TECHRON®

TECHNICAL MANUAL

Includes Service Information

8604
GRADIENT AMPLIFIER

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8	STANDBY-P
9	OVRLD RESET-P
10	SPARE
11	SPARE
12	SPARE
13	OPEN
14	CURRENT MONITOR-N
15	FAILURE-N
16	READY-N
17	OVRLD-N
18	OVERTEMP-N
19	NEG.TEMPERATURE SIMULATOR-N
20	POS.TEMPERATURE SIMULATOR-N
21	STANDBY-N
22	OVRLD RESET-N
23	SPARE
24	SPARE
25	SPARE

A.3. J3, INTERLOCK

PIN	FUNCTION
1	+1 SLAVE IN
2	NOT USED
3	NOT USED
4	AMPLIFIER OUTPUT
5	NOT USED
6	INTERLOCK IN
7	INTERLOCK OUT
8	OPEN
9	GROUND
10	-1 SLAVE IN
11	GROUND
12	NOT USED
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A.4. J101, ANALOG INPUT

PIN	FUNCTION
FEMALE	NON-INVERTING
MALE	INVERTING
SHELL	GROUND

A.5. J102, CURRENT MONITOR

PIN	FUNCTION
CENTER	CURRENT MONITOR (20 AMPS/VOLT)
SHELL	GROUND

1. SAFETY

1.1. INTRODUCTION

Model 8604 operates with 208 VAC 3 phase power.

WARNING

THE UNIT MAY CARRY LETHAL VOLTAGES WHETHER OR NOT MAIN POWER SOURCE IS CONNECTED. DO NOT ATTEMPT TO SERVICE THIS UNIT IN ANY MANNER UNLESS YOU HAVE READ AND UNDERSTAND THIS MANUAL. WITHOUT STRICT ADHERENCE TO SAFETY PROCEDURES, ATTEMPTS TO REPAIR OR SERVICE MODEL 8604 AMPLIFIER COULD RESULT IN FATAL ELECTRICAL SHOCKS.

In addition to physical hazards to servicing personnel, certain electrical conditions could be damaging to components parts.

CAUTION

The main circuit board should only be handled in a static-free environment. Accidental charges of static electricity could damage sensitive electronic components.

1.2. DISCONNECTING POWER SUPPLY

Before attempting any servicing of Model 8604, shut down outside power supply by disconnecting plug from rear of unit.

Rear Circuit Breaker CB1 (Item 59 on Illustration 6-1) may be used to temporarily shut down power unit. However, disconnecting the plug provides extra measure of safety to the servicing technician.

1.3. DISCHARGING CAPACITORS

Illustration 1-1 shows power supply components as viewed from bottom of unit with bottom panel removed.

WARNING

AFTER POWER SOURCE HAS BEEN DISCONNECTED, CAPACITORS RETAIN A LETHAL ELECTRIC CHARGE. BEFORE PERFORMING ANY SERVICE WORK, ALLOW CAPACITORS TO DISCHARGE AND VERIFY THE DISCHARGE STATE.

Model 8604 includes a bleeder resistor that is designed to discharge capacitors within one minute after power shut off (see illustration 1-2). Do not perform any work inside the 8604 until one minute has passed.

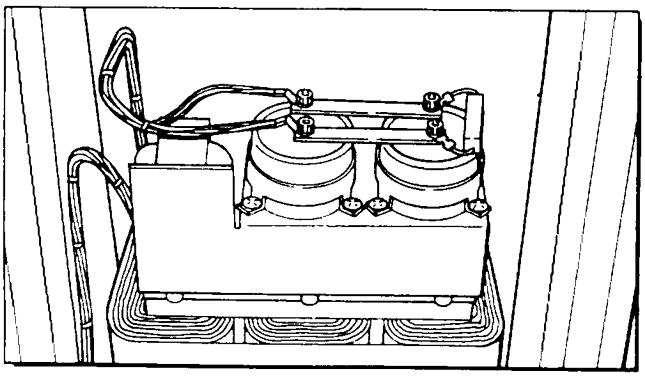

Illustration 1-1 Power Supply Components

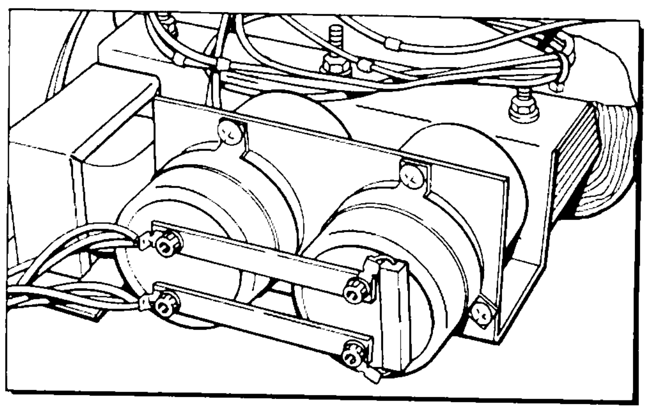

Illustration 1-2 Capacitor Terminals

Capacitor terminals are directly connected to terminals of 35A Bridge (Item 38 on Illustration 6-1). Illustration 1-3 shows detail of bridge terminals and identifies direct (+) and (-) connections to capacitors. (Right side fan removed).

1. After shutting off power, wait one minute.
2. Remove fan cover (Item 46 on Illustration 6-1) to expose bridge rectifiers.
3. Verify capacitor discharge by connecting across "+" and "-" (top and bottom) terminals of the bridge rectifiers. Rectifier positions are shown in illustration 1-3.
4. Voltmeter should give reading of less than 50 volts.

1.4. FLOATING GROUND

Internal electrical components of Model 8604 Amplifier are not grounded to chassis.

WARNING

GROUNDING CANNOT BE PREDICTED BY VISUAL INSPECTION. UNTIL CAPACITORS ARE ALLOWED TO DISCHARGE, HIGH VOLTAGES MUST BE ASSUMED PRESENT AT BOTH CAPACITORS, IN CAPACITOR WIRING AND AT ALL POINTS CONNECTED WITH CAPACITORS.

Because of this floating ground feature, all test equipment used in servicing Model 8604 should not be earth ground. There is a possibility of spurious readings occurring from the use of grounded test equipment.

1.5. HANDLING MAIN CIRCUIT BOARD

CAUTION

Main circuit board can be damaged by accidental static electricity.

When the main circuit board is in place and connected, the assembly is protected. However, this protection is not available when the four ribbon cables have been disconnected from the circuit board. The main circuit board should only be worked on in a static-free environment.

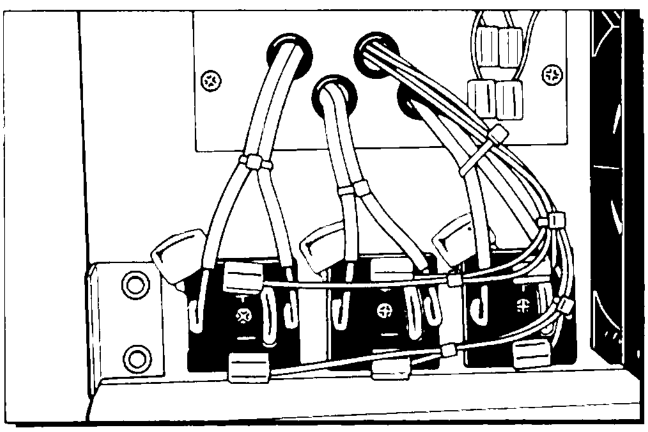

Illustration 1-3 Capacitor Test Points

2. THEORY OF OPERATION

2.1. CONCEPTS

The fundamental objective of a power amplifier is to transfer energy from an available supply to a load in a prescribed/controlled manner. Voltages in excess of ± 160 peak volts and ±180 amperes are available. The test signals require DC coupled response to the load with low noise at all frequencies. The load current may be the programmed output variable and not the voltage. This controlled current mode is useful in areas where the field produced by a coil needs to be proportional to coil current and not voltage.

2.1.1. Output Stage Topology

Illustrations 2-1 and 2-2 are block diagrams of the topologies commonly used for direct-coupled amplifiers. The totem-pole is the most common and makes available a peak voltage to the load of 1/2 of the total supply voltage (Vcc) while exposing the output stage devices to stress from the total supply voltage (2 Vcc). Only one half of the supply is used at a time, reducing the supply operating efficiency as well. The full bridge output stage as shown makes full use of the available supply voltage as the peak output to the load is 2 Vcc.

The peak-to-peak output voltage of the full bridge is actually twice the available supply voltage (4 Vcc). The maximum voltage stress to the output stage devices is the same as in the totem-pole topology (2 Vcc). The supply utilization is now total.

2.1.2. Output Stage

Operation of the full bridge to produce a positive output current requires that the output stages one and three be increased in conductance in synchrony and output stages two and four be decreased in synchrony, decreasing as one and three are increasing.

In class AB operation, the conductance of two and four would diminish to zero and stages one and three would increase to the level required to carry the desired positive peak output current. For a negative output current the roles of the pairs one and three and two and four are interchanged with two and four ultimately carrying the negative peak output current.

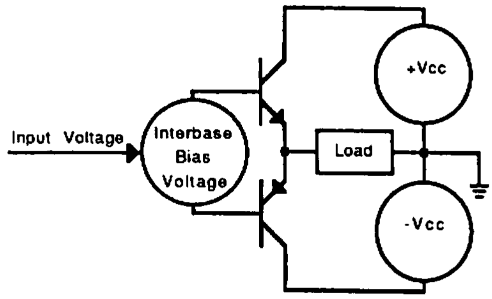

Illustration 2-1 Totem-Pole Topology

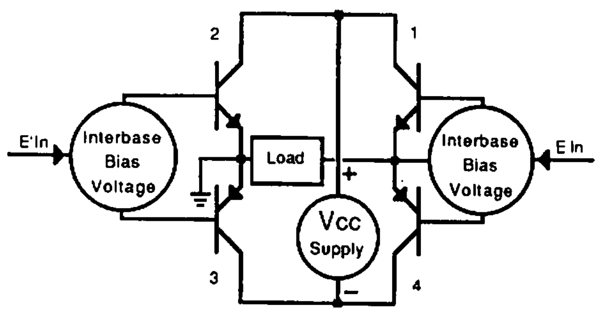

Illustration 2-2 Full Bridge Topology

2.1.3. Output Stage Terminology

The names one, two, three and four are not the names that are preferred for describing the output stages. Since the output stages are constructed with bipolar transistor devices, the preferred and more descriptive terminology is to name an output stage in terms of whether the stage acts as a giant NPN or PNP stage and whether it is on the high (output) side of the load or low (ground) side of the load. Thus stage one is generally referred to as the high side NPN stage and stage three is referred to as the low side PNP stage.

2.1.4. Transistor Topologies

There are four basic composite transistor topologies (Illustration 2-3) which may be used in any configuration which can be derived by recursive application of the forms. Other three terminal devices such as FETs could be substituted for the bipolar transistors without loss of generality. In the application of the 8604 all of the devices of the output stages are bipolar.

The principle output devices are NPNs paralleled 20 times. They are driven in two groups of ten from a pair of NPN driver transistors (Darlington form). NPN stages use an NPN predriver (Darlington form) driving the drivers. PNP stages use a PNP predriver (Complementary form) driving the drivers.

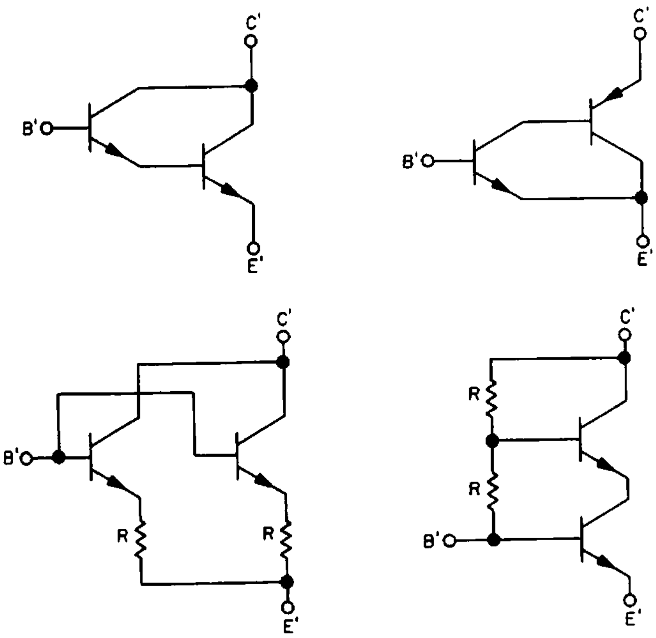

Illustration 2-3 Composite Transistor Topologies

2.1.5. Bridge Stages

The 8604 is built around a voltage amplifier which first drives the high side of the bridge. The low side of the bridge is in turn driven from the high side such that one half of the voltage of the output signal is imposed on the supply rails. This condition constitutes the proper synchrony of the stages of the bridge. Note that the amplifier dissipation is distributed evenly over 40 output devices for a single polarity of output current. Negative feedback is used liberally to acquire the control of the bridge balance and insure the required overall linearity. Wide gain-bandwidth IC op-amps are therefore used.

2.1.6. Protection Circuitry

As with all things there is a breaking point and amplifiers are no exception. Protection circuitry is used to prevent electrical stimulus from being able to reach the breaking point. When continuing a high level of output current would cause the output semiconductors to overheat, the current must be reduced to limit the junction temperature. A fundamental problem of protecting output semiconductors is that they do not have an output terminal which indicates the junction temperature. The critical parameter is sealed inside opaque metal cases.

This has led to the use of simulation methods to predict the junction temperature. An electronic analog of the heating process is created which can be monitored for excessive equivalent temperature. An electronic multiplier is used to compute instantaneous power by computing the product of the semiconductor voltage and current. Its output is applied to an electrical impedance which is designed to have the same time characteristics as the junction. After the ambient temperature is added to the output, the result is an electrical analog proportional to the absolute temperature in degrees Kelvin of the output semiconductor junctions. This temperature information is then compared to the maximum allowed junction temperature of 200 degrees Centigrade and the current drive to the output devices is reduced to prevent the temperature from becoming excessive.

Electronic power supply interlocking is used to allow multiple amplifiers to power a common load. Should any one unit of a system not be able to operate, it is imperative that none of the units be active. The amplifiers must enter the ready state in unison. A disabled amplifier could be damaged by large output signals from its companion units.

The heatsink materials are protected from excessive temperatures (over 150° Centigrade) by thermal limit switches. Exceeding of the instantaneous current limits of the output devices is prevented by electronic current limiters.

The power transformer is protected against overtemperature conditions by internal limit switches which are coupled to the interlock and power control circuitry. Fault conditions in the power supply are protected with circuit breakers. A fault in the output stages is electronically detected and the main supplies are disabled until the control circuitry is down-powered and repowered.

2.2. OUTPUT STAGES

Each output stage or quadrant is built on a separate electrically isolated forced-air heatsink. Twenty NPN bipolar output transistors are directly mounted to each sink. By allowing each heat sink to be electrically isolated from the chassis and the other output stages, the devices were able to be connected without insulating mounting hardware directly to the heatsink. Lower junction temperature for the output transistors is provided by this mode of operation.

Each heatsink is a high-efficiency forced-air heat exchanger with convoluted aluminum fin-stock bonded to the outside of the two vertical risers of a thick "H"-shaped aluminum extrusion. The center cross-member of the "H" is used to mount the output semiconductors on its underside.

The twenty output devices are driven by two NPN bipolar devices, each driving ten of the outputs. The output devices are divided with ten to one side of the heatsink and ten to the other side. The driving transistors are located on the opposing sides of the heatsink. This cross-coupled orientation is used to provide thermal degeneracy on a side-to-side basis.

Wiring of the emitter and base circuits of the output devices and drivers is provided by two printed circuit boards which are placed at the bottom of the upper channel of the "H". The output device emitter wiring circuit board is below the output device base wiring circuit board. The circuit board material is a high-temperature G-30 material to allow operation to a temperature limit of 150^{o} Centigrade.

The entire output sink may be disconnected and removed from the amplifier by removing six fasteners and the connecting small signal wiring which passes over the top of the heatsinks. Two of the fasteners at the middle of the heatsink are used to connect the high-current signals to the sink. The remaining four fasteners at the ends of the sinks are provided for mechanical support.

2.2.1. NPN Stage

Referring to the schematic of the output stages, it may be seen that the high side NPN output devices are labeled Q600-609 and Q612-621. Emitter current is used to provide the needed degeneracy for paralleling by using the resistors R601-610 and R615-624. Base current is removed from the output devices by the resistors R611, R625 and R614,R626. Each of these resistors is formed by the use of two resistors, one on each end of the heatsink. A high-frequency load is provided for this stage by using a series RC formed by R600-627 and C600. All of the other output stages are formed similarly as regards these elements.

2.2.2. Output Drivers

The drivers are Q610 and Q611 respectively. Half of the output transistors on each end of the heatsink are driven by one of these two devices. Base emitter resistors, R612 and R613 are used to set the quiescent current point of the predriver devices and remove current from the bases of the drivers. This structure is common to all four of the output stages.

2.2.3. Predriver

Both drivers are driven by Q650 through a compensation network composed of L650, C650, and R650 all of which are mounted on the predriver circuit board suspended above the heatsink. Driver base current removal can be expedited by Q651 in the case of rapidly switching currents. This device will not see much action in normal use. A system would need become unstable for this device to come into use. This topology is shared by the low side NPN stage but is different than the PNP stages.

2.2.4. Output Stage Bias

The quiescent bias current of the high side of the bridge is controlled by Q652 which is connected as a VBE multiplier. Q652 is thermally joined to the heatsink and compensates for the base-emitter voltage temperature coefficient of the drivers and output devices. The base-emitter coefficient of the predriver is compensated by D650. R651 in series with R652 is used to adjust the bias. With no load current and 25^{o} Centigrade heatsinks, the bias may be adjusted by setting the voltage across either R611 or R614 to 0.400VDC. R654 is used to reduce any sensitivity of the quiescent bias point to the current flowing through the bias circuitry from the last voltage amplifiers of the gain stages. C652 prevents instability in the bias servo. The NPN low side output stage has the same construction and biasing procedures.

C654 and R655 join to the input of the high side PNP output stage. The result is reduced inductance in the input lead of each stage which improves stability in the predriver stages. C653 and C651 compensate the entire output stage and provide a capacitive load to the current limited last voltage amplifiers to form a slew rate limit mechanism.

2.2.5. Fault Detection

D600 and D601 sample the stage and drive the fault detector of the high side of the bridge. Should an output device fail with a collector to emitter short, the base of the output devices will be powered by the breakdown of the base emitter junction of the failed device.

2.2.6. PNP Stages

The PNP output stages are similar to each other in structure. The high side PNP stage has an identical output configuration to the NPN stage. Collector current is sampled by resistors R701-710 and R724-733. The predrivers are the major difference between NPN and PNP stages. Q750 is the predriver to the drivers, Q710 and Q711 of the high side PNP stage.

Compensation is provided by the emitter network composed of R750, L750, and C750. C701, C751 and C752 are also used for stage compensation. D750 is used to temperature compensate the base-emitter junction voltage coefficient of Q750.

Additional high frequency compensation is incorporated in the low side of bridge output stages by using RL networks in the emitter leads of the drivers. The inductors are constructed with ferrite beads. Using the low side NPN stages as an example, R857 and R858 are in parallel with the beads.

2.2.7. Protection Temperature Sensors

IC temperature sensors U800 and U900 are used on the low side of the bridge stages to provide information to the protection circuitry. The output of each of these sensors is a current proportional to the absolute temperature. The signals +TEMP and -TEMP are scaled as 10 millivolts per degree Kelvin. Since the bridge is balanced in actual operation the temperature of the NPN high side of the bridge should be essentially the same as the low side PNP output stage.

Overtemperature in the output heatsinks is prevented by bi-metal switches (TS1 and TS2) mounted on the high side of bridge heatsinks.

2.2.8. Output Terminator

The output stages drive the load through an output terminator network composed of L90, C90, R91, C91, R92 and C92. This network is used to provide isolation from the load and a consistent high frequency load for the amplifier in R90-92.

R90 is a resistor with a positive temperature coefficient. Rapidly rising output current will cause R90 to increase in resistance. This forces more current through L90, protecting R90 from burn out.

2.2.9. Flyback Diode

Flyback pulses from inductive loads are prevented from reverse biasing the output stages by D607, a high current bridge rectifier mounted beneath the output pan and next to the buss bar assembly. The buss bar assembly is used to provide a very low inductance high current interconnect system to the output stages.

2.2.10. Current Sampling

Output current may be sampled by attaching the load to the terminal labeled, sensed common. R761-763 are used to produce a voltage for the current control circuitry of the input stages. Using the output terminal labeled common, bypasses the current sampling.

2.3. GAIN STAGES

The full bridge output stage is controlled by first driving the high side of the bridge. The low side of the bridge is driven such that half of the output voltage is impressed on the Vcc supplies. The gain stages control the drive and balance of the bridge.

2.3.1. Last Voltage Amplifier

Drive to the high side of the bridge comes from the last voltage amplifier. Q207 and Q208 form this amplifier. The last voltage amplifier is current limited by Q206 and Q209. This provides a slew limit in that the load to the stage is dominated by capacitance in the output stage. Q207 and Q208 are emitter degenerated by R225 and R228.

Current limiting of the output stages is provided by diodes (D200-211) which limit the output drive of the last voltage amplifiers.

R244 and C223 along with R245 and C224 by joining the output signals and supplies respectively reduce the inductance of these lines by paralleling.

C210 and C212 provide high frequency feedback from the output to the input of the last voltage amplifiers. Input signals to the amplifiers are currents input to their bases and R224 and R227.

Currents to the input of the last voltage amplifiers are provided by the grounded base stages of Q203 and Q204. Voltage dividers R249 and R246 and R247 and R248 provide operating states for Q203 and Q204 which prevent the forward biasing of the base collector junctions even when the output flyback diodes are forward biased and the Vcc supplies swing slightly beyond ground.

Complimentary differential amplifiers drive Q204 and Q203. Q205 and Q202 amplify the difference between the feedback signal from the output and the input signal from U202. The feedback signal is attenuated by R226, C211, R216, R213, R215, R223, and R218. The input signal is coupled through R242, R214, C205, R219, R217 and C220. The operating state of Q202 and Q205 is such that collector operating voltage is insured no matter what signal conditions prevail. Emitter degeneracy with partial pole removal is provided by R211-212 and R220-221 and C221 and C208.

Current sources which bias Q202 and Q205 make it possible to interrupt the drive to the amplifier. The protection circuitry controls these bias currents. Q205 is biased by U200, a monolythic current mirror. Biasing Q202 is Q200 and Q201 which form a mirror and function well due to emitter degeneracy using R209 and R210 in the absence of being monolythic. Controlled currents are provided by signals +LH and -LH from the protection circuits. R222 causes the input characteristic of U200 to be identical to the input characteristic of the mirror of Q200 and Q201.

2.3.2. Error Amplifier

Amplifier U202 is a high performance FET input op-amp. Local degeneracy is provided by C202. The main feedback loop around the power amplifier forms a non-inverting gain of 20 using R208, R251, C204 and R207. The -1 input used with slave operation is provided by R203, R250 and C226. U202's offset voltage is compensated by R204 through R205.

The voltage offset may be adjusted by placing S1 in the slave mode with no inputs connected to the +1 and -1 inputs and adjusting R204 for zero volts DC at the amplifier main output.

R202 and C200 function as a filter for RF input suppression. R200, R201, R253 and C225 form a non-inverting input of +1 gain for use with the slave mode of operation. R253 and C225 are used to provide phase compensation for the input to output transfer function. Likewise R250 and C226 compensate the -1 input phase response. S1 is used to switch between the master and slave modes of operation. In the master mode, the signal input to the power amplifier is derived from line X4 via S1-A. The -1 input is then grounded by S1-B.

2.3.3. Bridge Balance Amp

The bridge is balanced by U203 which drives the two low side of bridge output stages through R243 and C222. This network provides some phase lead to improve the stability margin of the bridge balance loop. Current to drive the NPN low side output stage is provided by a current mirror composed of Q210, Q211, R229 and R230. This current source may be disabled by the protection circuitry removing current from line +LL. In a similar manner, the current drive to the PNP low side output stage is provided by U201, a monolythic current mirror. U201 is driven from the protection circuit control line -LL. R231 is used to degenerate the input characteristics to mimic the NPN side mirror.

U203 drives the low side output stages such that the feedback signal through R232, C214 and R233 produces the same current that is produced by the input signal through R240 from the high side output. A DC current is flowing in R232 and R233 which is incidental to the process of monitoring the Vcc supplies. Offset errors caused by mismatch of R232 and R233 are compensated with the static balance control, R234 and R235. Signal balancing of the bridge is accomplished by using the dynamic balance control of R236 and R237 which shunt the feedback divider resistors, R238 and R239.

The static balance is adjusted by setting +Vcc equal in magnitude to -Vcc. Adjustment of the dynamic balance is accomplished by loading the amplifier for full current when driven by clip level low frequency signals. U203 should saturate just before U202.

Local degeneracy of U203 is provided by R241. R252 is used to reduce the interaction of the dynamic balance control and the amount of output current being drawn from the amplifier. The voltage on the output of U203 is determined by the degeneracy of the output stage and the current sampling resistors in the output assembly, R761-763.

Capacitors C201, C216, C217 and C218 bypass the 15 volt supplies to the op-amps. High frequency types such as used for U202 and U203 require local bypassing for stability.

2.4. INPUT (SIGNAL PROCESSING & CURRENT CONTROL)

The principal input to the gradient amplifier is through the digital inputs. These inputs are all optically isolated and designed to terminate a balanced line of EIA 422 type. Sixteen bits of parallel input are strobed by a strobe line. The input is of 2's complement form and is applied to a DAC with two external 8 bit latches.

Data to the DAC, U120, is inverted by the opto receivers U100-115. The MSB is further inverted for 2's complement representation. The inversion of the data is done to result in the latch status indicators being logic true, i.e. when a one is on the data line, the indicator will be lit. E102-E119 (Red) are used to indicate the data line status. E101 and E100 (Green) indicate DAC input status.

Output from the DAC is on pin 6. The output of U120 is also inverted which is corrected by a current to voltage conversion in U122. With a positive digital word the output of U122 is negative.

U121 is a precision 10 volt reference with its output on pin 6. The amplifier current per LSB is controlled by adjusting P101. The DAC offset is adjustable using P100.

The data strobe also triggers monostable U124 which in turn gates the DAC output at U127. R101 is selected to produce a switch opening at U127 from 1 to 64µS long when the input is low. U127-A gates the input to U128. C128 and C129 hold the input to U128-A at the last DAC output level during DAC transitions. U127-B is balanced for charge transfer by C102 to produce a minimum disturbance to the signal.

2.4.1. Power Up Reset

U132-A, R104, D106 and C142 form a power up reset stage. When the + input to U132-A goes negative to ground, the output of U132-A will go to -15 volts pulling the cathode of D103 to a TTL low. D104 prevents the RESET bar signal from going negative.

The remainder of U132, sections B and C, will force the DAC to a power up condition when the output of the protection circuitry is in current limit. All three sections of U132 are wired "or" so that any section will force the DAC to -1 LSB.

2.4.2. Analog Input

B7 allows the source of the signal input to the current control amplifier to be selected as the digital input (DAC output) or the analog input. The analog input is a differential input using U126 which receives its input signal from the front panel or rear panel J2 jacks. The J2 female pin is the non-inverting input. J2-23 on the rear panel is the non-inverting input and J2-10 is the inverting input.

2.4.3. Shim Input

S2 selects the front or rear analog input. The back panel input is active when S2 is in the rightmost position. The analog input may be used as a shim input by leaving SW2 in the rear input position and jumpering B9.

The common mode rejection of the analog input is tuned for optimum rejection at low frequencies by adjusting the trimmer of resistance network N100. The high frequency common mode is adjusted by tuning C123 which is tuned to set C122 + C123 equal to C140.

2.4.4. Controlled Current Mode

2.4.4.1. Current Control Amplifier

The controlled current mode works by U128-B comparing the current output of the amplifier with the desired current at the output of U128-A. The current control amplifier, U128- B, is offset zeroed by P102 via R105. R106 and C130 provide the proper impedance to U128-B for minimum offset drift.

2.4.4.2. Current Sense Amplifier

The current of the amplifier is sensed by R761-763 and amplified by U130 for use in the current control loop. U130 acts as a differential amplifier with an adjustable gain control in the resistor network N102. Resistors R118 and R119 along with C137 and C138 compensate the sense resistors for their series inductance. The output of U130 is calibrated for 20 amperes per volt of output. The zero offset of U130 is eliminated by adjustment of P107 via R117.

2.4.5. Input

D100, D101, D102, Q100 and Q101 form a bridge with Q100 and Q101 performing as high quality diodes. This bridge clamps the output of U128-B if the output of U128-B exceeds 10.3 volts. The output level of the controlled current stage is adjusted by the value of R113, R114 and the setting of P106. This allows the amplifier to be operated with controlled output voltage limits that are not subject to minor line voltage fluctuations if so desired. By placing a jumper at B8 the voltage clipper is disabled.

2.4.6. Current Monitor Output

The current monitor output is made available on the front panel at J102 with R120 and a BNC connector. A differential output is made available to the rear panel J2 connector through J200 by using a unity gain inverter, U131. The gain of unity is set by R123 and R124. The output is isolated from capacitive loads by R121 and R122. R125 and C139 provide the proper source impedance for minimum offset errors of U131.

2.4.7. Current Loop Compensation

The B6 selectable network of R116 and C136 or R115 and C135 comprise the principle compensation networks which serve to control the open loop gain of the closed loop controlled current system.

In the controlled voltage mode of operation these compensation parts are not used.

2.4.8. Amplifier Enable

The opto receiver for enabling the amplifier, U117, may be bypassed for servicing. The amplifier will be enabled by using the jumper B4 in the manual position. An enable bar signal would otherwise be required of the interface to operate the amplifier. R100 acts to disable the unit if no jumper is present at B4. The amplifier is disabled by causing the protection circuit to gate off the current sources used to drive the output stages from the gain stages.

2.5. PROTECTION CIRCUITRY

The protection circuitry furnishes the following two forms of protection to the amplifier:

1. Protection from overheating of the output semiconductors.
2. Protection from subsequent destruction as a consequence of output device failure.

Output peak current limiting was provided and discussed in the section on the gain stages. The heatsinks are protected against materials damage due to over temperature by switches discussed in the section on the output stages. The main power transformer is protected against excessive coil heat by switches discussed in the section on power supplies.

2.5.1. Output Transistor Temperature

The output semiconductors are protected by simulation methods. An analog of a worst case junction temperature is computed by taking the product of the output semiconductor current and voltage and applying this stimulus to a thermal impedance analog of a worst case output device.

The heatsink actual temperature is added to result in an absolute temperature model of the junction temperature.

The low side of the bridge is observed to compute the device temperatures. This is based on simplicity and convenience since the low side of the bridge is common to ground. The high side of the bridge is constrained by the bridge balance amplifier to have the same dissipation as the low side. The low side PNP output stage conducts simultaneously with the high side NPN stage to produce a positive output current.

Q301 functions as a two quadrant multiplier to compute the product of current and voltage in the low side PNP output stage. Voltage is converted to a current by R322 which is connected to -Vcc. The current is sensed between the lines of -ICL and -ICOM. R321, N301(7-8), R323 and R332 provide a differential input to Q301. The differential output of Q301 is converted to single-ended by an op-amp current mirror built with U300-C, N301(1-2) and

N301(2-3). The output current at N301(3), a virtual ground, is combined with currents from the heatsink temperature sensor U900 and a fixed temperature offset current through N301(3-5).

The network composed of N302(7,8,9,10), C306, C307 and C308 is used to simulate the thermal impedance of a worst case transistor. At 25° Centigrade, the output of U300-D (T301) should be +12 VDC. At 200° Centigrade the T301 will be -9 VDC. With a 25° heatsink and no excitation, the offset balance of Q301, R334 is adjusted for +12 VDC at T301. The voltage at T303 (-TEMP) should be +2.98 VDC +/-0.06 volts. The conversion factor of temperature to voltage is 10 millivolts per degree Centigrade. T302 of the low side NPN sensing protection circuitry should read the same voltage at 25° C.

The output T301 is input to two amplifiers which are saturated in normal operation. U301-C and U301-D are saturated at their positive output limits in normal operation. A current from R325 + R326 through R324 defines the temperature threshold at which U301-D will begin a controlled gain (R329 and R330) transition from the saturated state. As the output of U301-D goes negative, the available drive current to Q205 which drives the high side NPN output stage is being removed and eventually extinguished.

If T301 becomes about -9.5 VDC, then U301-C will follow suit becoming negative and removing the drive current to U201 which drives the low side PNP output stage. This threshold is defined by a current from R325 through R326 + R324. Since this must always coincide with a higher temperature than the temperature which disabled the high side of the bridge, it is never possible for the bridge to become unbalanced due to operation of the protection circuit.

If the low side of the bridge were to be protected before the high side of the bridge, the resulting imbalance of the bridge would cause the power dissipation to not be equal in the high and low sides of the bridge. The gain of U301-C is controlled by R329 and R328. The operating current of the mirrors, U200 and U201 is determined by R331 and R327.

2.5.2. Simulator Output

The outputs of the simulation signals T300 and T301 are available for external analysis. A balanced output from each simulator is produced for external observation. U302-C with U302-D provide the simulation output corresponding to positive currents and U302-A with U302-B provide the output corresponding to negative output currents. The temperature range of 25° to 200° Centigrade provides an output of +10 to -10 volts at J200-12 (J200-14) with a corresponding output of -10 to +10 volts at J200-11 (J200-13).

2.5.3. Amplifier Disable

The protection circuitry is used to disable the amplifier on command. Line DA when driven negative drives all of the sections of U301 to disable the current mirrors that they power and thus disables all of the four output stages. The signal through D303 disables positive output currents and the signal through D302 disables negative output currents. D305 is used to reduce the common mode input voltage to U301-A and U301-B which would create an inverted output if allowed to exceed the amplifiers common mode input range. In the case of U301-C and U301-D the output invoked by exceeding the common mode input range is identical to the desired output, and thus no problem. The outputs of the simulation signals are available for external analysis at T300 and T301.

2.5.4. Output Stage Fault

Should a failure occur that causes the output stages to conduct a large common mode current for more than a few microseconds, the amplifier will be disabled by the fault detection circuitry. The high side of the bridge is sampled by Q302 and Q303 to sense common mode currents. If the high side NPN stage is on, Q303 will be on. If the high side PNP stage is also on, Q302 will be on. When both Q303 and Q302 are on, a current will charge C300 across R302 and drive the opto-emitter of U303. This will trigger the SCR of U303 and latch the FAULT bar line low.

The low side of the bridge is sampled for common mode current by Q305 and Q306. The charging of C309 across R336 turns on Q304 which triggers U303 via the electrical gate input of the SCR. Whichever input triggers U303, the result is the same in that the control power supply which powers the SCR of U303 must be unpowered to unlatch U303 before operation of the main amplifier can be reattempted.

FAULT bar low places the amplifier in the standby state which removes power from the Vcc supplies and thus eliminates all potentially destructive current from the apparently failed amplifier.

2.6. STATUS AND INTERLOCK

2.6.1. Interlock

When multiple amplifiers are combined to form a larger amplifier it is necessary to interlock the power controls of the units so that all of the units are powered simultaneously. Should one unit of a group not be enabled, it may be damaged by currents output from the other units.

The basic interlock system of the 8604 requires that the INT IN line be released from ground. The natural unpowered state of this line is conducting to ground through a depletion mode N-channel FET Q500. The gate of Q500 must be biased negative to open the drain to source channel.

The drains of all interlocked units will be pulled high by all of the R521s when all of the Q500s are off. The threshold for the enabling of the amplifiers is set to 10 volts and each input is low-pass filtered by R520 and C502. D501 and D502 protect the inputs against transients and dissimilar AC potentials on the grounds of the interlocked units.

When INT IN goes high, the output of U501-D goes low producing a current which lights the READY indicator E502 and enables the solid-state main power relays SS1- and SS2+ which switch the three phase power to produce the Vcc supplies. R518 provides hysteresis of U501-D's switch point to insure a good trigger of the relays. Current limiting resistors are in both legs of the circuit going to the relays for safety should an internal fault occur in the relays.

The gate voltage for Q500 is provided by U501-C. When the output of U501-C indicates that a chassis is ready, a current may be taken through R524 at INT OUT from INT COM. This would allow units that are not electrically common to ground to be interlocked with other units that are by using an optically isolated interlock.

2.6.2. Startup delay

U501-C is driven from a timing network. When the unit is first powered, C504 is discharged and must be charged by current through R525. When the potential on C504 exceeds the ground potential on the hysteresis feedback divider of R523, R522 and R535, the output of U501-C will go low.

2.6.3. HI Line Voltage

C504 may be discharged by three other detectors in the system. U501-A detects excessive line voltage as evidenced on the unregulated negative supply of the control supply. If this supply is too negative as determined by the setting of R512 used with R511 and R513, the output of U501-A will be held low. R516 going to the R535 tap of the hysteresis network of U501-C provides the needed hysteresis of this detector. The high voltage detector is set to disable the supplies at ten percent high line voltage. D511 is used to prevent a state at low line voltage where the amplifier is disabled with ENABLE bar high but has the output of R512 above the signal from D500. C501 prevents ripple on the unregulated supply from toggeling U501-A's output state. U501-A may also be signaled from the ENABLE bar signal through D500. When this line is high, U501-C's output will be low.

2.6.4. Fault

The FAULT bar line may also discharge C504 through D504. E505 and current supply resistor R529 indicate on the front panel if this state has been entered.

2.6.5. Overtemp

C504 may be discharged by the overtemperature protection signal which comes from U501-B through D503. If any one of the three coils of the three-phase main transformer or one of the two high side heatsinks exceeds its allowed temperature limits, a thermal switch will open and J400-19 will be disconnected from ground. R509 will pull up this line and the signal through low pass filter R507 and C500 will overcome the current to the -15 supply through R508 and the output of U501-B will go low. E501, the high temperature front panel indicator will also light. Since removing the power to the main supply does not defeat the cooling fans, the unit will cool down and the overheated switch will cool enough to close and power will be restored.

Any time that the unit is not in the ready state (but powered), the standby state will be occupied and indicated by E504. U500-C drives E504 and is controlled by the ready signal on the output of U501-D. The junction between E504 and its current limiting source resistor R530 is the DA line which is used to signal the protection circuitry to disable the amplifier. Therefore any time that the amplifier is in standby, it is also disabled in all power stages and the main supply although some charge might momentarily remain on the Vcc supplies.

2.6.6. Overload

Should the amplifier be overdriven at any time, a large error signal will be produced at the output of U202 (line A1). If this signal is greater than ten volts in magnitude, it may be safely assumed that some form of overload is in process. U500-A and U500-B function as window detectors to detect such a condition. The reference potentials for detection are supplied by R500, R501 and R502. If A1 signal is outside of this voltage window, the output of U500-A and U500-B will be low. U500-D is used to latch the output of the window detector.

Normally the input to U500-D from the window detector is high with R504 holding the input at +15. The other input to U500-D is one diode potential above ground as Q501 is on and saturated. When the window detector drives the voltage at the junction of R503 and R504 negative with respect to the collector of Q501, the hysteresis of R505 to R504 is so large as to latch the output of U500-D low. E500 will then be lit with the current flowing through R506. In order to release U500-D from this state it is necessary to turn off Q501 allowing its collector to be pulled to -15 by R528. An output of this signal is taken through R540 to J300-14 to allow both a master and slave chassis to be cleared by the same signal from the master's Q501. Q501 is controlled by a current through R527 from U502. When no input is given to U502 (as in a slave chassis), the output is low and that Q501 is off. Note that whenever the standby state is entered the output of U500-C will force U500-D to reset with the signal through D505.

The status of the amplifier is made available to the controlling computer by means of digital differential signals. READY, FAILURE, TEMP and OVLD status are all output. The ready signal from U501-D is coupled through Q502 and D506 to an RC network C506 and R531 which delays the standby to ready transition status signal to allow the amplifier to be in full control after being enabled by the computer before it reports that it is ready. D507 prevents the input from being overdriven with positive voltage input. R531 and an internal undershoot diode protect from excessive negative inputs.

The input to the FAILURE, TEMP, and OVLD status outputs are all similarly protected with current limiting resistors and a diode for positive overdrive. Each of these outputs responds to the signal that drives the corresponding visual indicator on the front panel.

2.7. POWER SUPPLIES

The main power supply of the gradient amplifier is a three phase 208VAC supply which is controlled by a small single phase 208VAC supply.

Upon entering the chassis the three phase power passes through a three pole high inrush current breaker CB1. This breaker is mounted on the rear of the unit and breaks all three legs of the power entry.

2.7.1. Relays

Electronic switching of the main supply is performed by two solid-state relays K1 and K2 which are controlled with a common control current from +SS1 to -SS2. The control current of the solid-state relay is internally optically isolated from the power circuitry. The power controlled by these relays goes to T1 which is wound with a delta primary and a "Y" secondary. The secondary drives a full-wave bridge composed of rectifiers D411, D412 and D413 driving capacitors C400, C407 and C408. C408 functions as a high frequency bypass of the Vcc supply.

2.7.2. Power Transformer

T1 has a thermal sensor in the form of a normally closed switch in each of its three coils. These switches are wired in series and returned to the thermal protection section of the status and interlock circuitry. T1 also has a Faraday shield to prevent signals from the Vcc supplies from being capacitively coupled to the AC mains.

2.7.3. Control Transformer

The control supply is a single phase transformer T2 with the primary used as an auto-former to power the four fans. The 208VAC is stepped up to 240VAC and the 120VAC fans are wired in series parallel with a 120VAC tap connected to their center point. The primary of T2 is protected by a breaker CB2.

The secondaries of T2 are Faraday shielded and connect to full wave rectifiers. The low voltage winding uses a full wave bridge to produce the unregulated supply for a +5 volt IC regulator U402. Rectifiers D407-410 and C406 provide the necessary unregulated voltage. The ground of the +5 supply is considered to be a digital ground and is kept separate from the analog ground until they join in the vicinity of the DAC U120.

Unregulated supplies are produced by a full wave center tapped winding using D400, D401, D405, D406, C402 and C404. From these supplies U400 and U401 produce regulated +15 and -15 volt DC supplies. The ground of these supplies is considered to be an analog ground. All of the regulated supplies have reverse polarity protection diodes and bypass capacitors for low impedance at high frequencies. D402, C401, D403, C403, D404 and C405 provide these functions. The unregulated negative supply is used by the overvoltage detector of the status and interlock circuitry.

3. TROUBLESHOOTING

3.1. INTRODUCTION TO TROUBLESHOOTING MODEL 8604

This section is not intended to provide complete troubleshooting specifications for all possible Model 8604 malfunctions. Rather, it is an informal set of shortcuts that are designed to aid in getting an inoperative Model 8604 back in service as quickly as possible.

The procedures outlined in this section are limited to the identification and isolation of the more typical problems. Further, this section will only be of value in the handling of gross component failures as distinct from intermittent malfunctions.

The procedures outlined in this section are directed to an experienced electronic technician. There is no attempt made to cover all of the many details involved in setting up and conducting typical electronic repair and test procedures. If components are replaced, refer to Section 3.16 "Component Replacement" for instructions on required adjustments.

3.2. REPAIR PRECAUTIONS

Model 8604 undergoes periodic engineering updates. As a result, modules and electronic assemblies may not be fully interchangeable between units. Particularly, the main circuit board undergoes periodic engineering modifications which could effect an interchange of two main circuit boards between Model 8604's from different production lots.

The safest field repair procedure is replacement of an individual component, and this section is designed to aid the repair technician in isolating common problems down to the component level.

3.3. PREPARATION FOR TROUBLESHOOTING

WARNING

THESE PROCEDURES ARE PERFORMED WITH UNIT UNDER MINIMUM 208 VAC POWER AND WITH PROTECTIVE PANELS REMOVED. TEST STEPS MUST BE FOLLOWED PRECISELY AND TECHNICIAN MUST EXERCISE EXTREME CAUTION TO AVOID ACCIDENTAL TOUCHING OF IMPROPER TERMINALS OR COMPONENTS. POWERFUL AND POTENTIALLY LETHAL ELECTRIC SHOCKS CAN OCCUR AS A RESULT OF ACCIDENTAL CONTACT WITH CAPACITORS, TERMINALS, HEATSINKS AND OTHER INTERIOR COMPONENTS.

3.3.1. Equipment Requirements

In addition to standard hand tools and electronic test equipment, the following specialized equipment is recommended to perform the tests in this Section. Using the equipment listed will help insure that Model 8604 can be tested and adjusted to factory specifications. Any compromises in equipment could result in a compromise in performance or calibration.

Hewlett Packard HP 400F Voltmeter
Tektronix 2215 Scope to observe waveforms
Fluke 8060A DVM to measure voltage
Wavetek Signal Generator 193 as signal source
Intermodulation Analyzer to measure distortion
Non metallic screwdriver for adjustments, GC 8276 or 8277
Current Shunt (Typical .005 ohms)

Table 3-1 Recommended Equipment

3.3.2. Switch Settings

The following trouble shooting procedures will refer to several different switch settings. Table 3-2 and Illustration 3-1 describe the location and function of the settings.

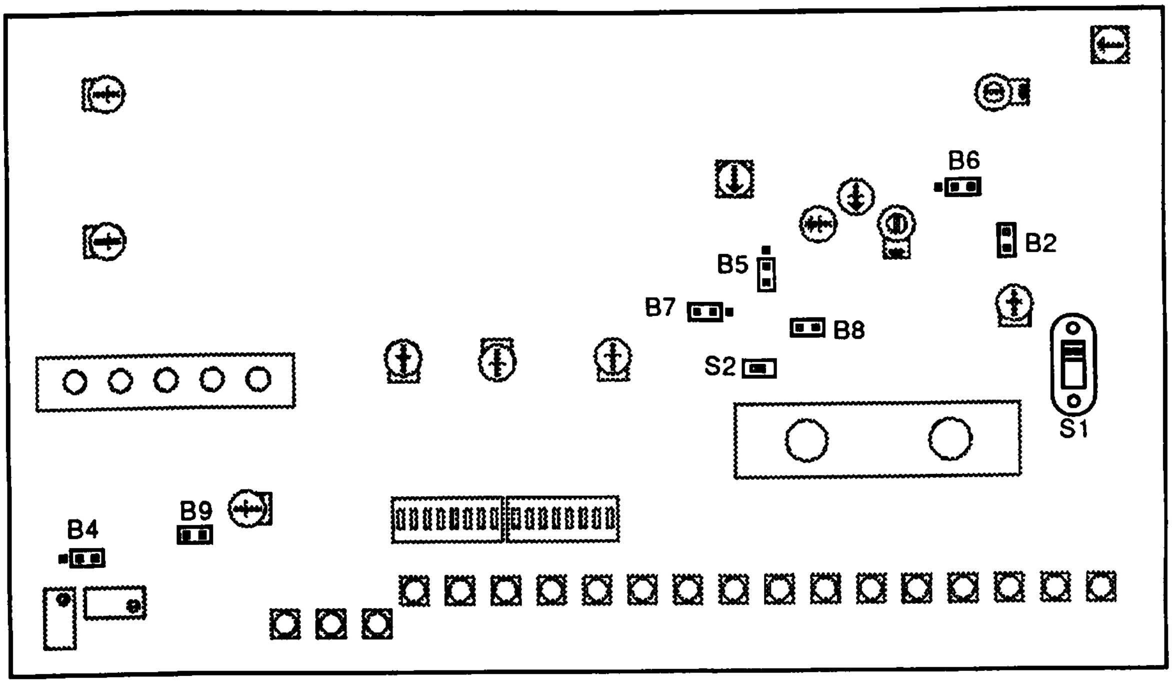

Illustration 3-1 Switch and Jumper Locations

Switch/ Jumper	Function	Position	Setting
B2	Eddy Current	Install	Enable
		Remove	Disable
B4	Enable	Right	Computer Control
		Left	Manual Enable
		Remove	Manual Disable
B5	Current/Voltage	Up	Constant Current
		Down	Constant Voltage
B7	Input Select	Right	Digital
		Left	Analog
B8	Voltage Clipper	Install	Disable
		Remove	Enable
B9	External Shim	Remove	Disable
		Install	Enable
S1	Master/Slave Switch	Up	Master
		Down	Slave
S2	Analog In	Left	Front
		Right	Rear
		Mid	None

Table 3-2 Jumper and Switch Functions

3.3.3. Signal Source

Test performed in this section will require a 300Hz sinewave burst. This signal may come from a digital or analog input. Both set ups are shown in the next sections.

3.3.3.1. Analog Input

Connect an analog generator to J1 on the front panel. The male pin is positive. Set the 8604 and generator as follows:

8604 Settings

B7	Left
B5	Down
S1	Down
S2	Mid

Generator Settings

Frequency	300Hz
Duty Cycle	20%
Repetition Rate	1Sec

3.3.3.2. Digital Input

Set ATE or MR computer to run a 300Hz sinewave burst on demand. Set the 8604 jumpers as shown below.

8604 Settings

B7	Left
B5	Right
S1	Down
S2	Mid

3.4. MAKE THOROUGH VISUAL INSPECTION

Here is a check list of areas requiring a thorough physical inspection before powering up unit for testing:

1. Remove top, front, side and rear panels from unit.
2. Thoroughly inspect all modules for charring, breaks, deformation or other signs of physical damage.
3. Look for foreign objects that may be lodged inside the unit.
4. Inspect entire length of wires and ribbon cables to look for breaks or other indications of physical damage.
5. If the above visual inspection shows any physical damage, replace the defective parts before proceeding to the following troubleshooting procedures.

3.5. PREPARATION FOR TESTING UNDER POWER

The following series of troubleshooting tests are made with unit under power and with a load attached:

1. Connect input voltage of 208 VAC, 3 phase.
2. Connect a 0.5 ohm, .5 mH load with positive lead at "Output" terminal and negative lead connected to "Sampled Common".

3.6. CHECK BY FUNCTION LIGHTS

This test will isolate problems using the function lights on the front panel. Refer to Illustration 3-2 for light functions.

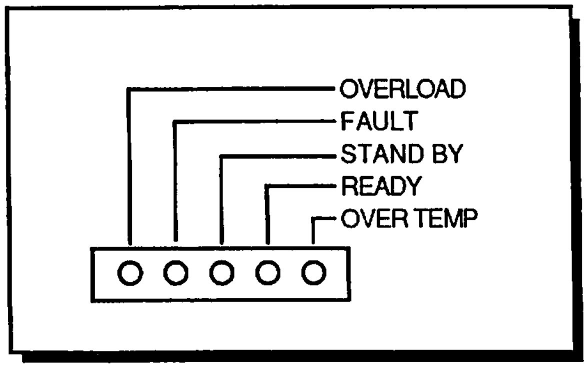

Illustration 3-2 Function Lights

1. Disable the amplifier.
2. If unit is operating properly, the STANDBY and OVERLOAD indicators will both be on. All other indicator lights should be out.
3. If STANDBY does not light and the fans or other indicator lights are on, there is a problem in the STANDBY circuit. Continue at Section 3.15.
4. Enable the amplifier.
5. Verify that the READY indicator is on and that the OVERLOAD indicator goes off.
6. If both READY and OVERLOAD indicators are on, there is a defect on the main board. Proceed to Section 3.9.
7. If unit does not come out of STANDBY from Step 4 above, there are several possibilities:

a. If STANDBY remains lit and all of the indicators are off, proceed to Section 3.15.
b. If both STANDBY and OVERTEMP are lighted, perform tests from Sections 3.11 through 3.13.
c. If both STANDBY and FAULT are lighted, the problem is likely in the output stage. Proceed to Sections 3.7 and 3.8.

3.7. OUTPUT STAGE TEST

This test will help identify a defective output transistor which will be one of the more likely causes of unit malfunction.

1. Turn AC power off.
2. Place red lead of ohm meter on heatsink of first output well and black lead on emitter bus strip of same well. See Illustration 3-3 for test points.
3. Test all four output wells in similar locations.
4. Compare ohm meter readings. All four readings should be very similar.
5. If meter reading on one well is lower than the others, that well contains a defective output transistor. Unsolder emitter resistors one at a time and check for shorts.

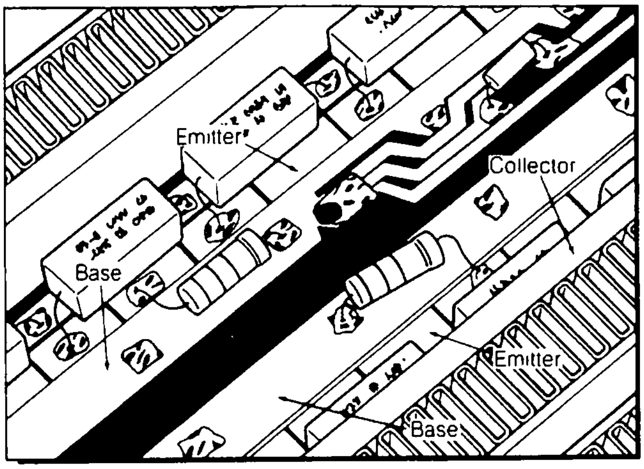

Illustration 3-3 Output Transistor Test Points

6. Replace any output transistor reading 0.66 ohms less resistance than others.
7. When testing output transistors, also test emitter resistor associated with each transistor.

Note: Resistors will either be operational or obviously defective. There is no "intermediate" level of function for these.

3.8. TEST DRIVER AND PREDRIVER TRANSISTORS

1. Test driver transistors. See Illustration 3-4 for test points.

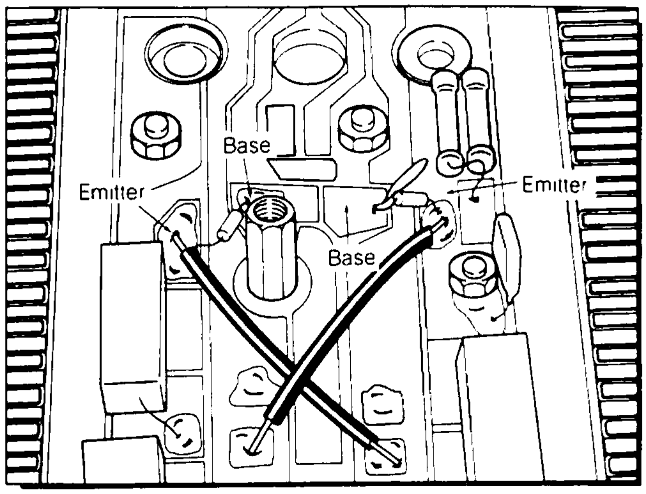

Illustration 3-4 Driver Transistor Test Points

2. Check predriver, a TO220 device, located on predriver board.

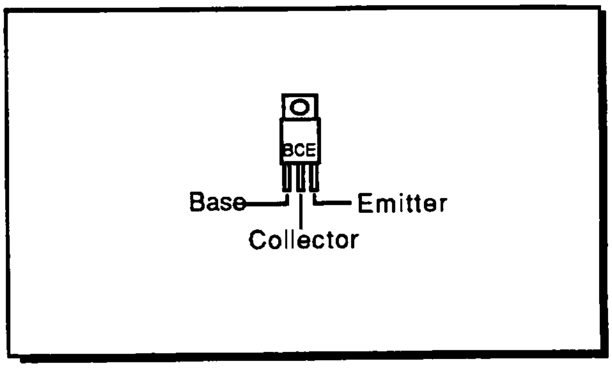

Illustration 3-5 Predriver Leads

3. When testing predriver, apply leads of ohm meter as follows:

- NPN wells (1 and 4): Red (+) on collector; black (-) on emitter.
- PNP wells (2 and 3): Black (-) on collector; red (+) on emitter.

4. Readings for predrivers should show extremely high resistance.
5. If predriver shows low resistance, replace.
6. If predriver is replaced on well 1 or 4, check bias servo, TO92 device, glued onto heatsink next to predriver board.

Note: Leads of bias servo are arranged Emitter -- Base -- Collector, when looking at the flat side of the device.

3.9. ISOLATE MAIN BOARD PROBLEM

If previous tests were normal, the cause for a defective unit is likely on the main board. The following tests will aid in narrowing down the possible problem areas.

Set up for main board tests as follows:

1. Connect a load: 0.5 ohm, 0.5 mH (as per previous test)
3. Set S1 up.
4. Start a 300 Hz toneburst.
4. Connect scope to T100 and ground.
5. There are several possible signal results from this test. Proceed to subsequent tests based upon the following schedule:

- Properly formed sinewave, no apparent input malfunction. Check U128B, U130. Check components in Gain Stage schematic numbers 200

- No signal or distorted check U120, U121, U122 if digital input. Check U126, U127-A, or U128-A.

•Oscillations or other could result from a various causes. Make erratic wave forms test from Section 3.10.

3.10. CHECK OUTPUT WAVEFORM OSCILLATIONS

This test may be conducted if the test results of Section 3.7 and 3.8 were oscillations at test point T100. Proper conduct of the test requires a solid familiarity with Model 8604 schematics and high proficiency with electronic test procedures.

1. Attach a scope probe to T201.
2. Start a 300 Hz tone burst, 20% duty cycle, at J1 and slowly raise the input voltage until an error signal is seen on T201.
3. Look for spurious responses up to clipping.
4. Capacitors and resistors marked as selectable on the output stage schematic may be selected within limits to keep T201 clean up to clipping.

The previous tests and checks have examined for the more common problems in the output section and the gain stage of the Main Board. If all of the previous tests have proven inconclusive, the following three troubleshooting tests should be conducted.

3.11. CHECK FOR DEFECTIVE THERMAL SWITCH OR THERMAL SWITCH WIRING

To check for a defective thermal switch or associated wiring flaws, consult wiring diagram and perform a continuity test through the thermal switch wiring path. An OVERTEMP condition places the amplifier in STANDBY. If the OVERTEMP pulse is extremely short, as it would be in the case of defective wiring or switches, the OVERTEMP pulse may be too brief to see. And since the return to READY is automatic after any OVERTEMP condition is over, the READY light will return. Thus, the signal STANDBY alternating with READY for no apparent reason could indicate a possible defect in thermal switches or their wiring.

3.12. CHECK FOR INADEQUATE COOLING AIR FLOW

1. Check air filters.
2. Clean any filter clogged with dirt.
3. With power ON, visually inspect fans for correct operation.
4. Replace any fan not operating, operating at reduced speed, or running backwards. (Air flow must go inward at fans, and outward from front panel grille. If a replacement fan happened to be defective, it might run backwards.)

3.13. CHECK FOR OVERHEATING OF INDIVIDUAL OUTPUT WELL

WARNING

DO NOT TOUCH OUTPUT WELLS. HEATSINKS CARRY ELECTRICAL CURRENT AND MAY BE HOT. SERIOUS BURNS OR ELECTRIC SHOCK MAY RESULT.

1. Turn power on.
2. Allow output well to heat up.
3. Disconnect power.
4. Place hand NEAR (do not touch) output wells, one at a time.
5. Test any output well which is substantially hotter than others.
6. See Section 4 for instructions on servicing of output components.

3.14. FURTHER TESTING

If Model 8604 is inoperative and all of the previous tests have failed to isolate the problem, you must now make a complete continuity test based upon the schematics and wiring diagram. The cause of the problem must be considered unusual or obscure.

As an alternative to a complete continuity test, the unit may be returned to TECHRON for factory testing repair.

3.15. INTERLOCK AND STANDBY

Problems involving the interlock and standby section can be isolated by tracing through schematic section 500. Standby can be invoked from several sources. Section 2.6. covers the standby circuit in detail.

Several common items can cause standby problems.

1. U500, U501, Q500 failure.
2. An open temperature switch circuit, check switch continuity in main transformer and on heatsinks.
3. High mains voltage, check that AC mains are 208 nominal.
4. Enable jumper, B4, not positioned properly.

- Right for external computer control
- Left for manual enable
- Remove for manual disable

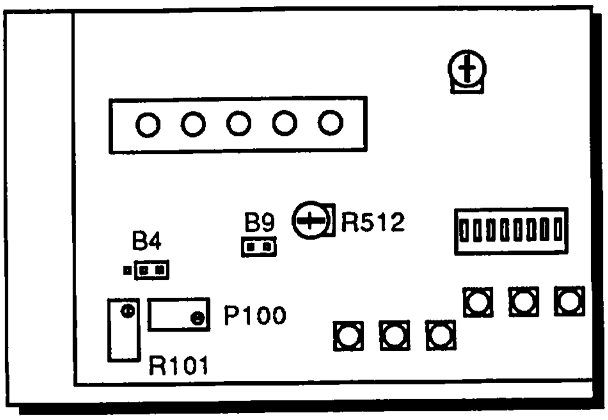

Illustration 3-6 B4 Location

3.16. COMPONENT REPLACEMENT

If any of the preceding tests resulted in component replacement, a proper servicing effort would call for conduct of the complete Testing and Adjustment procedure (Section 5). If it is not practical to run the complete Testing and Adjustment procedure, an expedient alternative would be to check only those adjustments related to specific components.

4. DISASSEMBLY AND ASSEMBLY

WARNING
MODEL 8604 CARRIES POTENTIALLY LETHAL VOLTAGES EVEN AFTER MAIN POWER SUPPLY HAS BEEN DISCONNECTED. AFTER POWER SHUTOFF, AND BEFORE ANY SERVICE PROCEDURE, WAIT AT LEAST ONE MINUTE FOR AUTOMATIC CAPACITOR DISCHARGE. VERIFY DISCHARGE BY TESTING CAPACITOR TERMINALS OR RECTIFIER BLOCKS.

4.1. INTRODUCTION TO DISASSEMBLY AND ASSEMBLY

From a mechanical standpoint, servicing of Model 8604 is straight forward. Illustration 6-1 is the master exploded-view assembly drawing that shows the relationship of modules and assemblies.

This section has two purposes:

- To review important safety information for the protection of both equipment and servicing personnel.
- To identify several assembly and disassembly procedures that might not be apparent from a study of Illustration 6-1.

4.2. IMPORTANT SAFETY INFORMATION

4.2.1. Introduction

Model 8604 operates with 3 phase power of 208 VAC.

In addition to physical hazards to servicing personnel, certain electrical conditions could be damaging to component parts.

4.2.2. Disconnecting Power Supply

Before attempting any servicing of Model 8604, shut down outside power supply by disconnecting plug from rear of unit.

Rear Circuit Breaker CB1 (Item 59 on Illustration 6-1) may be used to temporarily shut down power to unit. However, disconnecting the plug provides extra measure of safety to the servicing technician.

4.2.3. Discharging Capacitors

Illustration 4-1 shows power supply components as viewed from bottom of Model 8604 with bottom panel removed.

Model 8604 includes a bleeder resistor that is designed to discharge capacitors within one minute after power shut off. Do not touch any internal part of Model 8604 until more than one minute after power shutdown.

Capacitor terminals are directly connected to terminals of the 35 amp Bridge. Illustration 4-2 shows detail of bridge terminals and identifies (+) and (-) connections to capacitors.

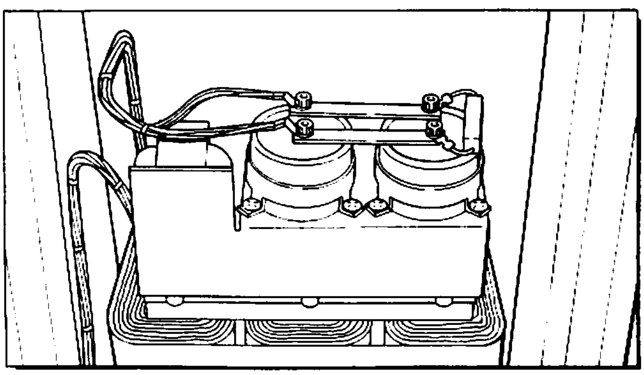

Illustration 4-1 Power Supply Components

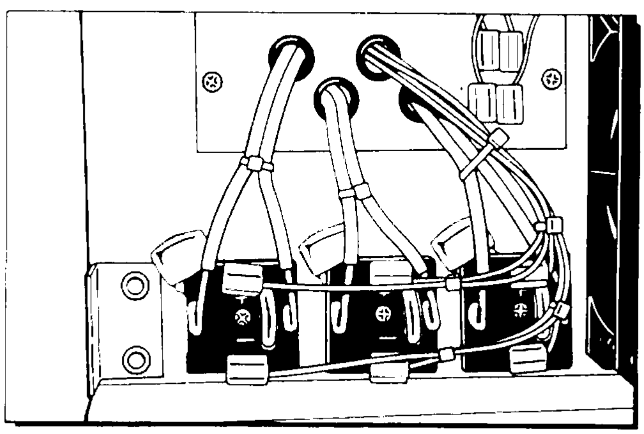

Illustration 4-2 Capacitor Test Points

1. After shutting off power, wait one minute.
2. Remove fan panel (Item 46 on Illustration 6-1) to expose Bridge.
3. Verify capacitor discharge by connecting two terminals of voltmeter to "+" and "-" terminals shown in Illustration 4-2.
4. Voltmeter should give reading of less than 50 volts.

4.2.4. Floating Ground

Internal electrical components of Model 8604 are not grounded to chassis.

Because of this floating ground feature, test equipment used in servicing Model 8604 should not be earth grounded. There is a possibility of erroneous readings occurring from the use of grounded test equipment.

4.3. EXTENDING 8604 OUT FROM CABINET

To remove the 8604 from the system rack, remove the four mounting bolts on each side of the front panels.

Side mounted chassis slide allow the unit to be pulled out of the cabinet for servicing. Unit can be rotated 90° up and down to allow easier access to rear and bottom components.

To pivot up or down, pull outside latches and gently rotate unit. The pivot "wheel" has stops that will hold unit at 45° and 90°.

4.4. REPLACING 8604 AS A MODULE

As an alternative to servicing the 8604 on site it may be replaced as a complete unit. Replacement permits servicing of a defective unit at a more convenient time and/or place.

To remove the 8604 from system rack:

WARNING

8604 WEIGHS OVER 100 POUNDS. HAVE ENOUGH HELP ON HAND TO SUPPORT THIS WEIGHT AS UNIT IS REMOVED FROM RACK.

1. Remove four mounting bolts on each side of unit.
2. Slide unit out to full extension of chassis slide.
3. Disconnect input and output wires and cable from rear of unit. Make sure locations of all wires and cables are noted to allow proper installation of replacement unit.
4. Depress spring-loaded catches on both chassis slides.
5. Slide unit completely out of chassis slides.

To install new 8604:

1. Insert unit in from front of chassis slides and push in until spring loaded catches are engaged.
2. Connect input and output wires and cables to connectors at rear of unit.
3. Remove front panels (see section 4-6).
4. Set jumpers and switches according to table 4-1.
5. Turn power on.
6. Watch for the READY and STANDBY light operation.
7. Replace front panels.
8. Install four screws to each side of the front panel to secure in the rack.

SWITCH/ JUMPER	FUNCTION	SETTING	MASTER SLAVE SETTING
B2	Eddy Current	Install	Not Critical
B4	Enable	Right	Right
B5	Current/Voltage	Up	Not Critical
B6	Compensation	Left	Not Critical
B7	Input Select	Right	Not Critical
B8	Voltage Clipper	Open	Not Critical
B9	External Shim	Install	Not Critical
S1	Master/Slave	Up	Down
S2	Analog In	Left	Left

Table 4-1 Switches and Jumpers

4.5. MODULE REMOVAL

Note: "Item" numbers used in this section refer to the key number used in Illustration 6-1. Illustration 6-1 is the master exploded-view assembly drawing of Model 8604. Fasteners, wiring paths, and the relative positions of modules can be determined from an inspection of this illustration.

The following subsections describe several precautions that should be noted in the servicing of the output shelf (64), individual output wells, and the main circuit board (12).

4.6. FRONT PANEL REMOVAL

To remove front panel (Item 8), twist ring fasteners (Item 11) 1/4 turn counter clockwise. Pull out lower edge of cover while releasing top edge of cover from the channel at top of chassis. See Illustration 4-3.

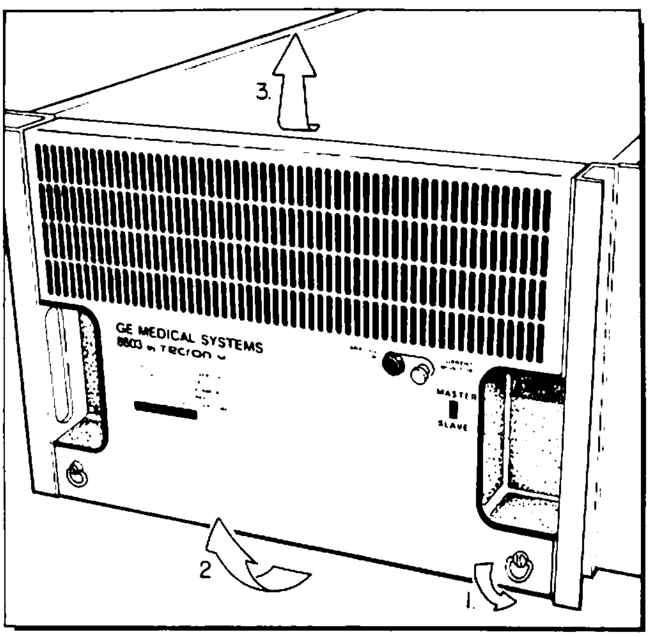

Illustration 4-3 Front Panel Removal

CAUTION

When replacing front panel, take care to protect ribbon cables and other connectors from being caught or damaged by front panel edges.

4.7. REMOVAL OF REAR, TOP, BOTTOM, AND SIDE PANELS

The front, top and bottom panels can be removed independently. The fan covers can also be removed individually.

4.8. REMOVAL OF OUTPUT SHELF

The output shelf (Item 64) is a frame that holds the four output wells.

To remove the output shelf:

1. Remove four mounting bolts at each side of unit. Pull out on chassis slide until springloaded catch is engaged.
2. Verify capacitor discharge (see Section 4.2.3).
3. Temporarily remove back panel (Item 60) to allow removal of top panel (Item 62) and bottom panel (Item 23). After top and bottom panels are removed, replace back panel to hold output shelf in place while disconnecting electric terminals.
4. Remove output wires to load from output terminals at rear of unit. Label wires to ensure proper connection after servicing.
5. Using a long arm 5/32" allen wrench, unscrew and remove single red and blue wires from capacitor terminals (Item 3, Illustration 6-3). Replace and finger-tighten socket caps to hold multiple wires in place.
6. Disconnect the in-line connections in the two gray wires.
7. Disconnect the 3-conductor in-line connection.
8. Disconnect the output interconnect board from Main Circuit Board.
9. Remove back panel.
10. Remove output shelf assembly (Item 64) from rear of unit.

If servicing of output shelf or individual output wells is required, proceed to Section 4.19.

4.9. INSTALLING OUTPUT SHELF ASSEMBLY

To install output shelf assembly:

1. Slide output shelf assembly (Item 64) in from above. Make sure that interconnect board is not damaged as shelf and front panel come together.
2. Replace back panel (Item 60).
3. Reconnect interconnect board to J400 on Main Circuit Board.
4. Reconnect two gray wires with in-line connectors.

Note: Wires are interchangeable and may be connected to either connector.

5. Reconnect 3-conductor in-line connector.

6. Reconnect single red wire and single blue wire to terminals on capacitors (Item 3, on Illustration 6-3). (Red on red, blue on blue.) Tighten socket cap screws with allen wrench.

CAUTION

Finger-tightening of (socket cap) screws on capacitor terminals is not sufficient. Use long arm 5/32" allen wrench to securely tighten screws.

4.10. REMOVING FANS

Model 8604 includes four fans (Item 41) that provide a flow of outside air through heat sinks. Fans are interchangeable. Internal heat protection will shut down amplifier if cooling frρm fans is insufficient to dissipate heat.

Fans are not repairable. Defective or inoperative fans must be replaced.

The following instructions describe replacing fan on one side only. Procedure is identical for all four fans.

To remove fans:

1. Turn off main circuit breaker.
2. Unplug Input Power Cord.
3. Wait one minute to allow capacitors to discharge.
4. Remove single screw (Item 52) on rear panel to loosen fan cover (Item 46).
5. Slide fan cover out.
6. Verify capacitor discharge.
7. Remove four socket cap machine screws (Item 40) holding each fan in position.
8. Remove white connectors for appropriate fan. Illustration 4-4 shows correspondence between fans and connectors. Front pair of connectors power front fan. Rear pair of connectors power rear fan.

4.11. INSTALLING REPLACEMENT FANS

To install a new fan:

1. Connect white terminals as shown in Illustration 4-4.
2. Make sure that air flow directional arrow on fan case points in to center of unit.
3. With fan in position, insert and tighten screws (Item 40) at each corner.
4. Slide in fan covers (Item 46). Fasten with single screw (Item 52) through rear panel.

4.12. REMOVING MAIN CIRCUIT BOARD

Removal of Main Circuit Board (Item 12) requires disconnection of ribbon cables and output board connector, disconnection of main power supply, and removal of four mounting screws.

CAUTION

Once ribbon cables, output board connector, and power supplies are disconnected, the Main Circuit Board is no longer protected against static electricity. Service Main Circuit Board in a static-free environment. Wear wrist static straps to guard against damage to Main Circuit Board.

To remove Main Circuit Board:

1. Turn off main circuit breaker.
2. Unplug input power cord.
3. Wait one minute to allow capacitors to discharge.
4. Verify discharge (see Section 4.2.3).
5. Remove front panel (see Section 4.6 for precautions on front panel removal and replacement).
6. Using ejector latches, disconnect ribbon cable from J100,J200, J300, and disconnect output interconnect board from J400.
7. Disconnect power supply from terminal "T" on right side of circuit board.

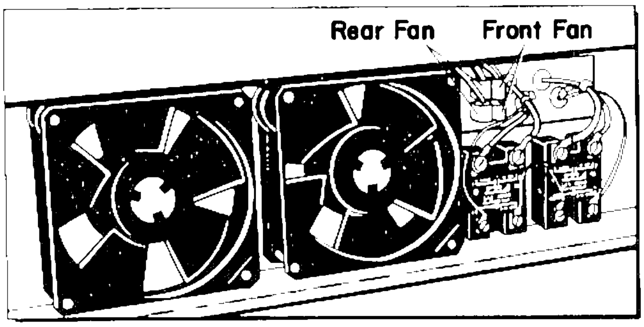

Illustration 4-4 Fan Connector Matching

8. After power supply is removed, inspect pins of terminal "T" and straighten any that may have become bent.
9. Remove four mounting screws from Main Board.
10. Main Circuit Board and gray insulating panel (Item 13) can now be lifted off.

4.13. INSTALLING MAIN CIRCUIT BOARD

To install Main Circuit Board:

1. Place gray insulator panel (Item 13) over mounting holes.
2. Place Main Circuit Board (Item 12) in position and attach with four black nylon mounting screws.
3. Connect power supply cables at "T" taking care to protect connecting pins.
4. Connect ribbon cable to J100, J200, J300, and output connector to J400. Note that ribbon cable makes a "U-turn" over the connector. Further, note that connections will only fit in the correct location and only in the correct orientation. Only slight force should be needed to connect each of these connections. See Illustration 4-5.
5. Refer to Section 5, Testing and Adjustment, for procedures to follow after replacement of Main Circuit Board.

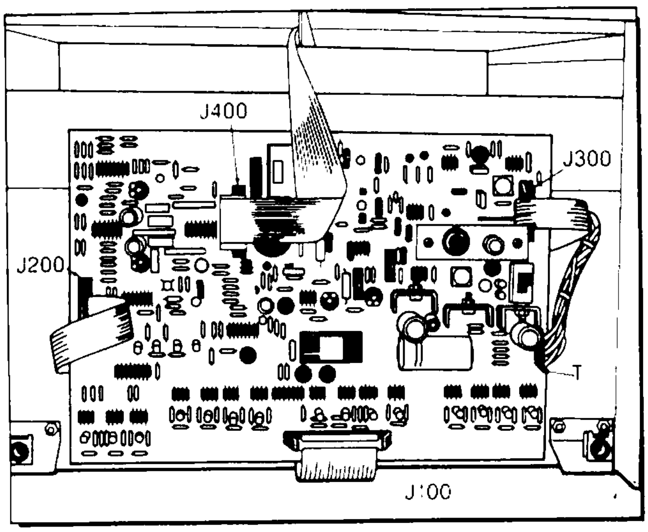

Illustration 4-5 Main Circuit Board Connections

4.14. REMOVING ANY OUTPUT WELL

Model 8604 contains four different output wells that are located on the output shelf assembly (Item 64).

While the four different output wells appear similar, each is different and must be placed in a specific position.

Output wells can be individually removed and installed without removing the output shelf.

Illustration 4-6 shows the correct orientation of each of the four output wells and shows how the four different wells can be distinguished.

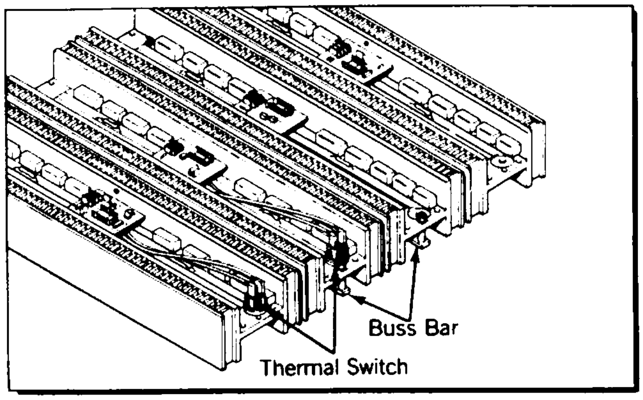

Illustration 4-6 Output Well Orientation

Unless specified otherwise, refer to Illustration 6-2 for details of output shelf assembly.

To remove any individual output well:

1. Turn off main circuit breaker.
2. Unplug input power cord.
3. Wait one minute to allow capacitors to discharge.
4. Verify discharge.
5. Remove top panel as explained in Section 4.7.
6. Disconnect output interconnect board from Main Circuit Board and from predriver boards at center of output wells.
7. Remove four corner screws on output.
8. In addition to the four corner mounting screws, each well is also fastened with two center screws, one of which may be recessed below the surface. These two center screws must also be removed.
9. Well is now disconnected both mechanically and electrically and may be removed.

4.15. INSTALLING OUTPUT WELLS

Refer to Illustration 4-6 for correct orientation and position of each of the four different output wells.

To install output wells:

1. Insert center conducting screws. Note that one of the center screws in each of the middle output wells is recessed below the surface. Torque 10 in./lb (± 20%).
2. Insert four corner mounting screws. Maximum torque, 6 in./lb (± 20%).
3. Reconnect output interconnect board to output wells and Main Circuit Board.
4. Tack interconnect board in place with silicone glue.

4.16. GENERAL INFORMATION FOR SERVICING OF POWER SUPPLY COMPONENTS

Note: All "Item" references are from Illustration 6-3.

Power supply components include: Two Capacitors (Item 19), Low Voltage Control Transformer (Item 5) and Power Transformer (Item 13).

To service power supply components:
1. Remove top panel and bottom panels (see Section 4.7).
2. Remove output shelf assembly to provide access to power supply components.

4.17. REMOVAL OF CAPACITORS AND CONTROL TRANSFORMERS

1. Remove mounting bracket (Item 8) which is held in position by three 1/4-20 x 2-1/2 capscrews (Item 10).

Note: In removing the capscrews take care to retain the shoulder washers that insulate mounting bolts from the bracket. There are six shoulder washers (Item 9), three on each side of the mounting bracket.

2. With capscrews removed, the entire bracket with capacitors and control transformer attached can be removed through the bottom of the unit.

4.18. SERVICING OF CAPACITORS

Each capacitor (Item 19) is attached to the mounting bracket (Item 8) with a 2-1/2" capacitor bracket (Item 4). Two bus bars (Item 2) and a bleeder resistor (Item 1) bridge the positive and negative terminals of the two capacitors.

CAUTION

In handling capacitors, take care to protect the cylindrical surface from scratches, particularly when removing and inserting in compression ring. Surface scratches or scrapes could penetrate through outer surface of capacitor.

To remove capacitors:
1. Verify discharge by connecting capacitor terminals with voltmeter. Voltmeter should show zero reading.
2. Remove the socket capscrews (Item 3) with a long arm 5/32 allen wrench.
3. Remove wires, noting mounting location for proper connection of replacement capacitors.
4. Remove bleeder resistor and bus bars.
5. Loosen bolts on capacitor brackets (Item 4).
6. Carefully slide capacitor out of capacitor bracket.

To install capacitors:
1. Carefully slide capacitor into capacitor bracket, taking care not to scratch surface of capacitor.
2. Tighten capacitor bracket.
3. Attach bus bars (Item 2) across terminals.

CAUTION

Be sure both positive and negative terminals are positioned identically and that bus bars are bridging terminals.

4. Attach bleeder resistor (Item 1) on terminals farthest from control transformer (Item 5).
5. Attach blue wire set to bottom (negative) terminal and red wire set to top (positive) terminal.
6. Finger-tighten terminal screws. (Single red and blue wires from the output shelf will need to be reattached before final tightening of terminal screws.)

4.19. SERVICING OF LOW VOLTAGE CONTROL TRANSFORMER

To remove control transformer:
1. Loosen two nuts (Item 6) holding control transformer to studs on large mounting bracket (Item 8).
2. Trace the wires from transformer to their terminations. Note and mark connections to ensure proper installation of replacement transformer.
3. Disconnect wires at termination points, unbundle, and remove low voltage control transformer.

To install control transformer:
1. Fasten control transformer (Item 5) to main mounting bracket (Item 8).
2. To reassemble inside unit, insert mounting bracket (Item 8) (with capacitors and transformer attached) through bottom of unit.
3. Insert 1/4-20 x 2-1/2 capscrews (Item 10) from bottom with shoulder washers (Item 9) on both ends. Fasten with 1/4-20 nuts (Item 12) and tighten securely.
4. Connect wires at termination points.

4.20. SERVICING OF POWER TRANSFORMER

To remove power transformer:
1. Note wire locations and mark as necessary. Particularly note the three Faraday shield wires from the transformer coils that are chassis-grounded behind the front panel. (Refer to Power Supply schematic in Section 6). Except for the three Faraday shields, disconnect wires at termination points.
2. Separate the mounting bracket (Item 8) from the power transformer (Item 13) as described in step 6, this section.
3. Remove Main Circuit Board as described in Section 4.12.
4. Loosen, but do not remove six capscrews (Item 15) from power transformer brackets.

WARNING

POWER TRANSFORMER (ITEM 13) WEIGHS OVER 40 POUNDS. DO NOT REMOVE MOUNTING BOLTS (ITEM 15) UNLESS TRANSFORMER IS SUPPORTED. IF SERVICING IS TAKING PLACE ON A WORKBENCH, TRANSFORMER CAN BE SUPPORTED FROM UNDERNEATH. IF SERVICING IS TAKING PLACE WHILE UNIT IS MOUNTED IN CHASSIS SLIDE, SERVICING IS MORE SAFELY DONE WITH UNIT POSITIONED VERTICALLY IN FRONT SIDE DOWN POSITION.

5. After ensuring that transformer is securely supported, complete the removal of six capscrews (Item 15). Detached transformer can be removed from the bottom of main unit.
6. Once transformer is removed from unit, upper and lower power transformer brackets (Item 14) can be removed by unbolting capscrews (Item 10).

To install power transformer:
1. Attach power transformer brackets (Item 14) to transformer with 3/4" capscrews. Be sure to place shoulder washers (6 each, Item 9) at top and bottom. Attach nuts (Item 12) and tighten securely.
2. Insert transformer from bottom of unit. Hold in approximate position while mounting bolts (3 each, Item 10) are inserted through front braces. Tighten three bolts securely.
3. Reattach mounting bracket (Item 8) that holds capacitors and low voltage control transformer. Be sure to use shoulder washers both top and bottom.
4. Insert stripped ends of Faraday shield wires in between the chassis front panel and the aluminum shim.
5. Fasten capscrews with 1/4-20 nuts and tighten securely.
6. Connect wires at termination points.
7. Replace output shelf as instructed in Section 4.9.

4.21. GENERAL INFORMATION FOR SERVICING OUTPUT WELL COMPONENTS

Note: Unless a different Illustration is specified, all "Item" numbers in this section refer to Illustration 6-4.

4.21.1. Distinguishing Output Well Differences

The four output wells appear similar, but each one is different. See Illustration 4-6 for explanation of differences and methods of identifying each.

4.21.2. Foam Insulation

Foam insulation between heat sinks and output shelf serves as gasket for cooling air. A gasket which is damaged or removed during service procedure must be replaced. Order replacement gasket material from TECHRON only.

4.22. INTERCONNECTING WIRE PROTECTION

Output well connector wiring (Item 28, Illustration 6-2), passes through a grommet on the rear edge of output shelf.

4.23. OUTPUT TRANSISTORS

1. Work from bottom of well.

2. For PNP wells (wells 2 and 3) only: Each output transistor is connected to a central bus bar via a collector resistor. (see Illustration 4-7). Unsolder collector resistor of faulty transistor from bus bar.
3. Remove transistor mounting screws. On PNP wells, resistor solder lug on one screw serves as star washer.
4. Turn output well over to work.
5. Unsolder leads of faulty transistor from center portion of gold colored base PC board and from emitter resistor lead.
6. Loosen leads, then remove faulty transistor.
7. Replace transistor with one having the same part number, same matching grade number.

CAUTION

Stable amplifier operation cannot be assured unless part number and grade number are matched on all transistors in each output well.

8. Apply heat sink compound (see Renewal Parts List) to surface of replacement transistor. Apply compound completely and lightly so that only a small amount will be squeezed out when transistor screws are tightened.
9. Install mounting screws and star washers (solder lug for PNP wells). Tighten mounting screws before resoldering leads. Torque to 25 in./lb. (± 20%).

CAUTION

Transistors must be tightly mounted by screws before soldering leads.

10. Clinch emitter resistor lead securely around emitter lead of transistor.

Note: To maintain the highest degree of dependability, emitter lead from transistor must be clinched around emitter resistor lead.

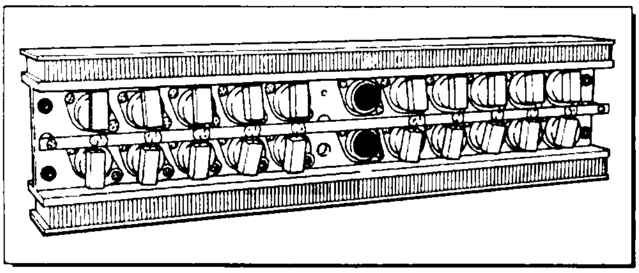

Illustration 4-7 Bottom View, PNP Output Well

11. Solder leads in place.
12. For PNP wells only: Resolder collector resistor lead back onto bus bar as before replacement. For examples, see other collector resistors on same bus bar assembly.
13. See Testing and Adjustment Procedure, Section 5, for necessary calibration procedures.

4.24. DRIVER TRANSISTORS

1. Position output well on its side to allow access to both top and bottom.
2. A center screw holds each predriver board in place. Remove this screw, then lift predriver board carefully, allowing wiring to act as a "hinge".
3. Remove mounting bolts from driver transistors.

CAUTION

To protect solder connections from predriver board, do not move board more than necessary.

4. Unsolder leads of faulty driver transistor.
5. Apply heat sink compound to mounting surface of replacement transistor. Apply lightly and completely. Only a small amount of heat sink compound should squeeze out when tightening transistor mounting screws.
6. Bolt new driver transistor in place. Torque range is 5 in./lb. to 16 in./lb..
7. Solder leads of new transistor in place.
8. See Testing and Adjustment Procedure for necessary calibration procedures.

4.25. EMITTER RESISTORS

Note: All .33 ohm 5 watt emitter resistors used in output wells, both top and bottom, are identical.

CAUTION

To insure matched performance for stable amplifier operation, order replacement resistors from TECHRON.

1. Unsolder resistor leads.
2. Loosen emitter resistor lead from emitter lead of transistor.
3. Install replacement emitter resistor observing "S" shape bends in leads.

CAUTION

The "S" shape bend aids in heat dissipation. Failure to make this bend may cause solder to melt.

4. Clinch emitter resistor lead tightly around transistor emitter lead.

Note: To insure the highest level of dependability in operation, emitter lead from transistor must be clinched around emitter resistor lead.

5. Solder emitter resistor lead to emitter lead of transistor.
6. See Testing and Adjustment Procedure, Section 5, for necessary calibration procedures.

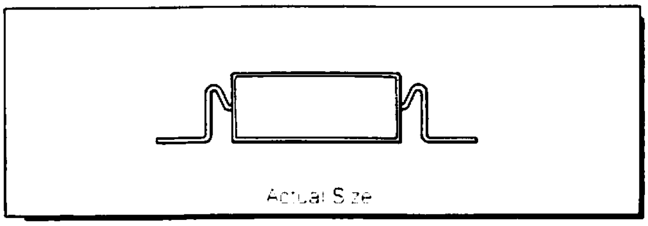

Illustration 4-8 "S" Shaped Bend In Emitter Resistor Leads

4.26. ELECTRONIC HEAT SENSORS, WELLS 3 AND 4 ONLY

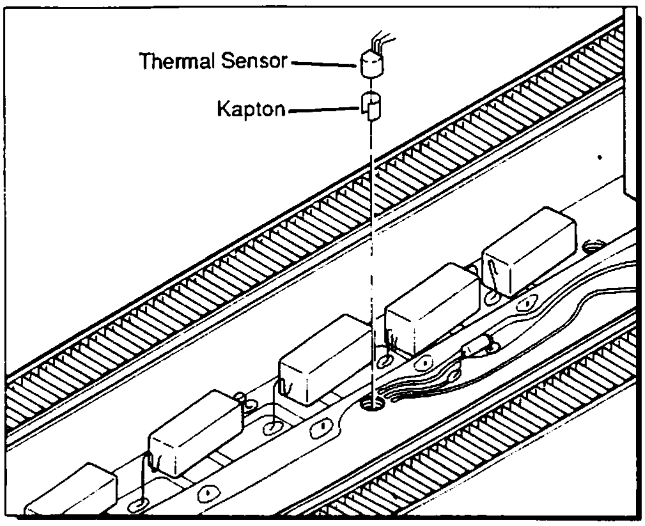

Illustration 4-9 Electronic Thermal Sensors

Note: If Kapton® insulating material remains in recess when sensor is removed, leave it in place and disregard inspection instructions below. If Kapton® comes out with sensor, follow applicable inspection and replacement instructions below.

1. Unsolder leads and pull sensor up and out of recess.
2. If the insulating Kapton® stays in place in the recess, leave in place and reuse.
3. Remove insulating tube from center lead of sensor.
4. Inspect insulating tube and Kapton® insulation for damage. If intact, reuse. If not, replace.
5. Carefully position three electronic heat sensor leads.
6. Install insulating tube over center lead.
7. Wrap insulation around replacement electronic heat sensor.
8. Insert sensor and insulation in recess.
9. Solder leads.
10. Replace 1% resistor located about two inches towards center from sensor.

BLUE	236 OHMS, 1%
GREEN	227 OHMS, 1%
YELLOW	218 OHMS, 1%

Table 4-2 Resistor Color Matching

Note: Resistor must be matched with temperature sensor. See Table 4-2 for proper matching. Color dot on sensor indicates matching type.

11. See Testing and Adjustment Procedure, Section 5, for necessary calibration procedures.

4.27. THERMAL SWITCH, WELLS 1 AND 2 ONLY

(See Illustration 4-6 for location.)

To remove:

1. Remove output well as explained in Section 4.14.
2. Disconnect leads from thermal switch.
3. Turn thermal switch counter-clockwise to remove from mounting position. Nut below is not captive.

To install:

1. Apply heat sink compound to thermal switch.
2. Install new thermal switch. Fasten nut on threaded shaft of thermal switch.
3. Reconnect black wires. Black wires are identical and interchangeable.

4.28. BIAS SERVO TRANSISTOR, WELLS 1 AND 4 ONLY

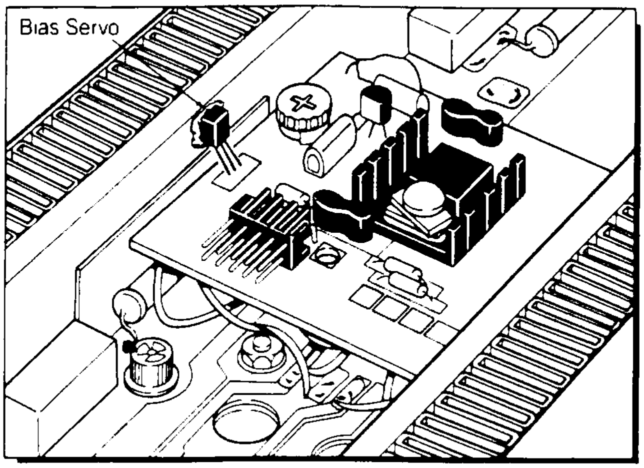

Illustration 4-10 Bias Servo Location

To remove:
1. Remove bias servo transistor from position on side of heatsink.
2. Remove old silicon glue from heatsink.
3. Unsolder bias servo transistor leads.

To install:
1. Solder leads of new transistor in place.
2. Position new bias servo transistor with flat side touching heatsink.
3. Glue new bias servo transistor in place with silicon glue. Use other bias servo as model of proper gluing procedure.

4.29. FLYBACK DIODE BLOCK

(see Item 17 on Illustration 6-2; also see Illustration 4-11)

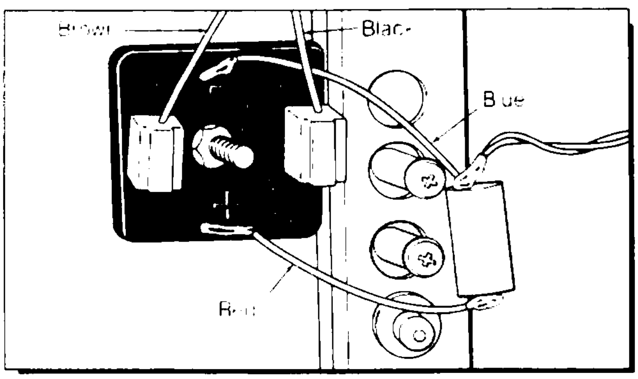

Illustration 4-11 Flyback Diode Block Detail

Note and mark wiring connections on Flyback Rectifier Block (see Illustration 4-11).

To remove:
1. Remove mounting nut and washer from captive mounting stud.
2. Unsolder red and blue wires.
3. Unplug brown and black wires.

To install:
1. Apply heatsink compound completely and lightly to flyback rectifier block mounting surface.
2. Install washer and mounting nut. Tighten.
3. Connect brown and black wires.
4. Solder red and blue wires.

4.30. CURRENT SAMPLING RESISTOR ASSEMBLY

(see Item 22, Illustration 6-2)

1. To remove current sampling resistor assembly as a unit, remove two large phillips screws on base plate.
2. Unsolder orange and black wires from bus bars.
3. Install new current sampling resistor assembly with mounting screws.
4. Orange and black wires pass through holes in bus bar, then are wrapped around bus bar and secured with heavy solder. Duplicate this soldering method when replacing these wires.
5. When servicing individual components of current sampling resistor assembly, observe the following points:

a. Remove small heatsink by removing two small phillips screws in heatsink.
b. Use heatsink compound between resistors and mounting plate and between resistors and heatsink.
c. On center resistor, route black wires down grooves on side of resistor, one black wire on each side. Glue wires in place.
d. Reassemble heatsink, resistors, and base plate.

4.31. SERVICING BUS BAR ASSEMBLY

Bus bar assembly includes four copper bus bars with insulation material between them. All bus bar assembly components are individually replaceable when removed from output shelf. See Illustration 6-4 for details of bus bar assembly.

Should insulation between individual bus bars require replacement, use only original equipment insulating material.

WARNING

SUBSTITUTING INSULATING MATERIAL OTHER THAN ORIGINAL SPECIFICATIONS MAY RESULT IN UNSAFE OR UNSTABLE OPERATION OF AMPLIFIER.

Order replacement insulation from TECHRON (see Renewal Parts List).

4.32. SERVICING MAIN BOARD ICS

Main Board ICs can be serviced without removing Main Circuit Board. Use "ice tongs" style IC extractor to avoid damaging these components.

4.33. SERVICING OTHER MAIN BOARD COMPONENTS

CAUTION

Main Board is double-sided and plated-through. Use extreme caution and very good solder removal methods to avoid damage to plating on circuit board.

See Section 4.12 for Main Circuit Board removal procedure. Observe cautions regarding static electricity. Service Main Board components in accord with standard PC board procedures.

4.34. POWER SUPPLY RECTIFIER BLOCKS

(Item 38, Illustration 6-1; also see Illustration 4-12)

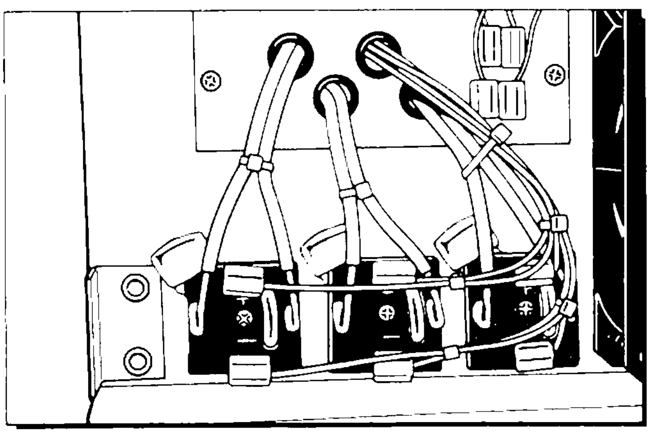

Illustration 4-12 Power Supply Rectifier Block

To remove:
1. Remove wires.
2. Remove phillips mounting screw. Nut is captive.

To install:
1. Solder two .1µF capacitors in place on new rectifier (refer to C409 through C414 on schematic).
2. Apply heatsink compound to block mounting surface.
3. Install mounting screw.
4. Reattach wires as shown in Illustration 4-12. Each block has two interchangeable wires of same color, along with red (+) and blue (-).

4.35. SOLID STATE RELAYS

(see Item 3 on Illustration 6-1; also Illustration 4-13)

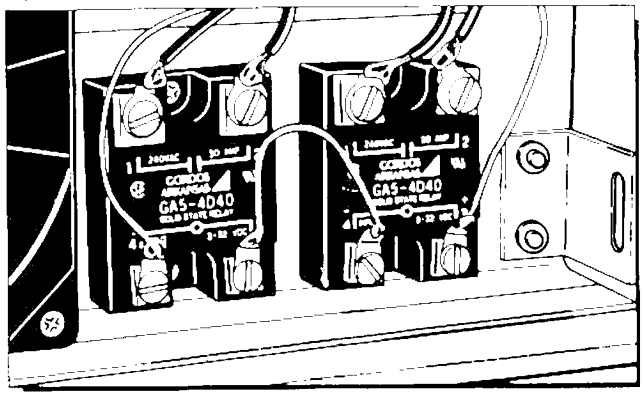

Illustration 4-13 Solid State Relays

To remove:
1. Remove two mounting bolts from solid state relay. Nuts inside are captive.
2. Apply heatsink compound lightly and completely to mounting surface of solid state relay.
3. Reattach.

4.36. RIBBON CABLES SERVING REAR PIN TERMINALS

Before removing Ribbon Cables, note routing. Reinstall according to original routing.

5. TESTING AND ADJUSTMENT

5.1. INTRODUCTION TO TESTING AND ADJUSTMENT

The procedures outlined in this section must be performed following service to the Model 8604 amplifier. Procedures in this section are NOT REQUIRED following the replacement of fans.

5.2. EQUIPMENT REQUIREMENTS

In addition to standard hand tools and electronic test equipment, TECHRON recommends the following specialized equipment to perform the tests in this Section. Using the equipment listed will help insure that Model 8604 can be tested and adjusted to factory specifications. Any compromises in equipment could result in a compromise in performance or calibration.

Tektronix 2215 Scope to observe waveforms
Fluke 8060A DVM to measure voltage
Wavetek Signal Generator 193 as signal source
Non metallic screwdriver for tests, GC 8276 or 8277
5 Milliohm Current Shunt
Digital Signal Source

Table 5-1 Recommended Equipment

5.3. INITIAL JUMPER SETTINGS

Perform the test in this Section in sequence. Before starting these test and adjustments, set the jumpers and controls on the 8604 main board as follows:

JUMPER	FUNCTION	INITIAL SETTING
B4	Enable	Right
B6	Compensation	Right
B7	Input Select	Left

Table 5-2 Initial Jumper Settings

5.4. ADJUSTMENTS WITH A TECHRON GAE

The TECHRON Gradient Amplifier Exerciser (GAE) is a precision piece of test equipment designed to speed the testing of the 8604. Whenever possible, the GAE should be used to adjust or verify that the 8604 is operating at peak performance.

Switch settings for the GAE are in bold face and all capitol letters.

5.4.1. Initial GAE settings

Set the GAE to the initial settings in Table 5-3.

• PWR/VAR/CLOCK	PWR
• VAR/XTAL	XTAL
• X5/X1	X1
• µ/Sample	20
• Delay/cont/pulse	CONT
• FUNCTION	15
• ZERO VAR/CAL	CAL
• SHUNT MON	MON
• SHUNT	20A
• GAIN VAR/CAL	CAL
• ZERO OUT	Up
• LINEARITY RANGE	12 Bit
• TRIGGER SEL	TR1
• METER RANGE	10V
• Rdy/stdby	stby
• Meter sel	IO
• Trigger sel.	TR1
• SCOPE SEL	ERR
• Meter range	10V
• S2	Right

Table 5-3 GAE Initial Settings

5.4.2. Disable/Enable Amplifier

The disable/enable procedures are used in several of the tests that follow. As applicable, instructions will refer back to this sequence.

- To enable the 8604, set the GAE **RDY/STBY** switch to **RDY**.
- To disable the amplifier, set the **RDY/STBY** switch to **STBY**.

5.4.3. Pre Test

1. Connect a load.
2. Turn on AC power to amp under test. The standby LED should be on.
3. Enable the amplifier
4. Approximately 1 second later, the standby LED should go out and the ready LED will come on.
5. Push the **INTLK** button on the exerciser and note that the amp immediately goes into standby. All the while the exerciser LEDs should, agree with the amplifier under test.
6. Set S1 up.
7. Connect a scope probe to T201
8. Increase the input signal until an error signal is seen on T201. See Illustration 5-1. Oscillations should not be observed on any part of the waveform.
9. Check operation of overload reset by resetting **OVERLOAD** on GAE. Check for ground to ground oscillations by attaching a scope probe to a ground test point.

5.4.4. Verify Slave Input

1. Attach channel 1 probe of an oscilloscope to T103.
2. Attach channel 2 probe of an oscilloscope to input waveform.
3. Set S1 down.
4. Set **FUNCTION** switch to **15**.
5. Push **+1** button on the exerciser.
6. Observe that channel 1 on the scope is in phase with channel 2.
7. Push **-1** button on the exerciser.
8. Observe that channel 1 on the scope is out of phase with channel 2.

5.4.5. Current Monitor Zero Adjustment

1. Disable the amp.
2. Remove the load.
3. Set the **SHUNT MON** switch to **MON**.
4. Connect a digital voltmeter across J102.
5. Adjust P107 for 0.000 on the meter.

5.4.6. Amplifier Offset Adjustment

1. Install a shorting plug in J101.
2. Enable the amp.
3. Set S1 down.
4. Connect a DC voltmeter to T103.
5. Adjust R204 for 0.00 Vdc (± .001 Vdc) on the voltmeter.

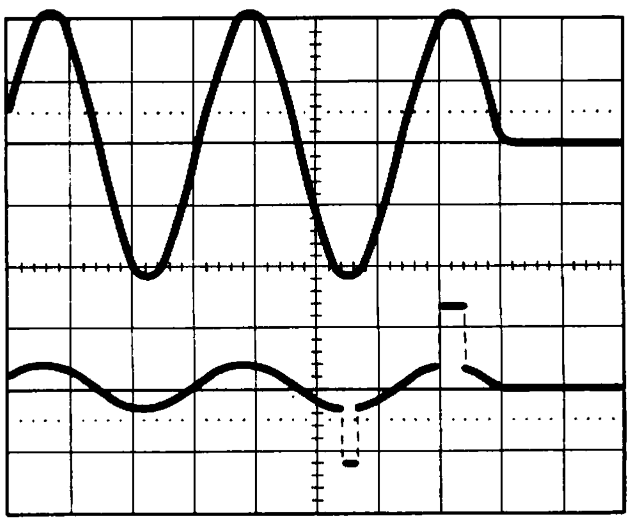

Illustration 5-1 Error Signal

5.4.7. Output Stage Bias Adjustment

This procedure tests each output well with voltmeter and adjusts for correct reading. Wells are to be tested in pairs (front two, then rear two); adjustments are for each pair in tandem. Illustration 5-2 shows the voltmeter test points.

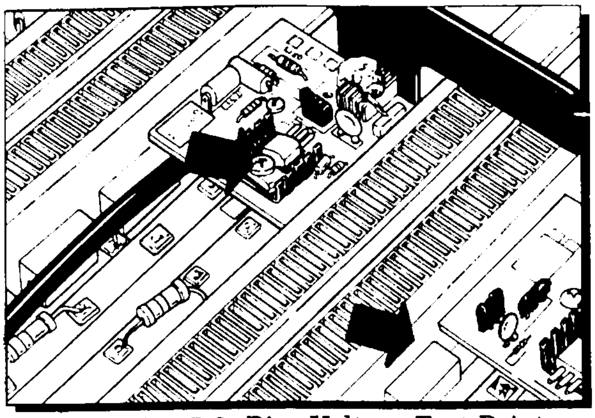

Illustration 5-2 Bias Voltage Test Points

Note: Allow output well heat sinks to cool to ambient temperature before performing this test.

1. Enable Amplifier
2. Set S1 down.

For rear pair of output wells:

3. Connect voltmeter as shown in Illustration 5-3.
4. Adjust R853 on predriver board #4 for reading of .400 VDC ±.01 VDC.

For front pair of output wells:

5. Connect voltmeter as shown in Illustration 5-2.
6. Adjust R615 on predriver board #1 for reading of .400VDC, ± .01 volts.

Note: This adjustment must be balanced between the two output wells controlled by each adjustment point. Measure all four points and identify the median values. Adjust R614 and R853 to bring the median values to .400 Vdc.

7. Check voltage across R611, R721, R734, R811, R921, and R935. The voltages should be within .01 volt. If not repeat steps 3 and 4 or 5 and 6.

5.4.8. Static Bridge Balance

1. Install a shorting plug in J101.
2. Enable the amplifier.
3. Connect positive DC voltmeter leads from front heat sink and to PNP resistor on heatsink #2 as shown in Illustrations 5-3 and 5-4. Connect negative lead to ground.
4. Adjust R234 to 0. 0Vdc ± .2Vdc.

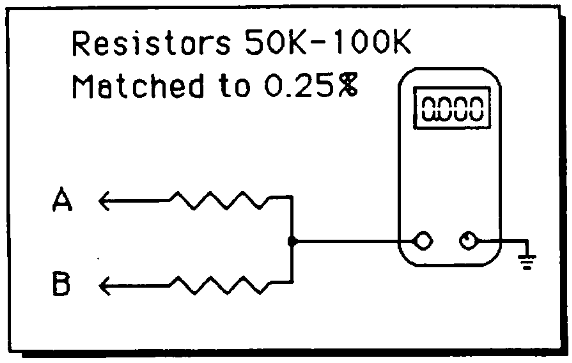

Illustration 5-3 Test Probe

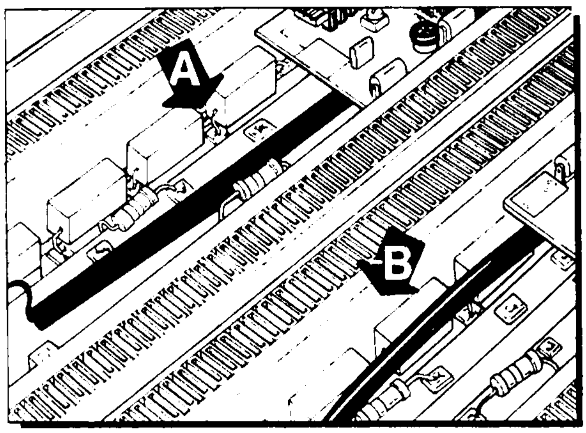

Illustration 5-4 Static Balance Test Points

5.4.9. Adjust and Verify Simulator Zero

This test requires interior of unit to be at a stable operating temperature. If unit has recently been operating under load, allow ten minutes of cool-down time (with fans operating) to obtain valid readings.

1. Disconnect Load.
2. Enable the amplifier
3. Set S1 down.
4. Determine the heatsink temperature by one of the following means:
- Measure the heatsink temperature with a laboratory grade thermometer.
- Measure the DC voltage from T302 to ground and multiply by 100. Result is temperature in degrees Kelvin.
7. Adjust R305 for the multiplier output voltage determined in step 5.
8. Determine the heatsink temperature by one of the following means:
- Measure the heatsink temperature with a laboratory grade thermometer.
- Measure the DC voltage from T303 to ground and multiply by 100. Result is temperature in degrees Kelvin.
9. Determine simulator output voltage from Table 5-4.
10. Connect a DC voltmeter from T300 to ground.
11. Adjust R305 for the simulator output voltage determined in step 8.

To verify proper operation follow these steps with the GAE:

12. Set the GAE **METER RANGE** switch to **10V**.
13. Set **METER SEL** switch to **T(+1)**. The meter reading should be 9.1 volts.
14. Rotate the **METER SEL.** switch to the other three T() positions. Each should have a magnitude of 9.1 volts, two positive two negative.

DegC	Deg. K	Simulator Output Voltage
10	283	SAT
11	284	SAT
12	285	SAT
13	286	SAT
14	287	SAT
15	288	SAT
16	289	SAT
17	290	12.96
18	291	12.84
19	292	12.72
20	293	12.60
21	294	12.48
22	295	12.36
23	296	12.24
24	297	12.12
25	298	12.00
26	299	11.88
27	300	11.74
28	301	11.64
29	302	11.52
30	303	11.4
31	304	11.28
32	305	11.16
33	306	11.04
34	307	10.92
35	308	10.80
36	309	10.68
37	310	10.56
38	311	10.44
39	312	10.32
40	313	10.20
41	314	10.08
42	315	9.96
43	316	9.84
44	317	9.72
45	318	9.60
46	319	9.48
47	320	9.36
48	321	9.24
49	322	9.12
50	323	9.00

Table 5-4 Temperature to Voltage Conversion

5.4.10. Analog Input Common Mode

1. Connect a signal generator to 8604 input for a common mode signal input. See Illustration 5-5.

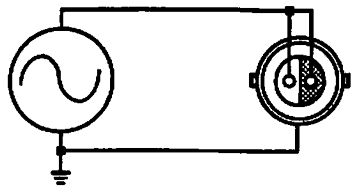

Illustration 5-5 Common Mode Input Connection

2. Set signal generator for a 1 Khz continuous trianglewave, 5 Vac peak.
3. Connect an oscilloscope to T103.
4. Adjust N100 and C119 for minimum amplifier output.

5.4.11. Analog Input Offset

1. Connect a load.
2. Set S1 up.
3. Set B5 up.
4. Connect a DC voltmeter to T103
5. Adjust P102 for 0.000 VDC, ± 2 mV.

5.4.12. Adjust Dynamic Gain

1. Set dynamic gain (R236) full clockwise.

5.4.13. Establish DC Reference

A DC reference needs to be established before adjusting the DAC. Chose one of the following two methods:

Method #1, measure with a relative reading voltmeter:

1. Insert a shorting plug into J1.
2. Measure T100 with a Fluke 8060A or equivalent meter using the 200 mV range.
3. Press the "REL" button to eliminate this initial offset.

Note: Do not change the voltmeter reference established by this step from this point.

Method #2, measure without a relative reading voltmeter:

1. Insert a shorting plug into J1.
2. Measure T100 with and DC voltmeter on the 200 mV range.
3. Record this reading. This reference will be used for the next step.

5.4.14. DAC Calibration

1. Disable the amp and reconnect the load.
2. Set the amplifier for digital input and constant current.
   - B7 - Right
   - B5 - Up
3. Set S1 down.
4. Set S2 in the middle position.
5. Set **FUNCTION** to 1.
6. Set **SHUNT MON** to **SHUNT**.
7. Set **GAIN** and **ZERO** to **CAL** positions,
8. Enable the 8604.
9. Connect a voltmeter to T100.
10. Adjust P101 for 10.000 VDC at T100.

11. Observe the LEDs, both red and green for the pattern shown in Illustration 5-6.

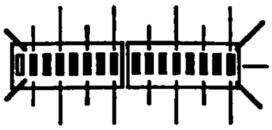

Illustration 5-6 LED 7FFF Pattern

12. Set the **ZERO OUT** switch down
13. Adjust P100 for 0.000 VDC at T100 using the 200 mV range.
14. Observe the LEDs, both red and green for the pattern shown in Illustration 5-7.

Illustration 5-7 LED 0000 Pattern

15. Repeat these adjustments until interaction is minimal.

5.4.15. Gate Adjust

1. Set the GAE **FUNCTION** switch to **0**
2. Set **µS/Sample** to **1000**.
3. Set switch S1 up.
4. Record voltage at T103.
5. Set the GAE **µS/Sample** to **10.**
6. Set **X5/X1** to **X5**.
7. Adjust C102 to make the readings equal.
8. Check all other sampling rates to make sure that the offset stays within ± 1 mv.

5.4.16. Adjust Clipper

1. Set the GAE to **FUNCTION** switch to **2**.
2. Set the **µS/Sample** to 100
3. Connect an oscilloscope to T103.
4. Remove jumper B8.
5. Adjust P106 for 110 Volts peak at T103.

5.4.17. Adjust Current Monitor Common Mode

1. Set the GAE **SCOPE SEL** switch to **ERR**.
2. Set the **µS/Sample** to **200**
3. Adjust N102 for less than 0.5 LSB (no **GAE** LEDs on) error on the 12 Bit linearity range.

5.4.18. Verify Linearity

1. Set the **FUNCTION** switch to **4**.
2. Set **DELAY/CONTINUOUS/PULSE** switch to **DELAY**.
3. Adjust **DELAY** control maximum clockwise.
4. Set both **GAIN** and **ZERO** switches to **VAR**.
5. Adjust both **GAIN** and **ZERO** controls as needed to verify less than .5 LSB linearity error for currents greater than 12.5 Amperes.
6. Set **Shunt/Mon** switch to **Mon** and repeat step 5 for current monitor linearity.
7. Set the **FUNCTION** switch to **5**.
8. Set the **LINEARITY RANGE** switch to **14 Bit**, **DELAY/CONTINUOUS/PULSE** to **CONT**.
9. Adjust the **GAIN** and **ZERO** controls as needed to verify less than 0.5 LSB linearity error for currents less than 12.5 Amperes.

5.4.19. Verify Stability

1. Disable the amplifier.
2. Set on **FUNCTION** switch to **10**.
3. Set **µS/Sample** to **10**.
4. Adjust **DELAY** for 20 milli-seconds of off time between pulses.
5. Set up scope for differential input (A-B or invert and add).
6. Connect scope non-inverted channel to T201 on main board.
7. Connect scope inverted channel to T105 on main board.
8. Enable the amplifier.
9. Observe for oscillations on waveform.
10. Repeat Step 9 for Function 11 and 12.
11. Continue to observe all waveform as amplifier warms up. There should be no oscillations seen at any time.

Proceed to Section 5.6 for final tests and adjustments.

5.5. TESTING 8604 WITHOUT A GAE

The only way to insure the 8604 is adjusted for optimum performance is to use automatic test equipment or a TECHRON GAE, Gradient Amplifier Exerciser. This section covers field adjustments to expedite an amplifier's return to service if ATE or a TECHRON GAE is not available.

5.5.1. Disable/Enable The Amplifier

The disable/enable procedure is used in several of the tests that follow. As applicable, instructions will refer back to this sequence. Illustration 5-8 shows the location of B4 on the 8604 main board. The remote enable position used only when testing with a GAE.

- ENABLE-Move jumper B4 to the left pair of pins.
- DISABLE-Remove jumper B4.
- REMOTE ENABLE-Move jumper B4 to the right pair of pins.

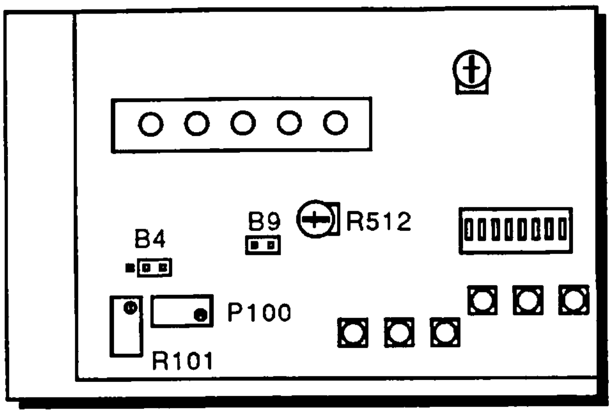

Illustration 5-8 B4 Location

5.5.2. Verify Slave Input

1. Attach an oscilloscope probe to T103.
2. Set S1 down.
3. Enable the amplifier.
4. Connect a signal generator as follows:
   - Inverting to J2-23
   - Non-Inverting J2-10
5. Observe the scope for proper wave form.

5.5.3. Current Monitor Zero Adjustment

1. Disable the amplifier.
2. Remove load.
3. Connect a DC voltmeter to J102.
4. Adjust P107 for 0.000 Vdc.

5.5.4. Output Voltage Offset Adjustment

1. Install a shorting plug in J101.
2. Enable the amplifier.
3. Set S1 to Slave position (down).
4. Connect a DC voltmeter to T103.
5. Adjust R204 for 0.000 VDC, ± .001Vdc.

5.5.5. Adjust Output Stage Bias

Bias adjustment is the same with or without the GAE. Refer to section 5.4.7. for adjusting output stage bias.

5.5.6. Adjust Static Balance

Static bridge balance adjustment is the same with or without the GAE. Refer to section 5.4.8. for adjusting the static balance.

5.5.7. Verify Simulator Zero

To adjust the temperature simulator output, refer to section 5.4.9., steps 1 thru 11.

5.5.8. Analog Input Adjustment

1. Install a shorting plug in J101.
2. Enable the amplifier.
3. Set S1 to Master (up).
4. Connect a DC voltmeter to T103.
5. Adjust P102 for 0.000 VDC ± 1.75mV.

5.5.9. Analog Input Common Mode Adjustment

1. Connect a signal generator to 8604 input for a common mode signal input. See Illustration 5-5.
2. Set signal generator for a 1 Khz continuous trianglewave, 5 Vac peak.
3. Connect an oscilloscope to T103.
4. Adjust N100 and C119 for minimum amplifier output.

5.5.10. Dynamic Gain Adjustment

1. Set R236 full clockwise.

5.5.11. DAC Offset and Adjustment

NOTE: Perform this step only if the DAC, U120, or the voltage reference IC, U121 have been replaced. Replacement of these two ICs is not recommended as field procedure. Replacement of the entire amplifier is preferred.

This procedure will require equipment that can produce a digital input at J3 of the 8604. The input signal described will be static and use hexadecimal notation.

1. Disable the amp.
2. Reconnect the load.
3. Set the amplifier for digital input B7 - Right
4. Constant voltage, B5 - Down
5. Set S1 down.
6. Set S2 in the middle position.
7. Connect a DC voltmeter to T100.
8. Write the hex value **7FFF** to port J3.
9. Enable the 8604.
10. Adjust P101 for 10.000 Vdc at T100.
11. Write the hex value **0000** to port J3.
12. Adjust P100 for 0.000 Vdc at T100.
13. Repeat these adjustments until interaction is minimal.

5.6. FINAL TESTS

This section is common to testing with and without a GAE.

5.6.1. Amplifier Protection

This section is common to testing with and without a GAE.

1. Check for proper operation of the fault circuitry by connecting the 1 K ohm fault test probe between the low PNP heatsink and the collector of the PNP predriver (see Illustration 5-9). The 8604 should enter standby with the fault LED and the overload LED on.
2. Power the unit down and back up. The amp should be enabled with the FAULT LED off.
3. Repeat Step 1 for high side PNP well.
4. Disconnect TS1 and TS2 and verify that unit enters temperature shutdown.

5.6.2. Reliability

1. Disable the amplifier.
2. Increase the AC line voltage to 228 volts AC.
3. Move B7 to the left position and B5 to the up position.
4. Connect a 500µH inductor to the amplifier OUTPUT and SAMPLED COMMON terminals.
5. Apply a signal to J101 as follows:
   +2.5 volts DC for 45 seconds
   -2.5 Volts DC for 45 seconds
6. Repeat Step 5.
7. Replace any output transistors that fail. Repeat this test until none fail.

5.6.3. Adjust High Mains Cut Off

1. Set line voltage 10% high (228.8VAC) and adjust R512 until E504 just lights.
2. Return line voltage back to normal (208VAC).

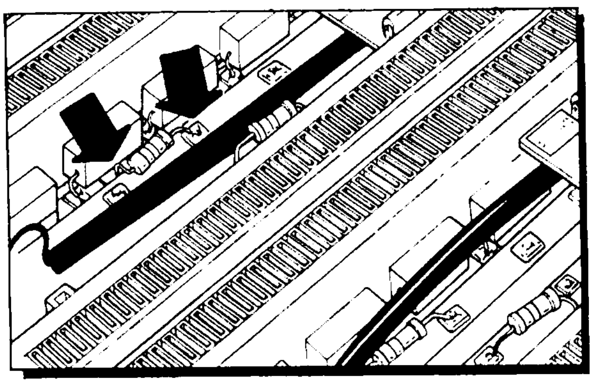

Illustration 5-9 Fault Circuit Test Point

5.6.4. Reset Clipper

Adjust P106 fully clockwise.

5.6.5. Seal All Adjustments

Use standard nail polish to seal all adjustment pots.

Note: Keep sealant away from control elements.

5.6.6. Set Switches and Jumpers

Illustration 5-10 shows the location of switches and jumpers. Refer to Table 5-5 for correct switch and jumper setting for either Master or Slave operation.

SWITCH/ JUMPER	FUNCTION	MASTER SETTING	SLAVE SETTING
B2	Eddy Current	Install	Not Critical
B4	Enable	Right	Right
B5	Current/Voltage	Up	Not Critical
B6	Compensation	Left	Not Critical
B7	Input Select	Right	Not Critical
B8	Voltage Clipper	Install	Not Critical
B9	External Shim	Remove	Not Critical
S1	Master/Slave	Up	Down
S2	Analog In	Not Critical	Not Critical

Table 5-10 Final Jumper Settings

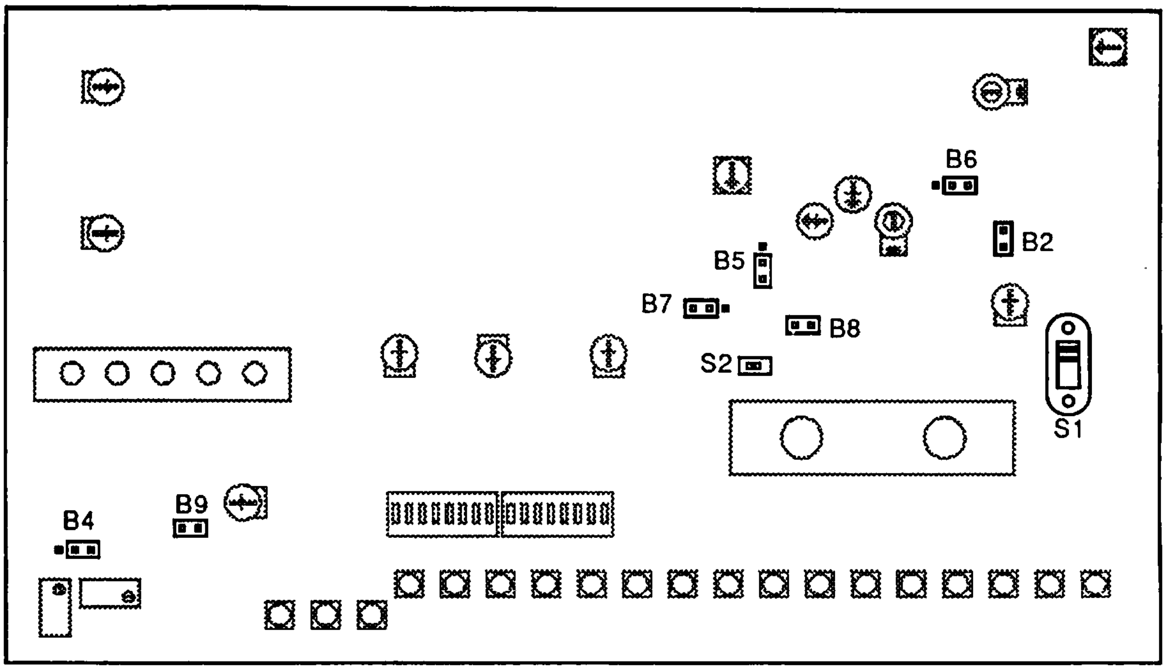

Illustration 5-10 Switch and Jumper Location

5.7. COMPONENT INTERACTION LIST

This section comprises a list of interaction between components. After replacement of any component, this table may be referenced to check other components that may need to be adjusted.

C100	NA
C101	C102
C102	ADJUST SAME
C103-C120	NA
C121	R101(SELECT)
C122	C123
C123	SAME
C124-C127	NA
C128	C102
C129	C102
C130-C132	NA
C133	SELECTED TO LOAD
C135	SELECTED TO LOAD
C136	SELECTED TO LOAD
C137	NA
C138-139	NA
C140	C123
C141	SELECTED TO LOAD
C142	NA
C200-228	NA
C300-309	NA
C400-408	NA
C500-506	NA
C600	NA
C614	NA
C650-654	NA
C700-701	NA
C750-752	NA
C800	NA
C850-853	NA
C900-901	NA
C950-953	NA
NEW C	
D100	P106
D101	P106
D102	P106
D103-105	NA
D200-211	NA
D300-305	NA
D400-413	NA
D500-511	NA
D600-601	NA
D607	NA
D650	R651
D750	NA
D850	NA
D950	NA
E100-E119	NA
E500-505	NA
K1-2	NA
L602	NA
L650	NA
L750	NA
L850	NA
L950	NA
N100	ADJUST SAME
N101	N102
N102	ADJUST SAME
N103-N110	NA
N300	R334
N302	NA
P100	ADJUST SAME
P101	ADJUST SAME
P102	ADJUST SAME
Q100-102	NA
Q200-211	NA
Q300	R334
Q301	R334
Q302-306	NA
Q200-502	NA
Q610-611	R651
Q612-621	NA
Q650	R651
Q651	NA
Q652	R651
Q700-721	NA
Q750	NA
Q800-809	NA
Q810-811	R853
Q812-821	NA

Q850	R853
Q851	NA
Q852	R853
Q900-921	NA
Q950	NA
R100	NA
R101	SELECT SAME
R102-R104	NA
R105	P102
R106	NA
R107	P106
R108	P106
R109	C102
R110-R111	NA
R112	C102
R113	P106
R114	P106
R118	N102
R119	N102
R120-R126	NA
R128	C102
R129	C102
R130	NA
R200-203	NA
R204	ADJUST SAME
R205	R204
R207-231	NA
R232-233	R236
R234	ADJUST SAME
R235	R234
R236	ADJUST SAME
R237-240	R236
R241	NA
R242-253	NA
R300-303	NA
R304	R305
R305	ADJUST SAME
R306	R305
R307-322	NA
R323	R334
R324-332	NA
R334	ADJUST SAME
R335-348	NA
R500-510	NA
R511	R512
R512	ADJUST SAME
R513	R512
R516-525	NA
R527-540	NA

R600-624	NA
R650	NA
R651	ADJUST SAME
R652	R651
R654	R651
R655	NA
R676	NA
R701-744	NA
R750	NA
R761-763	N102
R800-811	NA
R812	SELECTED WITH U800
R813-827	NA
R850-852	NA
R853	ADJUST SAME
R854-856	R853
R857-858	NA
R900-922	NA
R923	SELECTED WITH U900
R924-945	NA
R950-952	NA
T1	NA
T2	R512
U100-U119	NA
U120	P101, P100
U121	P101, P100
U122	C102
U124	R101 (SELECT)
U126	N100, C123
U127	C102
U128	C102, P102
U130	N102
U131-132	NA
U200-201	NA
U202	R204
U203	R234
U300	R305, R334
U301-302	NA
U400	P102, R512
U401-402	NA
U500-503	NA
U800	R812
U900	R923

6. REPLACEMENT PARTS AND SCHEMATICS

6.1. GENERAL PARTS INFORMATION

Section 6 contains illustrations, parts list, and schematics for the 8604 gradient amplifier. This information should be used with the service, repair and adjustment procedures in other sections.

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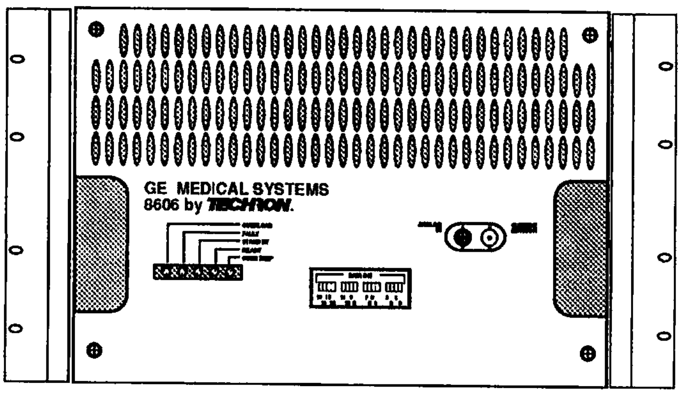
TECHRON®

SUPPLEMENT TO 8604 TECHNICAL MANUAL

Includes Service Information



8606
GRADIENT AMPLIFIER

Techron Division of Crown International, Inc., 1718 W. Mishawaka Road, Elkhart, IN 46517-4095

K80384-9
12/90

TECHRON
LIMITED ONE-YEAR WARRANTY

SUMMARY OF WARRANTY

CROWN INTERNATIONAL, INC., 1718 W. Mishawaka Road, Elkhart, Indiana 46517 (Warrantor) warrants to the ORIGINAL COMMERCIAL PURCHASER ONLY of each NEW TECHRON product, for a period of one (1) year from the date of purchase by the original purchaser (warranty period) that the product is free of defects in materials or workmanship and will meet or exceed all advertised specifications for such a product. This warranty does not extend to any subsequent purchaser or user, and automatically terminates upon your sale or other disposition of our product.

ITEMS EXCLUDED FROM WARRANTY

We are not responsible for product failure caused by misuse, accident or neglect. This warranty does not extend to any product on which the serial number has been defaced, altered or removed. It does not cover damage to loads or any other products or accessories resulting from Techron product failure. It does not cover defects or damage caused by your use of unauthorized modifications, accessories, parts, or service.

WHAT WE WILL DO

We will remedy any defect in materials or workmanship by repair, replacement, or refunds. If a refund is elected, then you must make the defective or malfunctioning component available to us free and clear of all liens or other encumbrances. The refund will be equal to the actual purchase price, not including interest, insurance, closing costs, and other finance charges less a reasonable depreciation on the product from the date of original purchase. Warranty work can only be performed at our authorized service centers or at our factory. Expenses in remedying the defect will be borne by Crown, including one way surface freight shipping costs within the United States. (Purchaser must bear the expense of shipping the product between any foreign country and the port of entry in the United States and all taxes, duties, and other custom's fee for such foreign shipments.)

HOW TO OBTAIN WARRANTY SERVICE

You must notify us of your need for warranty service not later than ninety (90) days after expiration of the warranty period. We will give you an authorization to return it to us for service. All components must be shipped in a factory pack or equivalent which, if needed, may be obtained from us for a nominal charge. Corrective actions will be taken within a reasonable time of the date of receipt of the defective product by us. If the repairs made by us are not satisfactory, notify us immediately.

DISCLAIMER OF CONSEQUENTIAL AND INCIDENTAL DAMAGES

YOU ARE NOT ENTITLED TO RECOVER FROM US ANY CONSEQUENTIAL OR INCIDENTAL DAMAGES RESULTING FROM ANY DEFECT IN OUR PRODUCT. THIS INCLUDES ANY DAMAGE TO ANOTHER PRODUCT OR PRODUCTS RESULTING FROM SUCH A DEFECT.

WARRANTY ALTERATIONS

NO PERSON HAS THE AUTHORITY TO ENLARGE, AMEND, OR MODIFY THIS WARRANTY. THE WARRANTY IS NOT EXTENDED BY THE LENGTH OF TIME WHICH YOU ARE DEPRIVED OF THE USE OF THE PRODUCT. REPAIRS AND REPLACEMENT PARTS PROVIDED UNDER THE TERMS OF THIS WARRANTY SHALL CARRY ONLY THE UNEXPIRED PORTION OF THIS WARRANTY.

DESIGN CHANGES

We reserve the right to change the design of any product from time to time without notice and with no obligation to make corresponding changes in products previously manufactured.

LEGAL REMEDIES OF PURCHASER

There is no warranty which extends beyond the terms hereof. This written warranty is given in lieu of any oral or implied warranties not contained herein. WE DISCLAIM ALL IMPLIED WARRANTIES, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. No action to enforce this Warranty shall be commenced later than ninety (90) days after expiration of the warranty period.

TECHRON division of Crown International, Inc.
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4/88

LIST OF EFFECTED PAGES

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1-1	0
2-1 to 2-4	0
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TABLE OF CONTENTS

ILLUSTRATIONS

TABLES AND SCHEMATICS

SECTION 1. INTRODUCTION

1.1. About This Manual

Use this manual with the Model 8604 manual, part number K80232B6.

The Model 8604 manual contains the bulk of information about Model 8606. Use the Model 8606 manual for information regarding the differences between the two models. Section 2 of this manual describes the additional theory and testing required for Model 8606. Section 3 shows the additional parts, schematics, and part numbers.

1.2. Safety

Model 8606 operates on 208 VAC 3-phase power.

⚠ WARNING

Do not attempt to service this unit in any manner unless you have read and understand the Model 8604 manual as well as this manual. The unit may carry lethal voltages whether or not the main power source is connected. Without strict adherence to safety procedures, attempts to repair or service Model 8606 could result in FATAL ELECTRICAL SHOCKS.

1.3. General Description

Model 8606 is essentially a Model 8604 with one major difference–the addition of the Eddy Current Board to the amplifier's Main Board. This addition includes a balanced input jack to the back panel.

The Eddy Current Board contains a 10 Hz low-pass filter as well as the eddy-current correction circuitry. You can read more about these additions in Section 2 of this manual.

This amplifier, like the Model 8604, is a high-power, precision, gradient amplifier capable of operating in a controlled-current mode or voltage mode. It also features a 16-bit digital input as well as an analog input.

You can combine Model 8606 amplifiers, through an interlock cable and master/slave configuration, to form one large amplifier for increased power.

For a detailed description of the amplifier, refer to Section 2 of the 8604 manual.

SECTION 2. EDDY CURRENT BOARD

2.1. Theory of Operation

Refer to Schematic J0233-7 in the back of this manual for the discussion of the eddy-current correction circuit.

The 8606 Eddy Current Board has four active RC circuits to provide pre-emphasis to the analog input of the amplifier. The circuitry inserts between the DAC input and the current control amplifier U128-B on the 8606 amplifier main board through connector J103.

R3, R4 and U1-B form a buffer/divider to isolate and drive the four RC networks on the Eddy Current Board. R3 and R4 form a divider to prevent overdriving of the common-mode input range of U3 and U4. The differentiating effects of the RC networks can double the peak voltages on step waveforms.

All four RC networks are similar and differ only by the capacitor used; therefore, we describe only one of the networks. The RC network includes C4, R8, and R17. U3-A is a high-impedance buffer that eliminates interaction between the RC network and the gain adjustment pot R21.

U2 is a precision 10 volt dc source. It sets the gain of the op-amp. J6 is a service jumper. With J6 on pins A-B, the input of U3-A connects to U2. You adjust the gain of the op-amp by measuring the ratio of T1 and T2. The operating position for J6 is on pins B-C.

U1-A and associated parts form a balanced shim input. N1 and C12 adjusts the common-mode rejection ratio. U5-A and associated parts form a 10 Hz low-pass filter to insure a pure dc shim.

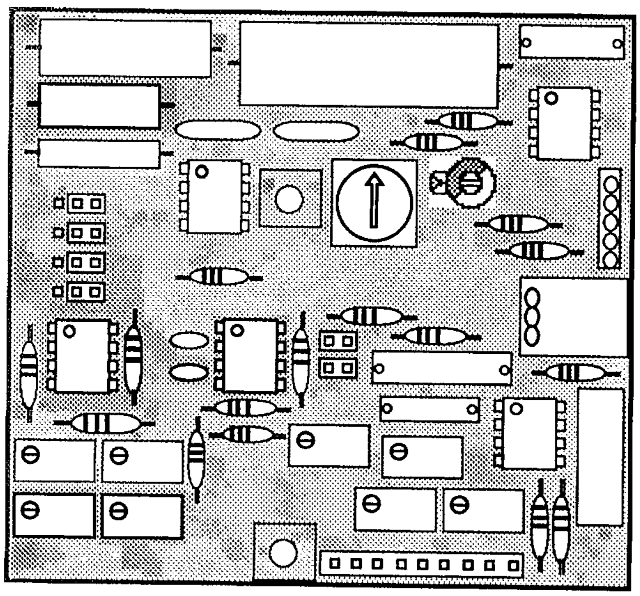

Illustration 2-1 Eddy Current Board

8606

B2 .... ON	B8 .... OFF
B4 .... RIGHT	B9 .... ON
B5 .... UP	S1 .... UP
B6 .... LEFT	S2 .... RIGHT
B7 .... LEFT	

GAE

1. PWR/VAR/CLOCK .... PWR
2. VAR/XTAL .... XTAL (Down)
3. X5/X1 .... X1
4. Microsec Sample 200
5. DELAY/CONT/PULSE ...... DEL
6. FUNCTION 2
7. ZERO VAR/CAL .... CAL (Down)
8. SHUNT/MON .... MON (Down)
9. 10A/20A SHUNT 20A
10. GAIN VAR/CAL .... CAL (Down)
11. ZERO OUT .... CAL (Up)
12. READY/STDBY .... STDBY (Right)
13. LINEARITY RANGE .... 12 Bit
14. METER SEL .... DAC
15. TRIGGER SEL TR3
16. SCOPE SEL .... MON
17. METER RANGE 10V
18. INPUT VOLTS 2.5
19. MON VOLTS 5.0

Oscilloscope

Trigger Source .... External
Trigger Mode .... Normal/ DC/ +Slope
Horz. Timebase .... 5ms per division
Channel 1 .... DC/ 20 Volts per div.
Channel 2 .... DC/ 1 Volt per div.
Vertical Mode .... Dual/ Chop
Position .... Center both Channels

Generator

Frequency .... 300 Hz
Waveform .... Square
Mode .... Tone Burst
Rate 50µs
Output 2.5Volts

Table 2-1 Initial Equipment Settings

2.2. Setup for Testing

Test the amplifier with or without using a TECHRON Gradient Amplifier Exerciser (GAE). Adhere to the same testing preparations, warnings, and requirements given in the 8604 manual, in addition to those given in this section. Find final adjustments to the Eddy Current Board in the GE System Manual.

⚠ WARNING

Shock Hazard! You must use caution to avoid touching dangerous terminals when the unit is powered and protective panels are removed.

1. Turn 8606 OFF at the rear panel circuit breakers and remove the front panel.
2. See Illustration 2-3 for equipment setup. A generator can substitute for the GAE.
3. See Table 2-1 for initial equipment settings.
4. Remove all jumpers from the Eddy Current Board and turn controls R17-R24 fully CW (clockwise).

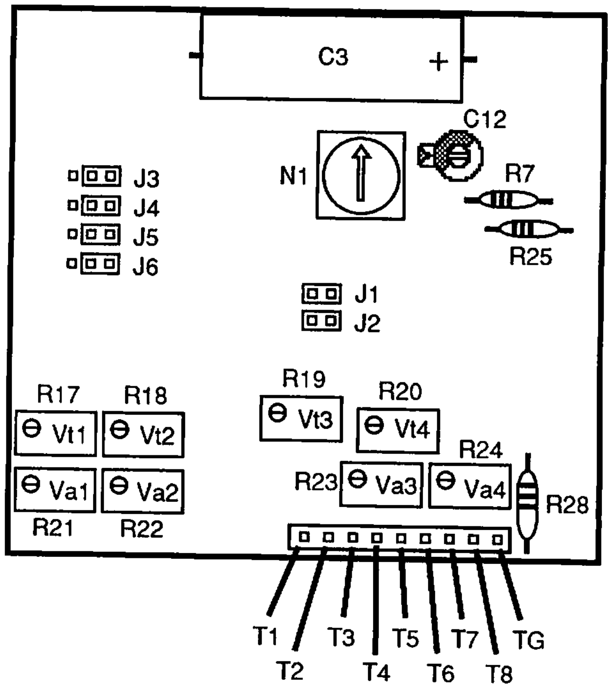

Illustration 2-2 Jumpers, Adjustments, and Test Points

2.3. Verify Signal and Reference

1. Turn 8606 ON. Observe oscilloscope: Ch2 should be a square wave ± 2.5 div. Ch1 a straight line, at no divisions.
2. Set RDY/STBY switch on GAE to RDY or, if not using a GAE, set Main Board jumper B4 LEFT to enable (See 8604 manual pg. 3-2). Ch1 signal should be the same as Ch2.

Note: See Illustration 2-2 for jumper, adjustment and test point locations.

3. Install jumper at J1 on the Eddy Current Board. Observe oscilloscope. Peaks on Ch2 should be 1 division higher than Ch1.
4. Set DVM for 20Vdc. Connect the negative lead to J101 (BNC on Main Board) shell. With the positive lead, measure the voltage on the right side of R7 on the Eddy Current Board. Results should be 10 Vdc ± .01 Vdc.

2.4. Verify Time Constants

1. Set scope for single channel display Ch1. Set the scope vertical gain Ch1 to 0.5V/Div. Waveform should be ± 1 vertical division.
2. Install J6 in the right-hand (BC) position. There should be no change in waveform.
3. Adjust R21 fully CCW. The waveform should be ± 1.2 to ± 1.4 divisions high.
4. Adjust R17 fully CCW. Leading edges of waveform should show small peaks 0.4 divisions high and three divisions long.
5. Remove J6 and install J5 in BC position.
6. Adjust R22 fully CCW (counterclockwise). The waveform should be ± 1.2 to ± 1.4 divisions high.
7. Adjust R18 fully CCW. Leading edges of waveform should show small peaks 0.4 divisions high and one division long.

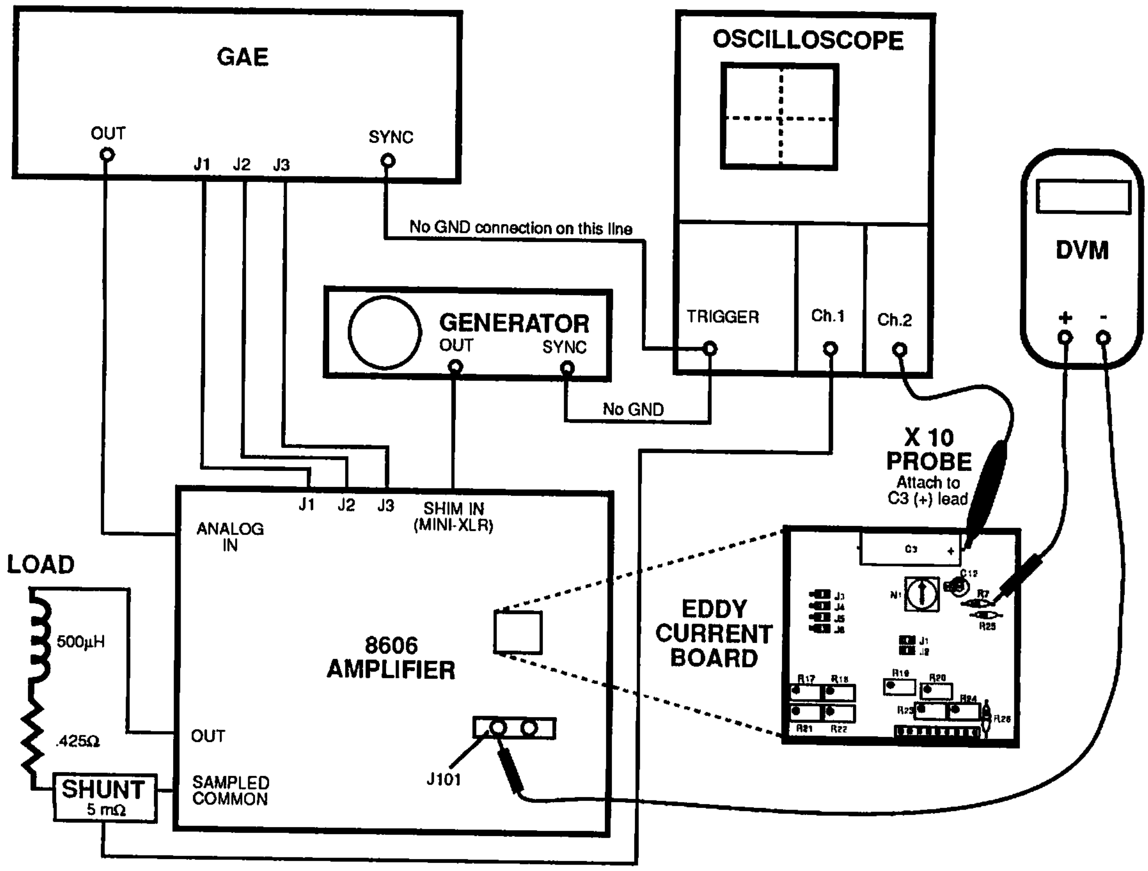

Illustration 2-3 Test Setup With GAE

8. Remove J5 and install J4 in BC position.
9. Adjust R23 fully CCW. The waveform should be ± 1.2 to ± 1.4 divisions high.
10. Adjust R19 fully CCW. There should be 0.1 vertical division of tilt on the horizontal portions of the waveforms. Leading edges should be higher than trailing edges.
11. Remove J4 and install J3 in BC position.
12. Adjust R24 fully CCW. The waveform should be ± 1.2 to ± 1.4 divisions high.
13. Adjust R20 fully CCW. There should be no change in waveform. Remove J3.

2.5. Verify Gain Adjustments

1. Install J6 in the left-hand (AB) position.
2. Connect the DVM (+) lead to T1 and adjust R17 for a voltage between 1.6 and 5 volts. All values should stabilize within 20 seconds and not drift more than ±.01 volts.
3. Connect the DVM (+) lead to T2 and adjust R21 for a voltage between 0 and 2 volts. All values should stabilize within 20 seconds and not drift more than ±.001 volts.
4. Remove J6.
5. Repeat steps 1-4 for the remaining three RC circuits using the appropriate jumper, adjustment, and test point locations.

2.6. Adjust Common Mode Rejection

1. Set GAE ZERO OUT switch down or, if not using GAE, reduce generator output to zero. All bit lights on 8606 should go out.
2. Set scope for dual trace at 0.5ms with Ch2 at 0.5V/Div. Connect Ch2 probe to left-hand leg of R25 and switch to 1X.
3. Set generator to 1kHz continuous triangle wave at 2 volts and connect, in common mode configuration (see Illustration 2-4), to Shim IN (back panel mini XLR).
4. Adjust N1 and C12 alternately to null the signal. Readjust scope if necessary.

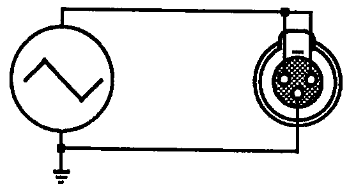

Illustration 2-4 CMR Input Connection

2.7. Verify 10Hz LP Filter

1. Connect generator to mini XLR in balanced configuration (see Illustration 2-5) and adjust a 1kHz sine wave for 2 volts (± 2 divisions on the scope).
2. Change scope to 20ms/Div. and connect Ch2 probe to top leg of R28 and switch to 10X.
3. Sweep frequency down until the sine wave is ± 1.4 divisions on the scope. This should be 10Hz ± 2Hz.
4. Install J2 and see 10Hz signal on Ch1 also. Readjust Ch1 to 0.5V/Div. if necessary.

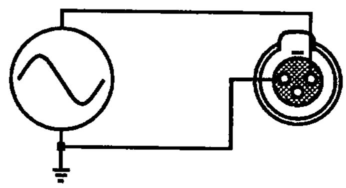

Illustration 2-5 Balanced Input

2.8. Return To Service

1. Switch GAE to STDBY or, if not using a GAE, set Main Board jumper B4 RIGHT and turn 8606 OFF.
2. Install jumpers J3, J4, J5, and J6 in the right-hand (BC) position.
3. Install the front panel.

SECTION 3. PARTS LISTS AND SCHEMATICS

3.1. General Parts Information

This section contains parts lists, schematics, and figures for the Techron 8606 Gradient Amplifier that are additional to those found in the 8604 manual. Use this information with the service, repair, testing, and adjustment procedures in Section 2.

Mechanical and structural parts are illustrated and indexed on an exploded view drawing.

Electrical and electronic parts are listed and indexed in both the exploded view drawing and the schematic parts lists.

The use of "REF." in a list means that there is no item or location number for reference.

3.2. Standard and Special Parts

Some electrical and electronic parts used in Techron products are standard items available from electronic supply houses; however, many parts are specially selected. To insure proper operation, all replacement parts should be ordered from TECHRON.

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3.6. Exploded View Parts

ITEM #	PART #	DESCRIPTION
1	C 6078-7	6-32 X .375 RDHD PH B SCREW
2	C 6776-5	#6 nylon lock washer
3	C 6961-4	6-32 nylon standoff stud
4	D 6350-9	.413 hex standoff brass 6-32
5	Q42597-7	Eddy Current Board
6	REF.	Main Board
7	C 7266-7	Mini XLR (TY3F)
8	B 5612-5	Cable, 2 conductor with shield (42 inches)
8	C 5014-3	Connector contact
8	C 7269-1	Connector housing, 3 contact
9	C 2276-1	3-48 hex nut
10	C 1824-9	#4 internal star washer
11	C 7284-0	3-48 X .375 screw
12	M20661J0	Back Panel
* 8	F11505J8	Front Panel
REF.	F10937-5	Label, Data Bit
* 7	D 7038-9	Handwell, plastic
* 22	D 6849-0	Handle, right
* 5	D 6850-8	Handle, left

* See 8604 manual Illustration 6-1 Main Chassis Exploded View

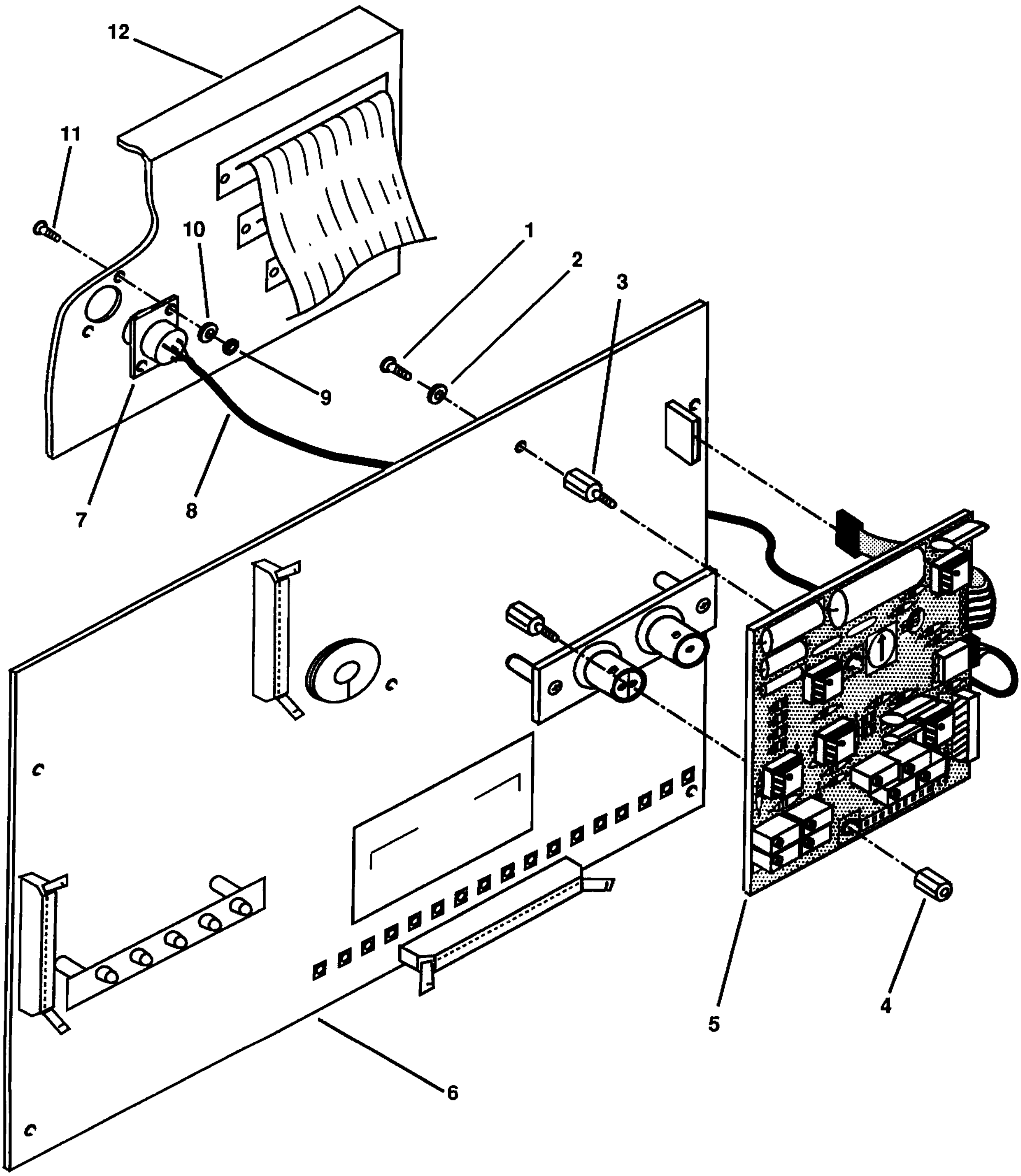

Illustration 3-1 Exploded View

3.7. Eddy Current Board Parts List

LOCATION #	PART #	DESCRIPTION
C1	C 7147-9	.47MF 50V 5% Metal Carbon Axial
C2	C 7146-1	2.0MF 50V 5% Metal Carbon Axial
C3	C 7145-3	10MF 50V 5% Metal Carbon Axial
C4	C 7148-7	.1MF 50V 5% Metal Carbon Axial
C5	C 6130-6	.1MF 50V Mono
C6	C 6130-6	.1MF 50V Mono
C7	C 3290-1	120PF Dipped Silver Mica
C8	C 3218-2	0.22MF 100V 10% Film
C9	C 7278-2	0.56MF Met Polyester 100V 10%
C10	C 5063-0	0.033MF 100V Film
C11	C 2938-6	0.1MF 200V 10% Film
C12	C 5058-0	30PF PC mnt. Trimmer Cap
C13	C 3410-5	100PF Dipped Silver Mica
J1	C 6419-3	Shunt, .025" Square Post
J2	C 6419-3	Shunt, .025" Square Post
J3	C 6419-3	Shunt, .025" Square Post
J4	C 6419-3	Shunt, .025" Square Post
J5	C 6419-3	Shunt, .025" Square Post
J6	C 6419-3	Shunt, .025" Square Post
N1	D 6613-0	Resistor network / Trimmer
R1		N/A
R2		N/A
R3	C 3686-0	4.99K ohm .25W 1% Resistor
R4	C 3686-0	4.99K ohm .25W 1% Resistor
R5		N/A
R6	C 5707-2	100K ohm .25W 1% MF Resistor
R7	C 5707-2	100K ohm .25W 1% MF Resistor
R8	C 5046-5	20K ohm .25W Resistor
R9	C 5046-5	20K ohm .25W Resistor
R10	C 5046-5	20K ohm .25W Resistor
R11	C 5046-5	20K ohm .25W Resistor
R12	C 7285-7	28.7K ohm .25W 1% Resistor
R13	C 7286-5	17.8K ohm .25W 1% Resistor
R14	C 7286-5	17.8K ohm .25W 1% Resistor
R15	C 7286-5	17.8K ohm .25W 1% Resistor
R16	C 7286-5	17.8K ohm .25W 1% Resistor
R17	C 7156-0	500K ohm Pot Multiturn
R18	C 7156-0	500K ohm Pot Multiturn

3.7. Eddy Current Board Parts List (Continued)

LOCATION #	PART #	DESCRIPTION
R19	C 7156-0	500K ohm Pot Multiturn
R20	C 7156-0	500K ohm Pot Multiturn
R21	C 7157-8	5K ohm Pot Multiturn
R22	C 7157-8	5K ohm Pot Multiturn
R23	C 7157-8	5K ohm Pot Multiturn
R24	C 7157-8	5K ohm Pot Multiturn
R25	C 2883-4	100K ohm .25W 5% Resistor
R26	C 2883-4	100K ohm .25W 5% Resistor
R27	C 2883-4	100K ohm .25W 5% Resistor
R28	C 4221-5	300K ohm .25W 5% Resistor
U1	C 6377-3	LF412A ACN Lodrift OP Amp
U2	C 7012-5	LT102IDCN8-10 IC
U3	C 6377-3	LF412A ACN Lodrift OP Amp
U4	C 6377-3	LF412A ACN Lodrift OP Amp
U5	C 7012-5	LT102IDCN8-10 IC
REF.	C 7160-2	9 pos Test Point Header
REF.	C 7268-3	3 pin Right Angle Header
REF.	D 6641-1	5 pos Ribbon Cable Connector
REF.	D 6693A0	PC Board, Eddy Current

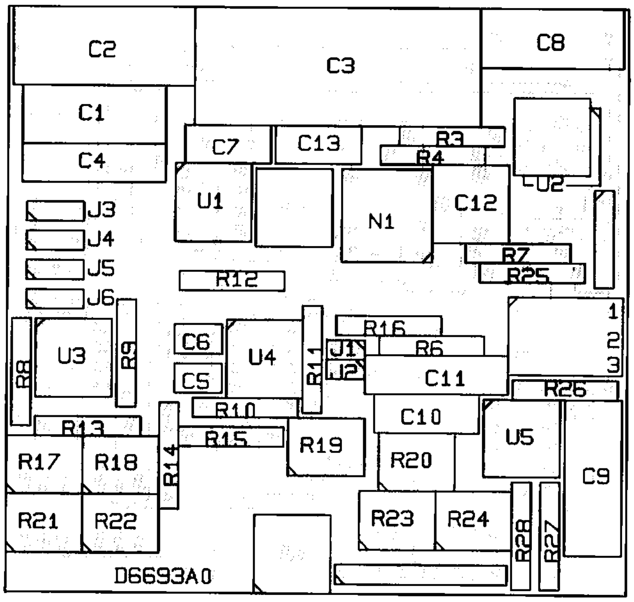

Illustration 3-2
Circuit Board, Eddy Current Module

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6.6. MAIN CHASSIS EXPLODED VIEW

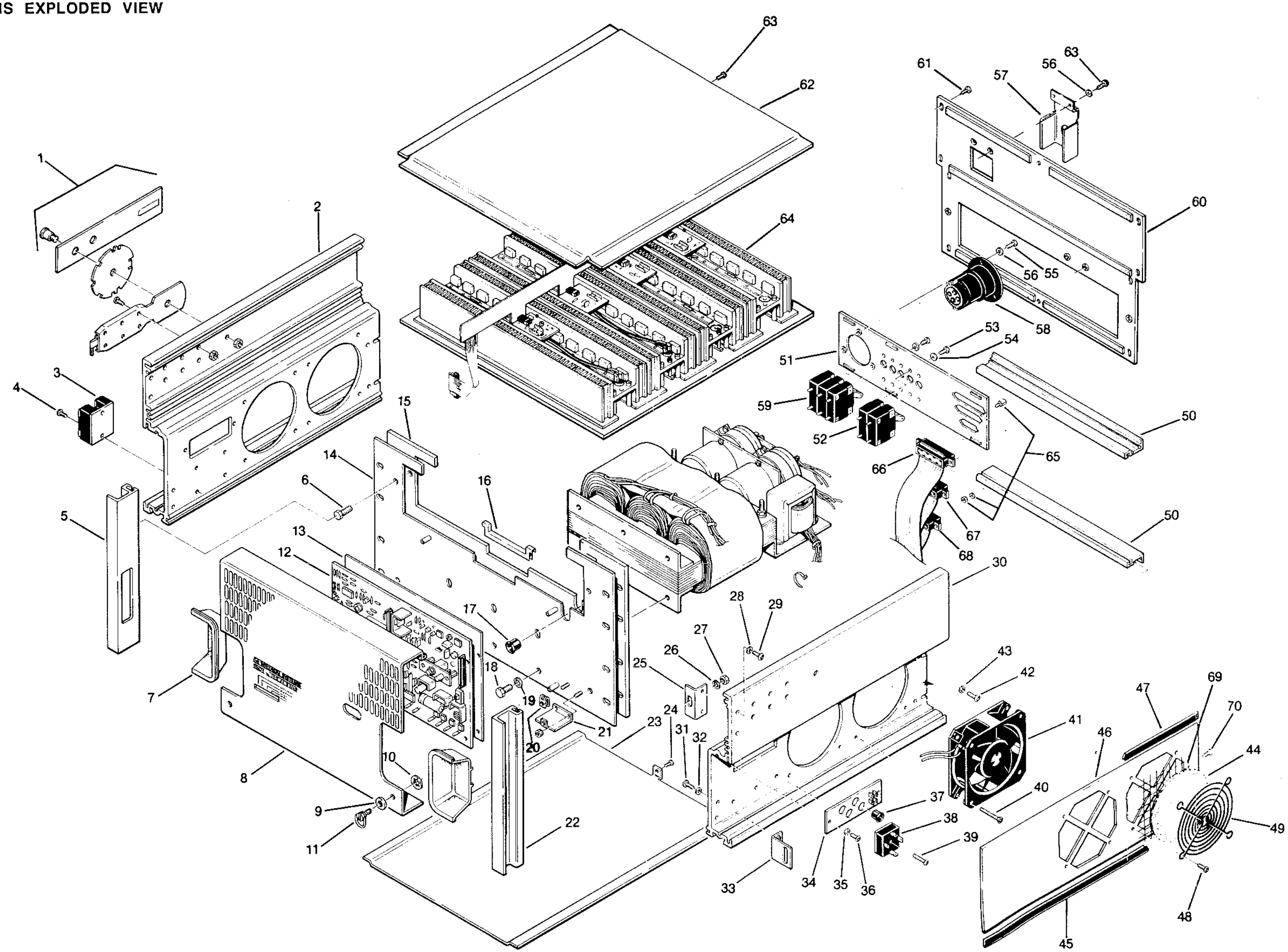


Illustration 6-1 Main Chassis Exploded View

6.7. MAIN CHASSIS PARTS LIST

ITEM #	PART #	QTY.	DESCRIPTION
1	D 6289-9	1 PR.	SLIDES, 18" WITH HARDWARE
2	F10756J8	1	PANEL, LEFT SIDE
3	C 7308-7	2	SOLID STATE RELAY, 40AMP
4	C 2228-2	9	8-32 X 5/8" MACHINE SCREW
5	D 6093K1	1	HANDLE, LEFT
6	C 6522-4	10	5/16-18 X 3/4" CAPSCREW
7	D 6108-1	2	HANDWELL
8	F10868J1	1	PANEL, FRONT
9	C 6816-0	2	NYLON WASHER
10	C 6507-5	2	#82 1/4 TURN STUD RETAINER
11	C 6506-7	2	#82 1/4 TURN FASTENER
12	—	1	CIRCUIT BOARD, MAIN
13	D 6146-1	1	INSULATOR, MAIN CIRCUIT BOARD
14	M20462L8	1	SKIN, FRONT PANEL
15	F10869J9	1	SUBPANEL, FRONT
16	B 5564-8	4.5"	CONTINUOUS GROMMET
17	C 4014-4	9	1/2" SNAP BUSHING
18	C 6522-4	10	5/16-18 X 3/4" CAPSCREW
19	C 6519-0	10	5/16 SPLIT RING LOCKWASHER
20	C 6505-9	2	#82 1/4 TURN RECEPTACLE
21	F10493J8	2	BRACKET, FRONT PANEL
22	D 6094K9	1	HANDLE, RIGHT
23	F10762J6	1	COVER, BOTTOM
24	C 5099-4	2	8-32 X .37 MACHINE SCREW
25	M20338-6	2	BRACKET, TOP SIDE
26	C 6519-0	10	5/16 SPLIT RING LOCKWASHER
27	C 6524-0	6	5/16-18 NUT
28	C 2279-5	10	#10 STAR WASHER
29	C 5305-5	10	10-32 X 1/2" FLAT HEAD MACHINE SCREW
30	F10755J0	1	PANEL, RIGHT SIDE
31	C 2049-2	10	10-32 X 1/2" MACHINE SCREW
32	C 2279-5	10	#10 STAR WASHER
33	M20339-4	2	BRACKET, BOTTOM SIDE
34	M43224A9	2	FAN TERMINAL PC BOARD
35	C 5594-4	10	#6 STAR WASHER
36	C 1954-4	8	6-32 X 1/4" MACHINE SCREW
37	C 4014-4	9	1/2" SNAP BUSHING
38	C 4305-6	3	35 AMP BRIDGE RECTIFIER
39	C 4252-0	3	8-32 X 7/8" MACHINE SCREW
40	C 2109-4	16	6-32 X 1/2" SOCKET CAP SCREW
41	C 6947-3	4	FAN,4.7" BALL BEARING
42	C 4017-7	8	10-24 X 3/4" THREAD FORMING SCREW
43	C 2279-5	10	#10 STAR WASHER
44	D 5459A7	4	FOAM, FAN FILTER
45	F10494-7	4	SLIDE, FAN SIDE PANEL
46	F10761J8	2	PANEL, FAN SIDE
47	F10494-7	4	SLIDE, FAN SIDE PANEL

ITEM #	PART #	QTY.	DESCRIPTION
48	D 6309-5	16	6-32 X 1/4" BLACK HEX HEAD SCREW
49	C 6596-8	4	COVER, FAN
50	F10753J5	2	RAIL, BACK PANEL
51	M20463K8	1	PANEL, 8604 CONNECTOR
52	C 6552-1	1	CIRCUIT BREAKER, 1A, 2 POLE, 240 VAC
53	C 4758-6	4	6-32 X 1/4 BLACK MACHINE SCREW
54	C 5594-4	10	#6 STAR WASHER
55	C 5297-4	4	8-32 X .37 TRUSS HEAD
56	C 1951-0	6	#8 STAR WASHER
57	F10919J2	1	COVER, OUTPUT
58	C 6549-7	1	FEMALE TWIST LOC208 VAC
59	C 6422A5	1	CIRCUIT BREAKER, 20A, 3 POLE, 240 VAC
60	M20464L4	1	PANEL, 8604 BACK
61	C 4035-9	8	#10-3/8" THREAD FORMING SCREW
62	F10766J7	1	COVER, TOP
63	C 5099-4	2	8-32 X .37 MACHINE SCREW
64	—	1	OUTPUT SHELF ASSEMBLY
65	C 6731-1	1	MOUNTING KIT
66	D 6431-7	1	J1 CABLE
67	D 6427-5	1	J2 CABLE
68	H42739-5	1	J3 CABLE
69	F10639J6	4	WIRE MESH, FAN FILTER
70	C 6078-7	16	6-32 X .37 ROUND HEAD MACHINE SCREW
	S 2162-6	---	UNISET 905-73 HEATSINK COMPOUND
	C 1811-6	---	4" CABLE TIE
	C 1812-4	---	7" CABLE TIE

6.8. HEAT SINK SHELF EXPLODED VIEW

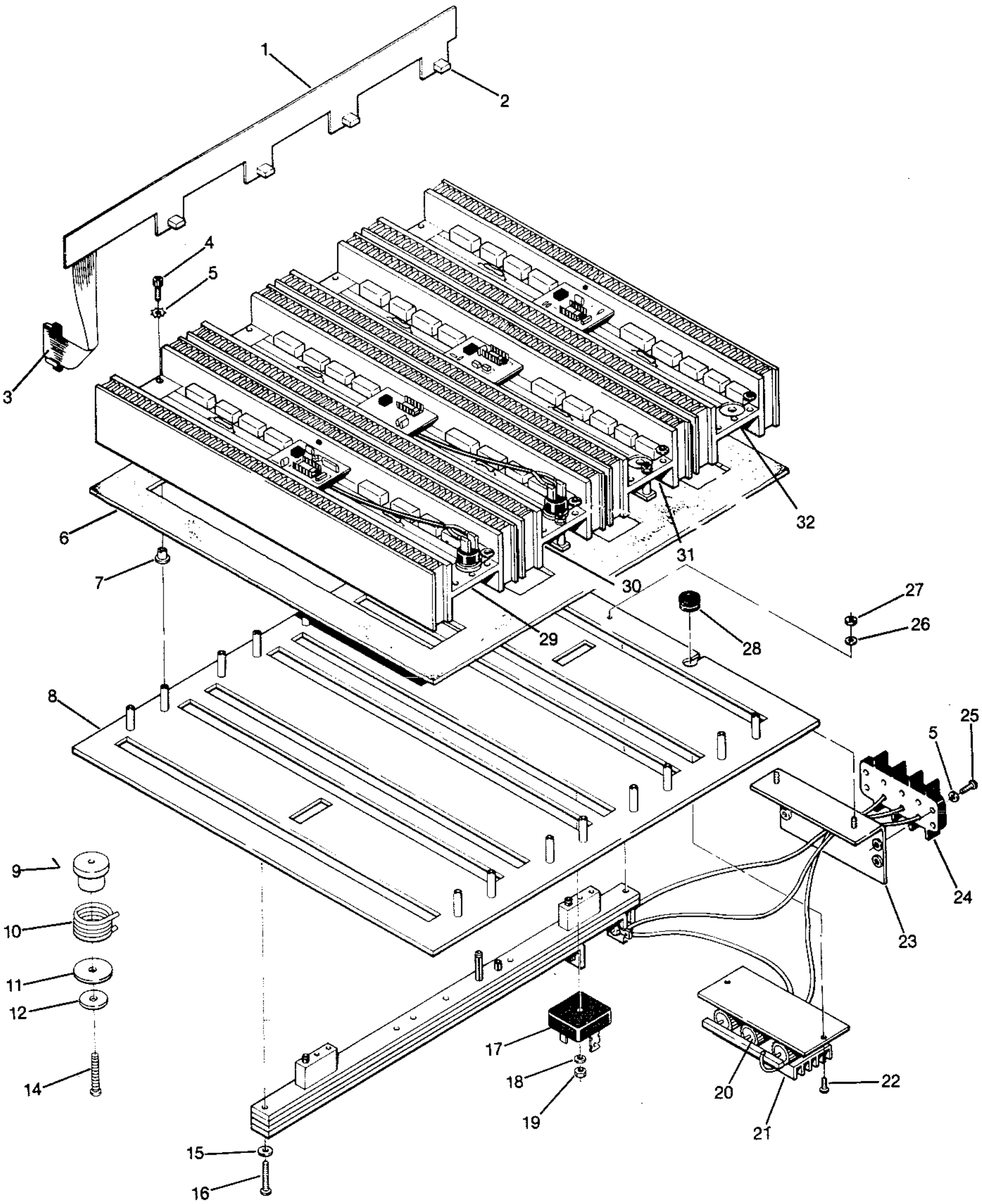


Illustration 6-2 Heat Sink Shelf Exploded View

6.9. HEAT SINK SHELF PARTS LIST

ITEM #	PART #	QTY.	DESCRIPTION
1	M43453-6	1	INTERCONNECT ASSEMBLY, HARDBOARD
2	C 6563-8	4	RECEPTACLE, 10-PIN
3	D 6346-7	1	7" CABLE AND CONNECTOR
4	C 5024-2	16	8-32 X 3/4" SOCKET HEAD SCREW
5	C 1951-0	24	#8 STAR WASHER
6	D 6145B9	1	HEATSINK SHELF INSULATOR
7	C 6729-5	16	#8 FIBER SHOULDER WASHER
8	M20505-0	1	HEATSINK SHELF
9	F10899-7	1	MOLDED COIL MOUNT
10	F10912-8	1	OUTPUT COIL
11	D 6418-4	1	COIL MOUNT
12	D 3609-1	1	FIBER WASHER
13			----DELETED----
14	C 6977-0	1	6-32 X 1 1/2" BRASS MACHINE SCREW
15	C 3575-5	4	WASHER, FIBER
16	C 6744-4	1	6-32 X 1 1/8" FLAT HEAD SCREW
17	C 4305-6	1	35A BRIDGE
18	C 2279-5	1	#10 STAR WASHER
19	C 2170-6	1	10-32 HEX NUT
20	C 6299-9	3	.1 OHM 50W RESISTOR
21	F10532J3	1	CURRENT SENSING HEATSINK
22	C 6014-2	2	8 X 5/8" PAN HEAD SCREW, SELF TAP
23	20456J5	1	BARRIER BLOCK MOUNT
24	C 6424-3	1	3 TERMINAL BARRIER BLOCK
25	C 2228-2	4	8-32 X 5/8" ROUND HEAD SCREW
26	C 5594-4	2	#6 INTERNAL STAR WASHER
27	C 1889-2	2	6-32 HEX NUT
28	C 1566-6	1	.375 GROMMET, GROOVED
29	—	1	OUTPUT ASSEMBLY, HI NPN
30	—	1	OUTPUT ASSEMBLY, HI PNP
31	—	1	OUTPUT ASSEMBLY, LO PNP
32	—	1	OUTPUT ASSEMBLY, LO NPN

6.10. POWER SUPPLY EXPLODED VIEW

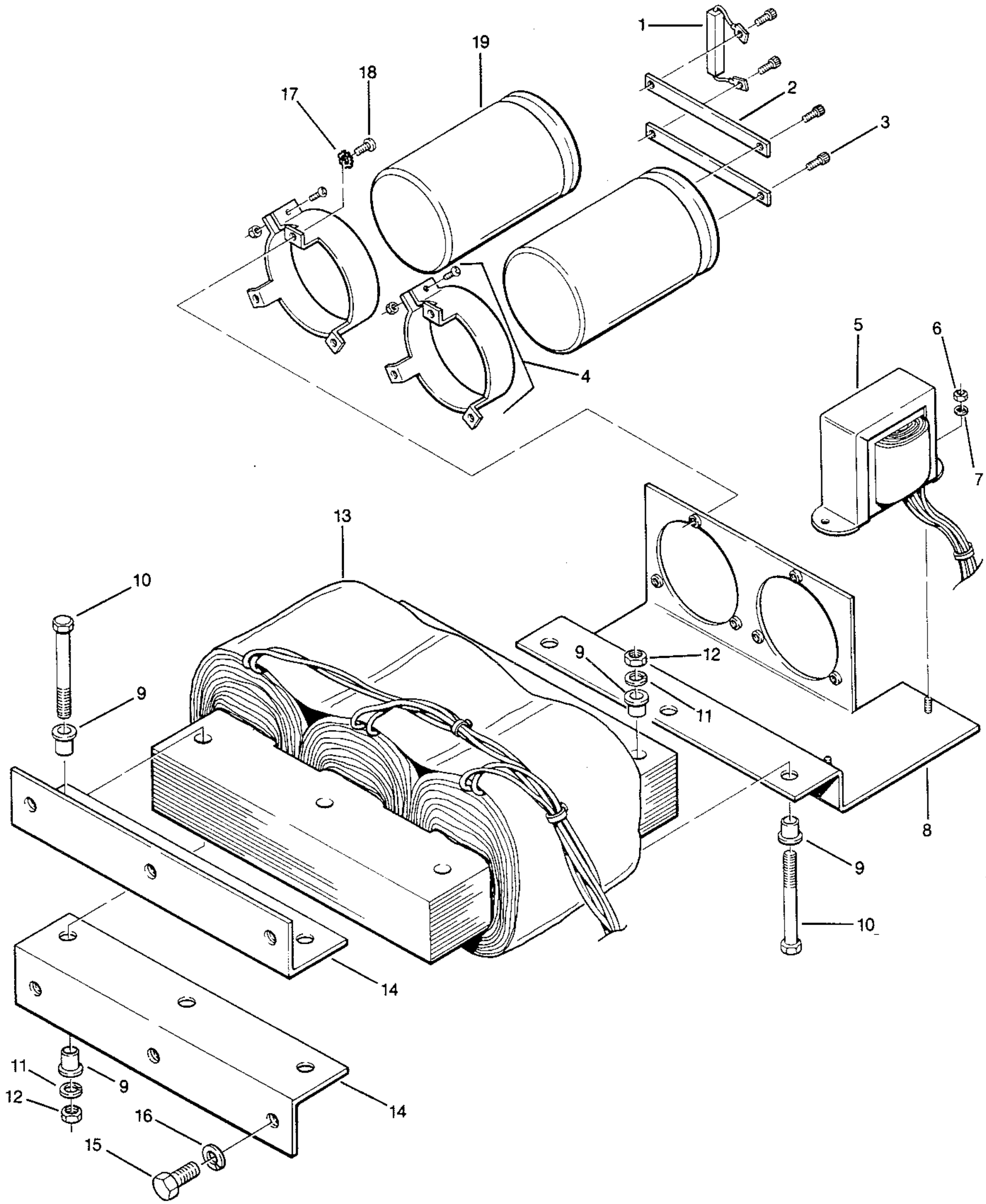


Illustration 6-3 Power Supply Exploded View

6.11. POWER SUPPLY PARTS LIST

ITEM #	PART #	QTY.	DESCRIPTION
1	C 6598-4	1	5K OHM 10W
2	F10795-7	2	BAR, CAPACITOR CONNECTING
3	C 6530-7	4	10-32 X 1/2" SOCKET CAPSCREW
4	C 6477-1	2	BRACKET, 2 1/2" CAPACITOR
5	M20489-7	1	208 CONTROL TRANSFORMER
6	C 1986-6	2	8 X 32 HEX NUT
7	C 1951-0	8	#8 STAR WASHER
8	M20441A6	1	BRACKET, MOUNTING - TRANS & CAP
9	C 6502-6	12	1/4" NYLON SHOULDER WASHER
10	C 6521-6	6	1/4-20 X 3.5 CAPSCREW
11	C 6518-2	6	1/4" LOCKWASHER
12	C 6523-2	6	1/4-20 NUT
13	D 6477-0	1	8604 POWER TRANSFORMER
14	M20337-8	2	BRACKET, POWER TRANSFORMER
15	C 6522-4	4	5/16-18 X 3/4" CAPSCREW
16	C 6519-0	3	5/16" LOCKWASHER
17	C 1951-0	6	#8 STAR WASHER
18	C 2271-2	6	8-32 X 3/4" MACHINE SCREW
19	D 6091-9	2	5000MF 200V CAPACITOR
	S 2162-6	—	UNISET 905-73 HEAT SINK COMPOUND
	C 1811-6	—	4" CABLE TIE
	C 1812-4	—	7" CABLE TIE

6.12. BUS BAR EXPLODED VIEW

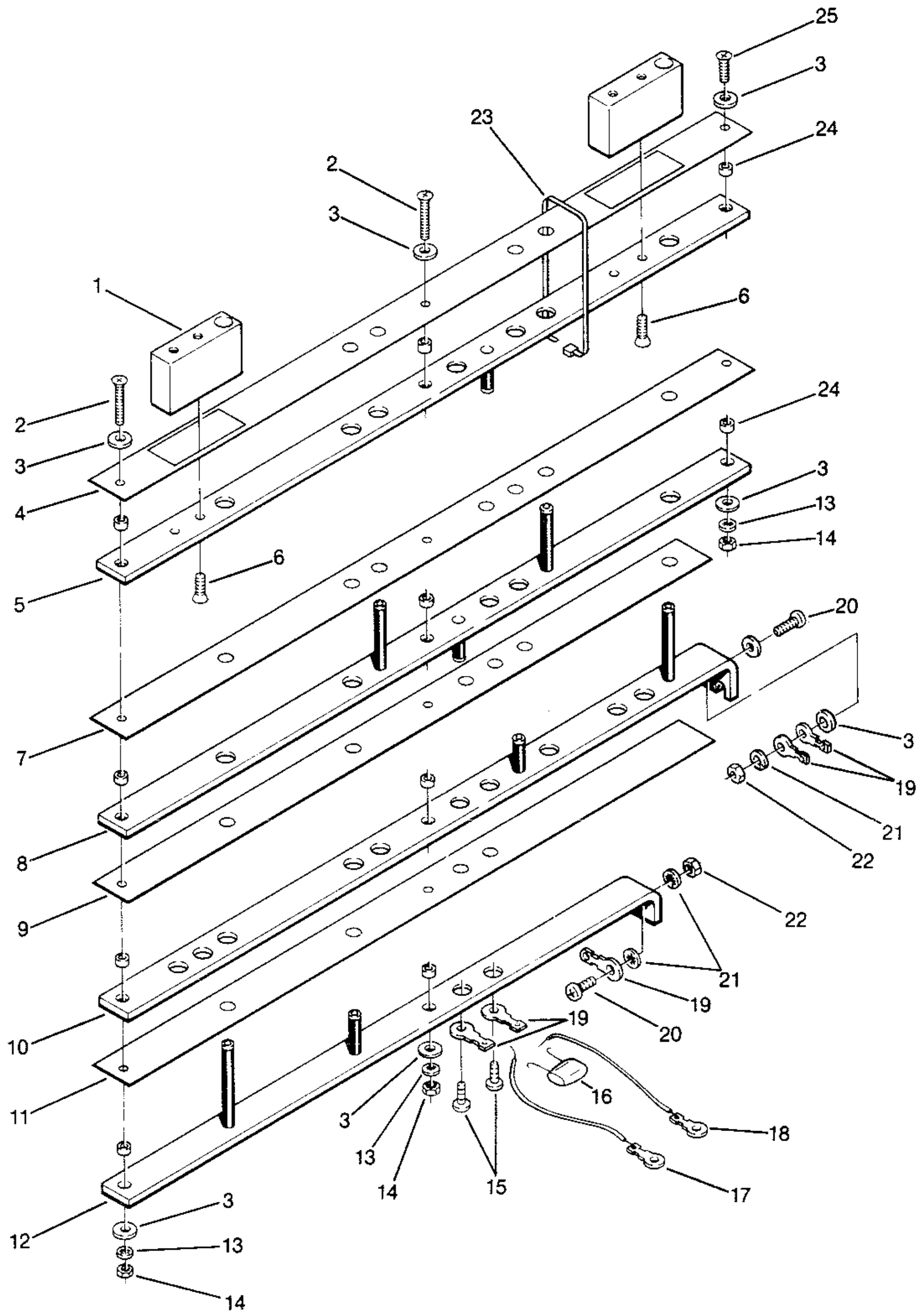


Illustration 6-4 Bus Bar Exploded View

6.13. BUS BAR PARTS LIST

ITEM #	PART #	QTY.	DESCRIPTION
1	F10526-6	2	+VCC BLOCK
2	C 6744-4	2	6-32 X 1 1/8" FLAT HEAD SCREW
3	C 3575-5	6	1/2" X .195 FIBER WASHER
4	D 6159-4	1	+VCC INSULATOR
5	M20401-2	1	+VCC BUS BAR
6	C 2274-6	4	8-32 X 3/8" FLAT HEAD SCREW
7	D 6162-8	1	-VCC INSULATOR
8	M20402-0	1	-VCC BUS BAR
9	D 6161-0	1	COMMON OUTPUT INSULATOR
10	M20531-6	1	COMMON OUTPUT BUS BAR
11	D 6160-2	1	OUTPUT INSULATOR
12	M20532-4	1	OUTPUT BUS BAR
13	C 5594-4	3	#6 STAR WASHER
14	C 1889-2	3	6-32 HEX NUT
15	C 2155-7	2	SCREW
16	D 4289-1	1	.47MF 200V POLY
17	—		NEGATIVE SUPPLY WIRE (BLUE)
18	—		POSITIVE SUPPLY WIRE (RED)
19	D 2934-4	6	SOLDER LUG .218 HOLE
20	C 6529-9	2	8-32 X 1/2" MACHINE HEAD SCREW
21	C 1951-0	2	#8 INTERNAL STAR WASHER
22	C 1986-6	2	8-32 HEX NUT
23	C 1812-4	1	7" CABLE TIE
24	C 5963-1	6	.141 X .250 X .125 NYLON SPACER
25	C 6345-0	1	6-32 X 1" FLAT HEAD SCREW

6.14. MAIN BOARD COMPONENT LAYOUT

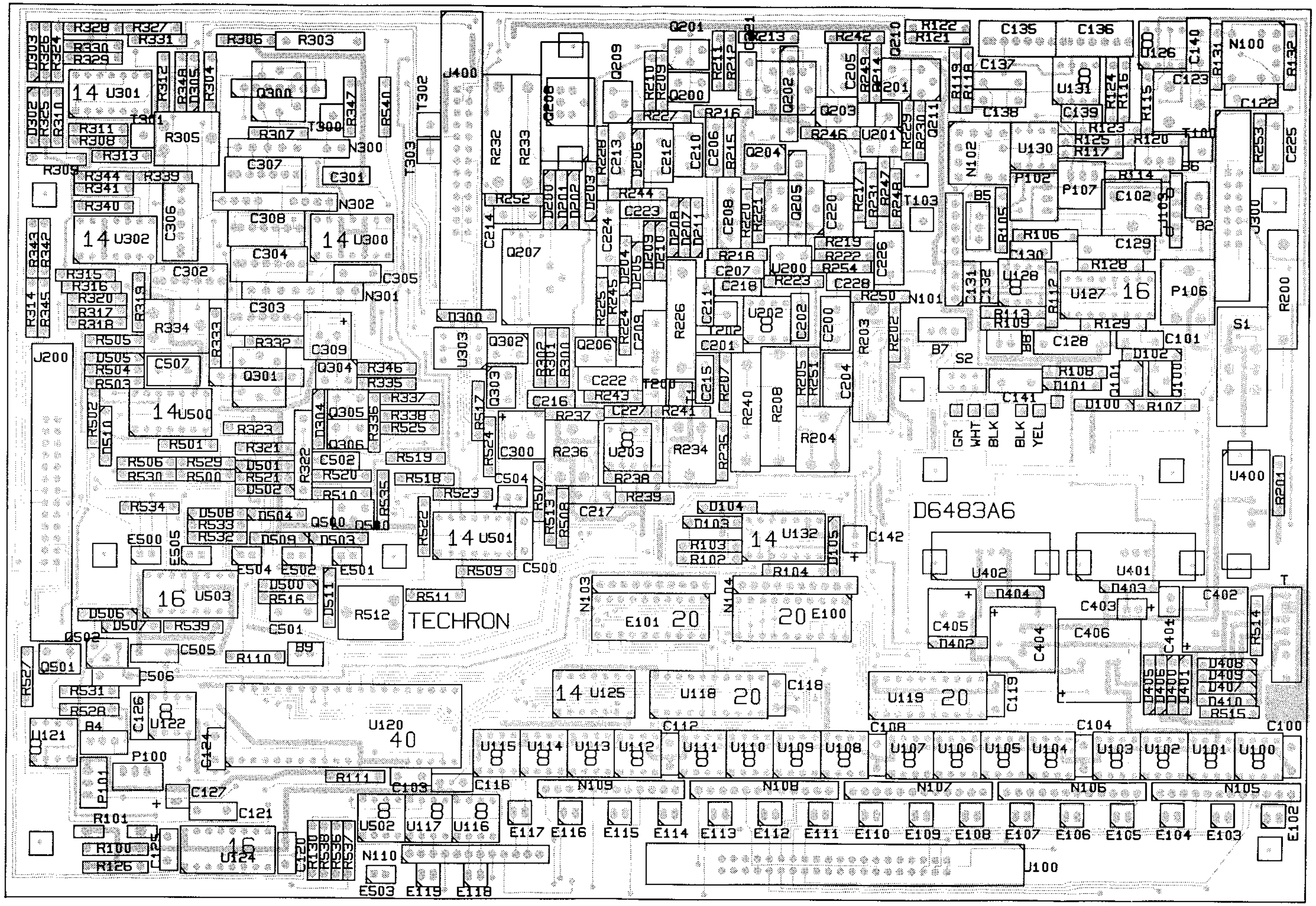


Illustration 6-5 Main Board Component Layout

6.15. MAIN BOARD SCHEMATIC PARTS

LOCATION	CPN	DESCRIPTION
B 2, B4-B9	C 6420-1	.025 SQ POST, #87307-2
	C 6419-3	SHUNT,.025 SQ POST 2 POS
C 100	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 101	C 2820-6	5.0PF MICA #D155C050D0
C 102	C 5058-0	30PF PC MNT.TRIMMER CAP
C 103	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 104	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 108	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 112	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 116	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 118	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 119	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 120	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 121	C 4295-9	180PF DIPPED SLIVER MICA CAP
C 122	C 3410-5	100PF DIPPED SILVER MICA
C 123	C 5058-0	30PF PC MNT.TRIMMER CAP
C 124	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 125	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 126	C 2821-4	10PF MICA
C 127	C 3728-0	10µF 50V VERT
C 128	C 6229-6	1750PF 63V 1% STYR
C 129	C 6229-6	1750PF 63V 1% STYR
C 130	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 131	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 132	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 135	D 4284-2	7330 PF 100V 2% STYR
C 136	D 4284-2	7330 PF 100V 2% STYR
C 137	C 4813-9	0.068µF100V CARB
C 138	C 4813-9	0.068µF100V CARB
C 139	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 140	C 3290-1	120PF DIPPED SILVER MICA
C 141	C 3409-7	47PF DIPPED SILVER MICA
C 142	C 5362-6	2.2µF 50V VERT ELECTROLYTIC
C 200	C 3410-5	100PF DIPPED SILVER MICA
C 201	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 202	C 6227-0	20PF MICA #D155E200JO
C 204	C 3409-7	47PF DIPPED SILVER MICA
C 205	C 3409-7	47PF DIPPED SILVER MICA
C 208	C 2342-1	27PF DIPPED SLVR MICA CAPC,
C 210	C 3627-4	82PF MICA #D155E820JO
C 211	C 2342-1	27PF DIPPED SLVR MICA CAPC,
C 212	C 3627-4	82PF MICA #D155E820JO

LOCATION	CPN	DESCRIPTION
C 214	C 2820-6	5.0PF MICA #D155C050D0
C 216	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 217	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 218	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 220	C 3409-7	47PF DIPPED SILVER MIC
C 221	C 2342-1	27PF DIPPED SLVR MICA CAPC,
C 222	C 3996-3	.0047µF200V 5%FILM
C 223	C 1751-4	0.01µF500V DISC
C 224	C 5243-8	0.1µF250V 5% POLYESTER
C 225	D 4448-3	56PF160V 2.5%STYR
C 226	C 3409-7	47PF DIPPED SILVER MICA
C 228	C 2342-1	27PF DIPPED SLVR MICA CAPC,
C 300	C 3729-8	100µF 16V VERT
C 301	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 302	C 5053-1	18µF 50V NP VERTICAL
C 302	C 5053-1	18µF 50V NP VERTICAL
C 303	C 7281-6	.27 µF METAL POLYESTER 10%
C 305	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 306	C 5053-1	18µF 50V NP VERTICAL
C 307	C 7281-6	.27 µF METAL POLYESTER 10%
C 309	C 3729-8	100µF 16V VERT
C 401	C 3728-0	10µF 50V VERT
C 402	C 4477-3	470 µF 35V VERT
C 403	C 3728-0	10µF 50V VERT
C 404	C 4477-3	470 µF 35V VERT
C 405	C 3729-8	100µF 16V VERT
C 406	C 7004-2	3300µF 16V 20% RAD ELECLYTIC C
C 500	C 1751-4	0.01µF500V DISC
C 501	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 502	C 1751-4	0.01µF500V DISC
C 504	C 6096-9	3.3µF 50V LOW LEAK
C 505	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 506	C 5639-7	0.1µF 63VOLT CERAMIC CAP
C 507	C 1751-4	0.01µF500V DISC
C 508	C 5825-2	470PF DIPPED SILVER MICA
D 100	C 3181-2	SILICON DIODE, 1N4148
D 101	C 3181-2	SILICON DIODE, 1N4148
D 102	C 5900-3	ZENER DIODE, 1N960B
D 103	C 3181-2	SILICON.DIODE, 1N4148
D 104	C 3181-2	SILICON DIODE, 1N4148
D 105	C 3181-2	SILICON DIODE, 1N4148
D 200	C 3181-2	SILICON DIODE, 1N4148
D 201	C 3181-2	SILICON DIODE, 1N4148
D 202	C 3181-2	SILICON DIODE, 1N4148
D 203	C 3181-2	SILICON DIODE, 1N4148

LOCATION	CPN	DESCRIPTION
D 204	C 3181-2	SILICON DIODE, 1N4148
D 205	C 3181-2	SILICON DIODE, 1N4148
D 206	C 3181-2	SILICON DIODE, 1N4148
D 207	C 3181-2	SILICON DIODE, 1N4148
D 208	C 3181-2	SILICON DIODE, 1N4148
D 209	C 3181-2	SILICON DIODE, 1N4148
D 210	C 3181-2	SILICON DIODE, 1N4148
D 211	C 3181-2	SILICON DIODE, 1N4148
D 300	C 3181-2	SILICON DIODE, 1N4148
D 302	C 3181-2	SILICON DIODE, 1N4148
D 303	C 3181-2	SILICON DIODE, 1N4148
D 304	C 3181-2	SILICON DIODE, 1N4148
D 305	C 3181-2	SILICON DIODE, 1N4148
D 400	C 2851-1	RECTIFIER, 1N4004 SILICON
D 401	C 2851-1	RECTIFIER, 1N4004 SILICON
D 402	C 2851-1	RECTIFIER, 1N4004 SILICON
D 403	C 2851-1	RECTIFIER, 1N4004 SILICON
D 404	C 2851-1	RECTIFIER, 1N4004 SILICON
D 405	C 2851-1	RECTIFIER, 1N4004 SILICON
D 406	C 2851-1	RECTIFIER, 1N4004 SILICON
D 407	C 2851-1	RECTIFIER, 1N4004 SILICON
D 408	C 2851-1	RECTIFIER, 1N4004 SILICON
D 409	C 2851-1	RECTIFIER, 1N4004 SILICON
D 410	C 2851-1	RECTIFIER, 1N4004 SILICON
D 500	C 3181-2	SILICON DIODE, 1N4148
D 501	C 3181-2	SILICON DIODE, 1N4148
D 502	C 3181-2	SILICON DIODE, 1N4148
D 503	C 3181-2	SILICON DIODE, 1N4148
D 504	C 3181-2	SILICON DIODE, 1N4148
D 505	C 3181-2	SILICON DIODE, 1N4148
D 506	C 3181-2	SILICON DIODE, 1N4148
D 507	C 3181-2	SILICON DIODE, 1N4148
D 508	C 3181-2	SILICON DIODE, 1N4148
D 509	C 3181-2	SILICON DIODE, 1N4148
D 510	C 3181-2	SILICON DIODE, 1N4148
D 511	C 3181-2	SILICON DIODE, 1N4148
D 512	C 2851-1	RECTIFIER, 1N4004 SILICON
E 100	C 7019-0	10 SEG LED BAR DISPLAY
E 101	C 7019-0	10 SEG LED BAR DISPLAY
	C 7067-9	20 PIN WIRE WRAP SOCKET
E 102	C 7135-4	RED T1 LED
E 103	C 7135-4	RED T1 LED
E 104	C 7135-4	RED T1 LED
E 105	C 7135-4	RED T1 LED
E 106	C 7135-4	RED T1 LED
E 107	C 7135-4	RED T1 LED
E 108	C 7135-4	RED T1 LED

LOCATION	CPN	DESCRIPTION
E 109	C 7135-4	RED T1 LED
E 110	C 7135-4	RED T1 LED
E 111	C 7135-4	RED T1 LED
E 112	C 7135-4	RED T1 LED
E 113	C 7135-4	RED T1 LED
E 114	C 7135-4	RED T1 LED
E 115	C 7135-4	RED T1 LED
E 116	C 7135-4	RED T1 LED
E 117	C 7135-4	RED T1 LED
E 118	C 7135-4	RED T1 LED
E 119	C 7135-4	RED T1 LED
E 500	C 4341-1	TI 3/4 RED L.E.D.
E 501	C 4341-1	TI 3/4 RED L.E.D.
E 502	C 4430A0	T 1.75 GREEN LED
E 503	C 7135-4	RED T1 LED
E 504	C 4431-0	YELLOW L.E.D.
E 505	C 4341-1	TI 3/4 RED L.E.D.
J 100	C 6884-8	40 PIN EJECT HEADER #102332-9
J 101	C 6977-2	BNC TWINAX
J 102	C 6011-8	BNC, PANEL MOUNT
J 103	C 7132-1	5PIN HEADER, SHROUDED
J 200	C 6463-1	STRAIT.EJECT 26P HDR
J 300	C 6461-5	STRAIT,EJECT 14P RIBBON CBL HD
J 400	C 6463-1	STRAIT.EJECT 26P HDR
N 100	D 6613-0	8604 INPUT RESISTOR/TRIMER
N 101	D 6411-9	INPUT RESISTOR NET 16 BIT GE
N 102	D 6214-7	RESISTOR TRIM NETWORK #3
N 103	C 7016-6	330Ω RES NETWORK
N 104	C 7016-6	330Ω RES NETWORK
N 105	D 6412A5	RESISTOR NETWORK A - 8603
N 106	D 6412A5	RESISTOR NETWORK A - 8603
N 107	D 6412A5	RESISTOR NETWORK A - 8603
N 108	D 6412A5	RESISTOR NETWORK A - 8603
N 109	D 6412A5	RESISTOR NETWORK A - 8603
N 110	D 6412A5	RESISTOR NETWORK A - 8603
N 300	D 4922-7	RESISTR NETWRK 16
N 301	D 4922-7	RESISTR NETWRK 16
N 302	D 6709-6	RESISTOR NETWORK #21
P 100	C 7020-8	200Ω MT POT
P 101	C 6886-3	10KΩ 20-TURN CERMET TRIMPOT
P 102	C 4843-6	100KΩ CERMET TRIM POT,
P 106	C 6346-8	2KΩ HORZ TRIMPOT
P 107	C 4843-6	100KΩ CERMET TRIM POT,

LOCATION	CPN	DESCRIPTION
Q 100	C 5135-6	2N5770 NPN
Q 101	C 5135-6	2N5770 NPN
Q 200	C 3625-8	2N4125 PNP
Q 201	C 3625-8	2N4125 PNP
Q 202	D 4837-7	SEL IT132 PNP
Q 203	C 3578-9	MPSA93 PNP
Q 204	C 3810-6	MPSA43/A42 NPN
Q 205	D 4838-5	SEL IT129 NPN
Q 206	C 3625-8	2N4125 PNP
Q 207	D 2923-7	SEL 2N4929 SS7304PNP
	C 5214-9	TO-5 HEAT SINK
	C 1250-7	TO-5 MOUNTING PAD
Q 208	C 5065-5	D40P5 PWR NPN
	C 6510-9	6107B-14MT T0220 HEAT SINK
Q 209	D 2961-7	SEL 2N3859A, SPS8010 NPN
Q 210	C 3625-8	2N4125 PNP
Q 211	C 3625-8	2N4125 PNP
Q 300	D 4837-7	SEL IT132 ,PNP
Q 301	D 4838-5	SEL IT129 NPN
Q 302	D 2961-7	SEL 2N3859A, SPS8010 NPN
Q 303	C 3625-8	2N4125 PNP
Q 304	C 3625-8	2N4125 PNP
Q 305	D 2961-7	SEL 2N3859A, SPS8010 NPN
Q 306	C 3625-8	2N4125 PNP
Q 500	C 6049-8	J-310 JFET
Q 501	C 3625-8	2N4125 PNP
Q 502	D 2961-7	SEL 2N3859A, SPS8010 NPN
R 100	C 2627-5	1. KΩ .25W 5% CF
R 101	--------	SELECTED BETWEEN 9K TO 11K ΩS
-----	C 6312-0	PC BD RESISTOR SOCKET-TEFLON
R 102	C 2631-7	10. KΩ .25W 5% CF
R 103	C 2631-7	10. KΩ .25W 5% CF
R 104	C 4223-1	360.KΩ .25W 5%CF
R 105	C 3221-6	10. MΩ .25W 5% CF RESISTOR
R 106	C 2629-1	3.3 KΩ .25W 5 CF
R 107	C 5046-5	20. KΩ .25W 5 CF
R 108	C 5046-5	20. KΩ .25W 5 CF
R 109	C 6402-9	51. Ω .25W 5% CF
R 110	C 4853-5	3.01KΩ .25W 1 MF
R 111	C 4905-3	25.5 Ω .5 W 1 MF
R 112	C 6402-9	51. Ω .25W 5% CF
R 113	C 3807-2	1.8 KΩ .25W 5 CF
R 114	C 2876-8	1.5 KΩ .25W 5% CF
R 115	C 4217-3	160.KΩ .25W 5%CF
R 116	C 4869-1	137.KΩ .5 W 1 MF
R 117	C 6878-0	47MΩ .25W 5% CF
R 118	C 5650-4	10. Ω .25W 1 MF

LOCATION	CPN	DESCRIPTION
R 119	C 5650-4	10. Ω .25W 1 MF
R 120	C 2627-5	1. KΩ .25W 5% CF
R 121	C 4867-5	49.9 Ω .25W 1 MF
R 122	C 4867-5	49.9 Ω .25W 1 MF
R 123	C 4859-2	10. KΩ .25W 1 MF
R 124	C 4859-2	10. KΩ .25W 1 MF
R 125	C 5163-8	5.1 KΩ .25W 5 CF
R 126	C 2631-7	10. KΩ .25W 5% CF
R 128	C 3115-0	1.4 KΩ .25W 1% MF
R 129	C 3115-0	1.4 KΩ .25W 1% MF
R 130	C 5169-5	330. Ω .25W 5 CF
R 200	C 6482-1	24.9KΩ 1.0W .5% MF
R 201	C 6398-9	1.31KΩ .25W .5% MF
R 202	C 2627-5	1. KΩ .25W 5% CF
R 203	C 6482-1	24.9KΩ 1.0W .5% MF
R 204	C 5062-2	100KΩ LIN.TRIM POT
R 205	C 5170-3	2.2 MΩ .25W 5 CF
R 207	C 6399-7	1.38KΩ .25W .5% MF
R 208	C 6482-1	24.9KΩ 1.0W .5% MF
R 209	C 3800-7	200. Ω .25W 5 CF
R 210	C 3800-7	200. Ω .25W 5 CF
R 211	C 6400-3	232 Ω .25W 1% MF, CRB14FX
R 212	C 6400-3	232 Ω .25W 1% MF, CRB14FX
R 213	C 4852-7	2.49KΩ .25W 1 MF
R 214	C 3686-0	4.99KΩ .25W 1 MF
R 215	C 3686-0	4.99KΩ .25W 1 MF
R 216	C 2627-5	1. KΩ .25W 5% CF
R 217	C 3686-0	4.99KΩ .25W 1 MF
R 218	C 3686-0	4.99KΩ .25W 1 MF
R 219	C 4852-7	2.49KΩ .25W 1 MF
R 220	C 6400-3	232 Ω .25W 1% MF, CRB14FX
R 221	C 6400-3	232 Ω .25W 1% MF, CRB14FX
R 222	C 2872-7	100. Ω .25W 5% CF
R 223	C 4852-7	2.49KΩ .25W 1 MF
R 224	C 2874-3	560. Ω .25W 5% CF25
R 225	C 1011-3	47. Ω .25W 5 CF3
R 226	C 6401-1	24 KΩ 1W 5% CF, CF200S
R 227	C 2874-3	560. Ω .25W 5% CF25
R 228	C 1011-3	47. Ω .25W 5 CF3
R 229	C 2872-7	100. Ω .25W 5% CF
R 230	C 2872-7	100. Ω .25W 5% CF
R 231	C 6402-9	51. Ω .25W 5% CF
R 232	C 6403-7	51 KΩ 1W 5% CF
R 233	C 6403-7	51 KΩ 1W 5% CF
R 234	C 5062-2	100KΩ LIN.TRIM POT

LOCATION	CPN	DESCRIPTION
R 235	C 3621-7	91. KΩ .25W 5 CF
R 236	C 6489-6	10K LIN PIHER POT, PT10V
R 237	C 2627-5	1. KΩ .25W 5% CF
R 238	C 5039-0	100. Ω .25W 1 MF
R 239	C 5039-0	100. Ω .25W 1 MF
R 240	C 6403-7	51 KΩ 1W 5% CF
R 241	C 2880-0	47. KΩ .25W 5% CF 25
R 242	C 4852-7	2.49KΩ .25W 1 MF
R 243	C 5169-5	330. Ω .25W 5 CF
R 244	C 1011-3	47. Ω .25W 5 CF3
R 245	C 3753-8	10. Ω .25W 5% CF
R 246	C 2876-8	1.5 KΩ .25W 5% CF
R 247	C 2876-8	1.5 KΩ .25W 5% CF
R 248	C 3619-1	6.2 KΩ .25W 5 CF
R 249	C 3619-1	6.2 KΩ .25W 5 CF
R 250	C 2630-9	3.9 KΩ .25W 5% CF
R 251	C 2630-9	3.9 KΩ .25W 5% CF
R 252	C 4346-0	33. KΩ .25W 5% CF
R 253	C 3804-9	2. KΩ .25W 5 CF
R 254	C 2631-7	10. KΩ .25W 5% CF
R 300	C 2626-7	470. Ω .25W 5% CF
R 301	C 2626-7	470. Ω .25W 5% CF
R 302	C 2626-7	470. Ω .25W 5% CF
R 303	C 7282-4	88.7KΩ 1% METAL FILM 1/2 W
R 304	C 2885-9	270.KΩ .25W 5% CF25
R 305	C 5062-2	100KΩ LIN.TRIM POT
R 306	C 5039-0	100. Ω .25W 1 MF
R 307	C 4859-2	10. KΩ .25W 1 MF
R 308	C 5235-4	110. Ω .25W 5 CF
R 309	C 3939-3	4.7 KΩ .25W 5% CF
R 310	C 4225-6	470.KΩ .25W 5%CF
R 311	C 4225-6	470.KΩ .25W 5%CF
R 312	C 3220-8	5.6 KΩ .25W 5% CF
R 313	C 5662-9	16.2KΩ .25W 1 MF
R 314	C 6402-9	51. Ω .25W 5% CF
R 315	C 4859-2	10. KΩ .25W 1 MF
R 316	C 4859-2	10. KΩ .25W 1 MF
R 317	C 6402-9	51. Ω .25W 5% CF
R 318	C 6404-5	82.5KΩ .25W 1% MF, CRB14FX
R 319	C 6405-2	11KΩ .25W 1% MF, CRB14FX
R 320	C 4859-2	10. KΩ .25W 1 MF
R 321	C 5039-0	100. Ω .25W 1 MF
R 322	C 7282-4	88.7KΩ 1% METAL FILM 1/2 W
R 323	C 5039-0	100. Ω .25W 1 MF
R 324	C 4859-2	10. KΩ .25W 1 MF

LOCATION	CPN	DESCRIPTION
R 325	C 5662-9	16.2KΩ .25W 1 MF
R 326	C 5235-4	110. Ω .25W 5 CF
R 327	C 3220-8	5.6 KΩ .25W 5% CF
R 328	C 4225-6	470.KΩ .25W 5%CF
R 329	C 2631-7	10. KΩ .25W 5% CF
R 330	C 4225-6	470.KΩ .25W 5%CF
R 331	C 3939-3	4.7 KΩ .25W 5% CF
R 332	C 6406-0	8.15KΩ .25W 1% MF
R 333	C 2885-9	270.KΩ .25W 5% CF25
R 334	C 5062-2	100KΩ LIN.TRIM POT
R 335	C 5165-3	27. KΩ .25W 5 CF
R 336	C 2626-7	470. Ω .25W 5% CF
R 337	C 2626-7	470. Ω .25W 5% CF
R 338	C 2626-7	470. Ω .25W 5% CF
R 339	C 6405-2	11KΩ .25W 1% MF, CRB14FX
R 340	C 6404-5	82.5KΩ .25W 1% MF, CRB14FX
R 341	C 4859-2	10. KΩ .25W 1 MF
R 342	C 6402-9	51. Ω .25W 5% CF
R 343	C 4859-2	10. KΩ .25W 1 MF
R 344	C 4859-2	10. KΩ .25W 1 MF
R 345	C 6402-9	51. Ω .25W 5% CF
R 346	C 5165-3	27. KΩ .25W 5 CF
R 347	C 5039-0	100. Ω .25W 1 MF
R 348	C 2631-7	10. KΩ .25W 5% CF
R 500	C 2631-7	10. KΩ .25W 5% CF
R 501	C 6407-8	39 KΩ .25W 5% CF
R 502	C 2631-7	10. KΩ .25W 5% CF
R 503	C 3939-3	4.7 KΩ .25W 5% CF
R 504	C 2632-5	15. KΩ .25W 5% CF
R 505	C 2631-7	10. KΩ .25W 5% CF
R 506	C 5168-7	2.7 KΩ .25W 5 CF
R 507	C 2883-4	100.KΩ .25W 5% CF25
R 508	C 3622-5	200.KΩ .25W 5 CF
R 509	C 2632-5	15. KΩ .25W 5% CF
R 510	C 5168-7	2.7 KΩ .25W 5 CF
R 511	C 5270-1	30. KΩ .25W 5 CF
R 512	C 6489-6	10K LIN PIHER POT, PT10V
R 513	C 2881-8	51. KΩ .25W 5 CF 25
R 514	C 2627-5	1. KΩ .25W 5% CF
R 515	C 2627-5	1. KΩ .25W 5% CF
R 516	C 3302-4	22. KΩ .25W 5% CF
R 517	C 3622-5	200.KΩ .25W 5 CF
R 518	C 4236-3	1.8 MΩ .25W 5%CF
R 519	C 2883-4	100.KΩ .25W 5% CF25
R 520	C 4219-9	220.KΩ .25W 5%CF

LOCATION	CPN	DESCRIPTION
R 521	C 2883-4	100.KΩ .25W 5% CF25
R 522	C 2627-5	1. KΩ .25W 5% CF
R 523	C 2632-5	15. KΩ .25W 5% CF
R 524	C 5168-7	2.7 KΩ .25W 5 CF
R 525	C 4220-7	240.KΩ .25W 5%CF
R 527	C 2876-8	1.5 KΩ .25W 5% CF
R 528	C 2880-0	47. KΩ .25W 5% CF 25
R 529	C 5168-7	2.7 KΩ .25W 5 CF
R 530	C 5168-7	2.7 KΩ .25W 5 CF
R 531	C 2628-3	2.2 KΩ .25W 5% CF
R 532	C 3302-4	22. KΩ .25W 5% CF
R 533	C 3302-4	22. KΩ .25W 5% CF
R 534	C 3302-4	22. KΩ .25W 5% CF
R 535	C 2872-7	100. Ω .25W 5% CF
R 536	C 2873-5	180 Ω .25W 5 CF
R 537	C 6129-8	91 Ω .25W 5% CF
R 538	C 6129-8	91 Ω .25W 5% CF
R 539	C 2627-5	1. KΩ .25W 5% CF
R 540	C 2626-7	470. Ω .25W 5% CF
U 100	C 6375-7	HCPL-2200 OP ISOLTR
U 101	C 6375-7	HCPL-2200 OP ISOLTR
U 102	C 6375-7	HCPL-2200 OP ISOLTR
U 103	C 6375-7	HCPL-2200 OP ISOLTR
U 104	C 6375-7	HCPL-2200 OP ISOLTR
U 105	C 6375-7	HCPL-2200 OP ISOLTR
U 106	C 6375-7	HCPL-2200 OP ISOLTR
U 107	C 6375-7	HCPL-2200 OP ISOLTR
U 108	C 6375-7	HCPL-2200 OP ISOLTR
U 109	C 6375-7	HCPL-2200 OP ISOLTR
U 110	C 6375-7	HCPL-2200 OP ISOLTR
U 111	C 6375-7	HCPL-2200 OP ISOLTR
U 112	C 6375-7	HCPL-2200 OP ISOLTR
U 113	C 6375-7	HCPL-2200 OP ISOLTR
U 114	C 6375-7	HCPL-2200 OP ISOLTR
U 115	C 6375-7	HCPL-2200 OP ISOLTR
U 116	C 6375-7	HCPL-2200 OP ISOLTR
U 117	C 6375-7	HCPL-2200 OP ISOLTR
U 118	C 7049-7	OCTAL D FLIP/FLOP 74LS273 SGS
U 119	C 7049-7	OCTAL D FLIP/FLOP 74LS273 SGS
U120	C 7011-7	16 BIT DAC
U 121	C 7012-5	LT102IDCN8-10 IC
U 122	C 7078-6	ADOP37FN OP AMP
U 124	C 5798-1	74LS123 DUAL MLTVBRT
U 125	C 5772-6	74LS04N HEX INVERTER
U 126	C 7075-2	OP27GN8 LINEAR TECH OP AMP

LOCATION	CPN	DESCRIPTION
U 127	C 7107-3	LF13331 QUAD FET SWITCH
U 128	C 5881-5	NE5532N DUAL OP-AMP
U 130	C 7075-2	OP27GN8 LINEAR TECH OP AMP
U 131	C 7075-2	OP27GN8 LINEAR TECH OP AMP
U 132	C 4345-2	LM339N VOLTCOMPARATR
U 200	C 6421-9	TI TL011CLP CURRENT SOURCE
U 201	C 6421-9	TI TL011CLP CURRENT SOURCE
U 202	C 6527-3	LF357 OP AMP
U 203	C 6527-3	LF357 OP AMP
U 300	C 4696-8	TLO74CN QUAD OP AMP
U 301	C 4160-5	HA1-4741-5 QUAD OP AMP
U 302	C 4696-8	TLO74CN QUAD OP AMP
U 303	C 6411-0	H11C2 OPTO SCR
U 400	C 5095-2	MC7815CT +15V.REGLTR
	C 6510-9	6107B-14MT T0220 HEAT SINK
U 401	C 5096-0	MC7915CT -15V.REGLTR
	C 6510-9	6107B-14MT T0220 HEAT SINK
U 402	C 5094-5	MC7805CT +5V.REGULTR
	C 6510-9	6107B-14MT T0220 HEAT SINK
U 500	C 4345-2	LM339N VOLTCOMPARATR
U 501	C 4345-2	LM339N VOLTCOMPARATR
U 502	C 6375-7	HCPL-2200 OP ISOLTR
U 503	C 6416-9	AM2631PC RS422 QUAD LINE DRVR
	C 4508-5	IC SOCKET, 16PIN DIP 3-640358
	C 6419-3	SHUNT,.025 SQ POST 2 POS
T 1	C 6420-1	.025 SQ POST, #87307-2
T 100	C 6420-1	.025 SQ POST, #87307-2
T 103	C 6420-1	.025 SQ POST, #87307-2
T 200	C 6420-1	.025 SQ POST, #87307-2
T 201	C 6420-1	.025 SQ POST, #87307-2
T 202	C 6420-1	.025 SQ POST, #87307-2
T 300	C 6420-1	.025 SQ POST, #87307-2
T 301	C 6420-1	.025 SQ POST, #87307-2
T 302	C 6420-1	.025 SQ POST, #87307-2
T 303	C 6420-1	.025 SQ POST, #87307-2
T	C 6481-3	AMPMOD4 8-PIN HEADER
S1	C 7106-5	ALCO DPDT AS2EG-PC
S 2	C 5080-4	DPDT PC-MNT SLIDE SWITCH
	C 7042-2	40 PIN DIP SOCKET GOLD PLATED

LOCATION	CPN	DESCRIPTION

6.16. POWER SUPPLY SCHEMATIC PARTS

LOCATION	CPN	DESCRIPTION
B1	C 6947-3	FAN,4.7" BALL BEARING
B2	C 6947-3	FAN,4.7" BALL BEARING
B3	C 6947-3	FAN,4.7" BALL BEARING
B4	C 6947-3	FAN,4.7" BALL BEARING
K1	C 7308-7	SOLID STATE RELAY, 40AMP
K2	C 7308-7	SOLID STATE RELAY, 40AMP
C400	D 6091-9	5000µF 200 VOLT CAP
C407	D 6091-9	5000µF 200 VOLT CAP
C408	D 4289-1	.47µF CAP
C409	C 2938-6	.1µF CAP
C410	C 2938-6	.1µF CAP
C411	C 2938-6	.1µF CAP
C412	C 2938-6	.1µF CAP
C413	C 2938-6	.1µF CAP
C414	C 2938-6	.1µF CAP
CB1	C 6422A5	BREAKER, 3 POLE 20 AMP
CB2	C 6552-1	BREAKER , 2 POLE 1 AMP
D411	C 4305-6	35 AMP BRIDGE RECTIFIER
D412	C 4305-6	35 AMP BRIDGE RECTIFIER
D413	C 4305-6	35 AMP BRIDGE RECTIFIER
T1	D 6477-0	8604 POWER TRANSFORMER
T2	M20489-7	8604 CONTROL TRANSFORMER, PREPED
-	C 6549-7	3 PHASE TWIST LOCK

6.17. PREDRIVER BOARD COMPONENT LAYOUT

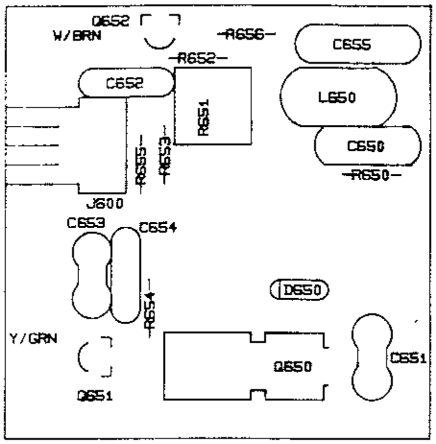


Illustration 6-6 Hi NPN Predriver Board

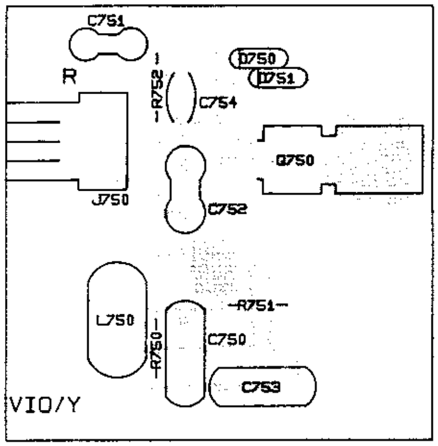


Illustration 6-7 Hi PNP Predriver Board

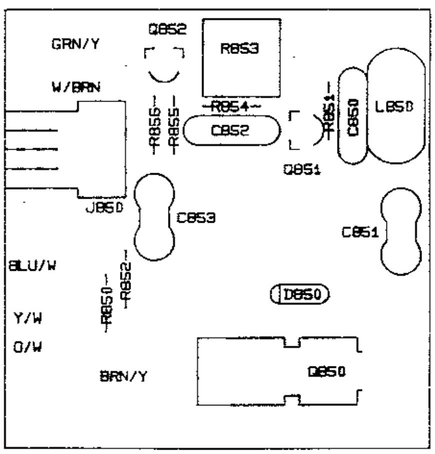


Illustration 6-8 Lo NPN Predriver Board

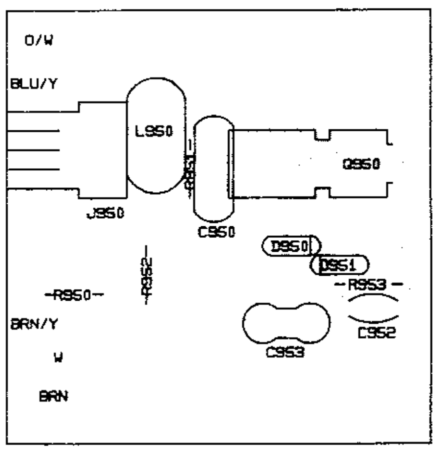


Illustration 6-9 Lo PNP Predriver Board

6.18. HIGH NPN OUTPUT STAGE PARTS LIST

LOCATION	CPN	DESCRIPTION
C600	C 6075-3	.047µF 250V 10% POLY
C650	C 3063-2	.0082µF 200V 10% FILM MYLAR
C651	C 3411-3	200PF DIPPED SILVER MICA
C652	C 3480-8	0.001µF 200V 10% FILM
C653	C 5825-2	470 PF DIPPED SILVER MICA
C654	C 3480-8	0.001µF 200V 10% FILM
C655	C 3285-1	.0022µF 200V 10% FILM
D650	C 2851-1	RECTIFIER, 1N4004 SILICON
D600	C 3181-2	SILICON DIODE, 1N4148
D601	C 3181-2	SILICON DIODE, 1N4148
J600	C 6564-6	10 PIN DOUBLE ROW HEADER
L650	C 3510-2	CHOKE, .5MH AXIAL LEAD
Q650	C 6436-7	2SC2336BR TO-220 NPN
	C 5341-0	TO-220 HEAT SINK
	C 6541-4	TO-220 TORQUE SPREADER
Q651	C 3625-8	2N4125 PNP
Q652	D 2961-7	SEL 2N3859A,SPS8010 NPN
Q600-Q609	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q610	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q611	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q612-Q621	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
R600	C 3931-0	12 Ω .25W 5% CF
R601-R610	C 3583-9	.33 Ω 5W 5% WIRE
R611	C 3931-0	12 Ω .25W 5% CF
R612	C 2872-7	100 Ω .25W 5% CF
R613	C 2872-7	100 Ω .25W 5% CF
R614	C 3931-0	12 Ω .25W 5% CF
R615-R624	C 3583-9	.33 Ω 5W 5% WIRE
R625	C 3931-0	12 Ω .25W 5% CF
R626	C 3931-0	12 Ω .25W 5% CF
R627	C 3931-0	12 Ω .25W 5% CF
R650	C 3960-9	82 Ω .25W 5% CF
R651	C 3672-0	2 KΩ TRIM POT
R652	C 2627-5	1 KΩ .25W 5% CF
R653	C 2627-5	1 KΩ .25W 5% CF
R654	C 6517-4	24 Ω .25W 5% CF
R655	C 3753-8	10 Ω .25 5% CF
R656	C 6089-4	5.6 Ω .25W 5% CF
TS1	C 6737-8	SPST NC THERMAL SWITCH, 150° C
-	M20507-6	ISA HEATSINK

6.19. HIGH PNP OUTPUT STAGE PARTS LIST

LOCATION	CPN	DESCRIPTION
C700	C 6075-3	.047µF 250V 10% POLY
C750	C 3996-3	.0047µF 200V 5%
C751	C 3411-3	200PF DIPPED SILVER MICA
C752	C 3219-0	.012µF 200V 10% FILM
C753	C 5825-2	470PF MICA
C754	C 1751-4	0.01µF 500V DISC CAP.
D 750	C 2851-1	RECTIFIER, 1N4004 SILICON
D 751	C 2851-1	RECTIFIER, 1N4004 SILICON
J 750	C 6564-6	10 PIN DOUBLE ROW HEADER
L 750	C 3510-2	CHOKE, .5MH AXIAL
Q700-Q709	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q710	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q711	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q712-Q721	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q750	C 5453A1	2SA1006BR TO-220 PNP
	C 5341-0	TO-220 HEAT SINK
	C 6541-4	TO-220 TORQUE SPREADER
R700	C 3931-0	12 Ω 2W 5% CF
R701-R710	C 3583-9	.33 Ω 5W 5% WIRE
R711-R720	C 3583-9	.33 Ω 5W 5% WIRE
R721	C 3931-0	12 Ω 2W 5% CF
R722	C 2872-7	100 Ω .25W 5% CF
R723	C 2872-7	100 Ω .25W 5% CF
R724-R733	C 3583-9	.33 Ω 5W 5% WIRE
R734	C 3931-0	12 Ω 2W 5% CF
R735-R744	C 3583-9	.33 Ω 5W 5% WIRE
R745	C 3931-0	12 Ω 2W 5% CF
R746	C 3931-0	12 Ω 2W 5% CF
R747	C 3931-0	12 Ω 2W 5% CF
R750	C 1011-3	47 Ω .25W 5% CF
R751	C 6089-4	5.6 Ω .25W 5% CF
R752	C 5038-2	39 Ω .25W 5% CF
TS2	C 6737-8	SPST NC THERMAL SWITCH, 150° C
-	M20507-6	ISA HEATSINK

6.20. LOW NPN OUTPUT STAGE PARTS LIST

LOCATION	CPN	DESCRIPTION
B800	C 6513-2	BEAD
B801	C 6513-2	BEAD
C800	C 3977-3	0.022µF 200V 5% FILM
C850	C 6804-6	0.1µF 100V AXIAL CER. CAP.

LOCATION	CPN	DESCRIPTION
C852	C 3480-8	0.001µF 200V 10% FILM
C853	C 5825-2	470PF MICA
D800	C 3181-2	SILICON DIODE, 1N4148
D801	C 3181-2	SILICON DIODE, 1N4148
D850	C 2851-1	RECTIFIER, 1N4004 SILICON
J 850	C 6564-6	10 PIN DOUBLE ROW HEADER
L 850	C 3510-2	CHOKE, .5MH AXIAL LEAD
Q800-Q809	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q810	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q811	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q812-Q821	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q850	C 6436-7	2SC2336BR TO-220 NPN
	C 5341-0	TO-220 HEAT SINK
	C 6541-4	TO-220 TORQUE SPREADER
Q851	C 3625-8	2N4125 PNP
Q852	D 2961-7	SEL 2N3859A, SPS8010 NPN
R800	C 3931-0	12 Ω .25W 5% CF
R801-R810	C 3583-9	.33 Ω 5W 5% WIRE
R811	C 3931-0	12 Ω 2 W 5% CF
R812	C 5342-8	236 Ω .5W 1% MF (USE WITH BLUE U800)
R812	C 5343-6	227 Ω .5W 1% MF (USE WITH GREEN U800)
R812	C 5344-4	218 Ω .5W 1% MF (USE WITH YELLOW U800)
R813	C 2872-7	100 Ω .25W 5% CF
R814	C 2872-7	100 Ω 2 W 5% CF
R815	C 3931-0	12 Ω .25W 5% CF
R816	C 5662-9	16.2KΩ .25W 1% MF
R817-R827	C 3583-9	.33 Ω 5W 5% WIRE
R818	C 5662-9	16.2KΩ .25W 1% MF
R828	C 3931-0	12 Ω .25W 5% CF
R829	C 3931-0	12 Ω .25W 5% CF
R850	C 5168-7	2.7 KΩ .25W 5% CF
R851	C 1011-3	47 Ω .25W 5% CF
R852	C 5168-7	2.7 KΩ .25W 5% CF
R853	C 3672-0	2 KΩ TRIM POT
R854	C 2627-5	1 KΩ .25W 5% CF
R855	C 2627-5	1 KΩ .25W 5% CF
R856	C 6517-4	24 Ω .25W 5% CF
R857	C 2857-8	2.7 Ω .5W 5% CF
R858	C 2857-8	2.7 Ω .5W 5% CF
U800	C 5826-0	LM 334A THERMAL SENSOR
-	M20507-6	ISA HEATSINK

6.21. LOW PNP OUTPUT STAGE PARTS LIST

LOCATION	CPN	DESCRIPTION
B900	C 6513-2	BEAD
B901	C 6513-2	BEAD
C900	C 3977-3	.022µF 200V 5% FILM
C950	C 3288-5	.015µF 100V 10% FILM
C952	C 1751-4	0.01µF 500V DISC
C953	C 5825-2	470PF DIPPED SILVER MICA
C954	C 3411-3	200PF DIPPED SILVER MICA
D 950	C 2851-1	RECTIFIER, 1N4004 SILICON
D 951	C 2851-1	RECTIFIER, 1N4004 SILICON
J 950	C 6564-6	10 PIN DOUBLE ROW HEADER
L 950	C 3510-2	CHOKE, .5 MH AXIAL LEAD
Q900-Q909	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q910	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q911	C 5869-0	NPN POWER TRANSISTOR, 2SD555RA
Q912-Q921	C 7123-0	NPN DUAL DIE POWERTRANSISTOR, SJ4429
Q 950	C 5453A1	2SA1006BR TO-220 PNP
	C 5341-0	TO-220 HEAT SINK
	C 6541-4	TO-220 TORQUE SPREADER
R900	C 3931-0	12 Ω 2W 5% CF
R901-R910	C 3583-9	.33 Ω 5W 5% WIRE
R911-R920	C 3583-9	.33 Ω 5W 5% WIRE
R921	C 3931-0	12 Ω 2W 5% CF
R922	C 2872-7	100 Ω .25W 5% CF
R923	C 5342-8	236 Ω .5W 1% MF (USE WITH BLUE U900)
R923	C 5343-6	227 Ω .5W 1% MF (USE WITH GREEN U900)
R923	C 5344-4	218 Ω .5W 1% MF (USE WITH YELLOW U900)
R924	C 2872-7	100 Ω .25W 5% CF
R925-R934	C 3583-9	.33 Ω 5W 5% WIRE
R935	C 3931-0	12 Ω 2W 5% CF
R936-R945	C 3583-9	.33 Ω 5W 5% WIRE
R946	C 3931-0	12 Ω 2W 5% CF
R947	C 3931-0	12 Ω 2W 5% CF
R950	C 5168-7	2.7 KΩ .25W 5% CF
R951	C 2872-7	100 Ω .25W 5% CF
R952	C 5168-7	2.7 KΩ .25W 5% CF
R953	C 5038-2	39 Ω .25W 5% CF
R954	C 2857-8	2.7 Ω .5W 5% CF
R955	C 2857-8	2.7 Ω .5W 5% CF
U900	C 5826-0	LM 334A THERMAL SENSOR
-	M20507-6	ISA HEATSINK

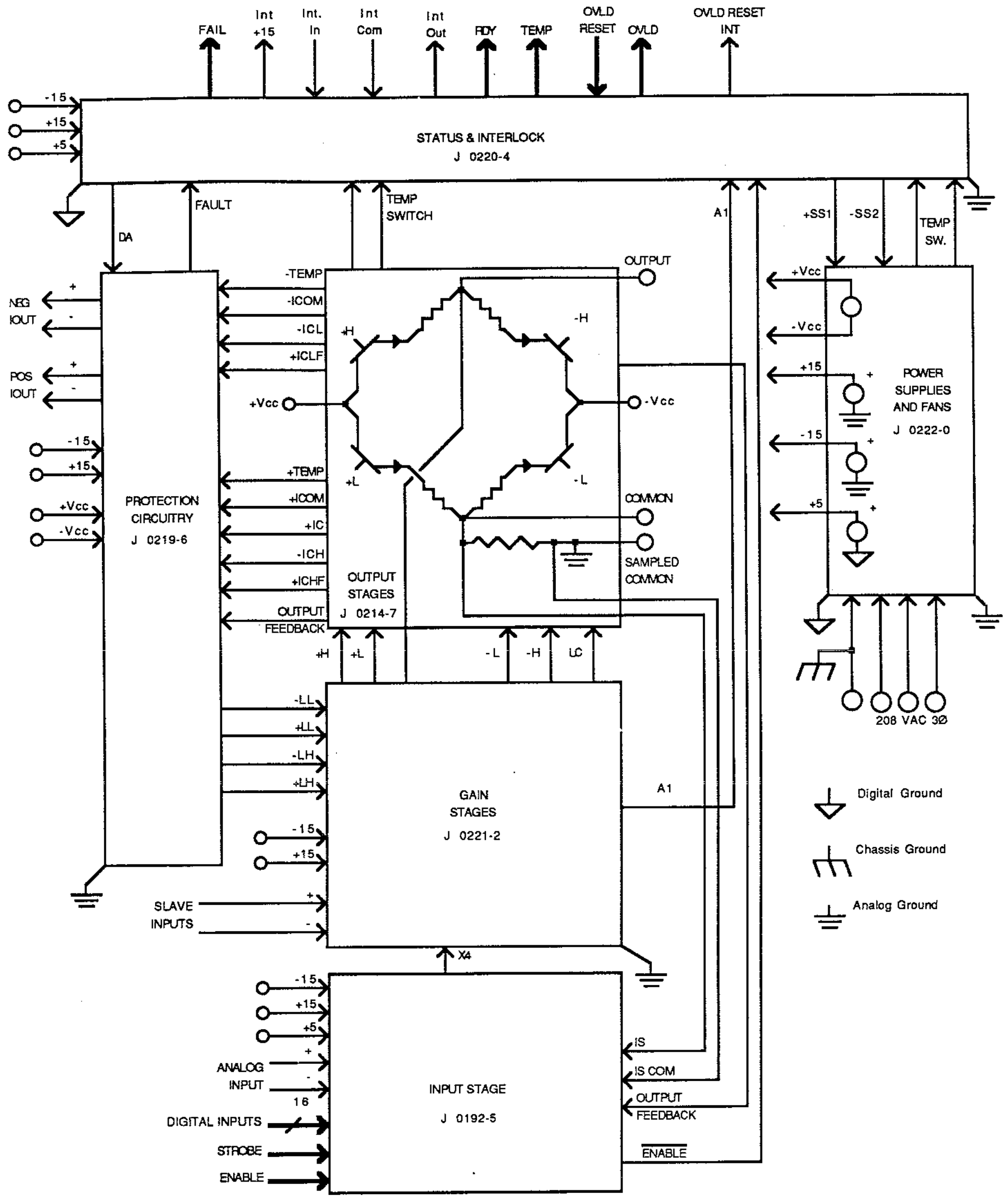
6.22. OUTPUT TERMINATOR BOARD PARTS LIST

LOCATION	CPN	DESCRIPTION
C90	C 3977-3	0.022 MF 200V 5% FILM CAP
C91	C 3978-1	0.047MF 200 V 5% FILM CAP
C92	C 3978-1	0.047MF 200 V 5% FILM CAP
L90		
R90	C 7102-4	4.7 OHM POSISTOR
R91	C 6625-5	5.6 OHM 5 W 5% METAL OXIDE
R92	C 6625-5	5.6 OHM 5 W 5% METAL OXIDE

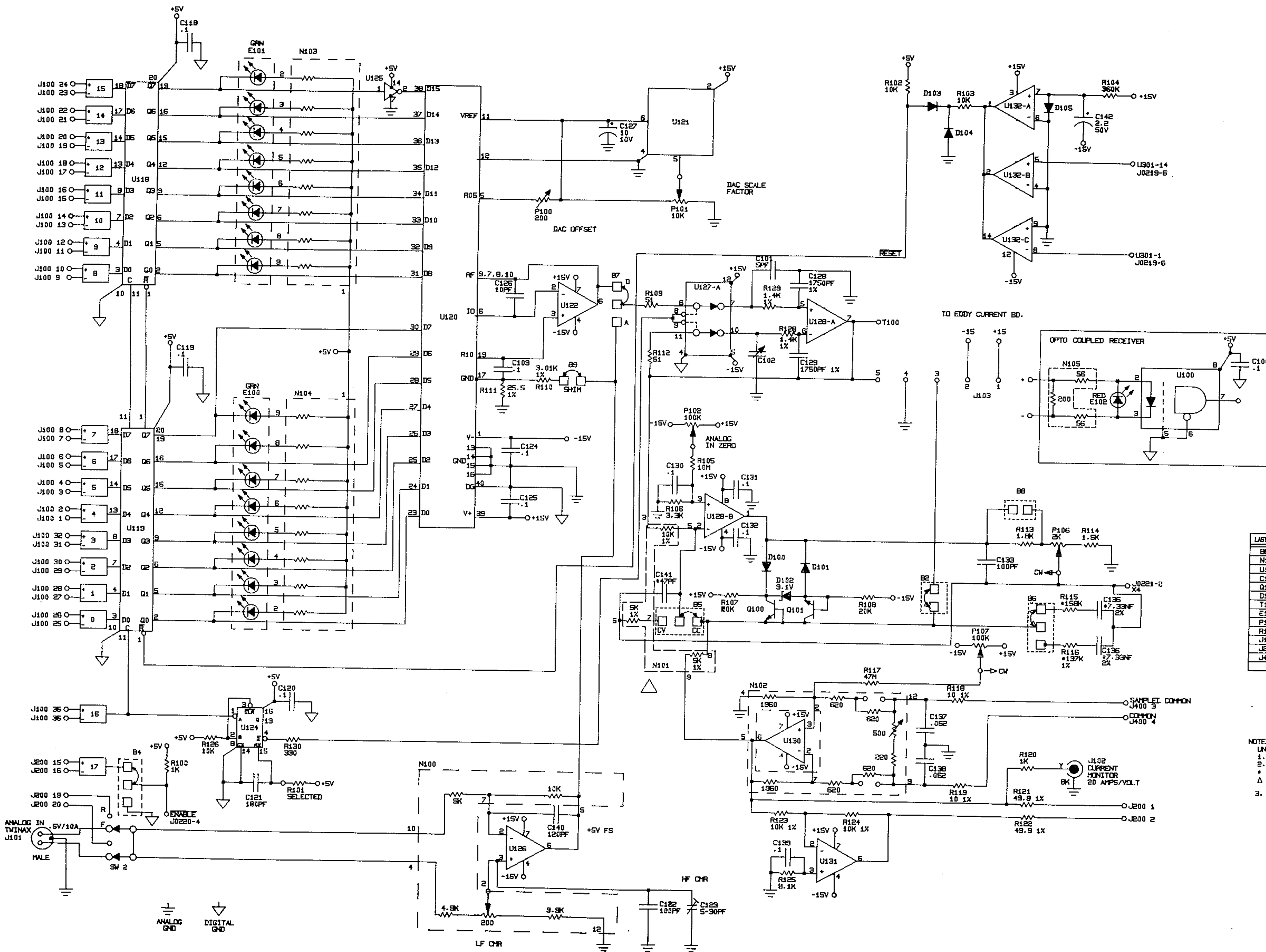
6.23. CURRENT SENSE PARTS LIST

LOCATION	CPN	DESCRIPTION
R761	C 6299-9	.1 OHM 50 WATT 1% WIREWOUND
R762	C 6299-9	.1 OHM 50 WATT 1% WIREWOUND
R763	C 6299-9	.1 OHM 50 WATT 1% WIREWOUND

6.24. SCHEMATIC, 8604 BLOCK DIAGRAM



6.25. SCHEMATIC J0192-5, DAC AND CURRENT CONTROL



OPTO COUPLED RECEIVER

0	C100 E102 N105 U100
1	C100 E103 N105 U101
2	C100 E104 N105 U102
3	C100 E105 N106 U103
4	C104 E106 N106 U104
5	C104 E107 N106 U105
6	C104 E108 N107 U106
7	C104 E109 N107 U107
8	C108 E110 N107 U108
9	C108 E111 N108 U109
10	C108 E112 N108 U110
11	C108 E113 N108 U111
12	C112 E114 N109 U112
13	C112 E115 N109 U113
14	C112 E116 N109 U114
15	C112 E117 N110 U115
16	C116 E118 N110 U116
17	C117 E119 N110 U117

LAST USED	OBSOLETED
B9	B3
N110	
U132	U129 U123
C142	[illegible]-C107, [illegible]-C111, [illegible]
Q101	
D105	
T100	
E119	
P107	P103, P104, P105
R130	R127
J103	
J200	
J400	

NOTES:

UNLESS OTHERWISE SPECIFIED

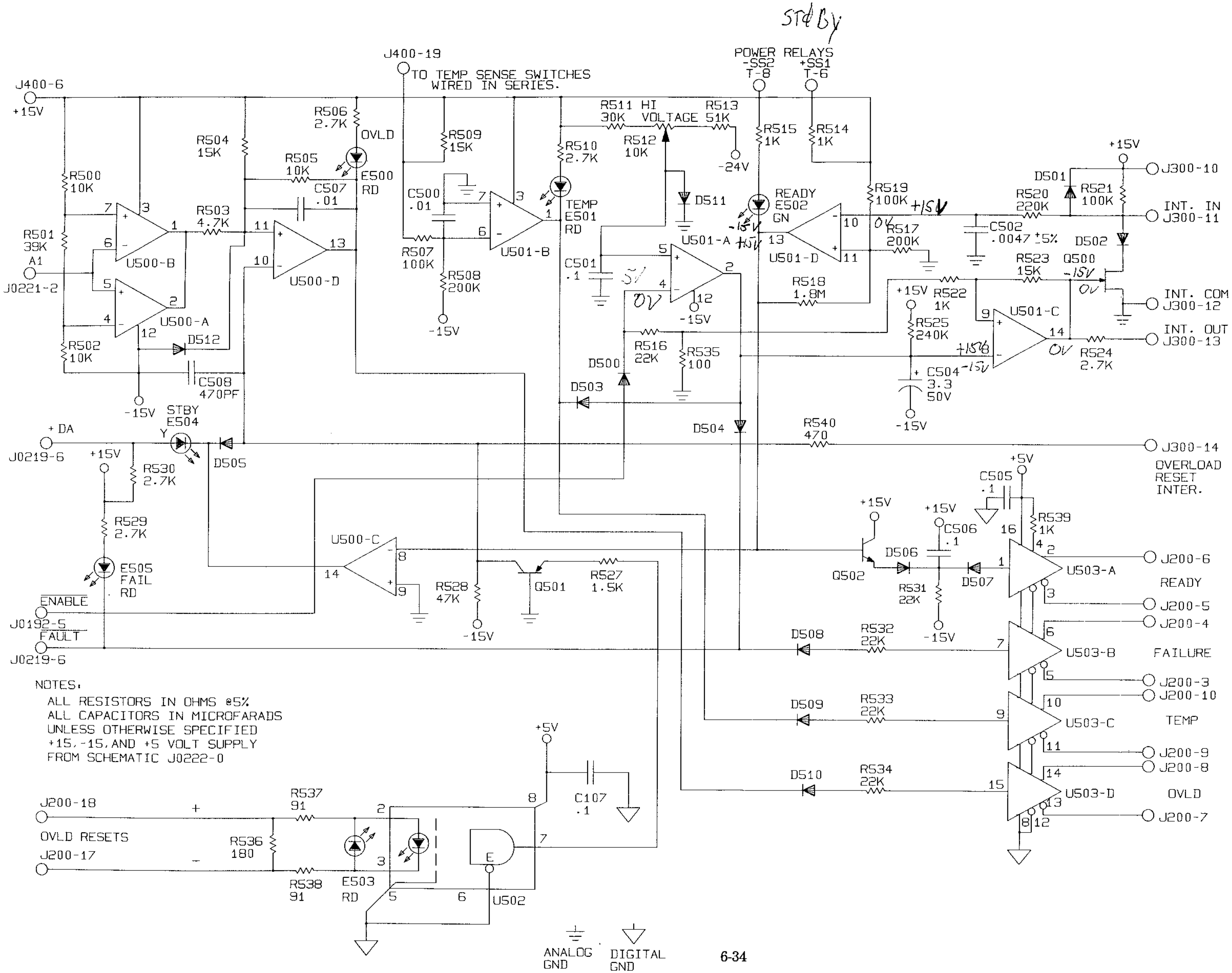
1. ALL CAPACITORS IN MICROFARADS
2. ALL RESISTORS IN OHMS .25W 5%

* COMPENSATION RELATED

Δ .25% RATIO MATCH AND 10 PPM/C TRACKING

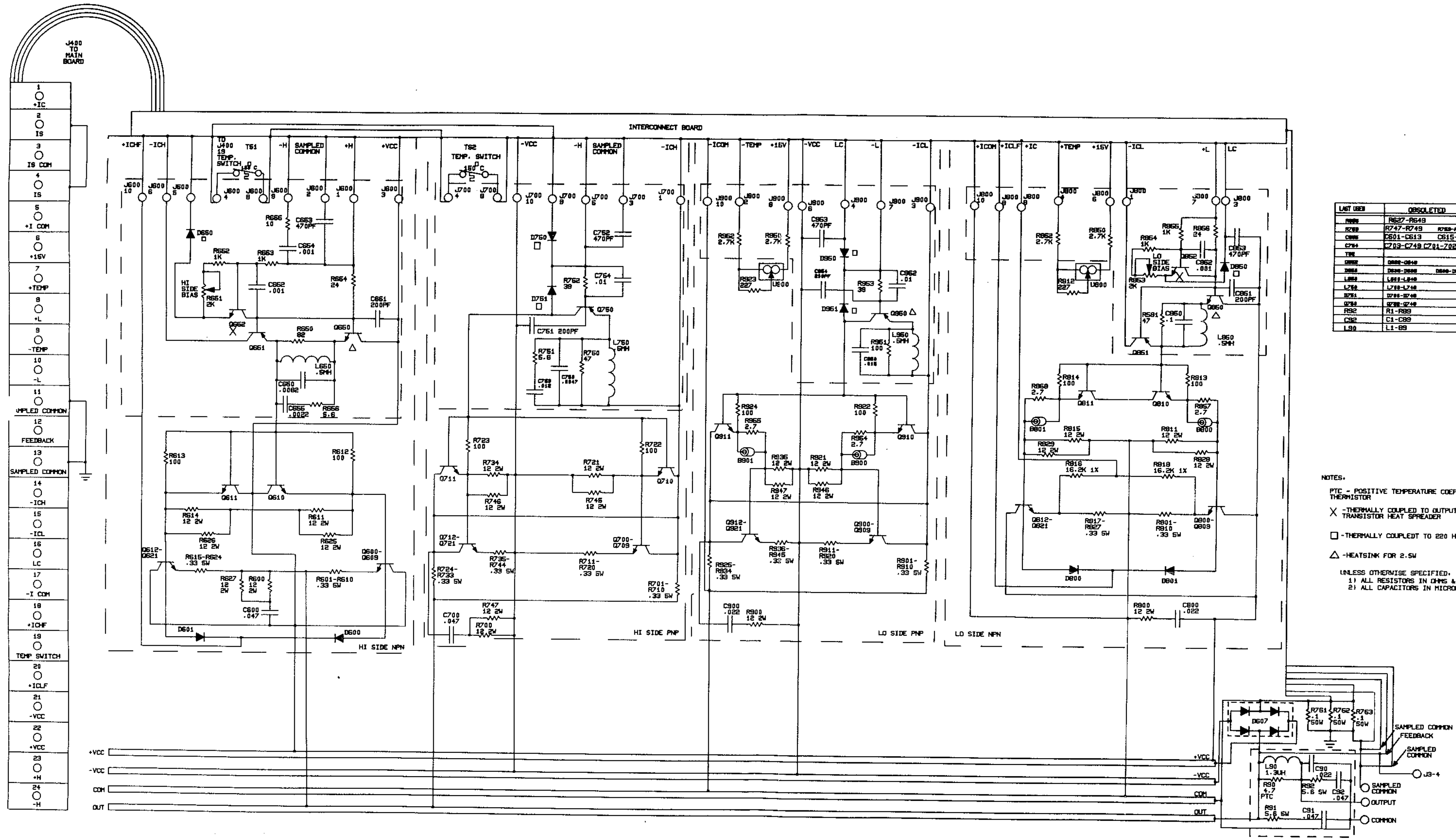
3. +15, -15, AND +5 VOLT SUPPLY FROM SCHEMATIC J0222-0

6.29. SCHEMATIC J0220-4, STATUS AND INTERLOCK



NOTES:
ALL RESISTORS IN OHMS ±5%
ALL CAPACITORS IN MICROFARADS
UNLESS OTHERWISE SPECIFIED
+15, -15, AND +5 VOLT SUPPLY
FROM SCHEMATIC J0222-0

30. SCHEMATIC J0214-7, OUTPUT STAGES



LAST USED	OBSOLETED
[illegible]	R627-R649
[illegible]	R747-R749 [illegible]
[illegible]	C601-C613 C615-C649
[illegible]	C703-C749 C701-702
[illegible]	
[illegible]	[illegible]
[illegible]	[illegible] [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
R92	R1-R89
C92	C1-C89
L90	L1-89

NOTES:

PTC - POSITIVE TEMPERATURE COEFFICIENT THERMISTOR

X -THERMALLY COUPLED TO OUTPUT TRANSISTOR HEAT SPREADER

□ -THERMALLY COUPLEDT TO 220 HEATSINK

△ -HEATSINK FOR 2.5W

UNLESS OTHERWISE SPECIFIED:
1) ALL RESISTORS IN OHMS & 5%
2) ALL CAPACITORS IN MICROFARADS