



QSC Audio Products, Inc., Costa Mesa California

MX 1500 & MX 2000
POWER AMPLIFIER SERVICE MANUAL

Revised December 2006

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MX1500 Specifications

OUTPUT POWER (per channel):

Continuous Average Output Power both channels driven.

8 ohms, 20 - 20kHz	0.1%	THD 330
8 ohms, 1kHz	1%	THD 360
4 ohms, 20 - 20kHz	0.1%	THD 500
4 ohms, 1kHz	1%	THD 570
2 ohms, 1kHz	1%	THD 750 +/- 1dB

BRIDGED MONO OPERATION:

16 ohms, 20 - 20kHz	0.1%	THD 660
16 ohms, 1kHz	1%	THD 720
8 ohms, 20 - 20kHz	0.1%	THD 1000
8 ohms, 1kHz	1%	THD 1100
4 ohms, 1kHz	1%	THD 1500 +/- 1dB

DISTORTION (8 ohms):

THD, 20-20kHz, from 250milliwatts to rated power, less than 0.1%, 0.015% typical.
SMPTE-IMD, less than 0.02%, 250 milliwatts to rated power.

FREQUENCY RESPONSE: 20-20kHz, +/-0.1dB. 8-300kHz, +/-3 dB.

DAMPING FACTOR: Greater than 200.

SLEW RATE: 20V per microsecond.

DYNAMIC HEADROOM: 3dB or 1000 watts instantaneous power @ 4 ohms.

NOISE: -100dB, 20-20kHz.

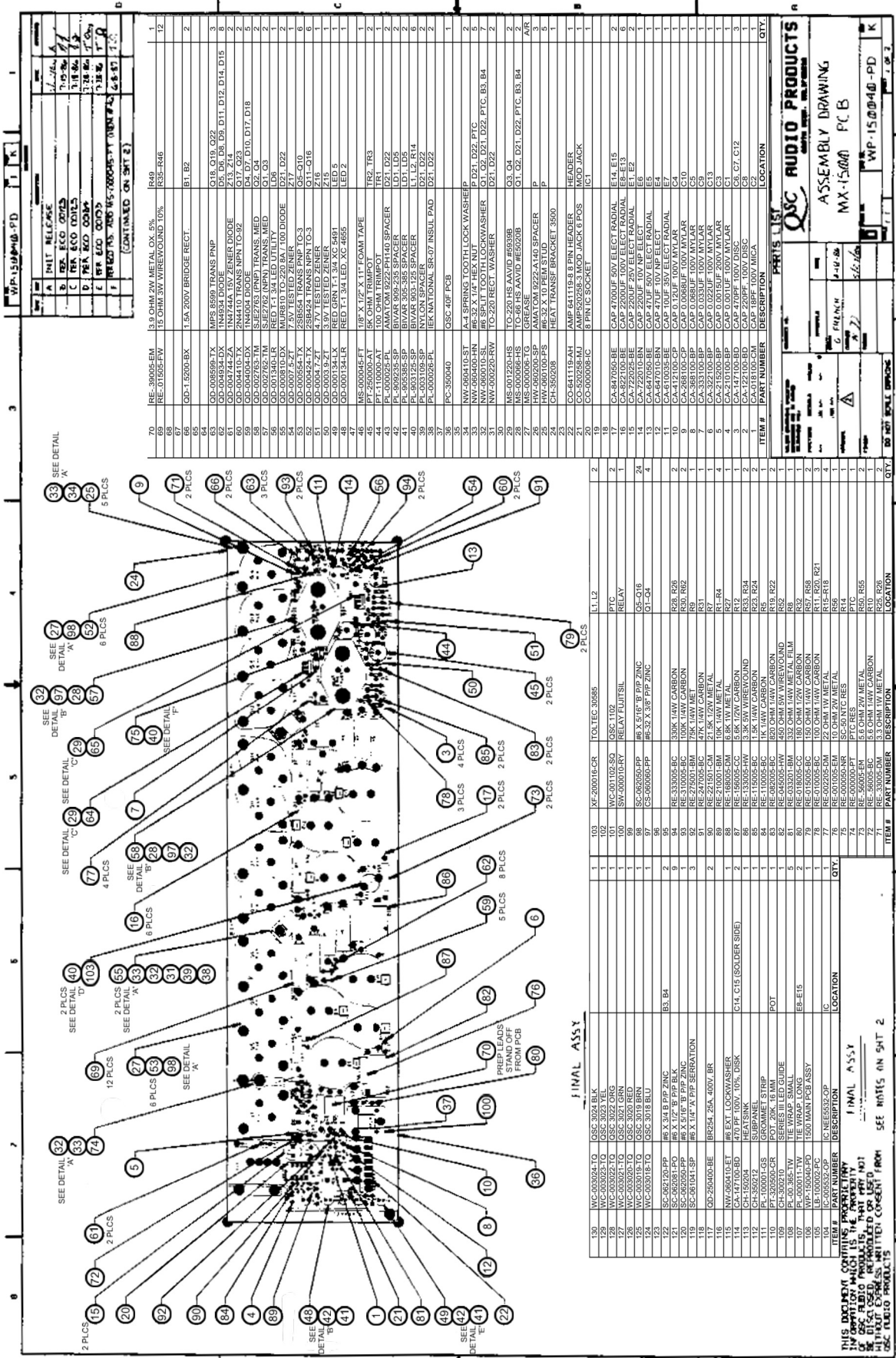
SENSITIVITY: 1V RMS for rated power (8 ohms).

INPUT IMPEDANCE: 10k unbalanced , 20k balanced.

DIMENSIONS: 3.5" tall (2 rack spaces), 19" wide, 17.9" deep.

WEIGHT: 47lbs net, 52 lbs shipping.

MX1500 Printed Circuit Layout & Parts List



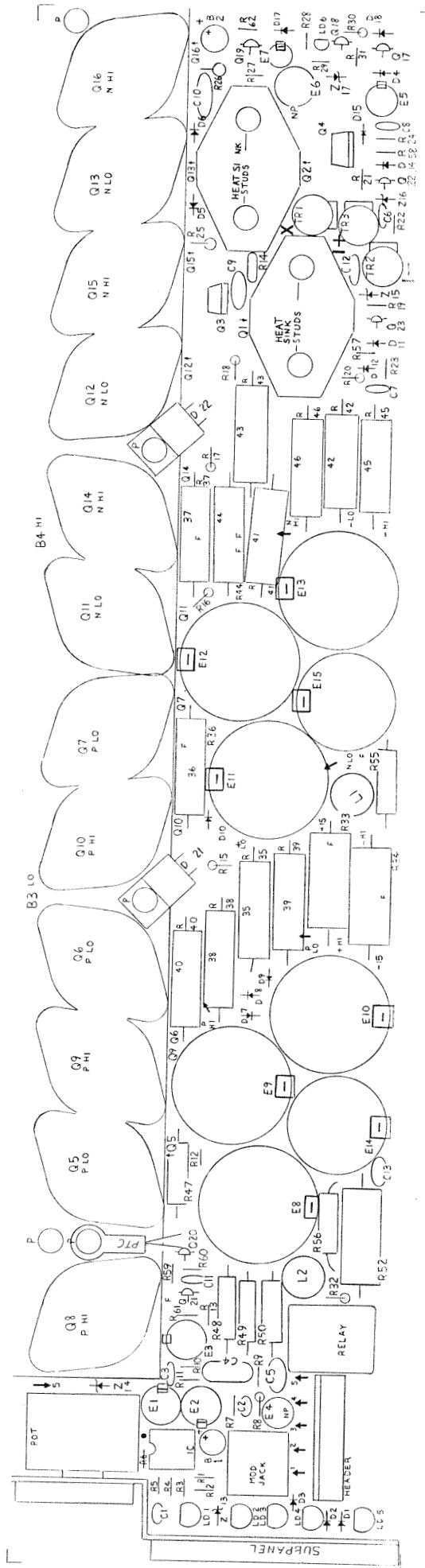
ITEM #	PART NUMBER	DESCRIPTION	LOCATION	QTY
1	OSQ-3024-YK	OSQ-3024-YK		1
2	OSQ-3022-TO	OSQ-3022-TO		1
3	OSQ-3021-TO	OSQ-3021-TO		1
4	OSQ-3019-TO	OSQ-3019-TO		1
5	OSQ-3018-BLU	OSQ-3018-BLU		1
6	OSQ-3017-PP	OSQ-3017-PP		1
7	OSQ-3016-PP	OSQ-3016-PP		1
8	OSQ-3015-PP	OSQ-3015-PP		1
9	OSQ-3014-SP	OSQ-3014-SP		1
10	OSQ-3013-PP	OSQ-3013-PP		1
11	OSQ-3012-PP	OSQ-3012-PP		1
12	OSQ-3011-PP	OSQ-3011-PP		1
13	OSQ-3010-PP	OSQ-3010-PP		1
14	OSQ-3009-PP	OSQ-3009-PP		1
15	OSQ-3008-PP	OSQ-3008-PP		1
16	OSQ-3007-PP	OSQ-3007-PP		1
17	OSQ-3006-PP	OSQ-3006-PP		1
18	OSQ-3005-PP	OSQ-3005-PP		1
19	OSQ-3004-PP	OSQ-3004-PP		1
20	OSQ-3003-PP	OSQ-3003-PP		1
21	OSQ-3002-PP	OSQ-3002-PP		1
22	OSQ-3001-PP	OSQ-3001-PP		1

ITEM #	PART NUMBER	DESCRIPTION	LOCATION	QTY
23	OSQ-3000-PP	OSQ-3000-PP		1
24	OSQ-2999-PP	OSQ-2999-PP		1
25	OSQ-2998-PP	OSQ-2998-PP		1
26	OSQ-2997-PP	OSQ-2997-PP		1
27	OSQ-2996-PP	OSQ-2996-PP		1
28	OSQ-2995-PP	OSQ-2995-PP		1
29	OSQ-2994-PP	OSQ-2994-PP		1
30	OSQ-2993-PP	OSQ-2993-PP		1
31	OSQ-2992-PP	OSQ-2992-PP		1
32	OSQ-2991-PP	OSQ-2991-PP		1
33	OSQ-2990-PP	OSQ-2990-PP		1
34	OSQ-2989-PP	OSQ-2989-PP		1
35	OSQ-2988-PP	OSQ-2988-PP		1
36	OSQ-2987-PP	OSQ-2987-PP		1
37	OSQ-2986-PP	OSQ-2986-PP		1
38	OSQ-2985-PP	OSQ-2985-PP		1
39	OSQ-2984-PP	OSQ-2984-PP		1
40	OSQ-2983-PP	OSQ-2983-PP		1
41	OSQ-2982-PP	OSQ-2982-PP		1
42	OSQ-2981-PP	OSQ-2981-PP		1
43	OSQ-2980-PP	OSQ-2980-PP		1
44	OSQ-2979-PP	OSQ-2979-PP		1
45	OSQ-2978-PP	OSQ-2978-PP		1
46	OSQ-2977-PP	OSQ-2977-PP		1
47	OSQ-2976-PP	OSQ-2976-PP		1
48	OSQ-2975-PP	OSQ-2975-PP		1
49	OSQ-2974-PP	OSQ-2974-PP		1
50	OSQ-2973-PP	OSQ-2973-PP		1
51	OSQ-2972-PP	OSQ-2972-PP		1
52	OSQ-2971-PP	OSQ-2971-PP		1
53	OSQ-2970-PP	OSQ-2970-PP		1
54	OSQ-2969-PP	OSQ-2969-PP		1
55	OSQ-2968-PP	OSQ-2968-PP		1
56	OSQ-2967-PP	OSQ-2967-PP		1
57	OSQ-2966-PP	OSQ-2966-PP		1
58	OSQ-2965-PP	OSQ-2965-PP		1
59	OSQ-2964-PP	OSQ-2964-PP		1
60	OSQ-2963-PP	OSQ-2963-PP		1
61	OSQ-2962-PP	OSQ-2962-PP		1
62	OSQ-2961-PP	OSQ-2961-PP		1
63	OSQ-2960-PP	OSQ-2960-PP		1
64	OSQ-2959-PP	OSQ-2959-PP		1
65	OSQ-2958-PP	OSQ-2958-PP		1
66	OSQ-2957-PP	OSQ-2957-PP		1
67	OSQ-2956-PP	OSQ-2956-PP		1
68	OSQ-2955-PP	OSQ-2955-PP		1
69	OSQ-2954-PP	OSQ-2954-PP		1
70	OSQ-2953-PP	OSQ-2953-PP		1
71	OSQ-2952-PP	OSQ-2952-PP		1
72	OSQ-2951-PP	OSQ-2951-PP		1
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74	OSQ-2949-PP	OSQ-2949-PP		1
75	OSQ-2948-PP	OSQ-2948-PP		1
76	OSQ-2947-PP	OSQ-2947-PP		1
77	OSQ-2946-PP	OSQ-2946-PP		1
78	OSQ-2945-PP	OSQ-2945-PP		1
79	OSQ-2944-PP	OSQ-2944-PP		1
80	OSQ-2943-PP	OSQ-2943-PP		1
81	OSQ-2942-PP	OSQ-2942-PP		1
82	OSQ-2941-PP	OSQ-2941-PP		1
83	OSQ-2940-PP	OSQ-2940-PP		1
84	OSQ-2939-PP	OSQ-2939-PP		1
85	OSQ-2938-PP	OSQ-2938-PP		1
86	OSQ-2937-PP	OSQ-2937-PP		1
87	OSQ-2936-PP	OSQ-2936-PP		1
88	OSQ-2935-PP	OSQ-2935-PP		1
89	OSQ-2934-PP	OSQ-2934-PP		1
90	OSQ-2933-PP	OSQ-2933-PP		1
91	OSQ-2932-PP	OSQ-2932-PP		1
92	OSQ-2931-PP	OSQ-2931-PP		1
93	OSQ-2930-PP	OSQ-2930-PP		1
94	OSQ-2929-PP	OSQ-2929-PP		1
95	OSQ-2928-PP	OSQ-2928-PP		1
96	OSQ-2927-PP	OSQ-2927-PP		1
97	OSQ-2926-PP	OSQ-2926-PP		1
98	OSQ-2925-PP	OSQ-2925-PP		1
99	OSQ-2924-PP	OSQ-2924-PP		1
100	OSQ-2923-PP	OSQ-2923-PP		1

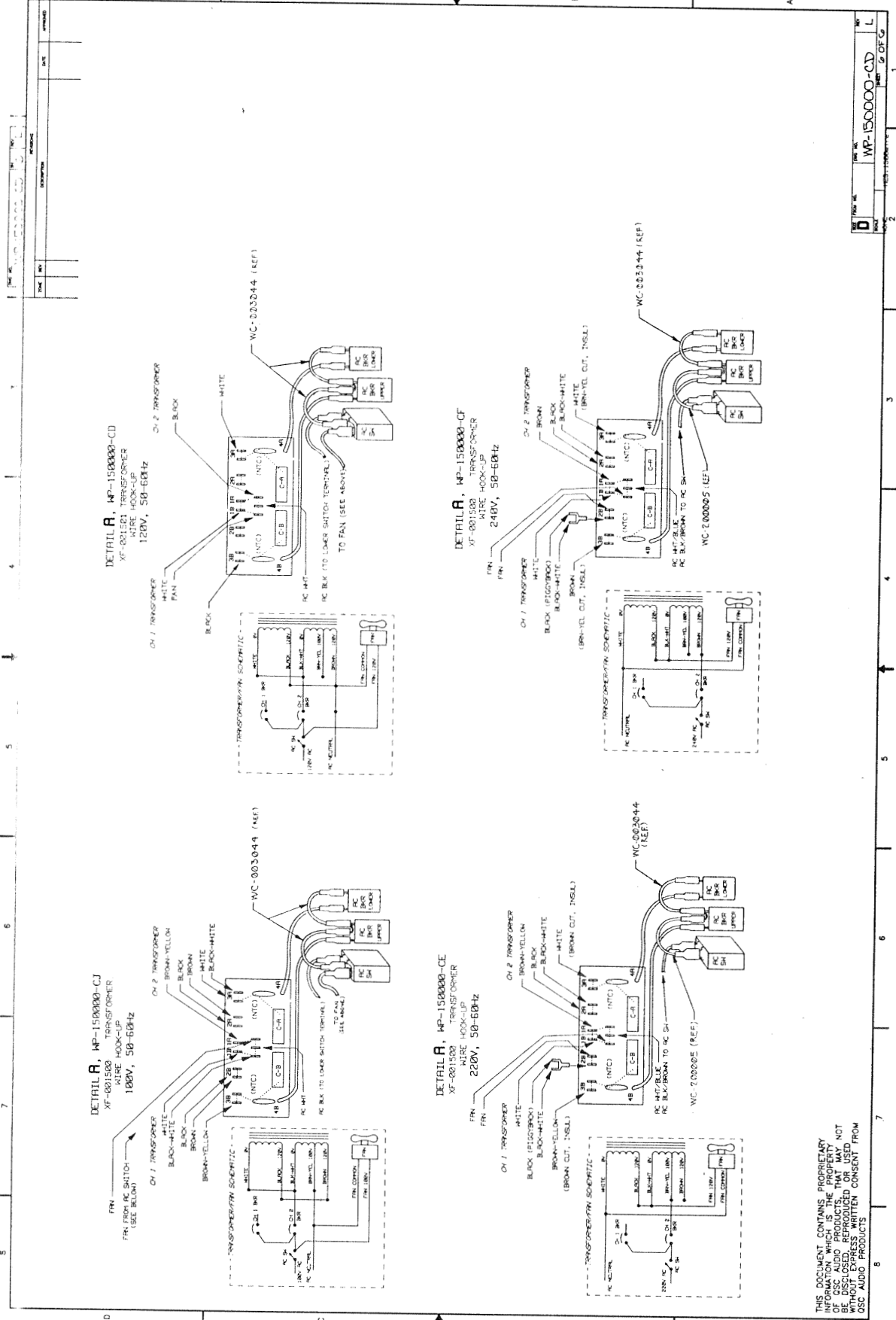
ITEM #	PART NUMBER	DESCRIPTION	LOCATION	QTY
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103	OSQ-2920-PP	OSQ-2920-PP		1
104	OSQ-2919-PP	OSQ-2919-PP		1
105	OSQ-2918-PP	OSQ-2918-PP		1
106	OSQ-2917-PP	OSQ-2917-PP		1
107	OSQ-2916-PP	OSQ-2916-PP		1
108	OSQ-2915-PP	OSQ-2915-PP		1
109	OSQ-2914-PP	OSQ-2914-PP		1
110	OSQ-2913-PP	OSQ-2913-PP		1
111	OSQ-2912-PP	OSQ-2912-PP		1
112	OSQ-2911-PP	OSQ-2911-PP		1
113	OSQ-2910-PP	OSQ-2910-PP		1
114	OSQ-2909-PP	OSQ-2909-PP		1
115	OSQ-2908-PP	OSQ-2908-PP		1
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117	OSQ-2906-PP	OSQ-2906-PP		1
118	OSQ-2905-PP	OSQ-2905-PP		1
119	OSQ-2904-PP	OSQ-2904-PP		1
120	OSQ-2903-PP	OSQ-2903-PP		1
121	OSQ-2902-PP	OSQ-2902-PP		1
122	OSQ-2901-PP	OSQ-2901-PP		1
123	OSQ-2900-PP	OSQ-2900-PP		1
124	OSQ-2899-PP	OSQ-2899-PP		1
125	OSQ-2898-PP	OSQ-2898-PP		1
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135	OSQ-2888-PP	OSQ-2888-PP		1
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138	OSQ-2885-PP	OSQ-2885-PP		1
139	OSQ-2884-PP	OSQ-2884-PP		1
140	OSQ-2883-PP	OSQ-2883-PP		1
141	OSQ-2882-PP	OSQ-2882-PP		1
142	OSQ-2881-PP	OSQ-2881-PP		1
143	OSQ-2880-PP	OSQ-2880-PP		1
144	OSQ-2879-PP	OSQ-2879-PP		1
145	OSQ-2878-PP	OSQ-2878-PP		1
146	OSQ-2877-PP	OSQ-2877-PP		1
147	OSQ-2876-PP	OSQ-2876-PP		1
148	OSQ-2875-PP	OSQ-2875-PP		1
149	OSQ-2874-PP	OSQ-2874-PP		1
150	OSQ-2873-PP	OSQ-2873-PP		1
151	OSQ-2872-PP	OSQ-2872-PP		1
152	OSQ-2871-PP	OSQ-2871-PP		1
153	OSQ-2870-PP	OSQ-2870-PP		1
154	OSQ-2869-PP	OSQ-2869-PP		1
155	OSQ-2868-PP	OSQ-2868-PP		1
156	OSQ-2867-PP	OSQ-2867-PP		1
157	OSQ-2866-PP	OSQ-2866-PP		1
158	OSQ-2865-PP	OSQ-2865-PP		1
159	OSQ-2864-PP	OSQ-2864-PP		1
160	OSQ-2863-PP	OSQ-2863-PP		1
161	OSQ-2862-PP	OSQ-2862-PP		1
162	OSQ-2861-PP	OSQ-2861-PP		1
163	OSQ-2860-PP	OSQ-2860-PP		1
164	OSQ-2859-PP	OSQ-2859-PP		1
165	OSQ-2858-PP	OSQ-2858-PP		1
166	OSQ-2857-PP	OSQ-2857-PP		1
167	OSQ-2856-PP	OSQ-2856-PP		1
168	OSQ-2855-PP	OSQ-2855-PP		1
169	OSQ-2854-PP	OSQ-2854-PP		1
170	OSQ-2853-PP	OSQ-2853-PP		1
171	OSQ-2852-PP	OSQ-2852-PP		1
172	OSQ-2851-PP	OSQ-2851-PP		1
173	OSQ-2850-PP	OSQ-2850-PP		1
174	OSQ-2849-PP	OSQ-2849-PP		1
175	OSQ-2848-PP	OSQ-2848-PP		1
176	OSQ-2847-PP	OSQ-2847-PP		1
177	OSQ-2846-PP	OSQ-2846-PP		1
178	OSQ-2845-PP	OSQ-2845-PP		1
179	OSQ-2844-PP	OSQ-2844-PP		1
180	OSQ-2843-PP	OSQ-2843-PP		1
181	OSQ-2842-PP	OSQ-2842-PP		1
182	OSQ-2841-PP	OSQ-2841-PP		1
183	OSQ-2840-PP	OSQ-2840-PP		1
184	OSQ-2839-PP	OSQ-2839-PP		1
185	OSQ-2838-PP	OSQ-2838-PP		1
186	OSQ-2837-PP	OSQ-2837-PP		1
187	OSQ-2836-PP	OSQ-2836-PP		1
188	OSQ-2835-PP	OSQ-2835-PP		1
189	OSQ-2834-PP	OSQ-2834-PP		1
190	OSQ-2833-PP	OSQ-2833-PP		1
191	OSQ-2832-PP	OSQ-2832-PP		1
192	OSQ-2831-PP	OSQ-2831-PP		1
193	OSQ-2830-PP	OSQ-2830-PP		1
194	OSQ-2829-PP	OSQ-2829-PP		1
195	OSQ-2828-PP	OSQ-2828-PP		1
196	OSQ-2827-PP	OSQ-2827-PP		1
197	OSQ-2826-PP	OSQ-2826-PP		1
198	OSQ-2825-PP	OSQ-2825-PP		1
199	OSQ-2824-PP	OSQ-2824-PP		1
200	OSQ-2823-PP	OSQ-2823-PP		1

ITEM #	PART NUMBER	DESCRIPTION	LOCATION	QTY
201	OSQ-2822-PP	OSQ-2822-PP		1
202	OSQ-2821-PP	OSQ-2821-PP		1
203	OSQ-2820-PP	OSQ-2820-PP		1
204	OSQ-2819-PP	OSQ-2819-PP		1
205	OSQ-2818-PP	OSQ-2818-PP		1
206	OSQ-2817-PP	OSQ-2817-PP		1

MX1500 Component Placement

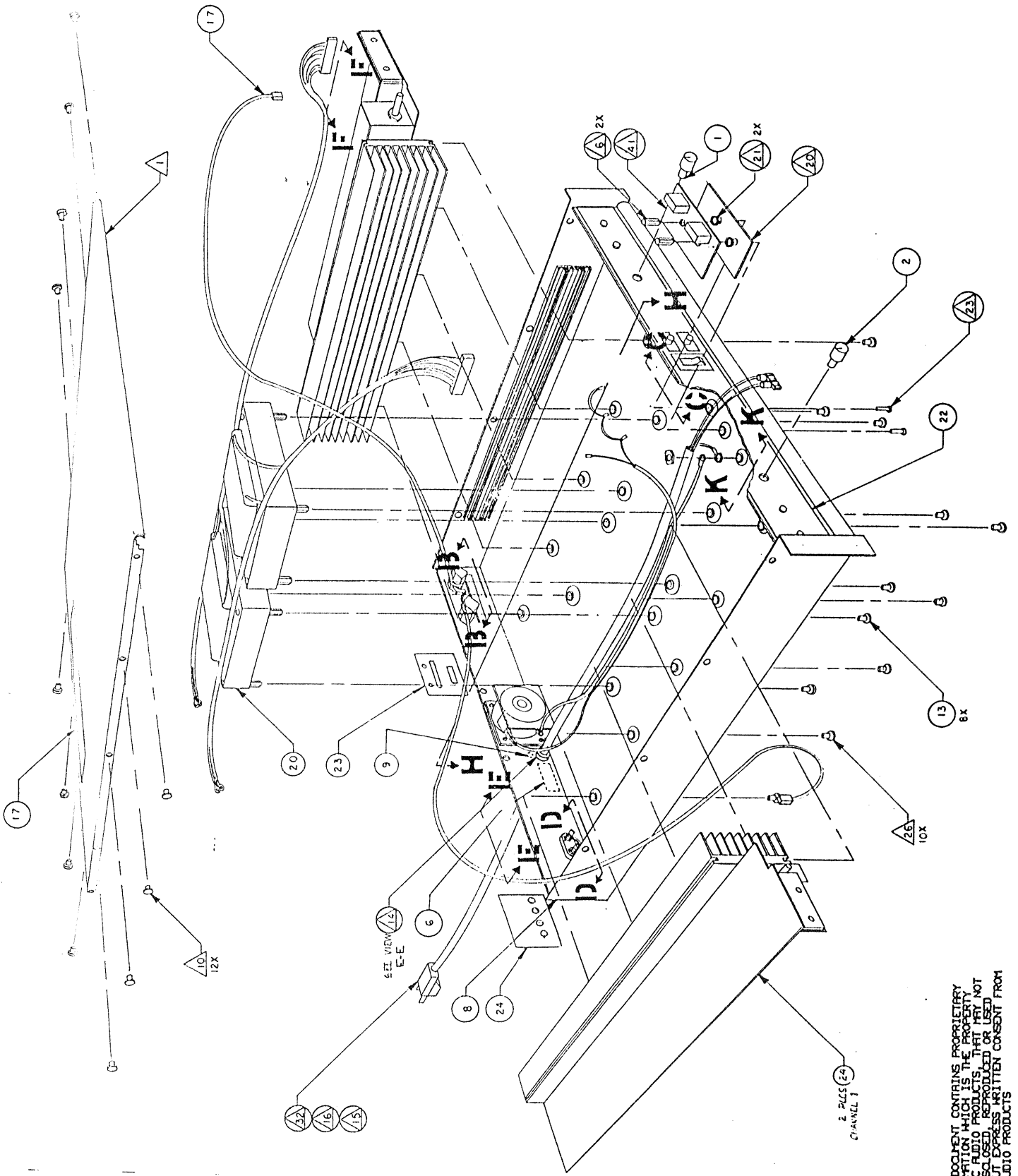


MX1500 Primary Wiring Information



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 8

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MX2000 Specifications

OUTPUT POWER (per channel):

Continuous Average Output Power both channels driven.

8 ohms, 20 - 20kHz	0.1%	THD 375
8 ohms, 1kHz	1%	THD 425
4 ohms, 20 - 20kHz	0.1%	THD 600
4 ohms, 1kHz	1%	THD 725
2 ohms, 1kHz	1%	THD 1000 +/- 1dB

BRIDGED MONO OPERATION:

16 ohms, 20 - 20kHz	0.1%	THD 750
8 ohms, 20 - 20kHz	0.1%	THD 1200
4 ohms, 1kHz	1%	THD 2000 +/- 1dB

DISTORTION (8 ohms):

THD, 20-20kHz, at rated power, less than 0.1%.
SMPTE-IMD, less than 0.025% at rated power.

FREQUENCY RESPONSE: 20-20kHz, +/-0.1dB. 8-300kHz, +/-3 dB.

DAMPING FACTOR: Greater than 200.

SLEW RATE: 20V per microsecond.

DYNAMIC HEADROOM: 2dB at 4 ohms.

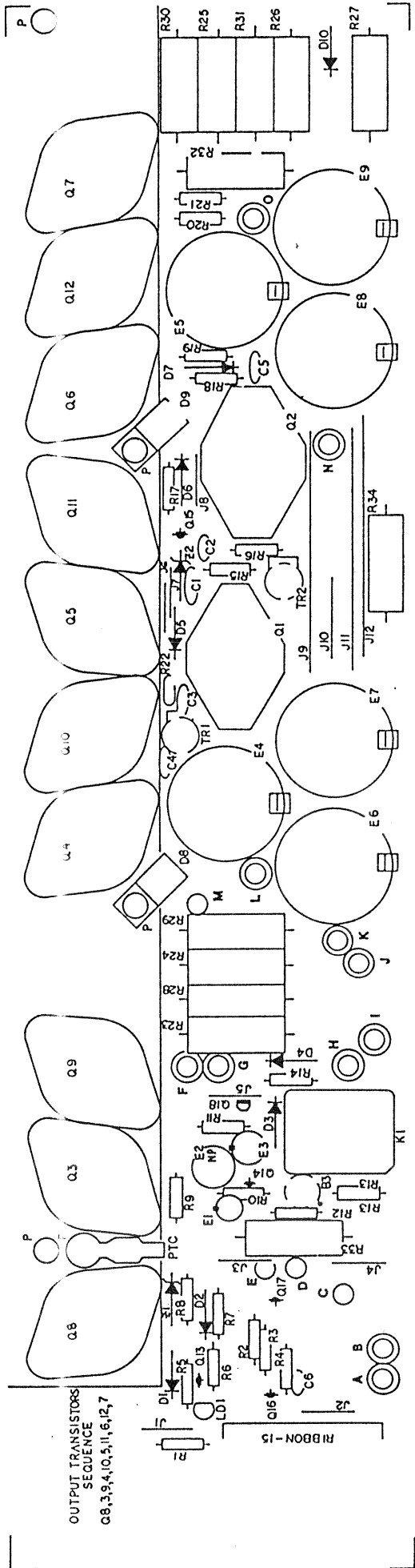
NOISE: -100dB, 20-20kHz at rated power.

SENSITIVITY: 1.07V RMS for rated power (8 ohms).

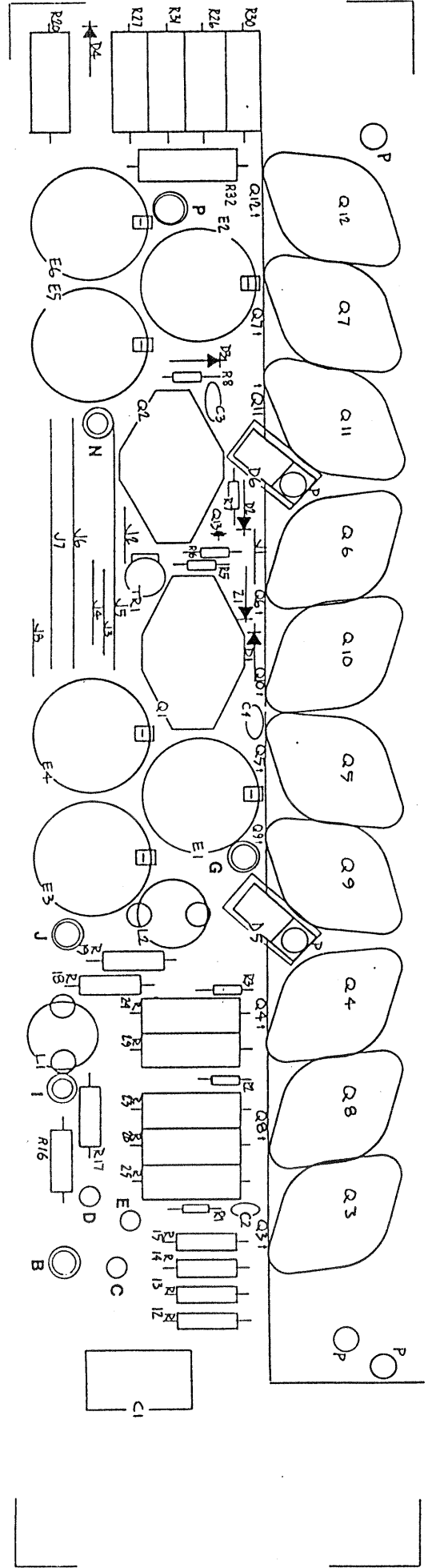
INPUT IMPEDANCE: 10k unbalanced, 20k balanced.

DIMENSIONS: 5.25" tall (2 rack spaces), 19" wide, 17.9" deep.

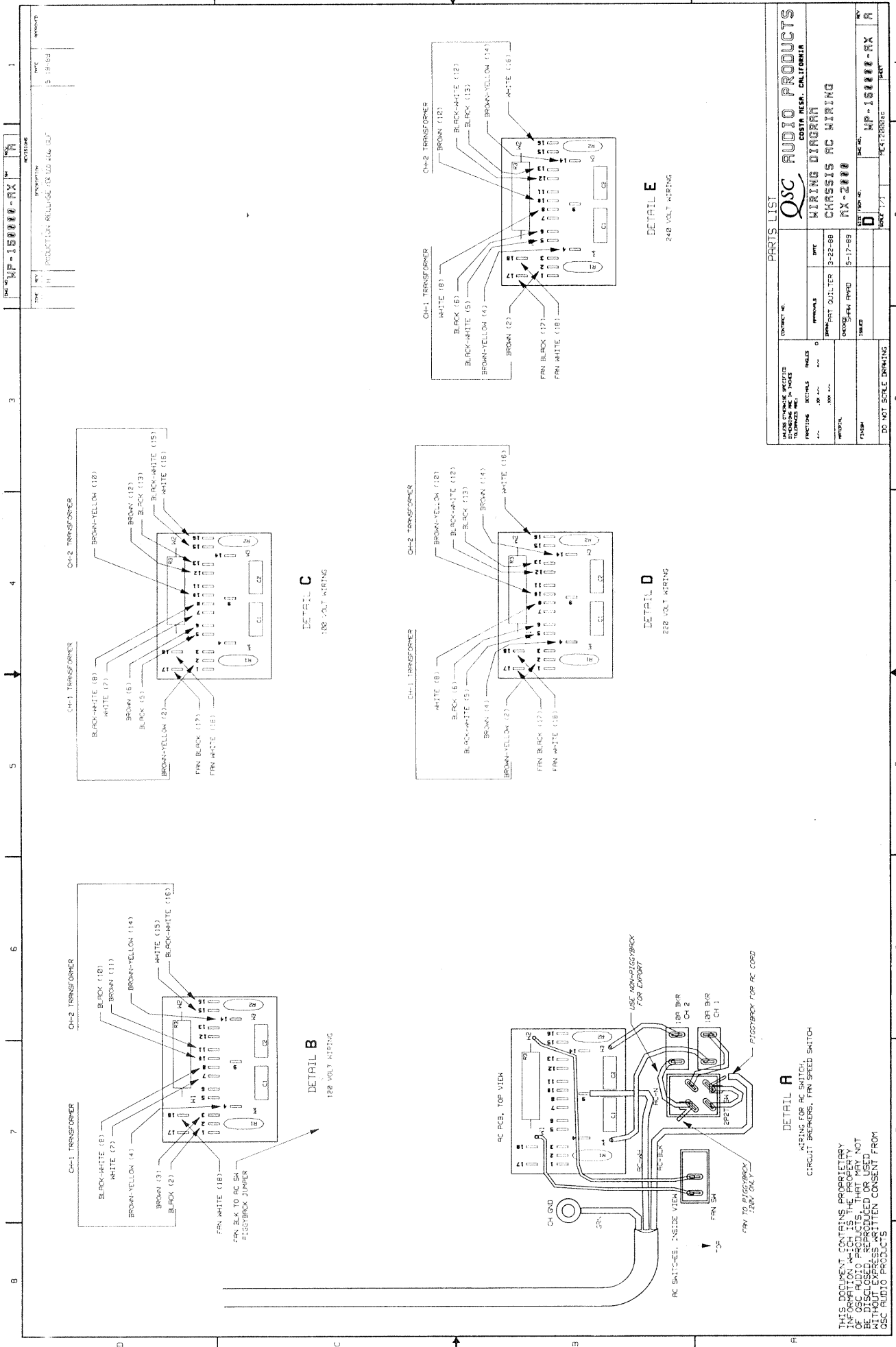
WEIGHT: 70lbs net, 76 lbs shipping.



MX2000 Component Placement



MX2000 Primary Wiring Information



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MX1500 AMPLIFIER CIRCUIT DESCRIPTION

The following circuit description refers to MX1500 and MX2000 products manufactured between 1985 and 1991. However, some reference designators and portions of the circuit descriptions may differ. In principle the MX2000 will follow the MX1500. The reader will want to cross relative part numbers from the MX2000 to the MX1500.

The MX1500 and MX2000 are electrically equivalent to the Series III Amplifiers 3500 and 3800. The MX1500 and MX2000 are Class G dual-monaural amplifiers. The power supplies are dual level, center-tapped, balanced, and bipolar. The channel power supplies are completely independent, except for the power cord and switch. The channels have separate supply transformers, circuit breakers, capacitors, and input/output wiring. Each channel can operate independently of the other.

The 2-step power supply allows these amplifiers to be twice as efficient as conventional designs. The driver and output transistors are subjected to lower voltage and current than traditional designs. This lowers the channel heatsink requirements and reduces component stress.

The lower supply voltage is operating at maximum output when the amplifier is producing approximately 1/3 rated power output (worst case thermal condition in conventional designs). With normal music signals, the high voltage output components supply current on signal transients.

Since these two amplifiers are DC coupled, they have output relay protection circuits. The protection circuit will prevent DC from reaching the load (speaker) and remove the load when the amplifier is overheating. The output relay disconnects the amplifier from the load and shorts the load to circuit ground.

MX1500 & MX2000 CIRCUIT DESCRIPTION

Please refer to the MX2000 schematic for the component identification numbers in this troubleshooting guide. The MX2000 has similar operation with different component identification numbers.

Power Supply

The AC power cord is connected to the supply transformers through a thermal (slow-blow) circuit breaker and the AC switch. A row of terminals on a small circuit board allows the transformer primary to be wired for 120V, 220V, or 240V, 50-60Hz operation (the MX1500 requires a special export transformer). There is a separate supply transformer for each channel.

The transformer secondary windings are connected to the channel module through

an 8-pin connector. The high voltage windings are rectified by B4, and filtered by E8,9,10 (positive) and E11,12,13 (negative). Half-voltage windings are rectified by B3 and filtered by E14 (positive) and E15 (negative).

In addition to the usual full-voltage positive and negative rails, we have secondary rails at half the voltage. These are used in the high-efficiency circuit discussed later on.

The output transistors collectors are grounded and the audio output is taken from the midpoint of the power supply capacitors. This requires separate filters, rectifiers, and transformer secondaries for each channel, but permits one channel to fail without effecting the other.

The +/-15V power supply, for the op amp, is derived by using dropping resistors (R33 and R34) and zener stabilizers (Z13 and Z14) from the main supply rails.

Complementary Output Transistors

The emitters of the positive and negative output transistors are connected to their respective power supply rails through load-sharing emitter resistors. The parallel bases of each bank are bypassed with 22-ohm resistors (R15-18). These "pull-up resistors" assure positive shut-off of the output transistors. The 500ma currents from the collectors of the driver transistors are connected to the output transistor bases and amplified to about 25A peak.

The collectors of all output transistors meet at a common ground. This means we can simply screw the cases of all four banks to a grounded heat sink, with no need for the usual insulating mica. This saves money and improves reliability through better cooling.

The speaker output is taken from the midpoint of the power supply capacitors. This means that the audio output voltage is superimposed on top of the DC supply voltages, which must be kept in mind when checking these voltages.

Complementary Driver Transistors, Crossover Bias, and High/Low driver circuit.

We use two stages of discrete devices to amplify the output of the op amp to full rated power. With a little added complexity, we have doubled the efficiency of the normal Class-B output stage.

Complementary drivers Q1 and Q2 are connected to the op amp through bias diodes D5 and D6. The forward voltage drop of the diodes matches the forward base voltage of Q1 and Q2. As the op amp swings above and below zero, it immediately drives Q1 or Q2. This minimizes the "dead zone" which causes crossover distortion. Trimmer T1 in parallel with R14 permits the bias to be fine-tuned. Emitter resistors R25 and R26 are used to stabilize the gain of Q1 and Q2. These resistors minimize the

driver transistor's tendency to draw more idle current as they heat up. The final collector current from Q1 and Q2 is about 500 ma. This current is drawn from the bases of the lower voltage output transistors Q5-7 and Q11-13.

The low voltage output transistors handle the first 50% of the output voltage. In order to deliver the remaining 50% of the output swing, we need to activate the high-voltage drivers Q3 and Q4. These transistors drive the high voltage output transistors Q8-10 and Q14-16. This is done by putting Q3 and Q4 in series with Q1 and Q2, and using the 3.9V zeners Z15 and Z16 for turn-on threshold.

To explain this, we will look at just the positive half of the circuit. Keep in mind that the same things will happen on the negative half-cycle. As the positive driver Q1 is driven harder, its collector current will pull the positive half-voltage power supply closer to ground. Since the entire supply is coupled together as a unit, this means all voltages move negative together. The speaker is connected to the common midpoint, so this results in a negative speaker output.

As we approach the point of 50% output, the positive half voltage supply will come within a few volts of ground. This carries the emitter of Q3 within a few volts of ground, until its base voltage drops below the voltage established by the zener (Z15). Q23, D11, & D12 become forward biased and begin to drive Q3. Q3 takes over the current coming from Q1, cutting off the low-voltage outputs and driving the high-voltage outputs. The output devices pull the high-voltage supply to ground, resulting in 100% output to the speakers. Since the half-voltage supply is carried below ground during this period, high-current diode D11 protects the low-voltage outputs from reverse polarity.

This reduces waste heat considerably, compared to the normal single-stage circuit. A power amp with a single level DC supply has a lot of voltage across the power transistors for all levels up to full output. This means that more power is wasted at moderate power levels than at full output. With lower level DC supplies for lower levels of output voltages (up to 50%), we reduce waste voltage and power.

The Z15 zener voltage (about 3.9V) is added to the overall saturation loss and reduces peak output voltage by this amount. The small transistor after the zener (Q23) isolates the loading effect of Q3 and Q4. This permits full signal swing and improves dynamic headroom.

It is difficult to switch smoothly between high and low power stages. The RC network R23 and C7 makes Q3 switch sooner at very high frequencies, improving the "step" performance. Coil L1, between the low and high-voltage filter capacitors, slightly "cushions" the transition.

Balanced Input Circuit, Gain Control, and Frequency Limits.

The first stage of the dual op amp is used as a balanced differential input. Any

signal appearing equally on both the positive and negative inputs results in no voltage across the op amp input terminals and no voltage at the output of the op amp. Noise signals, which normally occur equally on both sides of the balanced line, are rejected. The audio signal appears as a difference between the balanced-line conductors and these signals appear at the same gain at the output of the op amp.

For unbalanced inputs, either input line may be grounded, and the circuit will respond at unity gain to the other line. For reasons of overall stability in actual use, QSC uses the inverting input for unbalanced signals.

After balanced-to-unbalanced conversion, the audio signal flows through R5 and C1, which roll off high frequency response (less than -2dB at 20KHz, and -3dB at 200KHz).

Amplifier Feedback Network, Gain Stage, Distortion LED, and Short Circuit Protection.

The actual power amplifier begins at the input to the second stage of the op amp. Audio feedback is established across R7 and R8. A 47uF non-polar capacitor (E4) in series with R8, ensures that 100% of the DC feedback goes to the op amp. These components also roll off low frequency response below 20Hz and ensure only a few millivolts of DC offset at the amplifier output. The feedback elements R9 and C4 reduce the feedback below 50Hz. This counteracts the rolloff of E4 in the region of 20- 30Hz. This circuit maintains flat audio response without unnecessary sub-audio bandwidth. The resultant low frequency response is down 0.2dB at 20Hz and 3dB at 8 Hz.

High frequency stability is established by C3 and C2. C3 is the primary "phase lag" capacitor, which sets the slew rate of the circuit. C2 establishes "phase lead" in the speaker feedback network, increases feedback at very high frequencies, and improves control at frequencies where oscillations might occur. C9 and C10 add a little more phase-lead margin. A speaker output filter, L2, R49, R50, and C5 isolates the amplifier from reactive loads at very high frequencies where instability might occur.

Most of the gain in the amplifier is contributed by the second stage of the op amp. This stage's primary job is to feed the driver transistors, but is also used to drive the Distortion LED (LD-1) and is tied into the short circuit protection scheme.

As long as the output of the amp is not clipping, the drive voltage to the bases of the driver transistors (Q1 and Q2) remains below 1.5 volts peak. At clipping the op amp will attempt to deliver a higher than normal voltage to the driver transistors. This excess voltage is used to drive the Distortion LED (LD-2) through small bridge rectifier B1. The THD circuit requires a voltage greater than 2.6 volts to operate. Any form of clipping immediately results in illumination of the Distortion LED.

In order to maintain good audio performance into low impedance loads, it is necessary to maintain a high output current limit. The normal current limit is determined by the base current to each driver through resistors and zener diodes (R19, R22, Z15, and Z16). When the op amp supply rails are at their normal 15V, this current is about 9ma and results in about a 25A current from the output transistors. The output transistors can withstand this much current into a shorted output for a few seconds.

The normal range of currents from the op amp is less than the current supplied from the main power supply rails by R33 and R34. On full power operation more current is drawn than these resistors can supply, especially if the amp is clipped and the op amp has to deliver extra current to the Distortion LED. To prevent the op amp rail voltage from being drawn down, we have a replenishing circuit from the speaker output through R52 (three parallel resistors in early versions) and rectifiers D8 and D9. As long as the load impedance is above 2 ohms, there will be enough output voltage to recharge the op amp rails through this network.

If the output is shorted, the output voltage will be clamped to a low value, the recharge will not occur, and the op amp will deplete its supply rails to about 6 volts. This will cut the current to the drivers drastically and reduces output current to a safe level the amp can withstand; until thermal shutdown occurs. The exact short circuit current limits are adjusted by 2K trimmers TR2 and TR3.

Output Protection and Signal Readout Circuits

There are three circuit protect functions; turn-on/off muting, thermal shutdown, and DC protection. The power for protect circuit operation is taken from the +46V output supply and an independent -24V power supply from the low voltage transformer secondary (through D4 and R32 and filtered by E5). A high-current relay is put in series with the speaker output; switched by small transistors Q17 and Q18. Diode D18 absorbs inductive kickback when the relay is shut off.

NOTE: The relay connects the load to ground when not activated. This not only helps protect the load from DC fault, but enables the "bridged mono auto back-up" feature.

When the amp first is turned on, the relay contacts are open and no sound appears in the speakers. With no current through the relay, the +8mA flowing through R12 from the positive supply lights the red section of the bicolor protect/power LED. E7 is initially discharged and takes about three seconds to charge to the point where R29 can turn on Q18. Q17 sends -20ma through the relay, turning on the speaker and overcoming the +8 ma into the pilot LED; reversing it to green.

LD6 in series with Q18 creates a -2.2V threshold at the base of Q18 (1.6V + .6V).

When the pilot LED is red, it has +1.6V across it, which means that the total voltage across R30 must be 3.8V before Q18 can turn on. When E7 reaches -15V, R29 will send enough current to get 3.8V across R30. Q18 turns on, driving Q17 and the relay. When the relay turns on, the voltage across the pilot LED is reversed. R30 sends positive feedback from this event back to Q18, which ensures a positive "latching" on or off. When the amp is turned off, E5 quickly discharges, removing power from the relay, and "resetting" E7 through D17.

Thermal protection is accomplished by using a "PTC" (Positive Temperature Coefficient) resistor attached to the heat sink. The +8ma from R12 flows through this part. Below 75C, the resistance remains at 100 ohms, which means that there is less than 1V dropped across the PTC. As temperature exceeds 80C, the resistance of the PTC goes up and the voltage drop increases. As the voltage reaches 3V, the flashing circuit (E3, R59-61, C11, Q20-21, driving Thermal LED LD1) is activated (through R13). This signals the user that temperatures are nearing the limit. When the temperature reaches about 95C, the voltage across the PTC reaches 6V; enough to turn off Q18 through the 7.5V zener Z17. This shuts off the relay and removes the load until the amp cools down and the PTC resistance returns to approximately 1k ohms.

DC protection is accomplished with another auxiliary circuit. R27 and E6 filter the audio output. If the frequency drops below 10Hz or if DC appears for more than .1 second, the voltage on E6 will rise to 2V. This forward biases the bridge rectifier B2 and turns on Q19. Q19 is connected to the rectifier so that either polarity of DC will trigger it. When Q19 turns on, it discharges E7 and shuts off the relay. The recharge time of E7 prevents destructive "chattering" of the relay.

IMPORTANT: The entire relay circuit is referenced to the power supply, not to ground. Be careful when measuring or substituting parts, to keep track of what voltages you are connecting to.

Input/Output Connections

The 1/4-inch and barrier strip input jacks are connected in parallel. The input connections are made to the circuit board through a 6 contact modular telephone-type connector. The speaker output connectors are 5-way binding posts. The speaker grounds are connected together. The speaker and power supply connections are made with an 8 contact connector on the circuit board.

TROUBLESHOOTING THE MX1500/MX2000 AMPLIFIER

Please refer to the MX1500 schematic for the component identification numbers in this troubleshooting guide.

Excessive Current Draw

The amplifier draws abnormal current when AC power is first applied (with or without signal, but without output load).

A. HIGH CURRENT DRAW, WITH NO OUTPUT SIGNAL (greater than 10 amps at 30VAC)

1. Shorted bridge rectifier B1 or B2.
2. Solder shorts on printed circuit board (from previous repair job?).
3. Supply clamping diodes D7, D10 shorted.
4. Outputs or driver transistors shorted on both supplies (NPN & PNP).

B. MEDIUM HIGH CURRENT DRAW, FAIRLY STABLE (increases slowly, less than 5 amps at 30 VAC)

1. Single polarity driver or output transistor short.
2. Single supply clamping diode D7 or D10 reversed or shorted.
3. Open bias diodes D5 or D6.
4. Both the trim pot TR1 and R14 (bias NTC resistor) are open.
5. Shorted mounting of D21-22.

C. HIGHER THAN NORMAL CURRENT DRAW, BUT THE AMP WORKS (Signal is Present)

1. Increasing (runaway) "soft" current draw:
 - a. Reversed or damaged supply capacitor: Caution, the capacitor may vent explosively.
 - b. Soft current draw, above 60VAC: Severely misadjusted bias circuit or defective bias diodes.
2. Severe oscillation (look at op amp output) causing current drain.
3. Shorted step diodes, high-level driver transistors. Check components in the step circuit.

Signal Amplification Problems

The amplifier passes a signal but is not running correctly.

First, distinguish between "ringing" which is momentary instability after a transition, "step" distortion, crossover distortion (both often show ringing), "overall" instability, or harmonic distortion).

1. Ringing: usually indicates marginal instability, triggered after passing over the crossover or step. Can indicate problem in "minor" stability components (see that section above). check output filter, R, L, R, C and inner coil R, L.
2. Step distortion: Check step circuit components (list) carefully, note exact output voltage where step cuts in (are both matched to 1V). Step turning on too late (too high) will hang up at 2 ohms. Check driver zener voltages, Z and Z. After inspecting all parts, see below:
3. "Boxcar" glitch (8-ohms, rectangular deviation); Reduce affected step cap. C7 or C8 by 50%, try new Q22, 23, sometimes helps, in severe cases, add 470 pF capacitor from collector-base of

Q3 or Q4 as necessary.

4. "Fuzzy" glitch (usually 4 ohms or lower): check/increase affected step speedup capacitor C7 or C8 by 25-50%

5. Spike: Check C7 or C8 (as above) or consult on possibility of 470 pF (max) across collector-base of upper driver transistor.

6. Severe at 2-4 ohms: step circuit switching late: values of Z15 or Z16 may need to be altered, Q23 or Q22 open, or R57/D11 or R58/D14 in series are missing/wrong.

7. Crossover distortion: (Notch or ringing at zero crossing)

Severe: shorted bias diode, defective trimmer components.

Moderate: out-of-spec bias diodes, defective trimmer components.

8. Can't get notch on minimum setting: see above, and check for base resistors on output devices.

9. Instability on one side: add .015uF trimmer bypass capacitor around TR1. Change the values of the driver emitter capacitors C9, C10.

10. Overall Instability: The output signal is usually distorted and is usually worse at a particular part of the output waveform. (Do not confuse with 60-120Hz. in the output signal, which spreads the signal trace evenly and vertically. Identify this problem by reducing the scope sweep rate to 10ms range and use "LINE" sync to look for 60-120Hz hum frequencies.)

11. Severe instability at all loads, often with excessive current draw: usually a bad or missing slew rate capacitor (C3) or feedback capacitor C2.

12. Medium instability, especially on low signals or 8 ohm or higher impedance loads:

13. A stability component is defective or not soldered well: feedback capacitor C2, secondary stability capacitors C9-10 (jump with a comparable value, see if worse, if so try replacing with 50% lower value).

14. If the oscillation occurs with very low gain, suspect an open circuit in the feedback shunt R8/E4 (or a broken circuit trace).

15. Replace the IC and check the IC socket for contamination.

16. Harmonic Distortion: These can be tough as sometimes cause is "buried" instability which is smoothed out by later stages. This can be checked by probing IC output, and using stability procedures above to improve. Otherwise:

Is it "Odd" (3rd order) or "Even" (second order) distortion?

Odd indicates an equal problem on both sides of zero, normally a part handling the full signal swing. Even indicates a mismatch between positive and negative, usually a bad part on one side of the circuit.

Poor Frequency Response

1. High freq, determined by input rolloff C1, and feedback capacitor C2 (wrong value also causes instability)

2. Low freq, determined by DC feedback rolloff E4, and "butterworth" feedback compensation network C4/R9 (see also Gain section).

Gain Wrong

1. Too high: Missing one of the two feedback resistors from output, R7 or R9; or input R1-4 is wrong value. (Faulty input resistors will cause the amplifier to fail the CM test.)
2. Too low: Above feedback values wrong or shunt resistor R8/E4 wrong or open (open causes very low gain with instability. Check circuit trace)

Incorrect Short Circuit Current Limits

1. The short circuit current is too high:
 - a. If the IC 15VDC supply checks normal (5-6 volts): defective Z15-16 zeners or shorted bias diode D5-6 (shows severe crossover).
 - b. If the IC 15VDC supply is too high (one or both supplies above 8VDC):
 - c. Replace the IC (poor output current),
 - d. One or more of the CLIP components is open: clip LED (LD2), feed resistor R11, 1.5A rectifier B1.
2. If the IC 15VDC supply rails are low into a short and a 2 ohm load (often on one side of the supply only):
 - a. Check for a defective chargeback diode D8 or D9 (the amp may have premature clipping at 4 ohms as well).
 - b. If the IC supply is OK until clipping the amp may have low gain devices above the "step". See that all upper outputs and emitter resistors are present and that the supply feed resistors (R33-34) are OK. An upper driver transistor may have very low gain.
 - c. If the clipping waveform collapses into a near-triangular signal (instead of flat-top clipping), the +/-15V supply filter capacitors may be defective. If both capacitors are aging equally, you may have to replace them to test this solution.

D.C. Fault Without Current Draw

In many cases, shorts in the circuit will cause current draw, but certain shorts will only cause DC offset in the output. In both cases, measuring all the voltages, looking for abnormal values can help trace the fault, which can be a solder short (zero volts), reversed zener or diode (.6V) reversed electrolytic (several volts), or wrong value parts (abnormal voltage). Look at the following points in the circuit.

1. Shorted IC rail, sometimes both shorted together; including mod jack.
2. Reversed 15V zener Z13,14 gives .6V on IC rail. Zero volts if blown.
3. TR 2 or TR3 all the way off or way too low in value.
4. Collector-base short on driver (rare without further damage). Sometimes IC forces the rest of the circuit into DC due to shorts in the feedback network, etc. To check this, remove IC, check for +15V, -15V, and see if adjusting current limit trimmers TR2,3 will produce a zero volt output (there will be no signal, of course). If so, output stage is probably OK, look for problems in IC, or its associated parts.
5. Defective/reversed IC (pull and check voltages)

Protection Circuit Troubleshooting

Note: all voltages are with respect to SPEAKER BUS. If amplifier itself is OK, you can conveniently measure voltages to ground by turning SIGNAL LEVEL OFF (so there is zero volts on speaker bus).

Relay Won't Come On

Check speaker bus for DC; if over 3V DC present, the protect circuit is operating normally to hold off operation. If no DC present, continue below:

1. Check Relay power voltage. With relay off, voltage at E5 should measure -47V (with relay on, about 27V). If not, check R32, D4, D18, E5 polarity.
2. Power OK, check voltage on timing capacitor E7. Should rise to 12-15V, in three seconds, which triggers Q18. If not check R28, R29, E7 polarity.
3. Timing voltage OK; check relay transistor Q17. If good, a 47K resistor from base to speaker bus should activate relay.
4. Relay Q17 OK, check driver Q18 and LED LD6. If the relay can be forced on by shorting Q17 (and the protect circuit stays on) check Z17, Q19, Q18, and R31.

No Red "Protect" LED

1. Check voltage on LED while relay is off. If over +2V, LED is bad. If 0V (no positive drive), there is no "protect" power (missing R12), which defeats all shutdown circuits.

No Muting Delay

(No Thermal or DC Protect Either; relay or circuit is "stuck on")

1. Relay Q17 shorted or wrongly stuffed. Check by jumping base to emitter, should turn it off.
2. Driver Q18 shorted or wrongly stuffed (check by jumping base to emitter).

Excess Muting Delay

1. Check timing capacitor E7 voltage. If it rises normally but circuit slow to turn on, check Z17 (lift temporarily), LD-6 bad or intermittent, R30 too low.
2. Timing capacitor voltage wrong; determine cause (R28,29, reversed E7, missing R62, reversed/wrong Q19)

No Thermal Shutoff

1. Put voltmeter across PTC and look for voltage to rise from .7V cold to 5.5V shutdown.
2. No Red "Protect", No Flashing; may have no R12, which defeats whole thermal circuit (no voltage across PTC).
3. Flashes but won't shut down; check Z17 high/missing, or R13 low, or relay drive circuit stuck on (see above).
4. Red "protect" /R12 OK, but no voltage across PTC; defective or shorted (lift temporarily, should thermal off immediately).

No DC Protect

1. B2, Q19 open
2. Replace LD-6 if voltage is less than 1.5V.

Relay Faults With Normally Operating Amplifier

1. Check Relay power voltage. With relay off, voltage at E5 should measure -47V (with relay on, about 27V)(E803 should measure -53V). If not, check R32, D4, D18, E5 polarity.
2. Power OK, check voltage on timing capacitor E7. Should rise to 12-15V, in three seconds, which triggers Q18. If not check R28, R29, E7 polarity.
3. Timing voltage OK; check relay transistor Q17. If good, a 47K resistor from base to speaker bus should activate relay.
4. Relay Q17 OK, check driver Q18 and LED LD6.

MX 2000 Power Amplifier Parts List

NPN PCB Assembly (2 per amplifier)

QSC part # WP-160046-PC

QSC Part #	Description	Qty.	Reference	Comments
CA-147100-BD	470PF, 100V, 10%, DISK	1		
CA-210100-BP	.001UF, 100V, 10%,MYLAR	1		
CA-368100-BP	.068UF, 100V, 10%,MYLAR	1		
CA-410160-BP	OBS-.1UF, 160V, 10%,MYLAR	1		
CA-822100-BE	2200UF, 100V, ELEC, RADIAL, 10%	4		
CA-833080-BE	3300UF, 80V, ELEC., RADIAL, 10%	2		
CA-168100-BD	680PF, 100V, 10%,DISK	1		
CH-350208-GX	OBS-3500 HEAT XFMR BRACKET FAB	1		
HW-060100-PS	#6-32 X 10 PEM STUD	5		
HW-060200-SP	OBS-9222-A140 AMATOM SPACER	5		
MS-000066-HS	TO-66 HEATSINK AAVID #E5020B	2		
NW-000220-RW	OBS-TO-220 RECT. WASHER	2		
NW-060010-SL	#6 SPLIT TOOTH LOCKWASHER	6		
NW-060400-HN	#6-32 X 1/4" HEX NUT	5		
NW-060410-ST	A-4 SPRING TOOTH LOCKWASHER	3		
PC-380046-HX	OBS-3800 NPN PCB	1		
PL-000025-PL	OBS-9222-PH140 AMATOM SPACER	2		
PL-000026-PL	OBS-TO-220 X 1 TEK-SIL INSLTOR	2		
PL-003109-SP	OBS-NYLON SPACER	2		
PL-905100-SP	SPACER,ROUND,NYLON,#6,0.100"L	4		
PT-250000-AT	5K OHM TRIMPOT	1		
QD-000424-TX	OBS-2SD424, TRANSISTOR, NPN, TO-3	10		
QD-0004.7-ZT	DIODE, ZENER, 4.7V TESTED	1		
QD-000810-DX	TO-220 8A/100V DIODE, FAST	2		
QD-002763-TU	2A, TO-220, PNP UNTESTED TRANS	2		
QD-004934-DX	1N4934 DIODE	3		
QD-005402-DX	1N5402 DIODE	1		
QD-008599-TX	MPS 8599 TRANSISTOR, PNP	1		
RE-.02205-FW	RESISTOR,WIREWOUND,0.22 10% 3W	10		
RE-.33005-DM	RESISTOR,METAL FLM,3.3 5% 1W	1		
RE-001005-EM	RESISTOR,METAL FLM,10 5% 2W	8		
RE-001505-DM	OBS-15 OHM, 1W, MET. OX. 5%	2		
RE-010005-BC	RESISTOR,CRBN FLM, 100 5% 1/4W	1		
RE-015005-BC	RESISTOR,CRBN FLM,150 5% 1/4W	1		
RE-082005-BC	RESISTOR,CARBON, 820 5% 1/4W	1		
RE-115005-BC	RESISTOR,CARBON,1.5K 5% 1/4W	1		
RE-130053-HW	RESISTOR,WIREWOUND,3K 5% 5W	1		
SC-060061-PP	#6-32 X 3/8" P/P BLACK	4		
SC-062050-PP	#6 X 5/16" "B" P/P ZINC	20		
WC-0.6022-JW	.6" JUMPER, 22 GA, SLD	3		
WC-0.9022-JW	.9" JUMPER, WHITE, 22 GA, SLD	2		
WC-2.5018-JW	2.5" JUMPER, WHT, 18 GA, SLD	3		
XF-200014-CR	2UH, 14 GA, COIL/VERTICAL	2		

PNP PCB Assembly (2 per amplifier)

QSC part # WP-160047-PC

QSC Part #	Description	Qty.	Reference	Comments
CA-168100-BD	680PF, 100V, 10%,DISK	1		
CA-210100-BP	.001UF, 100V, 10%,MYLAR	2		
CA-222100-BP	.0022UF, 100V, 10%,MYLAR	1		
CA-333100-BP	.033UF, 100V, 10%,MYLAR	1		
CA-347100-BP	OBS-.047UF, 100V, 10%,MYLAR	1		
CA-610035-BE	10UF, 35V, ELEC., RADIAL, 10%	1		
CA-647050-BE	47UF, 50V, ELEC., RADIAL, 10%	1		
CA-722010-BN	220UF, 10V, RADIAL, NON-POLAR	1		
CA-822100-BE	2200UF, 100V, ELEC, RADIAL, 10%	4		
CA-833080-BE	3300UF, 80V, ELEC., RADIAL, 10%	2		
CH-350208-GX	OBS-3500 HEAT XFMR BRACKET FAB	1		
HW-060100-PS	#6-32 X 10 PEM STUD	5		

PNP PCB Assembly continued

QSC Part #	Description	Qty.	Reference	Comments
HW-060200-SP	OBS-9222-A140 AMATOM SPACER	5		
MS-000066-HS	TO-66 HEATSINK AAVID #E5020B	2		
NW-000220-RW	OBS-TO-220 RECT. WASHER	2		
NW-060010-SL	#6 SPLIT TOOTH LOCKWASHER	7		
NW-060400-HN	#6-32 X 1/4" HEX NUT	5		
NW-060410-ST	A-4 SPRING TOOTH LOCKWASHER	2		
PC-380047-JX	OBS-3800 PNP PCB	1		
PL-000025-PL	OBS-9222-PH140 AMATOM SPACER	2		
PL-000026-PL	OBS-TO-220 X 1 TEK-SIL INSLTOR	2		
PL-003109-SP	OBS-NYLON SPACER	2		
PL-903125-SP	SPACER,ROUND,NYLON,0.125"L	2		
PL-905156-SP	SPACER,ROUND,NYLON,#6,0.155"L	1	REF. LD1	
PT-110000-AT	100 OHM TRIMPOT	1		
PT-250000-AT	5K OHM TRIMPOT	1		
QD-000004-TX	MPS-U05 TRANSISTOR, NPN	1		
QD-0003.9-ZT	DIODE,ZENER,3.9V TESTED	1		
QD-000554-TX	OBS-2SB554,TRANSISTOR,PNP,TO-3	10		
QD-0007.5-ZT	DIODE,ZENER, 7.5V TESTED	1		
QD-000810-DX	TO-220 8A/100V DIODE,FAST	2		
QD-001340-LR	LED, RED, T-1 3/4 UTILITY	1		
QD-002762-TU	2A, TO-220, NPN UNTESTED TRANS	2		
QD-004004-DX	1N4004 DIODE	4		
QD-004410-TX	2N4410, TRANSISTOR, NPN, TO-92	2		
QD-004934-DX	1N4934 DIODE	3		
QD-005402-DX	1N5402 DIODE	1		
QD-008599-TX	MPS 8599 TRANSISTOR, PNP	3		
QD-1.5200-BX	1.5A 200 VOLT BRIDGE RECTIFIER	1		
RE-000009-PT	90 C PTC RESISTOR	1	PTC	
RE-000050-NR	NTC THERMISTOR, 50 OHM	1		
RE-001505-DM	OBS-15 OHM, 1W, MET. OX. 5%	2		
RE-.02205-FW	RESISTOR,WIREWOUND,0.22 10% 3W	10		
RE-010005-BC	RESISTOR,CRBN FLM, 100 5% 1/4W	3		
RE-012005-DM	RESISTOR, METAL FLM, 120 5% 1W	1		
RE-015005-BC	RESISTOR,CRBN FLM,150 5% 1/4W	1		
RE-.33005-DM	RESISTOR,METAL FLM,3.3 5% 1W	1		
RE-082005-BC	RESISTOR,CARBON, 820 5% 1/4W	1		
RE-115005-BC	RESISTOR,CARBON,1.5K 5% 1/4W	2		
RE-130005-HW	RESISTOR,WIREWOUND,3K 5% 5W	1		
RE-156005-CC	OBS-5.6K OHM,1/2W, CARBON, 5%	1		
RE-168005-DM	OBS-6.8K OHM, 1W, MET. OX. 5%	1		
RE-210005-BC	RESISTOR,CARBON,47K 5% 1/4W	2		
RE-230005-BC	OBS-30K OHM, 1/4W, CARBON, 5%	1		
RE-247005-BC	RESISTOR,CARBON,47K 5% 1/4W	1		
RE-310005-BC	RESISTOR,CRBN FLM,100K 5% 1/4W	2		
RE-333005-BC	RESISTOR,CRBN FLM,330K 5% 1/4W	2		
SC-060061-PP	#6-32 X 3/8" P/P BLACK	4		
SC-062050-PP	#6 X 5/16" "B" P/P ZINC	20		
SW-000013-RY	RELAY, SPDT, 15A, 24VDC	1		
WC-001102-SQ	INSUL. SLEEVE QSC 1102,.6",CLR	2		
WC-0.6022-JW	.6" JUMPER, 22 GA, SLD	8		
WC-0.9022-JW	.9" JUMPER, WHITE, 22 GA, SLD	1		
WC-2.5018-JW	2.5" JUMPER, WHT, 18 GA, SLD	3		

Gain PCB Assembly

QSC part # WP-160048-PC

QSC Part #	Description	Qty.	Reference	Comments
CA-018100-CM	18PF, 100V, 5%, MICA	1		
CA-047100-BD	47PF,100V,10%,DISK	1		
CA-210100-BP	.001UF,100V,10%,MYLAR	1		
CA-215100-BP	.0015UF,100V,10%,MYLAR	1		
CA-410100-BP	.1UF, 100V, 10%, MYLAR	1		
CA-412100-CP	.12UF, 100V, 5%, MYLAR	1		
CA-547016-BN	4.7UF, 16V, RADIAL, NON-POLAR	1		

Gain PCB Assembly continued

QSC Part #	Description	Qty.	Reference	Comments
CA-647010-BN	47UF, 10V, RADIAL, NON-POLAR	1		
CA-722010-BN	220UF, 10V, RADIAL, NON-POLAR	1		
CA-722025-BE	220UF, 25V, ELEC., RADIAL, 10%	2		
CA-747010-BE	470UF, 16V, ELEC., RADIAL, 20%	1		
CO-000008-IC	8 PIN IC SOCKET	1		
CO-520258-MJ	OBS-6 CONNECTION MODULE JACK	1		
PC-380048-EX	OBS-3800 GAIN PCB	1		
PL-905385-SP	SPACER,ROUND,NYLON,#6,0.385"L	3		
PL-909235-SP	HOLDER,LED,90 DEGREE,NYLON	3		
QD-000134-LR	RED T-1 3/4 LED, XC 4655	2		
QD-000134-LX	RED/GREEN T-1 3/4, XC 5491	1		
QD-004744-ZA	1N4744A 15 VOLT ZENER DIODE	2		
QD-004934-DX	1N4934 DIODE	2		
QD-1.5200-BX	1.5A 200 VOLT BRIDGE RECTIFIER	1		
RE-010005-BC	RESISTOR,CRBN FLM, 100 5% 1/4W	1		
RE-033201-BM	RESISTOR,METAL FLM,332 1% 1/4W	1		
RE-045010-HW	RESISTOR,WIREWOUND,450 10% 5W	1		
RE-.56005-BC	OBS-5.6 OHM, 1/4W,CARBON,5%	1		
RE-110005-BC	RESISTOR,CARBON,1K 5% 1/4W	1		
RE-210001-BM	10.0K OHM, 1/4W, METAL FLM, 1%	4		
RE-221501-CM	RESISTOR,MET FLM,21.5K 1% 1/2W	1		
RE-275001-BM	RESISTOR,MET.FLM,75.0K 1% 1/4W	1		
WC-0.6022-JW	.6" JUMPER, WHITE, 22 GA, SLD	1		

A/C PCB Assembly

QSC part # WP-160400-PC

QSC Part #	Description	Qty.	Reference	Comments
CA-368250-AS	.068UF,250V,SURGE CAP.	2		
CO-000000-ZT	Z-TABS WITH SUPPORTS	17		
PC-160400-CX	OBS-MX 2000 AC PCB	1		
RE-000160-NR	OBS-SG-160 NTC,2.5 OHM, 15A	2		
RE-033010-NW	RESISTOR,WIREWOUND, 330 10% 15W	1		
WC-003033-TQ	OBS-WIRE,AC PCB, 1500	2		
WC-003816-AX	OBS-QSC WIRE 3816	2		

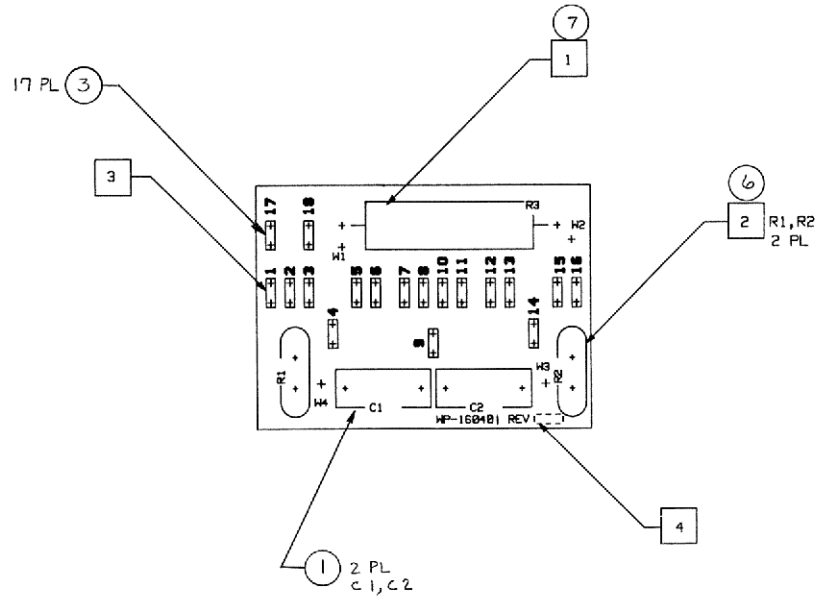
A/C PCB Assembly, Export

QSC part # WP-160401-PC

QSC Part #	Description	Qty.	Reference	Comments
CA-368250-AS	.068UF,250V,SURGE CAP.	2		
CO-000000-ZT	Z-TABS WITH SUPPORTS	17		
PC-160400-CX	OBS-MX 2000 AC PCB	1		
RE-000160-NR	OBS-SG-160 NTC,2.5 OHM, 15A	2		
RE-047010-NW	RESISTOR,WIREWOUND, 470 10% 15W	1		
WC-003033-TQ	OBS-WIRE,AC PCB, 1500	2		
WC-003816-AX	OBS-QSC WIRE 3816	2		

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REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	PROD. RELEASE PER ECO 1253	10-9-91	LSM
	A1	OBSOLETE PER ECO 1786	3-29-93	LSM



- 4. STAMP WITH CURRENT REV LTR APPROX WHERE SHOWN.
- 3. THIS LOCATION IS NOT USED.
- 2. PREP COMPONENT PER RD-004027.
- 1. PREP COMPONENT PER RD-004018.

NOTES: UNLESS OTHERWISE SPECIFIED.

OBSOLETE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:		CONTRACT NO.		QSC AUDIO PRODUCTS COSTA MESA, CALIFORNIA	
FRACTIONS	DECIMALS	ANGLES	APPROVALS		
1/16	.005	1/2	INCH	LEDRA	9-25-91
MATERIAL			CHECKED	SIZE FACT NO.	
SEE SHEET 2			ISSUED	C	
FINISH			SCALE		REV
DO NOT SCALE DRAWING			1:1		A1

ARCHIVE
DO NOT REMOVE

MAR 29 1993

DWG NO. WP-160401-PC
 SHEET 1 OF 2
 REV A1

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REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	PER ECO 606	1-21-89	JA
	A1	OBsolete PER ECO 1786	3-29-93	ASM

ITEM	PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	QTY
1	CA-016100-CH	10PF, 100V, 5%, NICA	CA	1
2	CA-037100-ED	47PF, 100V, 10%, DISK	CS	1
3	CA-210100-PP	.001UF, 100V, 10%, MYLAR	C1	1
4	CA-215100-BP	.0015UF, 100V, 10%, MYLAR	C2	1
5	CA-410100-BP	.1UF, 100V 10%, MYLAR	C6	1
6	CA-412100-CP	.12UF, 100V, 5%, MYLAR	C3	1
7	CA-543016-BN	4.7UF, 16V, RADIAL, NON-POLAR	E1	1
8	CA-647010-BN	47UF, 10V, RADIAL, NON-POLAR	E4	1
9	CA-722010-BN	22UF, 10V, RADIAL, NON-POLAR	E6	1
10	CA-722025-BE	22UF, 25V, ELEC., RADIAL, 10%	E2,3	2
11	CA-747010-BE	47UF, 10V, ELEC., RADIAL, 10%	E5	1
12	CO-050508-TC	8 PIN IC SOCKET	IC1	1
13	CO-520258-NJ	6 CONNECTION HOOD JACK	HOOD JACK	1
14	PC-380048	3800 GAIN PCB	GAIN PCB BOARD	1
15	PL-806365-SP	SPACER, BIVAR 906-385	L01,2,5	3
16	PL-809235-SP	SPACER, BIVAR 909-235	L01,2,5	3
17	QD-060134-LR	RED T-1 3/4 LED, XO 4655	L01,2	2
18	QD-060134-LX	RED/GREEN T-1 3/4, XO 5491	L05	1
19	QD-064744-ZA	1N4744 15V ZENER DIODE	Z1,2	2
20	QD-064934-DX	1N4934 DIODE	D2,3	2
21	QD-1.5200-BX	1.5A 200V BRIDGE RECTIFIER	R1	1
22	RE-56006-EC	5.6 OHM, 1/4 WATT, CARBON, 5%	R7	1
23	RE-010006-EC	100 OHM, 1/4 WATT, CARBON, 5%	R11	1
24	RE-033201-EM	332 OHM, 1/4 WATT, NET. FILM, 1%	R10	1
25	RE-045006-HW	450 OHM, 5 WATT, WIREWIND., 10%	R15	1
26	RE-110006-EC	1K OHM, 1/4 WATT, CARBON, 5%	R5	1
27	RE-210000-DM	10K OHM, 1/4 WATT, NET. FILM, 1%	R1,2,3,4	4
28	RE-221501-DM	22.5K OHM, 1/2 WATT, NET. FILM, 1%	R9	1
29	RE-275001-SH	27K OHM, 1/4 WATT, NET. FILM, 1%	R8	1
30	WC-0.8022-JU	.6" JUMPER, WHITE, 22 GA, SLD	Z3	1
31				
32				
33				
34				
35				

OBsolete

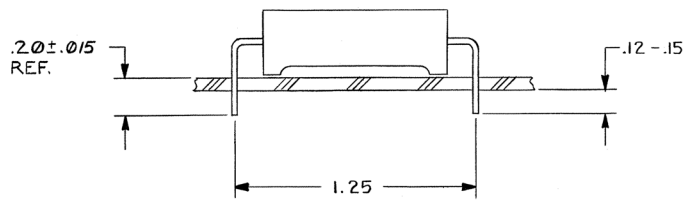
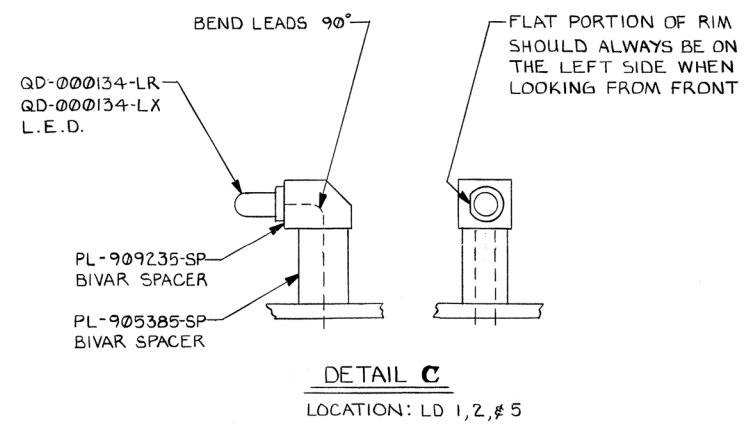
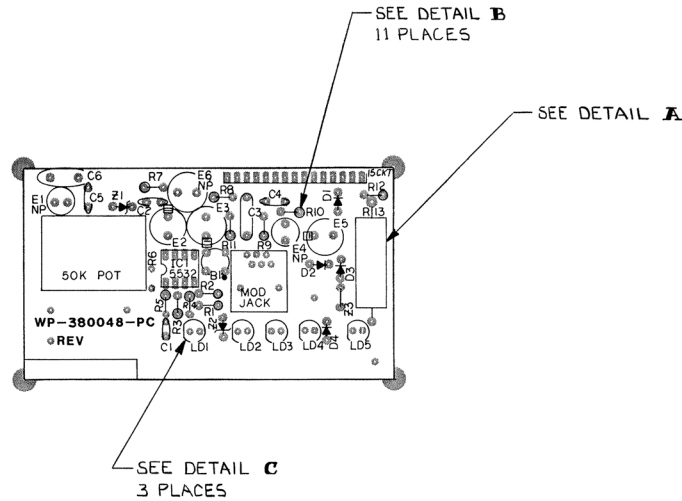
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FRACTIONS	DECIMALS	ANGLES						COSTA MESA, CALIFORNIA	
1/16	.001	1/16		LEORA	11-22-88	MX 2000 GAIN PCB ASSY			
.001						SIZE	FRSH NO.	DRG NO.	REV
						C		WP-160048-PC	A1
DO NOT SCALE DRAWING						SCALE	SHEET 1 OF 2		

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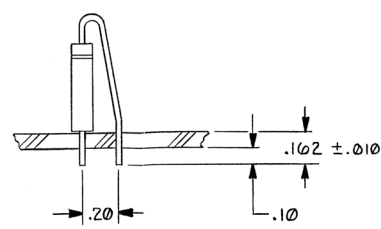
MAR 29 1993

DWG NO. WP-160048-PC 1 A1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



DETAIL A
LOCATION: R13



DETAIL B
LOCATION: Z1, 2
R1, 2, 3, 4, 5, 7, 8, 9,
10 11 # 12

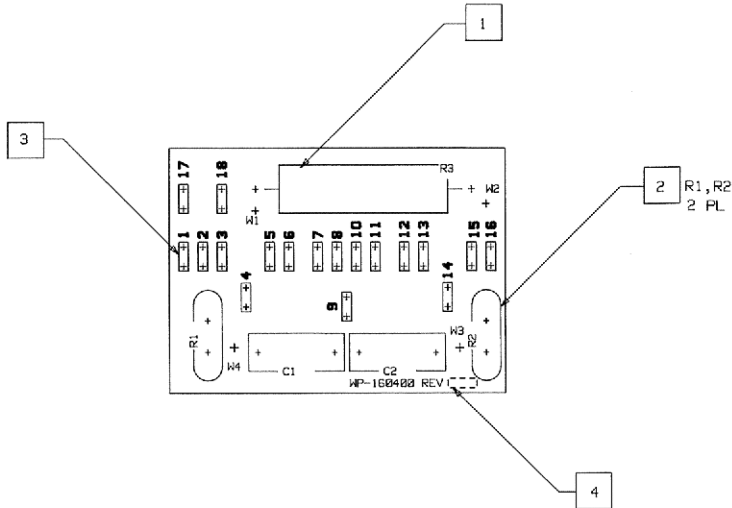
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SIZE: C	FSCH NO.	ENG NO.	REV: A1
SCALE	WP-160048-PC		SHEET 2 OF 2

WP-160048-PC 2 A1

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REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	INITIAL RELEASE ECO 510	9-26-88	BRD
	B	PER ECO 452	5-12-89	<i>[Signature]</i>
	C	PER ECO 685	5-21-90	<i>[Signature]</i>
	C1	OBSOLETE PER ECO 1786	3-29-93	<i>[Signature]</i>



ITEM NO.	QTY	PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR
14				
13	1	RE-033010-NW	330 OHM 15W, 10%	R3
12	2	RE-000160-NR	5G-160 NTC, 2.5 OHM	R1-R2
11				
10				
9				
8	2	WC-003016-AX	QSC WIRE 3016	W3, W4
7	2	WC-003033	WIRE, AC PCB, 1500	W1, W2
6				
5	1	PC-160400	MX 2000 AC PCB	
4				
3	17	CO-000000-ZT	Z-TABS	2-18
2				
1	2	CA-368250-AS	.060UF 250V SURGE CAP	C1, C2

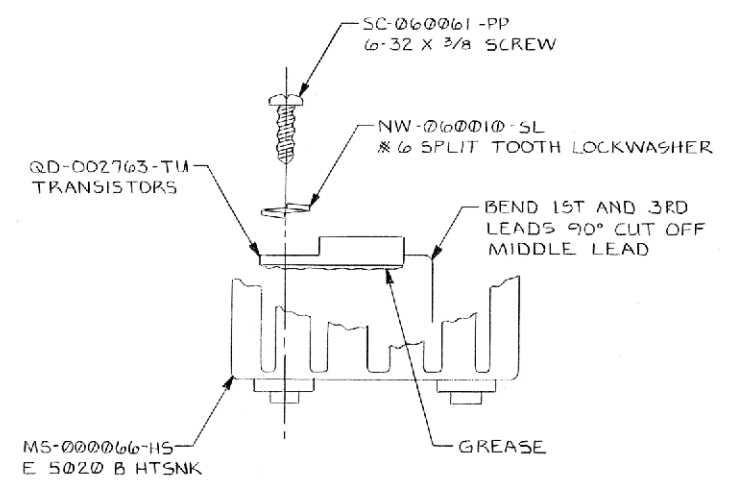
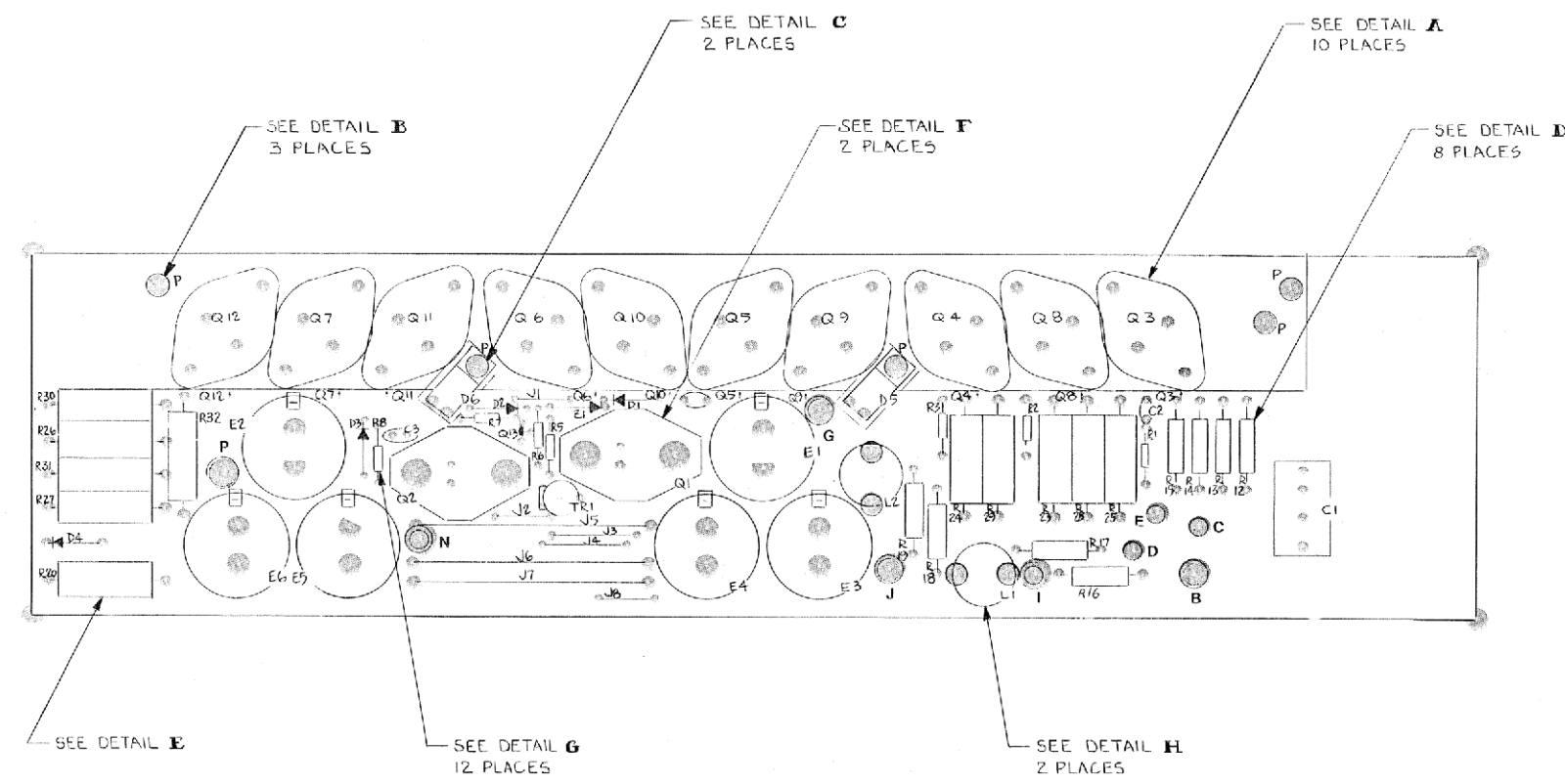
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- 3. THIS LOCATION IS NOT USED.
- 2. PREP COMPONENT PER RD-004027.
- 1. PREP COMPONENT PER RD-004018.

NOTES: UNLESS OTHERWISE SPECIFIED.

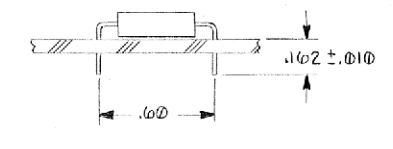
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±	.00 ±	±	DATE	
	.000 ±		GRANT FRENCH 2-2-88	
MATERIAL			CHECKED	5-29-90
FINISH			ISSUED	
DO NOT SCALE DRAWING			SIZE	FIG. NO.
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			SCALE	1:1
				PC1:160400AD

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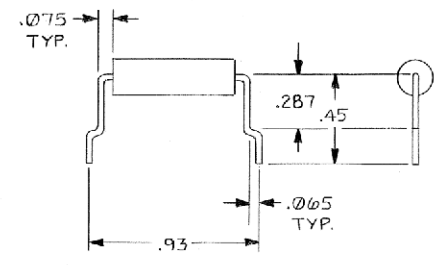
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REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



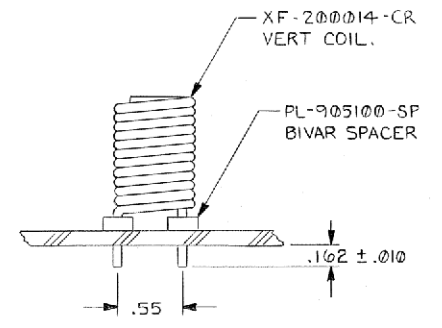
DETAIL F
LOCATION: D5,6 & Q1,2



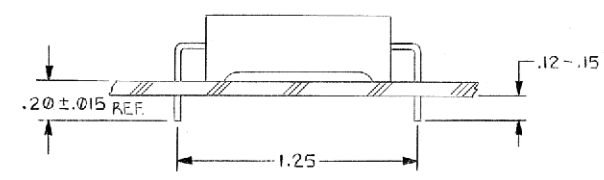
DETAIL G
LOCATION: D1,2,3,4, R1,2,3,5,6,7,8, Z1



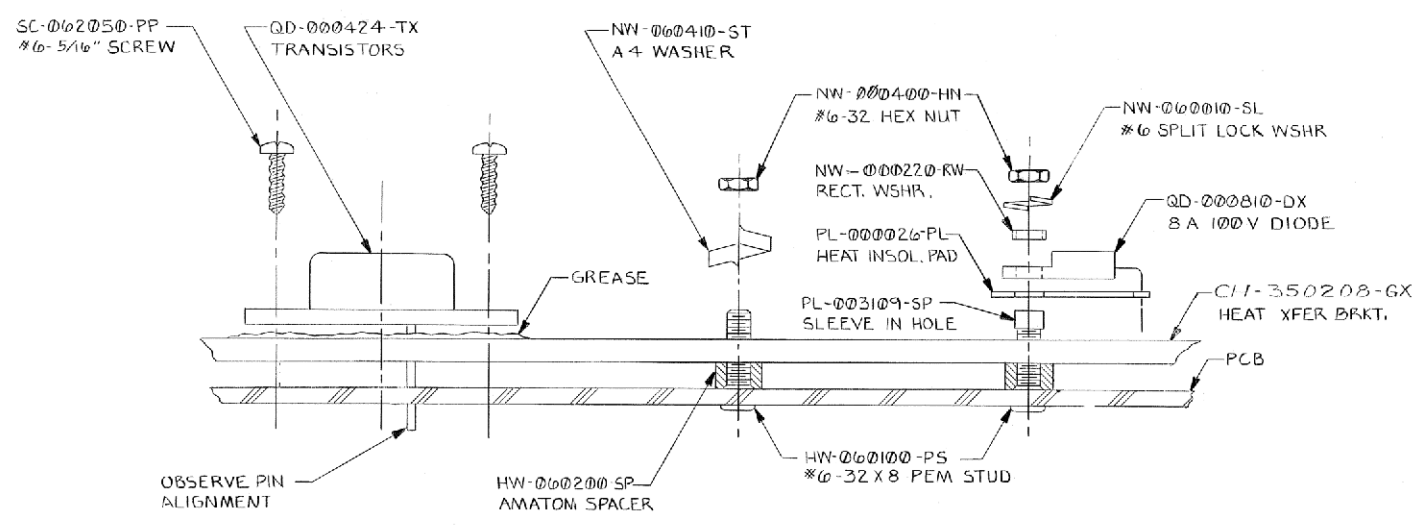
DETAIL D
LOCATION: R 12, 13, 14, 15, 16, 17, 18, & 19



DETAIL H
LOCATION: L 1,2



DETAIL E
LOCATION: R 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, & 32



DETAIL A
LOCATION: Q 3,4,5, 6, 7, 8, 9, 10, 11, & 12

DETAIL B
LOCATION: P

DETAIL C
LOCATION: P, D5,6

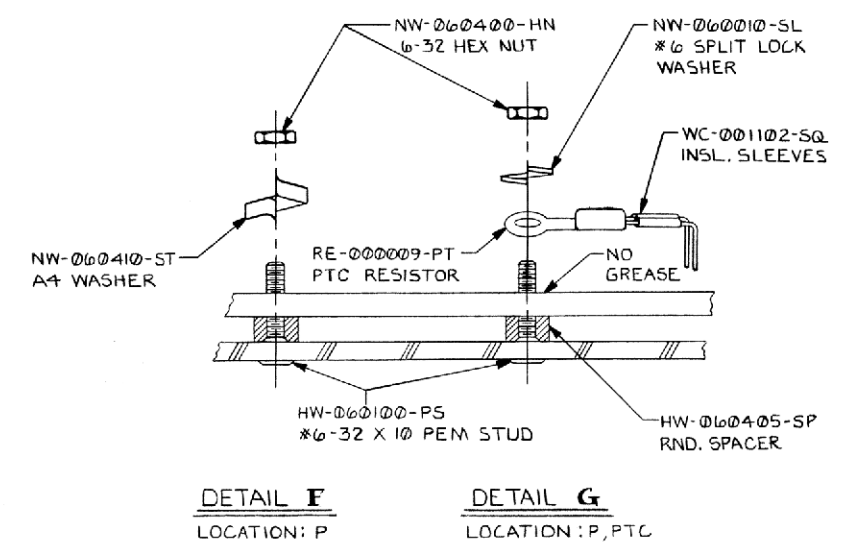
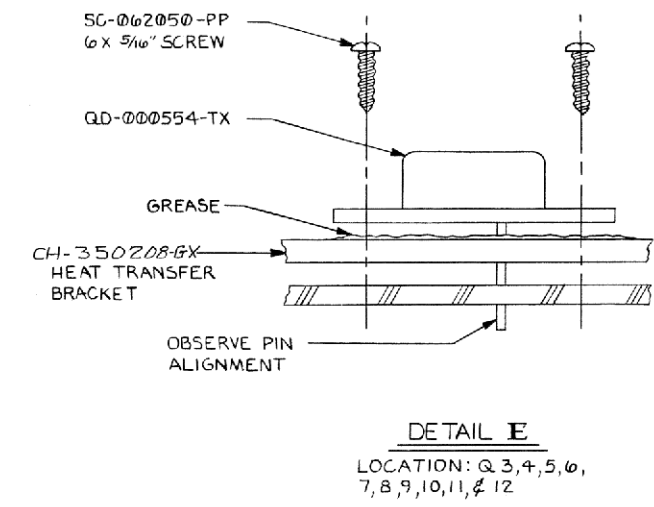
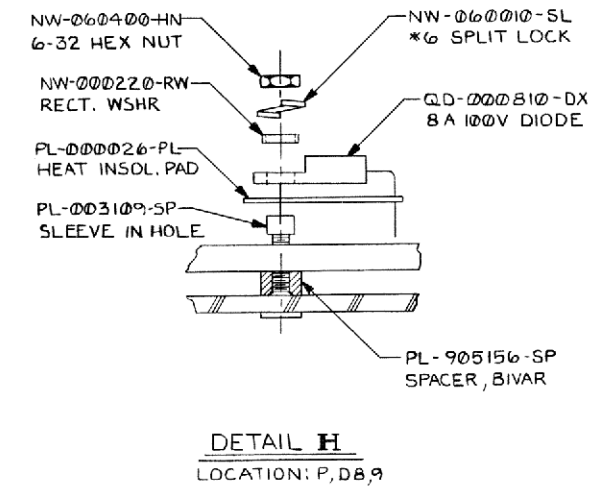
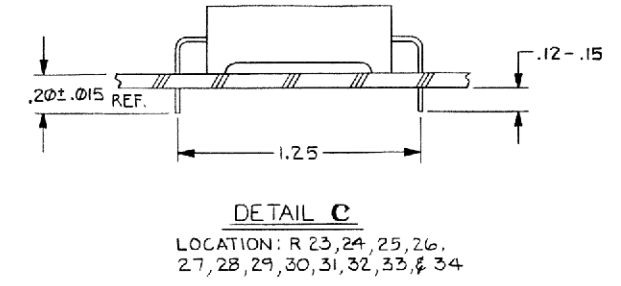
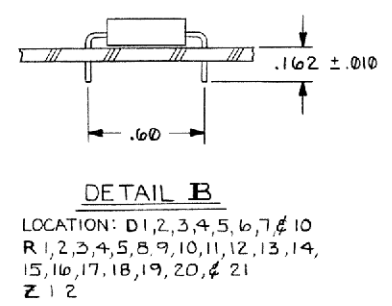
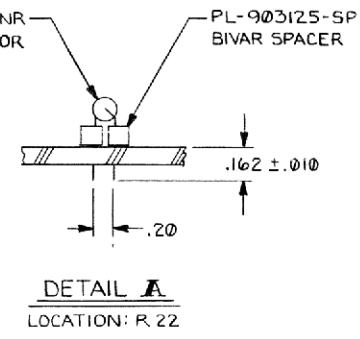
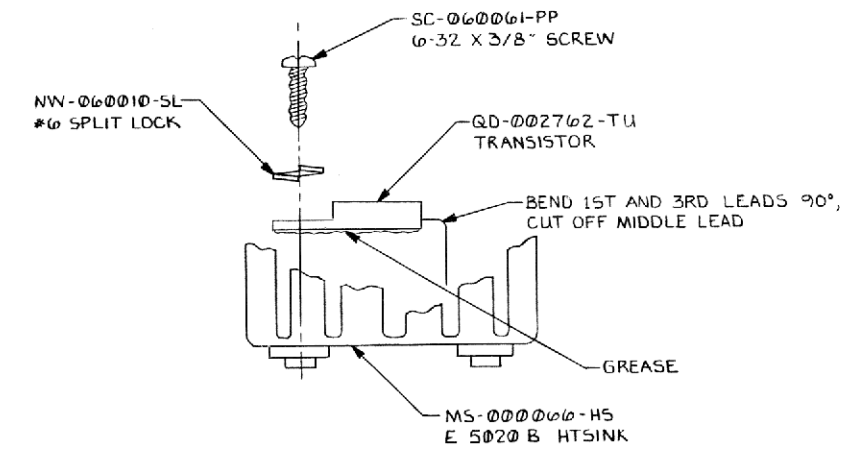
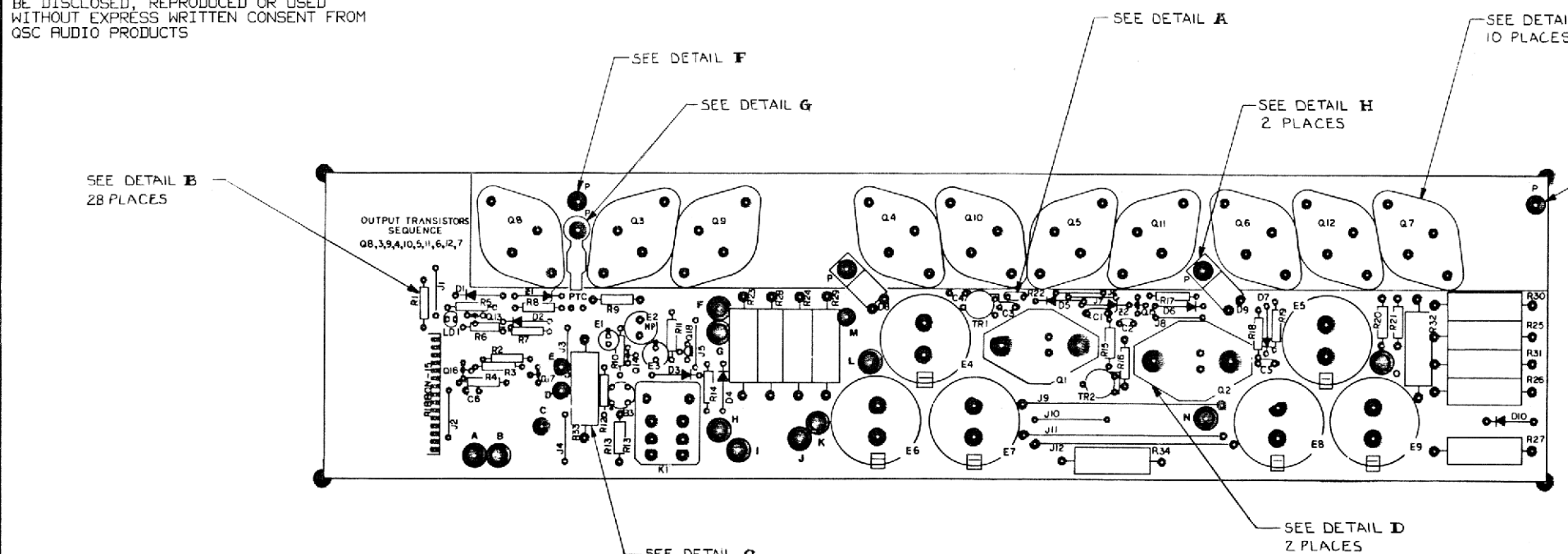
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REV H1	DWG NO. WP-160046-PC	REV H1
SHEET 2 OF 4		

NPN PCB ASSY. SHEET 2 OF 4

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REV NO.		REV		DATE		APPROVED	
ZONE	REV	DESCRIPTION		DATE			
	A	PER ECO 606		1-27-89		G.F.	
	K	PER ECO 1353 WR		2-11-92		AGM	
	L	PER ECO 1270B	WR	2-11-92		AGM	
	M	PER ECO 1441		3-23-92		AGM	
	M1	OBsolete PER ECO 1786		3-29-93		AGM	



PARTS LIST		OBSOLETE	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:		CONTRACT NO.	
FRACTIONS	DECIMALS	APPROVALS	
±	.XX ±	DATE	
±	.XXX ±	DESIGN	LEORA
MATERIAL		CHECKED	
SEE SHEETS 2 & 3		ISSUED	
FINISH		SIZE	F50H NO.
DO NOT SCALE DRAWING		SCALE	NONE
		DATE	11-18-88
		REV	M1
		SHEET	1 OF 3

QSC AUDIO PRODUCTS
COSTA MESA, CALIFORNIA

MX 2000 PNP PCB ASSY

WP-160047-PC

MX 2000 PNP PCB ASSY SHEET 1 OF 3

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