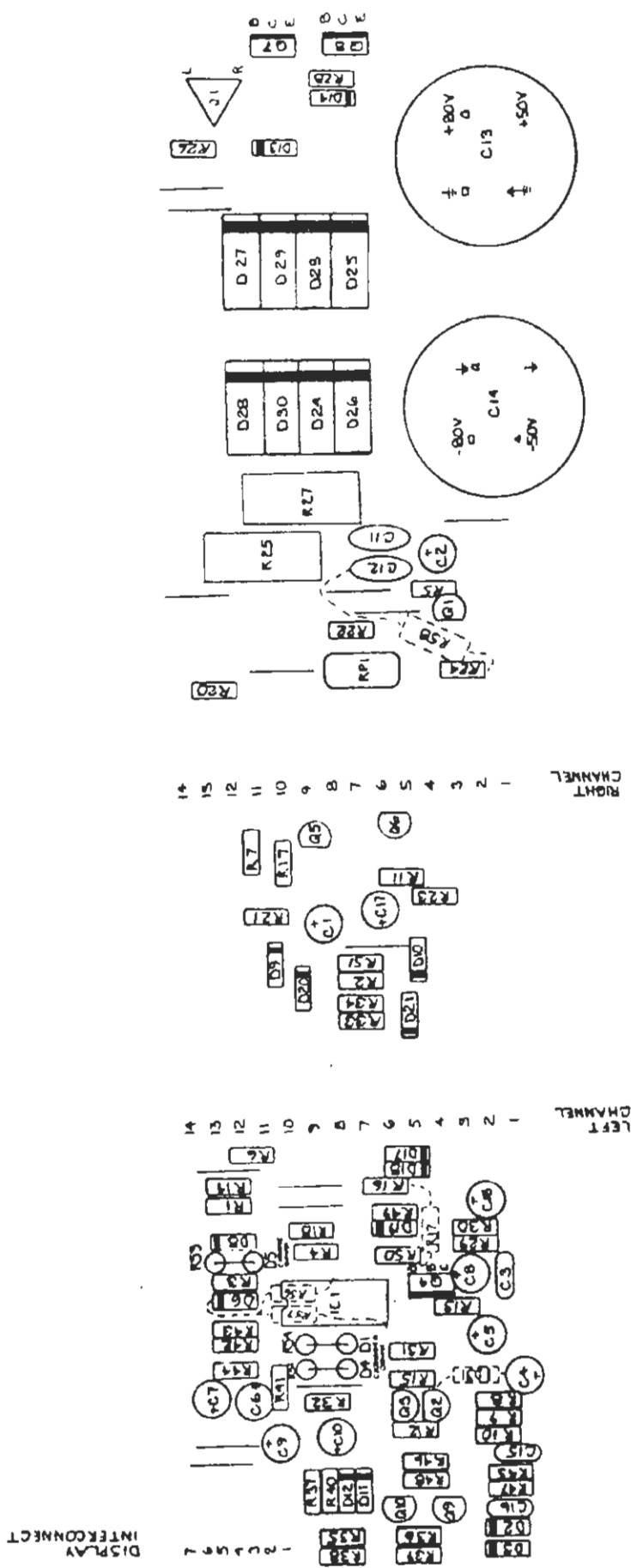


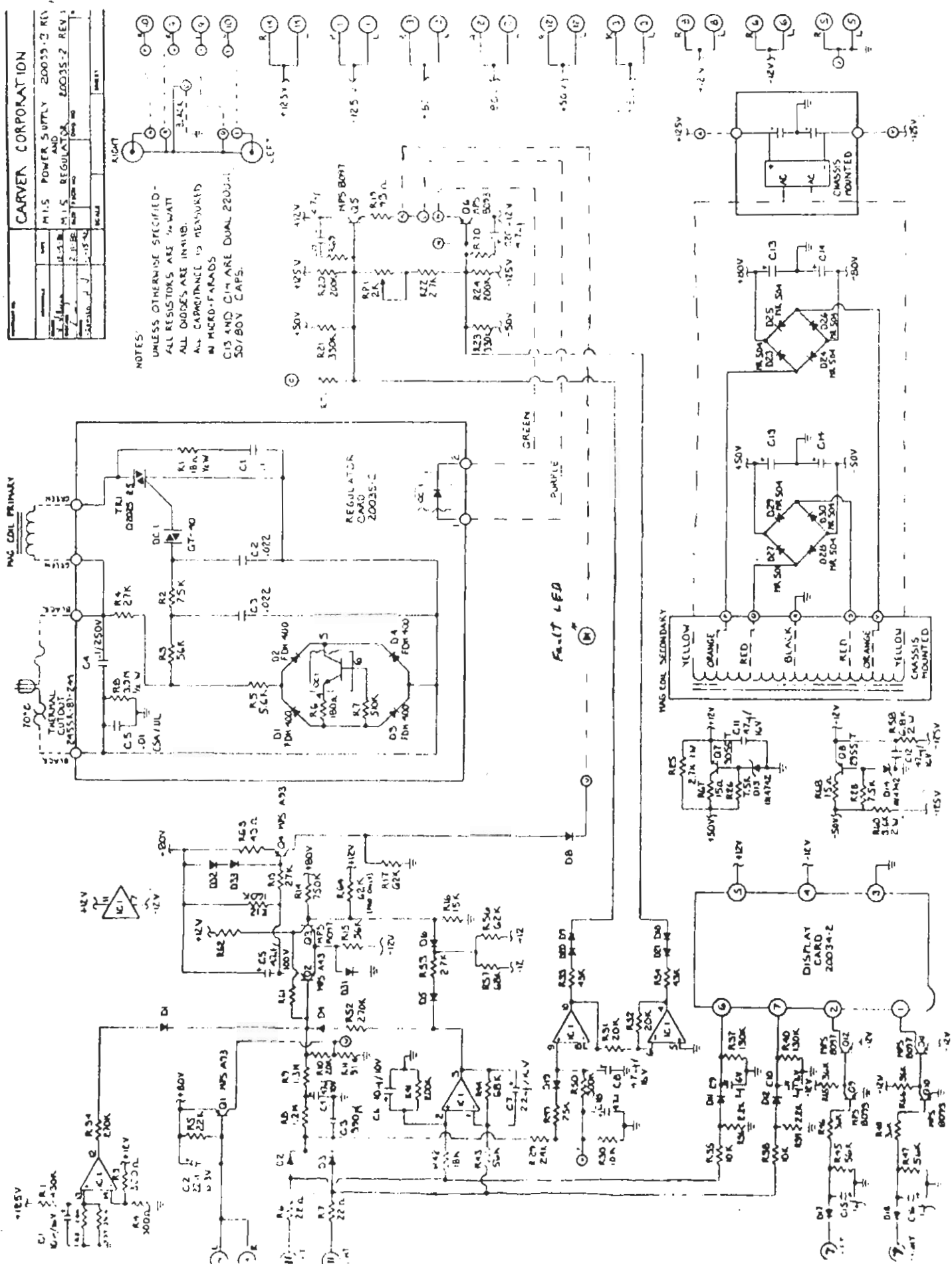
CARVER CORPORATION
AMP CARD 20U32-3



DI-DO SOCKETS HAVE
THIS PIN OUT

CARVER CORPORATION
M1.5 POWER SUPPLY 20033-2

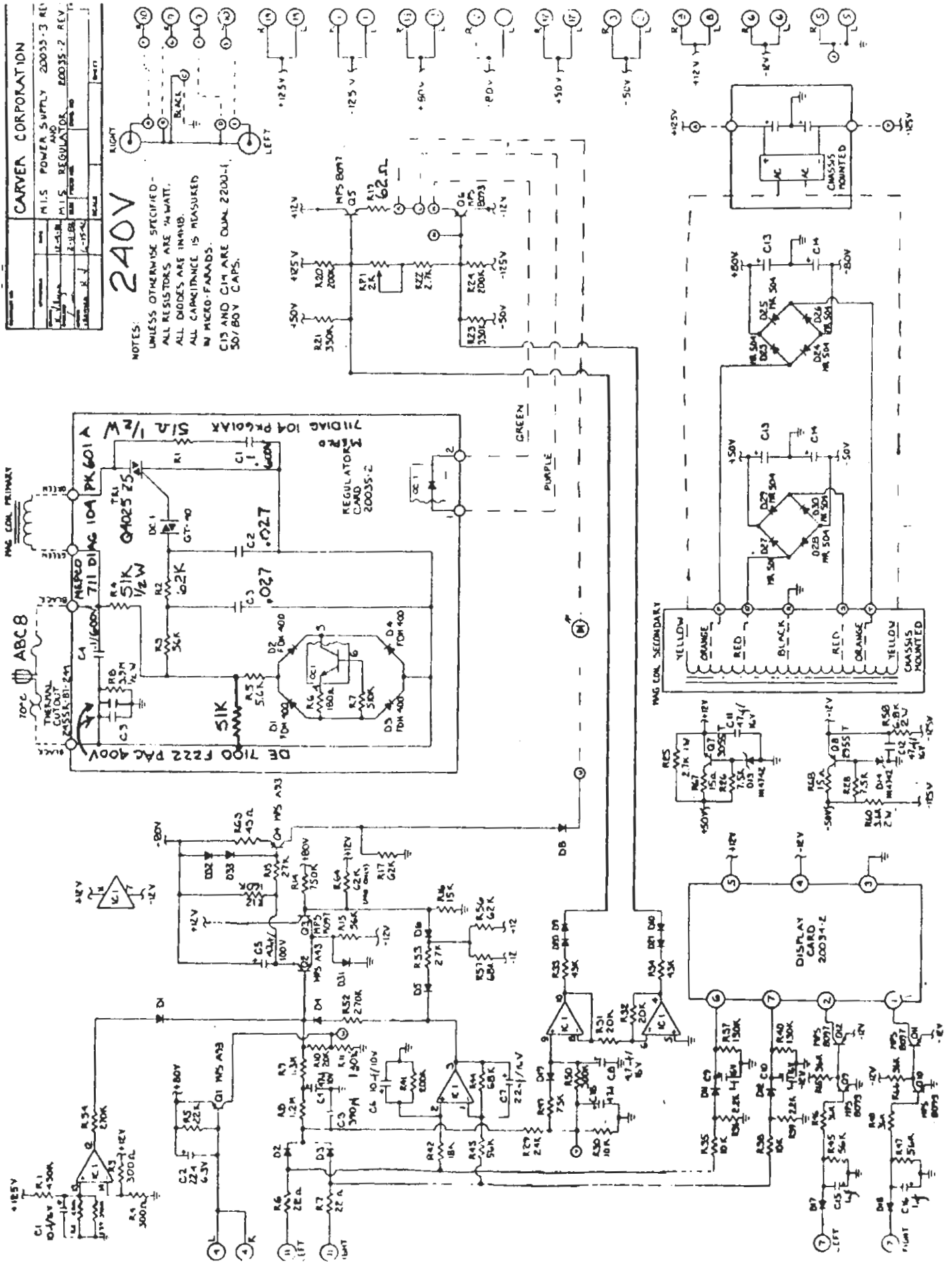




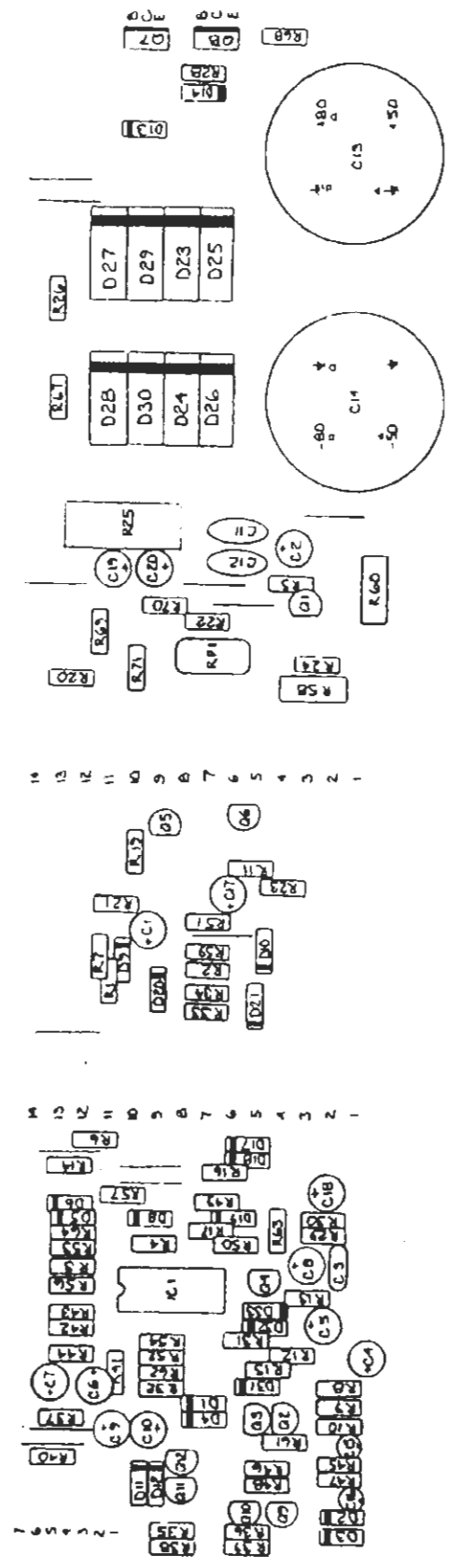
CARVER CORPORATION			
Part No.	M.I.S. POWER SUPPLY 20033-3 RE	Rev.	1
Alt. Part No.	M.I.S. REGULATOR	Rev.	2
Alt. Part No.	20033-2 REV.	Rev.	1
Alt. Part No.	20033-2 REV.	Rev.	1

240V

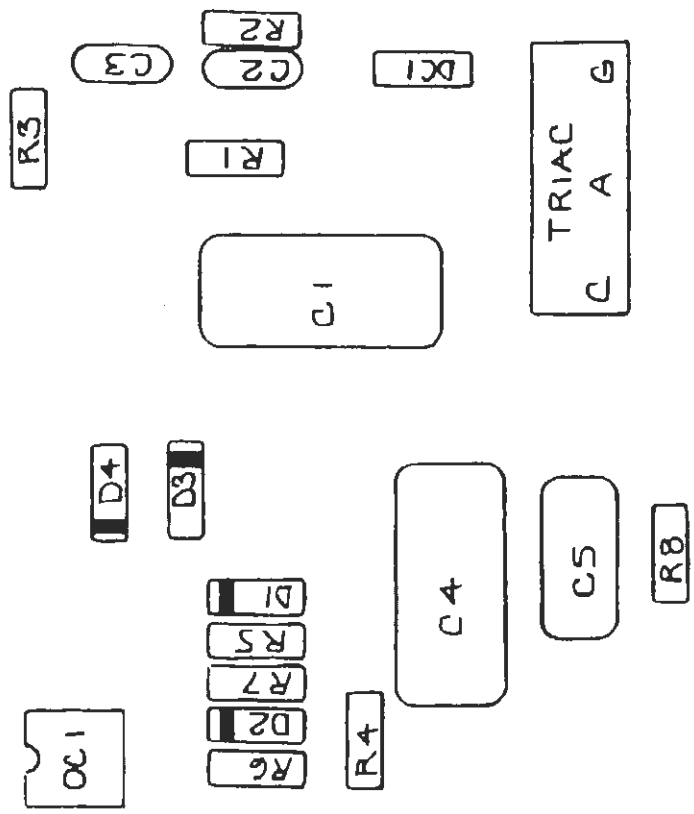
NOTES:
 UNLESS OTHERWISE SPECIFIED -
 ALL RESISTORS ARE 1/4WATT.
 ALL DIODES ARE IN-40.
 ALL CAPACITORS ARE IN MICRO-FARADS.
 C13 AND C14 ARE DUAL 2200-1,
 50V/80V CAPS.

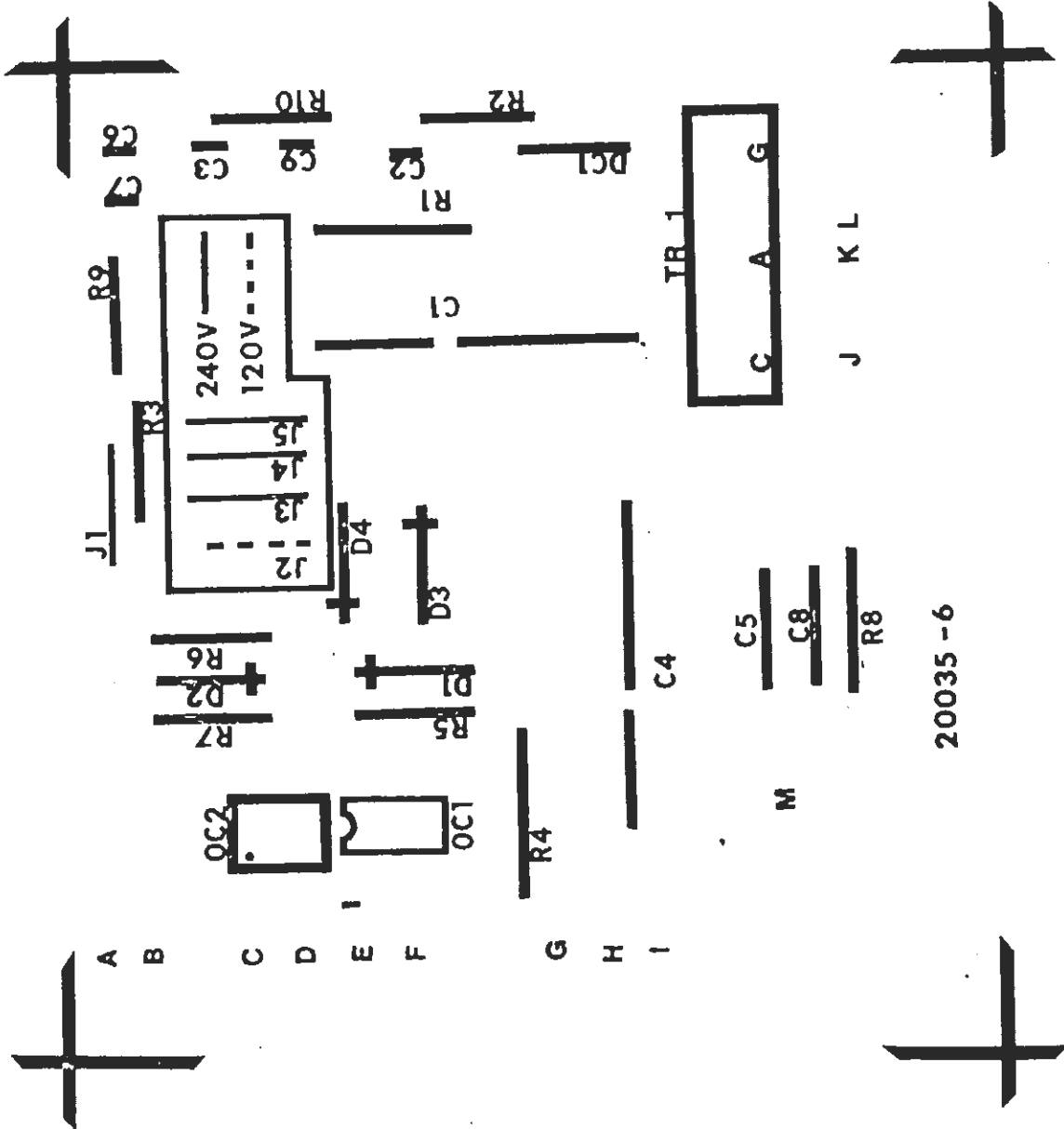


CARVER CORPORATION
 P-1.5 POWER SUPPLY 20033-3



CARVER CORPORATION
M1.5 REGULATOR 20035-2



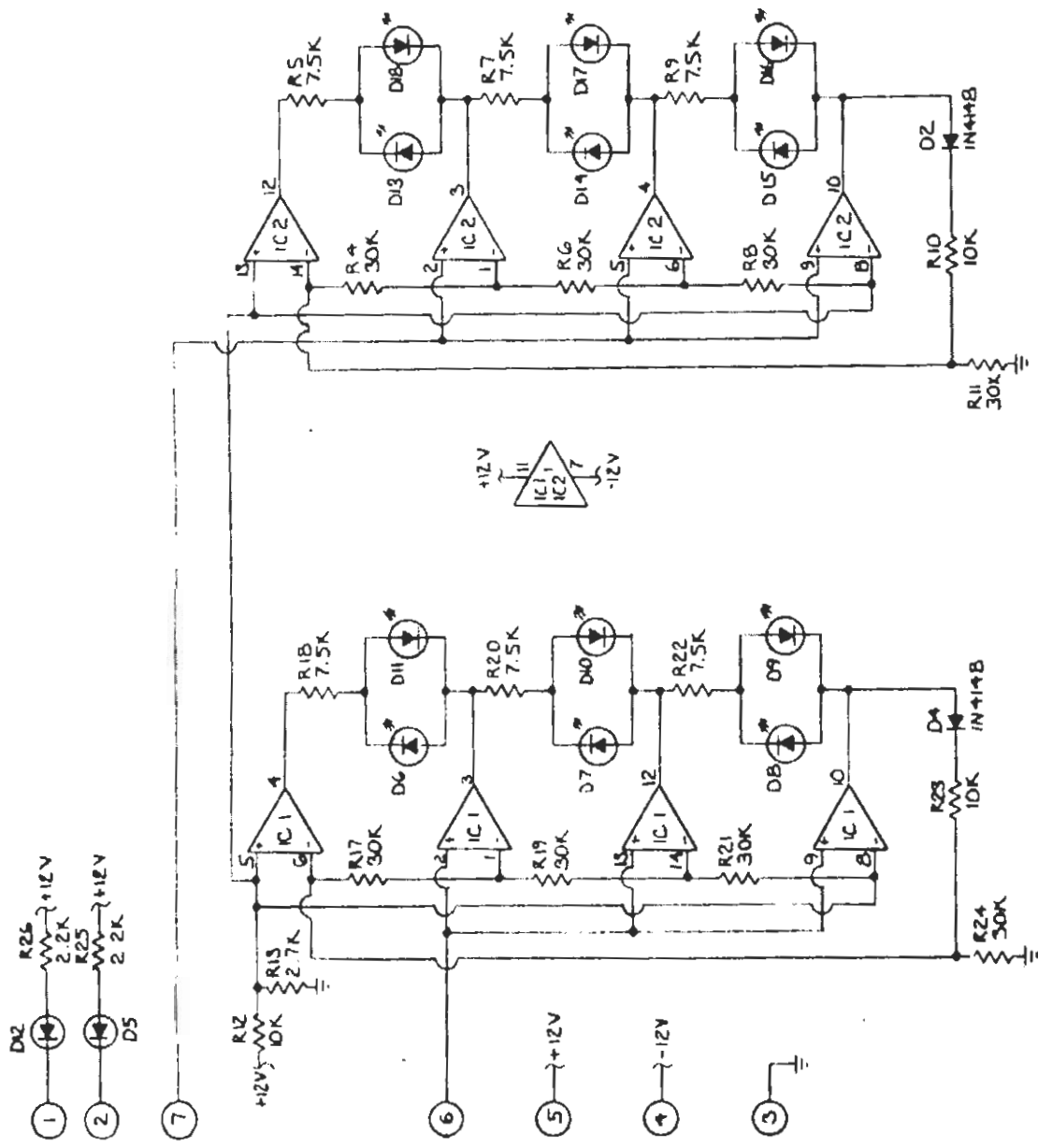


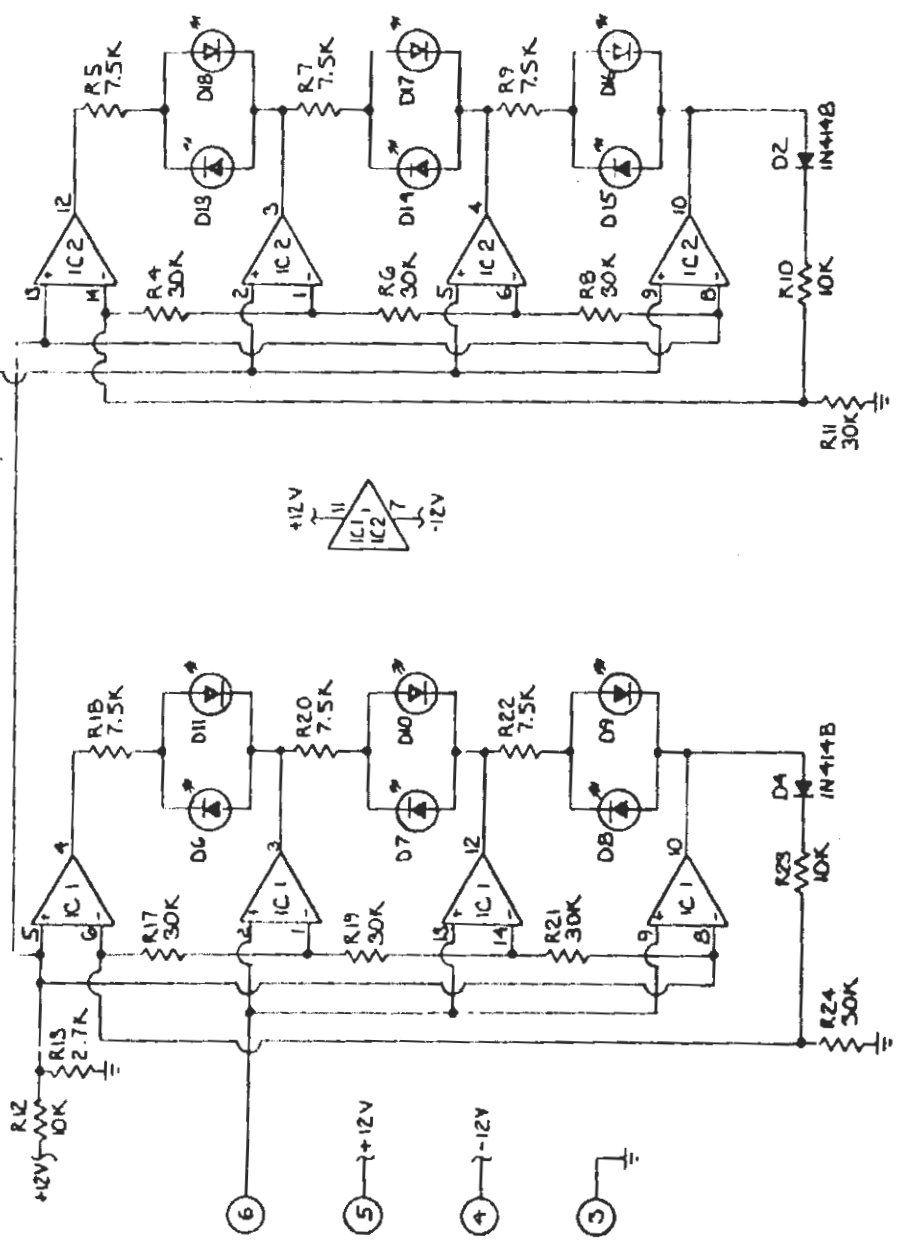
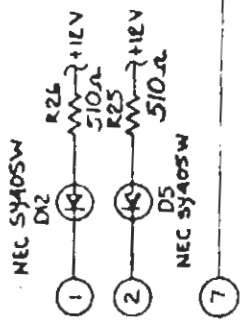
20035-6

NOTES -
 ALL RESISTORS ARE 1/4 WATT
 IC'S ARE 4136
 UNLESS OTHERWISE NOTED -
 ALL DIODES ARE SR505W.

CARVER CORPORATION

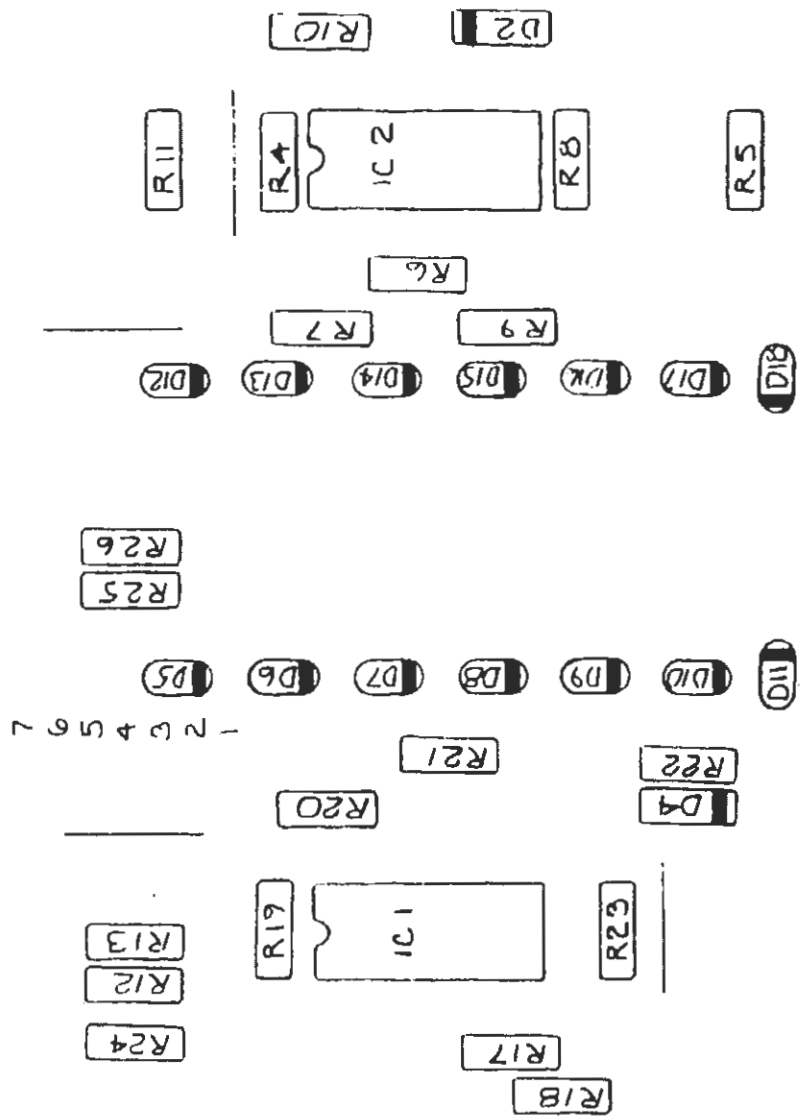
M1.5	DISPLAY	20034-2	REV. 0
DATE	DESIGNED BY	2-11-82	
REV.	BY		
REV.	BY		
REV.	BY		





NOTES -
ALL RESISTORS ARE 1/4 WATT.
IC'S ARE 4136.
UNLESS OTHERWISE NOTED.
ALL DIODES ARE 5R505W.

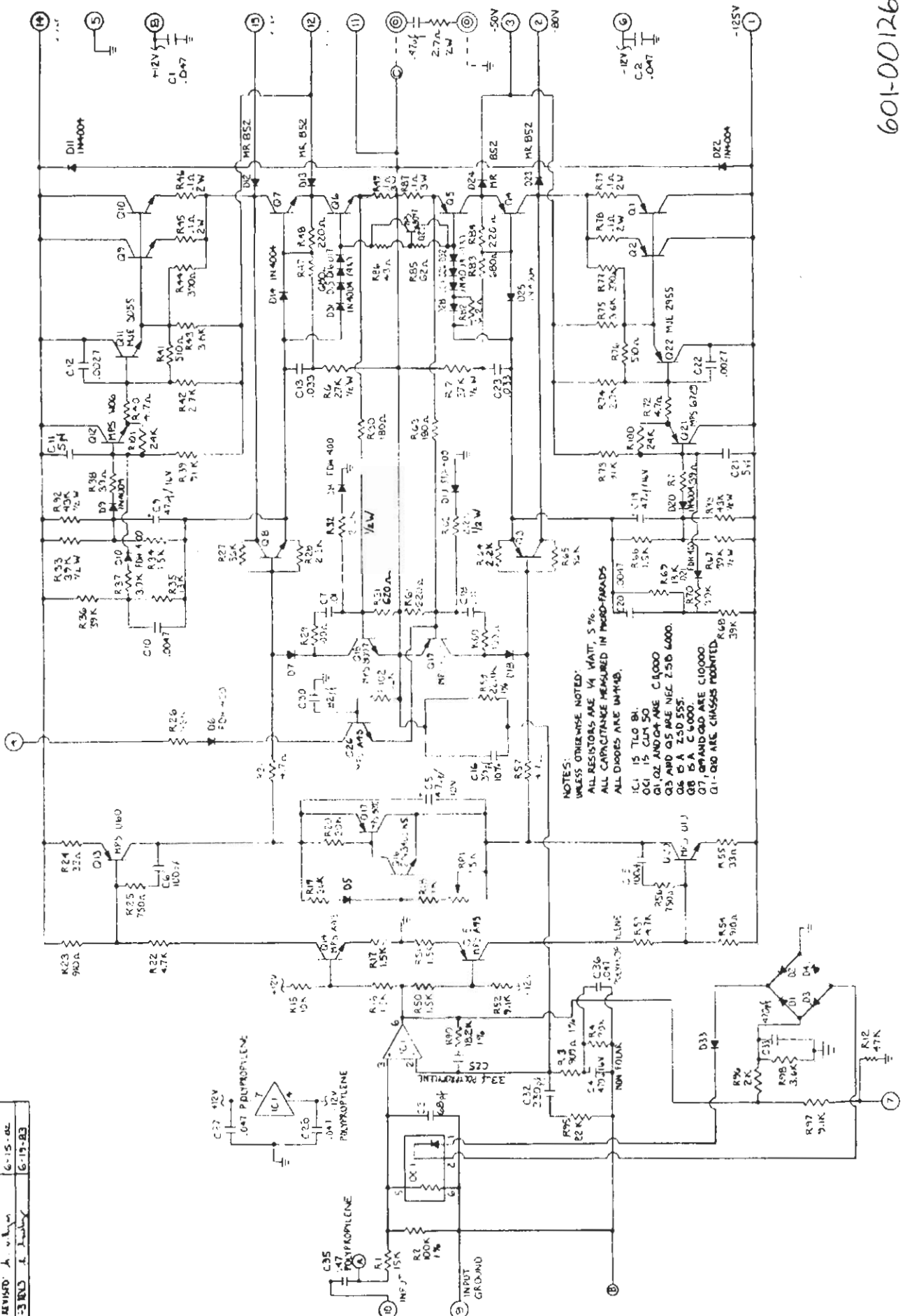
CARVER CORPORATION	
M 1.5 DISPLAY	20034-2 REV.
DATE:	2-11-82
BY:	
REV:	
REV:	



M15601-00126-00

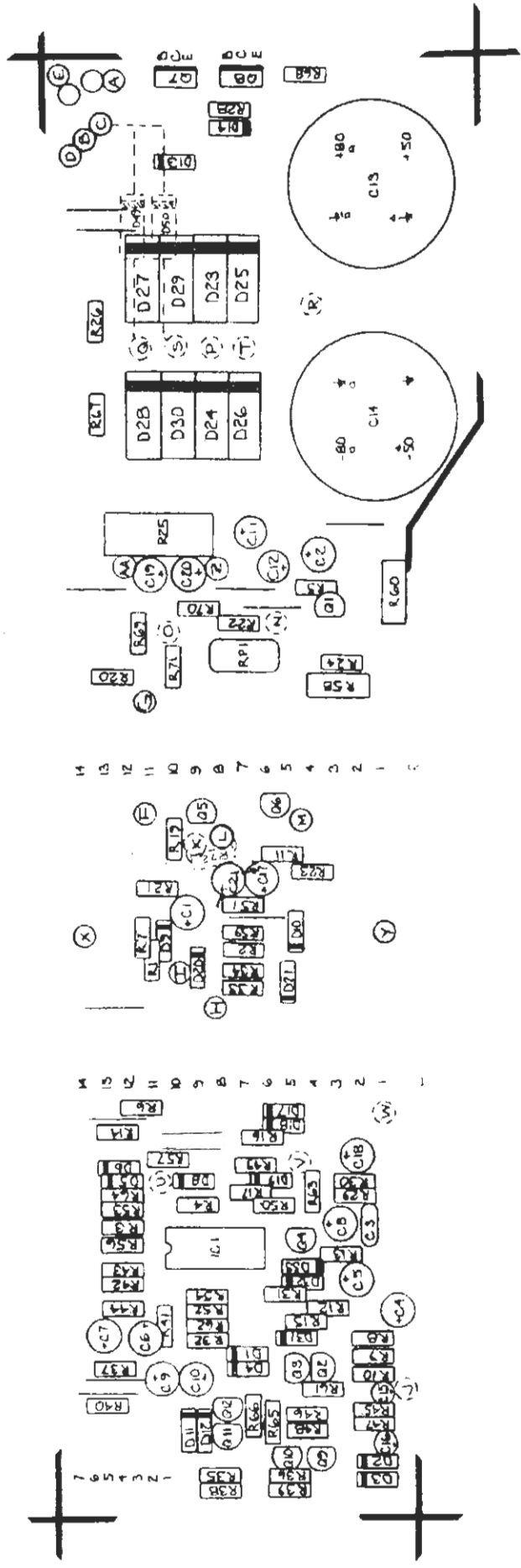
REV E ECO 339
 REV F ECO 350
 REV G ECO 443 1/15 gm
 REV H ECO 463 1/15 gm

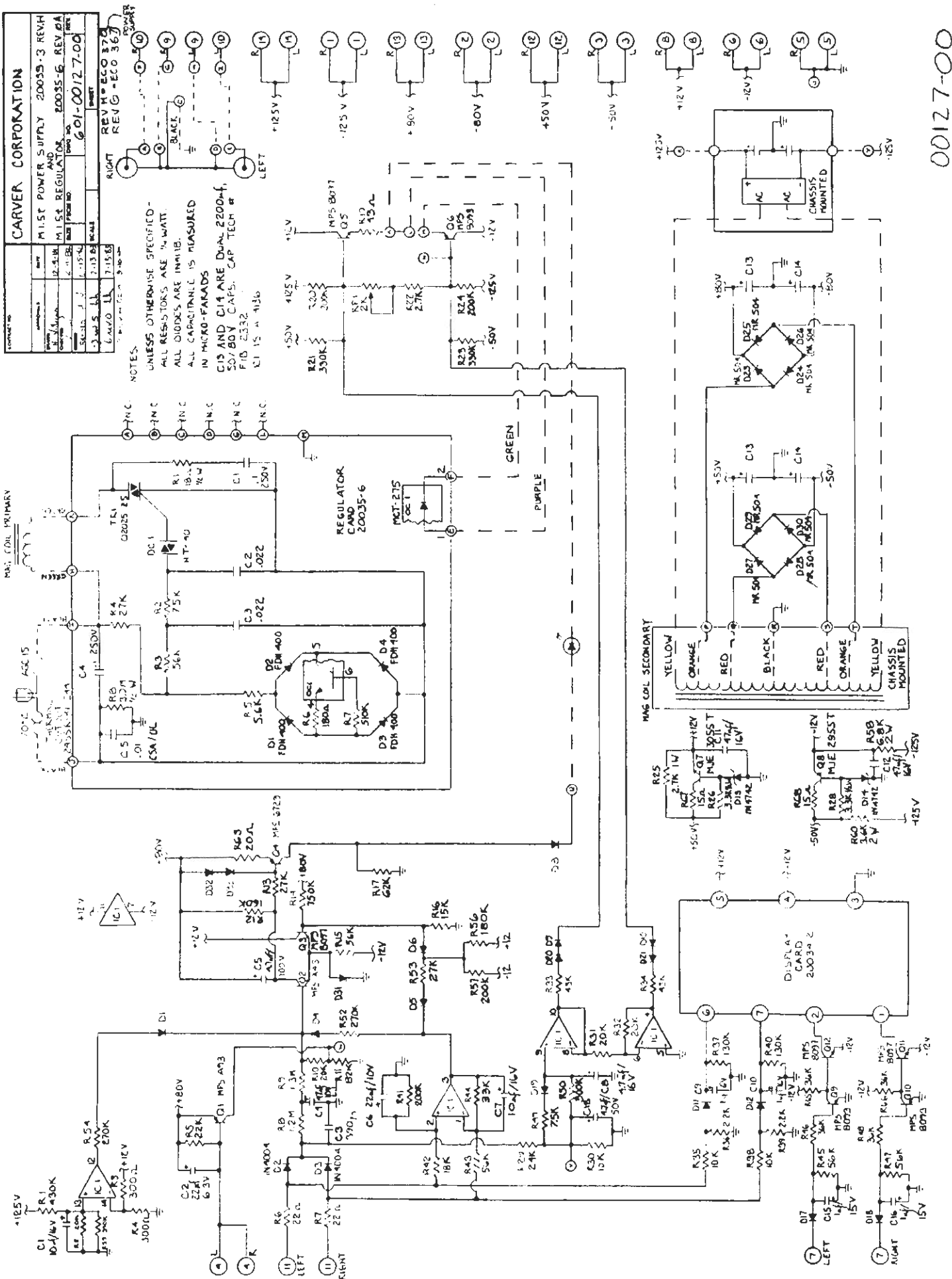
AMP CARD	2002L-3	REV. 3-80
DRAWN:	J. Wilk	2-10-80
CHECKED:	A. Mann	2/10/82
REVISED:	A. Wilk	6-15-82
DESIGNED:	J. Wilk	6-19-83



601-00126-1

CARVER CORPORATION
 N-1.5E POWER SUPPLY 20033-3
 PM-1.1.5



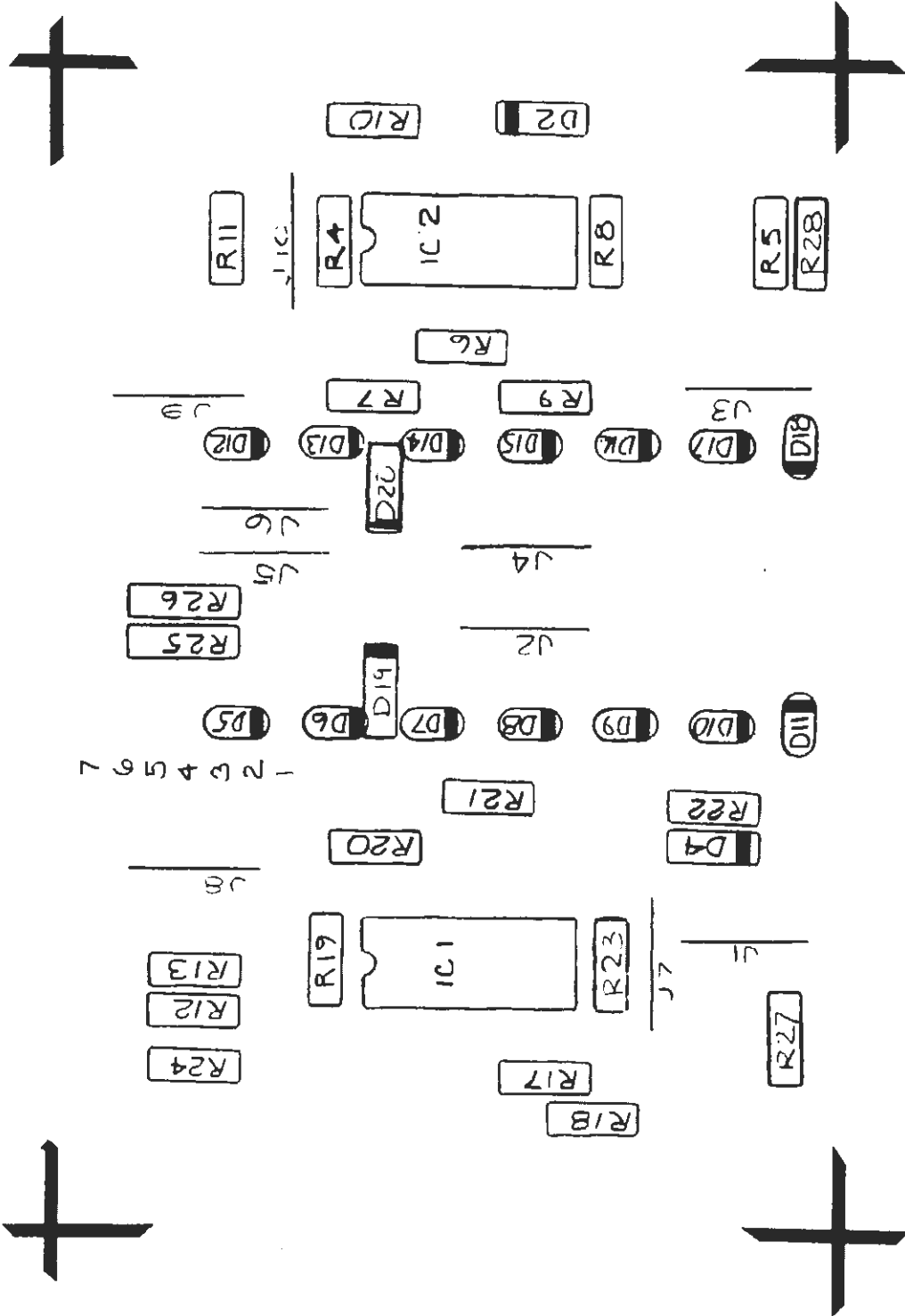


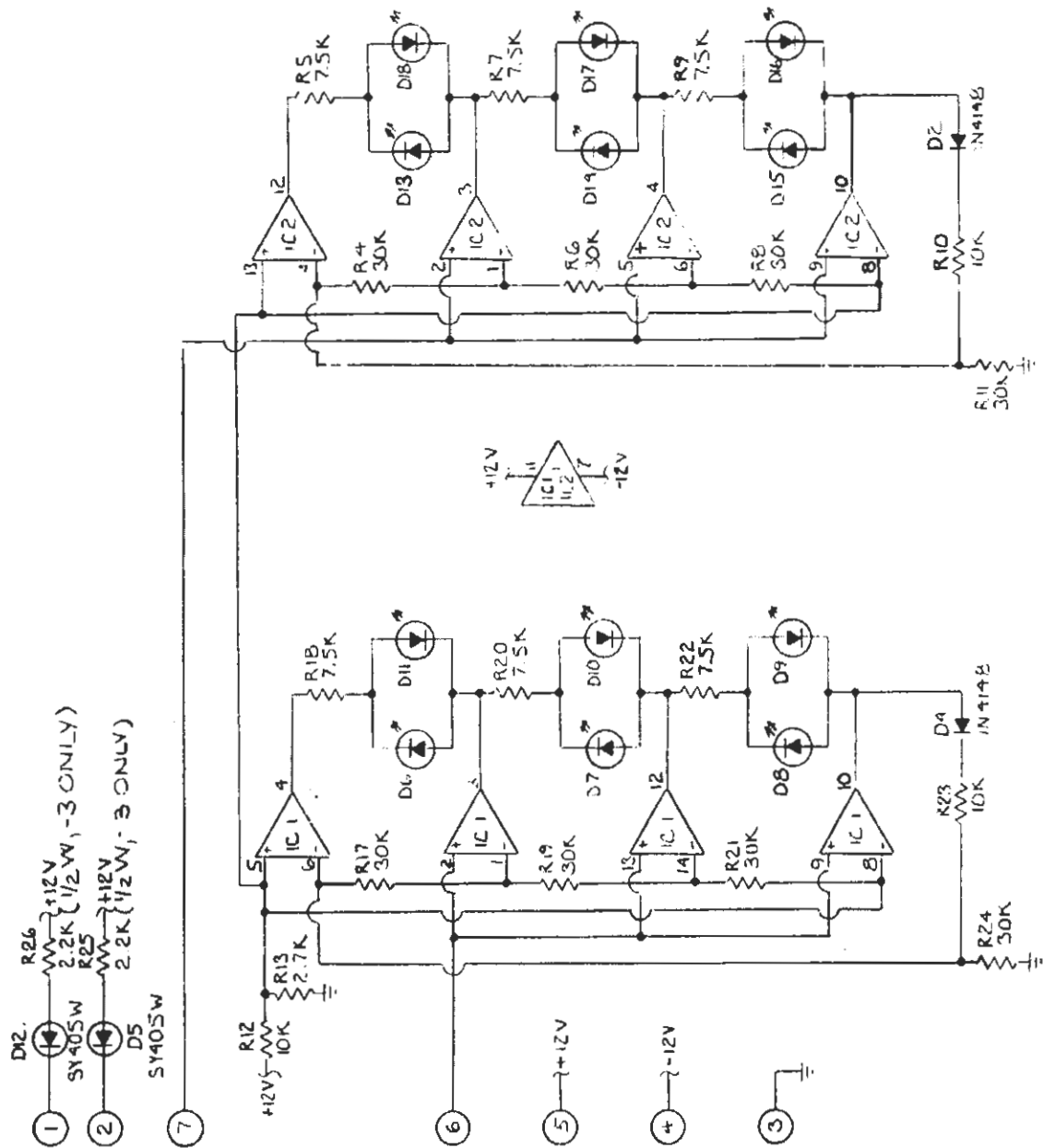
CARVER CORPORATION			
REV H	ECO 374	DATE	7-15-68
REV G	ECO 367	DATE	3-10-68
M.I.S.E. POWER SUPPLY	20035-3	REV H	DA
M.I.S.E. REGULATOR	20035-6	REV G	DA
DESIGNED BY	J. J. JONES	DATE	7-15-68
DRAWN BY	J. J. JONES	DATE	7-15-68
CHECKED BY	J. J. JONES	DATE	7-15-68
APPROVED BY	J. J. JONES	DATE	7-15-68
PROJECT NO.	601-00127-00		

NOTES:
 UNLESS OTHERWISE SPECIFIED -
 ALL RESISTORS ARE 1/4 WATT.
 ALL DIODES ARE INMMB.
 ALL CAPACITANCE IS MEASURED
 IN MICRO-FARADS
 C13 AND C14 ARE DUAL-2200µf,
 50V BOB CAPS. CAP TECH or
 FID 2332
 R1 IS A 4136

00127-00

CARVER CORPORATION
DISPLAY 20034-3





NOTES -
 ALL RESISTORS ARE 1/4 WATT.
 IC'S ARE 4136.
 UNLESS OTHERWISE NOTED.
 ALL DIODES ARE 5R505W.

601-00128-00

CARVER CORPORATION	
M.T.S. #	DISF. AV 20034.2 REV. (A)
DATE	2-11-82
REV.	3 REV (A)
REV.	
REV.	

00128-00

**CARVER CORPORATION
SERVICE BULLETIN**

Service Bulletin # M-1.5t-1

Model M-1.5t

Serial # All

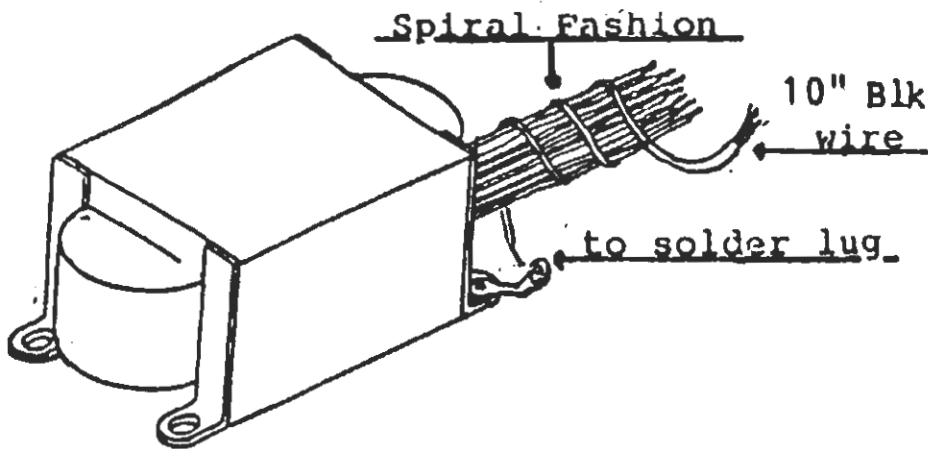
Reason: Excessive right channel buzz with shorted inputs.

Procedure: On the inside front transformer mounting bolt remove nut and scrape metal clean. Add a #6 solder lug and retighten mounting nut. Add 10 inches of Blk #18 wire from the solder lug and wrap wire in a spiral fashion around all Transformer secondary wires. (2 yellow, 2 red, 2 orange, 1 black) in a tightly bundled pack at about 2 turns per inch. Solder loose end to Power Supply ground point. Position wire bundle towards rear of chassis away from the Right channel amplifier PCB.

from ECO 853

Delete:

Add: Qty (1) 111-20051-00 #6 lug
Qty (1) 401-10133-00 #18 wire
(black 10 inches)



SERVICE APPROVAL _____
ENGINEERING APPROVAL _____

Robert W. Long

4/17/89 DATE

CARVER CORPORATION SERVICE BULLETIN

Service Bulletin # M-1.5t-2	Model: M-1.5t	Serial Nos. All
REASON: Part is no longer available.		Date: 1/20/92

DELETE Qty 2 Capacitor, Dual 2200µF/50V/80V (C13,14) 205-00028-00	ADD Qty 1 Capacitor Card Assy (CCA) (C13,14,22,23) 602-00500-01
---	---

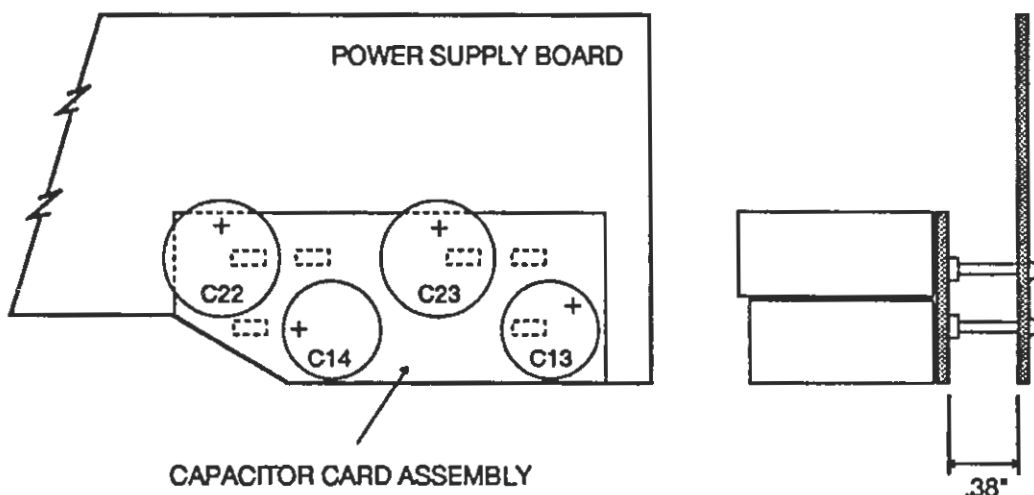
PROCEDURE

The dual capacitors used for C13 and C14 (P/N 205-00028-00) on the power supply board in the Carver M-1.5 power amplifier are no longer available.

If replacement of C13/C14 becomes necessary, we are providing a substitute part (Capacitor Card Assembly P/N 602-00500-01) which is pin-for-pin compatible with C13 and C14 on the power supply board.

To install the Capacitor Card Assembly:

1. Remove 2 screws from the bottom of the chassis securing the capacitor bracket located on top of C13 and C14.
2. Unsolder C13 and C14 from the power supply board.
 Note: There are 8 pins per capacitor; 4 electrical connections and 4 connections for mechanical support.
3. Remove C13 and C14 from the power supply board and from the capacitor bracket.
4. Install the Capacitor Card Assembly so that the angled corner of the Card aligns with the angled corner on the power supply board (see illustration below). Solder into place.
5. Reinstall the 2 screws to secure the capacitor bracket in place.



Service Approval 	Engineering Approval 1-22-92
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