POWER SUPPLY FOR HP 1000 "A" MODEL COMPUTERS AND EXTENDERS

(2105A, 2108A, 2109A, 2112A, 2113A 12979A, AND 12990A)

THEORY OF OPERATION

NOTE

This document is part of the HP 1000 M, E, and F-Series Computers Engineering and Reference Documentation and is not available separately.

Contents

Figures

Power Supplies

Section	Description	Computer Serial Prefix
IXA	"A" Model Power Supply	Obsolete
IXB	"B" Model Power Supply (5061-1356)	Prior to 2108
IXC	"B" Model Power Supply (5061-3476) *	2108-2305
	"B" Model Power Supply (5061-6615) *	2305 or later
IXD	12944B Battery Box (12944-60001)	
IXE	12991B Battery Box (12991-60001)	
IXF	Crossover Board Assembly (5060-8345)	
IXG	12740A FPP Power Supply (12740-60001)	
IXH	"B" Model Power Supply (5061-34761, 5061-6615) Theory of Operation	

* Refer to index on page IXC-ii for "B" Power Supply Components.

1. GENERAL INFORMATION

The Power Supplies for the 2105/2108 Processors are complex circuits which supply the necessary regulated DC voltages and coordinated logic signals for operation of the CPU, memory and I/O interface cards of the 21MX Computer Series. The required input power is from an input AC power line from 47 to 64 Hz and over a voltage range of 110 ±20% VAC or 220 ±20% VAC. Maximum input voltamperes of the 2108 are approximately 650 and the maximum input voltamperes of the 2105 are approximately 450. The overall efficiency of the power supplies range between 65% and 80%, depending upon loading.

The power supplies operate in four different modes. These are:

1. Operate
2. Line standby
3. Battery standby
4. CPU-MEM Alarm

The computer itself does not distinguish between the line standby mode and the battery standby mode, but these two states are entirely different within the power supply.

In the operate mode, all output voltages are present and current is available up to the full capacity of each output. In the two standby modes, only those voltages necessary to permit the semiconductor memory to retain its contents are present. In CPU-MEM alarm all voltages associated with respective alarm are shut down, requiring a reset to line standby mode for normal operation to resume.

As the two standby names imply, the line standby mode receives input power from the AC line power plug whereas the battery standby mode operates off of power supplied from a 12 volt storage battery.

The optional nickel cadmium battery supplied with the computer, when fully charged, provides standby power for at least two hours. Longer standby periods may be realized by the use of a larger external storage battery of voltage range 10 — 14 VDC and of approximately 3.5 amp hr capacity per 2 hours of desired standby time. It should be noted that the CPU power supply provides a constant current charge of 250 mA to the battery whenever AC line power is present.

The supply output voltage specifications and their current ratings are shown below, with an * indicating those voltages which are present only during the operate mode.

OUTPUT TERMINAL VOLTAGE	2108/2109 OPERATE CURRENT	2108/2109 STANDBY CURRENT	2105 OPERATE CURRENT	2105 STANDBY CURRENT	MAXIMUM VOLTAGE DEVIATION
+5 volts (CPU and I/O)	35	*	25	*	±0.25V
-2 volts (CPU and I/O)	5	*	5	*	±0.40V
+12.0V (I/O)	3	*	2	*	±0.5V
-12.0V (I/O)	3	*	2	*	±0.5V
+5.0V (mem)	5	5	5	5	±0.25V
+12.5V (mem)	1.8	0.5	.5	.5	±0.5V
-12.5V (mem)	1.8	0.5	.5	.5	±0.5V

*Indicates that this output voltage is 0 during standby mode.

Physically the power supplies consist of two major P.C. board assemblies and five minor P.C. board assemblies.

The two major assemblies contain all circuits necessary for full operation from the AC power line. Three of the minor assemblies contain circuits which in conjunction with the two major assemblies permit standby operation from a 12 volt battery.

The remaining two minor boards serve only to interconnect the two major board assemblies.

Of the two major board assemblies, one contains all circuits associated with the isolated output voltages and control logic. This board has no voltages present greater than +28 VDC. This board (5060-8349 or 5060-8355) is located directly under the top cover of the computer, circuit side up when the supply is installed.

The other major assembly contains circuits associated with the power line input and other circuits where hazardous voltages in excess of 350 VDC are present. This board (5060-8343 or 5060-8354) is inaccessible when the supply is installed in the computer.

Transformers and optical isolators provide isolation in excess of 1500 volts between the supply outputs and the input power line. Practices necessary for UL recognition have been observed.

2. Electrical Description

The operate and line standby modes of operation employ a combination of a high voltage DC switching preregulator, two multi-output DC to DC converters and several series pass regulators.

The battery standby mode of operation employs three independent switching regulators.

All power switching in the regulators and DC to DC converters is performed at a frequency of approximately 20 kHz.

This frequency of operation results in very small size and weight of magnetic components and capacitors and produces no audible noise.

The preregulator and DC to DC converters share a common clock.

The battery powered regulators share a separate clock.

The major energy storage in the supply occurs at the line input capacitors at approximately 300 VDC. Energy storage at this high voltage, prior to the preregulator allows the computer to operate undisturbed despite line dropouts of several cycles and permits the memory to hold up for several hundred milliseconds even without a standby battery installed.

3. GENERAL OPERATION

Referring to the state transition diagram in figure 1, at initial point when all power is off to supply and AC voltage is applied the power supply moves to the line standby state, Memory lost signal will be generated due to the fact that prior to entering line standby no memory supply voltages were present — therefore, contents of memory have been lost. At approximately 70 — 75 volts AC supply will output memory voltages. A reset of power supply logic is performed by the key switch on the front panel of the computer (or via rear panel power control connector) in order to prepare power supply to enter operate state. The key switch is then turned to operate, allowing the power supply to enter the operate state if the input AC line is sufficiently high which is determined by PUUP sense circuitry. In the operate state all CPU voltages are up and in regulation and all CPU timing and control signals generated in the supply are issued. The supply can be returned to the line standby state by turning the key switch to standby position or by removing the AC input voltage. By doing so the CPU is shut down in an orderly manner such that it can be re-enabled with little problem. When returned to line standby by switch, power supply will remain in that state until switched to operate in a power down condition, unit will remain in line standby state long enough to determine if power-fail recovery option has been installed. If the option is not available the power supply will completely power down and initial power up procedure will be followed on powering supply up again.

If power fail system has been installed and battery is sufficiently charged and AC power down, the power supply enters battery standby state where memory voltages are maintained and memory overvoltage and undervoltage sense circuitry remains active. If at any time in battery standby state the battery becomes discharged the power supply will also completely power down and initial power up procedure will be followed. If battery remains charged, on AC power up, if front panel switch is in operate, power supply will enter directly into operate state.

Under the conditions of a CPU or memory overvoltage or overcurrent it enters the appropriate alarm state. In the CPU alarm state, all CPU voltages are shut off while memory voltages remain unaffected. In the memory alarm state all output voltages are shut down. Operate state may be re-entered by turning front panel switch to reset — then back to operate. If, though, the overvoltage or overcurrent still exists the supply will re-enter the alarm state. This condition will continue to exist until the overvoltage or overcurrent condition is removed.

4. POWER SUPPLY SIGNALS

The power supply provides three signals to the CPU for computer operation. These signals are 1) power up (PWU), 2) power on (PON), and 3) "not" memory lost ($\overline{\text{MLOST}}$). The following paragraphs provide a functional description of these signals.

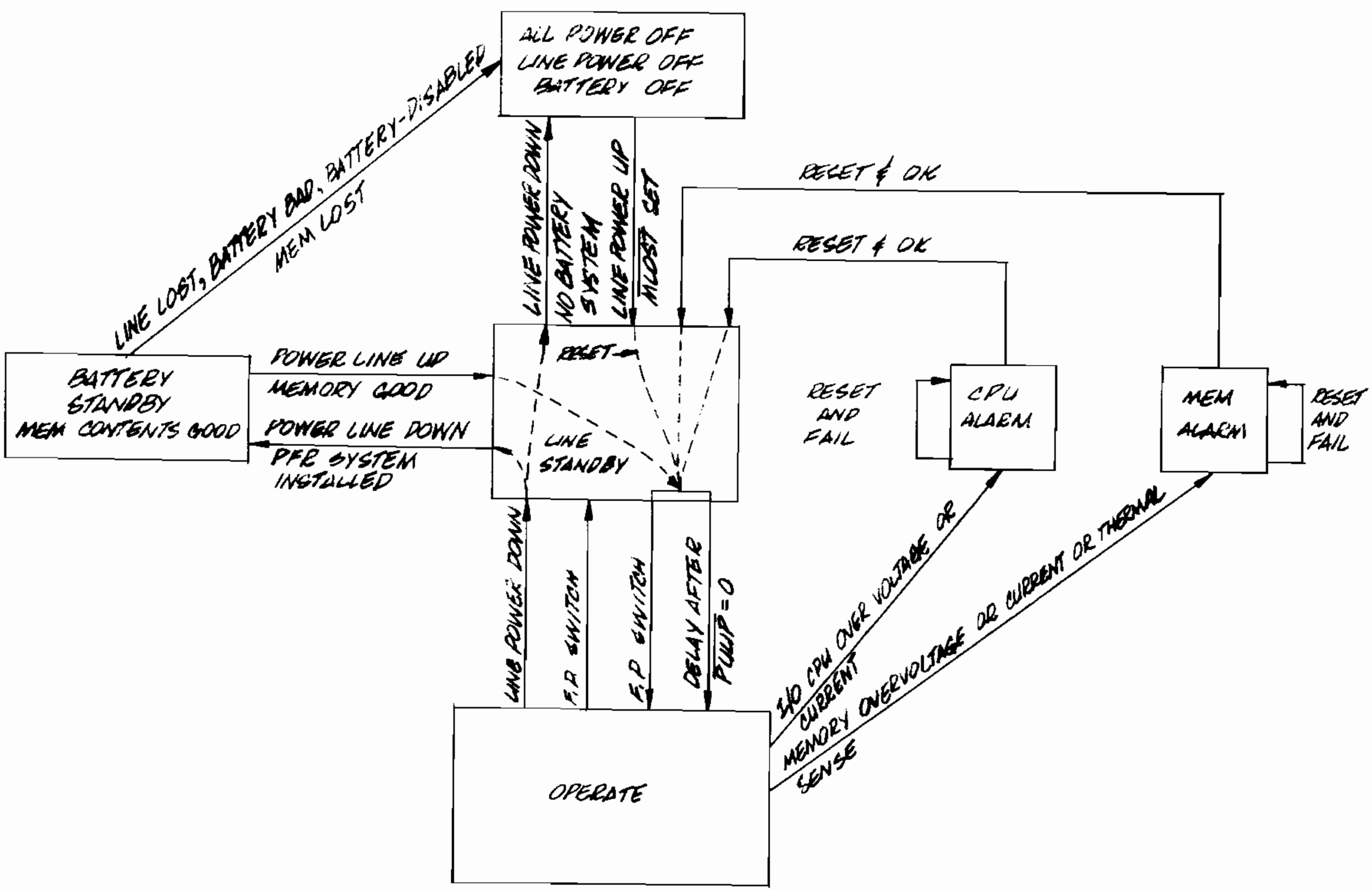


Figure 1. Power Supply State Transition Diagram

4.1 PWU

This signal is high whenever the power supply is in the operate state and the line voltage is within proper tolerances. PWU will go low immediately upon detection of a line voltage failure or alarm condition.

The function of PWU is to initiate a power fail software routine on its falling edge and an auto restart software routine on its rising edge. After PWU switches low for a line voltage failure or by rotating the key-operated switch from OPERATE to STANDBY, all output voltages will remain in regulation for a minimum of 500 μsec to permit execution of the power fail software routine. Upon restoration of power or by rotating the key-operated switch from STANDBY to OPERATE, PWU will go high within approximately one second.

4.2 PON

This signal is similar to PWU except that PON remains high for 500 μsec to 1 msec after PWU switches low. PON switches high simultaneously with PWU. The purpose of PON is to allow the CPU to access memory when the computer operating voltages are within tolerances, and to inhibit the CPU from accessing memory when computer operating voltages are low. Low operating voltages could cause the CPU to write erroneous data into memory.

4.3 $\overline{\text{MLOST}}$

This signal is low whenever there is a possibility that erroneous data may be in memory as a result of memory power supply voltages being out of tolerance, which may occur during initial power up. Automatic restart capability is inhibited whenever $\overline{\text{MLOST}}$ is low. A reset must be performed by the front panel switch or rear panel power control connector to enter the operate state when $\overline{\text{MLOST}}$ is low. Following a reset, rotate key-operated switch from STANDBY to OPERATE. $\overline{\text{MLOST}}$ will remain low for several milliseconds after PON and PWU switch to high. This will indicate to the CPU that a software routine to clear memory of any erroneous data must be performed. The conditions which will cause $\overline{\text{MLOST}}$ to be low are the following:

a. Low line and battery voltages.

b. Memory voltage out of tolerance at any time.

If the power fail recovery system is installed and operating properly, $\overline{\text{MLOST}}$ will remain high through any line voltage losses provided that the battery voltage remains above 10.5 volts. This will ensure valid memory contents and allow the auto restart capability (if enabled) to be performed.

5. LOWER BOARD OPERATION

AC line voltage is directly applied to the input bridge circuitry (see figure 2), which generates the B+ level for the preregulator circuit, and to the internal supply circuitry which generates voltages used by lower board logic. As the AC level increases the 40 kHz clock circuitry becomes enabled. This circuit generates the 20 kHz squarewave for the inverter drive circuitry and the input 20 kHz sawtooth to the pulse width modulator. At approximately 70 to 80 VAC the power up sense circuit is enabled which first generates inverter enable, preregulator enable, and pulse width modulator enable. The pulse width modulator circuit receives the input sawtooth waveform from the clock circuitry and the variable DC from the error amplifier and outputs a 20 kHz pulse train of varying duty cycle which is directly proportional to the DC level from the error amplifier. The output waveform from the pulse width modulator is fed to the preregulator level

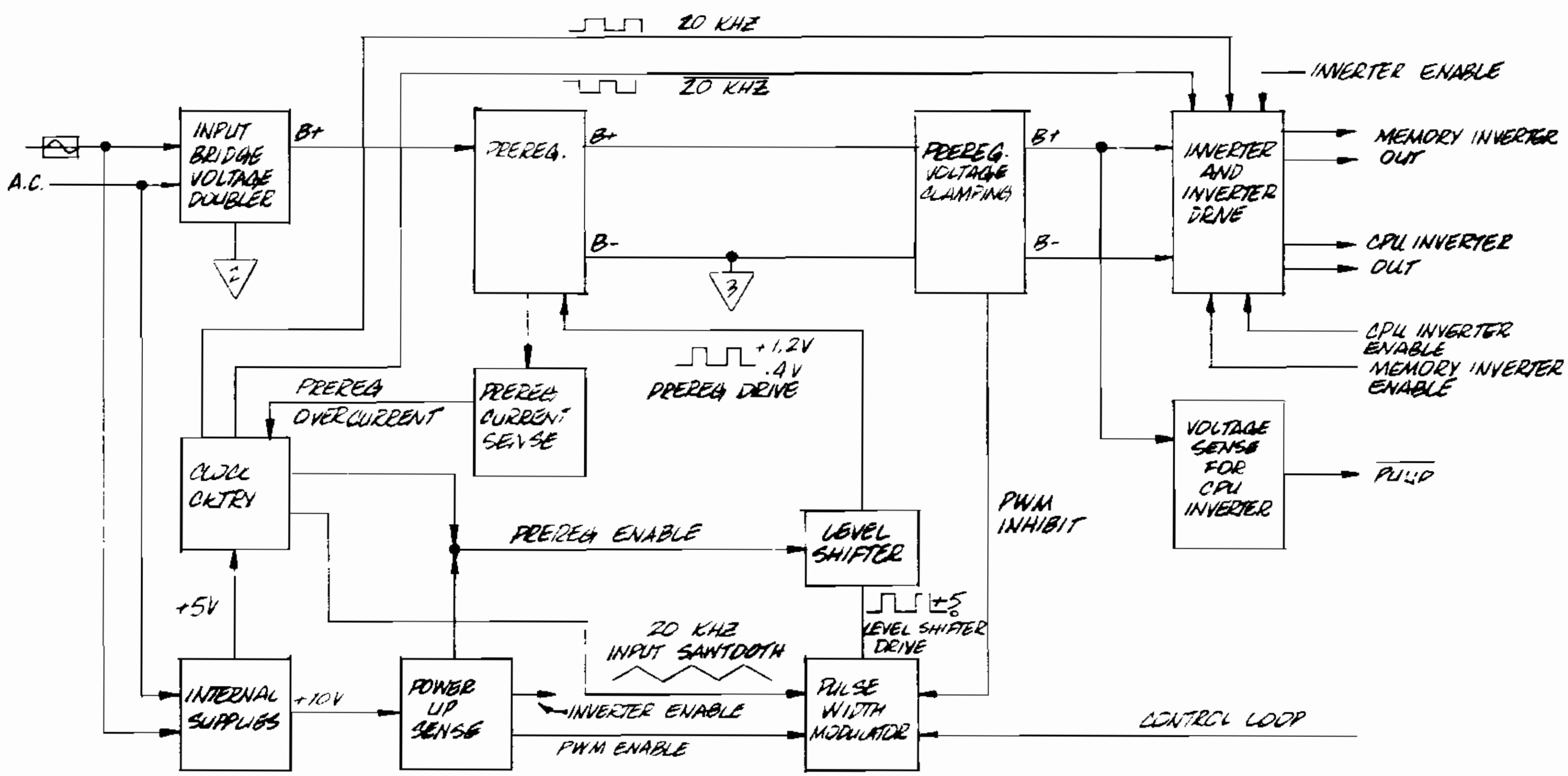


Figure 2. Lower Board Block Diagram

shifter which adjusts the waveform to conform with the biasing in the preregulator. The preregulator receives the waveform from the level shifter and converts it to a varying DC level, labeled B- or common point # 3. This DC level is proportional to the duty cycle of the input waveform so it can be seen that the error amplifier's DC level is transformed into a B- DC level by way of analog to digital and digital to analog conversion. A current sense line is taken from the preregulator and at any time excessive preregulator current is drawn a preregulator overcurrent signal is generated which shuts off the level shifter circuitry and removes the drive signal to the preregulator. B+ is also fed into the high voltage crowbar circuitry which senses if B+ exceeds 400V. If this condition occurs the crowbar circuitry is activated and B+ is shorted to ground which blows the AC input fuse. B+ is also fed to the line voltage sense circuitry. At 88 VAC (or other line voltage set by variable resistor R120) B+ has reached sufficient level to activate the sense circuitry causing $\overline{\text{PUUP}}$ to go low and allowing CPU inverters and CPU output voltages to come up. B+ and B- are finally fed to the inverter and inverter drive circuitry which is designed to generate an inverter output waveform by switching between B+ and B-. These two square waves are applied to the primaries of the CPU and memory power transformers located on the upper power supply PCA. Connected to the memory inverter output is the bootstrap supply circuitry. This circuit aids the internal supplies and bypasses surge limit resistance in the bridge circuitry for more efficient operation of the lower board circuitry.

6. INPUT RECTIFIER AND VOLTAGE DOUBLER

On initial power up, B+ is generated through CR45, CR44, CR41 and CR40 bridge circuit which is in series with R57. R57 acts as surge limit resistor for charging capacitors C1 and C2. Once line voltage has risen sufficiently to enable and maintain the memory inverters, part of the inverter signal is coupled back through T4 to the gates of CR49 and CR50 turning them on. This then creates a bypass circuit around R57, increasing efficiency under load. CR51 and CR48 are inserted in the gate circuitry to prevent reverse biasing. Since the gate signal fed from T4 is 20 kHz, the SCR's are effectively turned on all the time while the memory inverter is enabled.

The B+ level is fed to C1 and C2 which are in series. If the unit is to be operated on 110 VAC a jumper is inserted on the rear panel terminal block, connecting the neutral of the line to the junction of C1 and C2 creating a voltage doubler. In 220V operation the jumper is removed and B+ is derived directly from the bridge circuit.

7. INTERNAL SUPPLIES AND POWER UP SENSE CIRCUIT

Line voltage is applied to 60 Hz transformer T3 and power is taken from the two secondary windings. One winding supplies power to the upper board internal supplies. The other winding is applied to CR30 diode bridge to obtain +10V (Vx) and -10V (V_y). The CR29 bridge acts as a bootstrap supply. Once the memory inverters are enabled power is fed through T4 to the bridge and ±10V in order to compensate for the increased load. The +10V (Vx) supply besides being used directly, also supplies power to the +5V regulator U5 which is used as a supply for all lower board chips. C28 between pins 1 and 3 of U5 is for filtering. C13 has been added to smooth out the voltage fluctuation caused by the interval between when the load on +10V is increased by enabling memory inverters, and when T4 is capable of supplying enough power to compensate for the load increase.

In the power up sense circuit +10 is applied to the emitter of Q14 via diode CR47. At the same time the voltage at the emitter of Q14 is fed to zener CR64 via R123 and is coupled to the base of Q14 by R60. At the point where the emitter is one diode drop above the zener voltage Q14 conducts. U4A is switched on after a slight delay caused by the R77, CR55, C41 and R76 time constant in order to allow +10V to stabilize and C13 to fully charge before enabling the inverters. As U4A is turned on U4B is turned off, allowing inverter enable to go high. At the same time U4C is turned off allowing preregulator enable to go high. U4D is also switched off which, after a delay determined by R63 and C34, allows the pulse width modulator to operate. This is to ensure that the inverters are operating before enabling the preregulator circuitry since preregulator control is dependent on the operation of the inverters.

Two hysteresis loops are incorporated into the power up sense circuitry. One created by R48 to compensate for slight voltage fluctuations during initial power up. The other is created by T4 which supplies the sense circuitry, once the memory power supply is activated, with a voltage which is stable over a wide range of line input voltage.

8. CLOCK AND PRE-REGULATOR ENABLE

The clock circuit consisting of U8B generates a 40 kHz, 90% duty cycle pulse train (see figure 3), that is used to derive all lower board waveforms. +5V lower board is fed to the non-inverting input of U8B by R62 and R71 divider. This causes the output of U8B to go high, which, in turn is fed back by R73. At the same time the output is also fed back to the inverting input of U8B by the R72 — C32 RC network. At the point where the level on the inverting input of U8B exceeds that of the non-inverting input, the output goes low and is held there for a predetermined period by the C32 — R64 network. The output then goes high and the oscillation repeats.

The pulse train is applied to U13A 'D' flip-flop. Both direct set and clear are disabled and the $\overline{Q}$ side is connected to the 'D' input to obtain a divide-by-2 function. The $\overline{Q}$ side is also connected to U12A which in conjunction with the pulse train from the clock circuit generates a 95% duty cycle pulse train at 20 kHz as seen in figure 3. This then drives U13B, which is the preregulator enable flip-flop. Both Q and $\overline{Q}$ sides of U13A are used as the input signals for the inverters as seen in figure 3.

The Q side of U13A is connected to the sawtooth generator for the pulse width modulator. U13B is wired such that as soon as a clock is applied it will set, turning U12B on which generates preregulator enable. The direct reset on U13B is connected to the preregulator current sense. If excessive peak current is drawn by the pre-regulator circuit then the sense line is brought low, disabling operation of the preregulator for the duration of the current 20 kHz cycle. This pre-regulator current limit is independent of the output voltage current sense circuits and serves primarily to protect preregulator transistor Q7 from excessive peak currents during transient conditions.

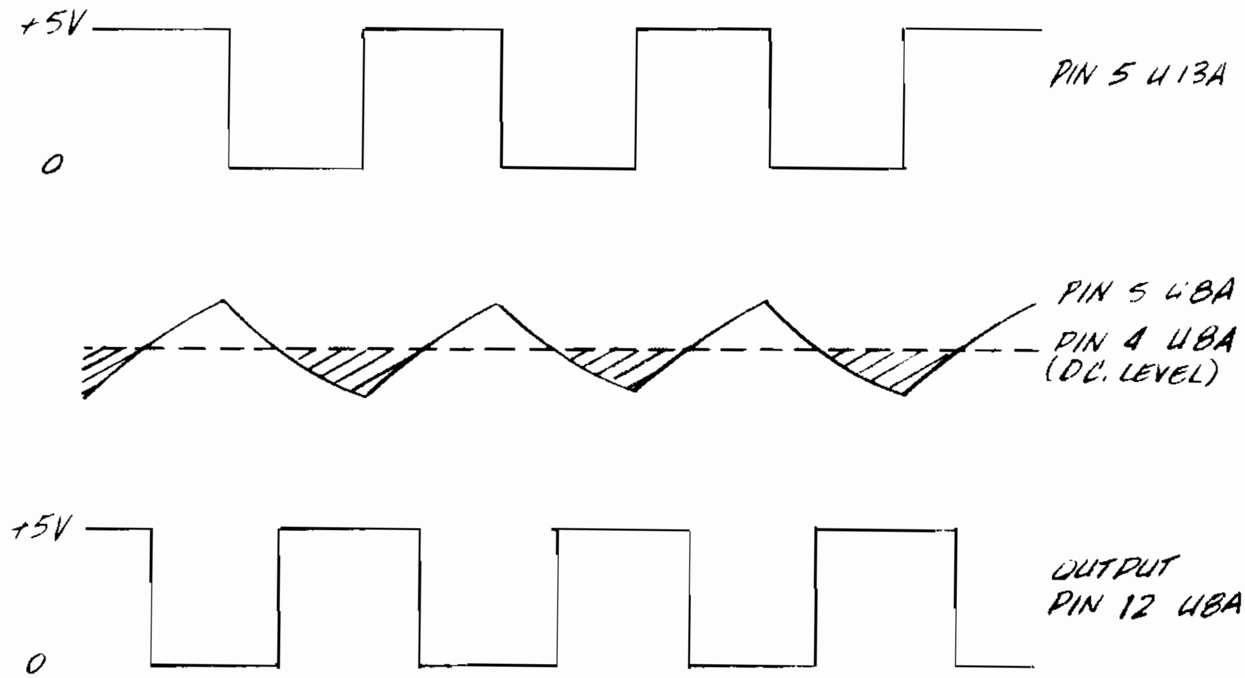


Figure 3. Lower Board Waveforms

9. PULSE WIDTH MODULATOR

The square wave output from U13A is applied to Q11 which generates a sawtooth waveform (see figure 3). This sawtooth waveform is applied to the inverting input of U8A. The non-inverting input is connected to a varying DC level generated by U11. The resulting output waveform at pin 12 is dependent on the DC level with respect to the sawtooth waveform. If the DC level is more negative than any part of the sawtooth, the output is always low. If the DC level is more positive than any part of the sawtooth, the output is always high. When the condition exists as in figure 3 where the DC level is at an intermediate level, a pulse train at pin 12 results. This is caused by the fact that whenever the DC level is more positive than the sawtooth (indicated by slashed lines) the output will be high and when the level is more negative the output will be low. As can be seen, changing the DC level with respect to the sawtooth will alter the times in which the output is high or low, thus allowing the ability to change the duty cycle of 'on' time with respect to pulse period. This is then used as a form of analog to digital converter, creating a drive waveform for the pre-regulator which, in turn acts as a high power digital to analog converter.

Diode CR46 is used by the power up sense circuitry to keep the output of the pulse width modulator at zero duty cycle and the preregulator off during initial power up.

10. PREREGULATOR LEVEL SHIFTER

The signal from the pulse width modulator enters U3 where it is gated by preregulator enable, generated by the power up sense circuitry. The open collector output transistors of U3 begin switching between a floating state and ground. R56 and R54 are used as pullup resistors to the input lines for U3.

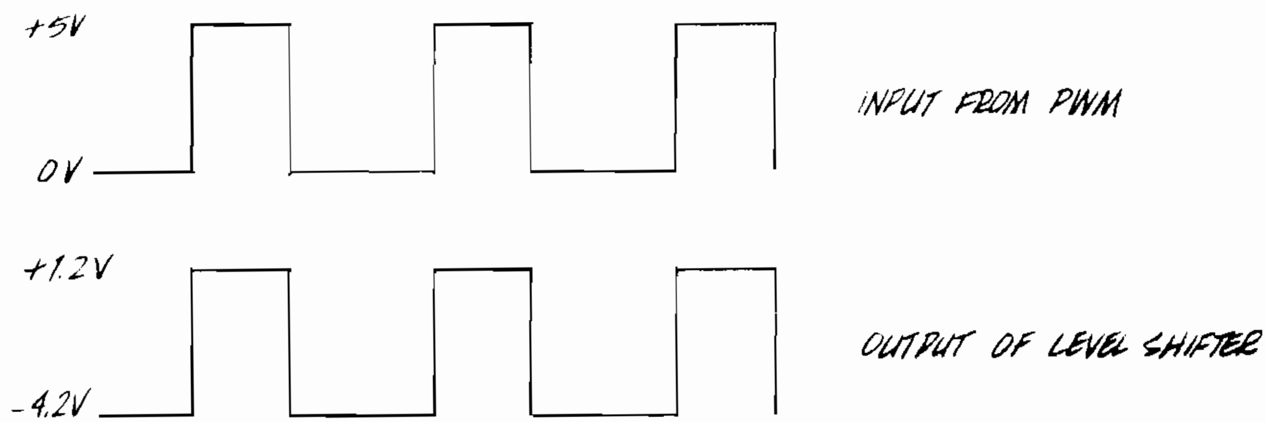
As the PWM input to U3 goes high the upper half of U3 switches Q10 on through R34. Q10 when switched on applies current from 5V through R33 — CR34 to the base of Q2 at E6. Q2 acts as a darlington driver for Q1. At the same instant the lower half of U3 turns Q12 off, which in turn removes the forward bias on Q9 turning it off.

As the pulse train goes low the upper half of U3 switches Q10 off while the lower half switches Q12 on, through R55. This creates a forward bias condition on Q9 which switches a negative current from a -4.22V source created by CR37, through R26 to E6 at the base of Q2 and through CR28 to the base of Q1.

This reverse base current on Q2 and Q1 improves the turn off time of Q1 and Q2 and is followed by reverse base emitter biasing on Q1 and Q2 in approximately 1 μsec as these transistors turn off. CR11 and CR34 serve as an anti-saturation clamp for Q1 and Q2 further improving turnoff time.

CR32 and CR33 together with R26 serve only as a protection circuit to shunt voltage away from other circuits in the event that Q1 fails with a Base-Collector short and open emitter.

As can be seen in diagram below, the resulting waveform at E6 is of the same phase as the input waveform but switches between -4.2V and +1.2V.



11. PREREGULATOR POWER STAGE

The preregulator power stage consists primarily of Q1, L1, CR5, input capacitors C1 and C2 and output capacitors C4, C11 and C12. Q1 and CR5 act as a switch controlled by the variable duty cycle of the pulse width modulator.

When Q1 is in the on state current flows from the + side of input capacitor C1 (B+) through the parallel combination of the output capacitors and the two inverter circuits to - preregulator output at inverter common. From inverter common current flows through inductor L1 and through Q1 back to the negative side of input capacitor C2 at preregulator common.

During this state a voltage appears across L1 which is equal to the difference between the input and output voltages of the preregulator. This voltage and the inductance of L1 determines the rate of change of current in L1:

$$\frac{dI_{L1}}{dt} = \frac{V_{in} - V_{out}}{L1}$$

The period of time during which Q1 is turned on determines the peak current level which builds up in L1 and consequently the level of energy stored in L1 and the average output current into the inverter circuits:

$$I_{P_{L1}} = T_{on} \frac{dI_{L1}}{dt} \quad \text{peak current}$$

$$U_{L1} = \frac{1}{2} L1 \, I^2_{P_{L1}} \quad \text{energy stored}$$

When Q1 turns off, the polarity of the voltage across L1 reverses causing CR5 to become forward biased. Current continues to flow from L1 through CR5 into the output circuit at a decreasing level as the energy stored in L1 is depleted. When the current in L1 drops to zero after a time interval determined by the value of output voltage, the inductance of L1 and the level of current in L1 at turn off of Q1

$$\left(\Delta T = \frac{V_{out}}{L} I_{P_{L1}}\right)$$

the voltage across L1 drops to zero also except for some minor ringing and CR5 is again reverse biased.

During the remaining time of the present switching period the current is supplied to the inverter circuits from the output capacitors alone.

At the beginning of the next cycle of the 20 kHz switching rate this process is repeated. The waveform at the collector of Q1 is shown in figure 4.

The complete preregulator circuit starting at the input current to photo-isolator U11 at pin J2-J on the lower board and ending at output capacitors C4, C11, C12 act as a low loss current-controlled current source translating control current levels at several milliamps and 1.5 volts to output currents of several amps at approximately 150 VDC.

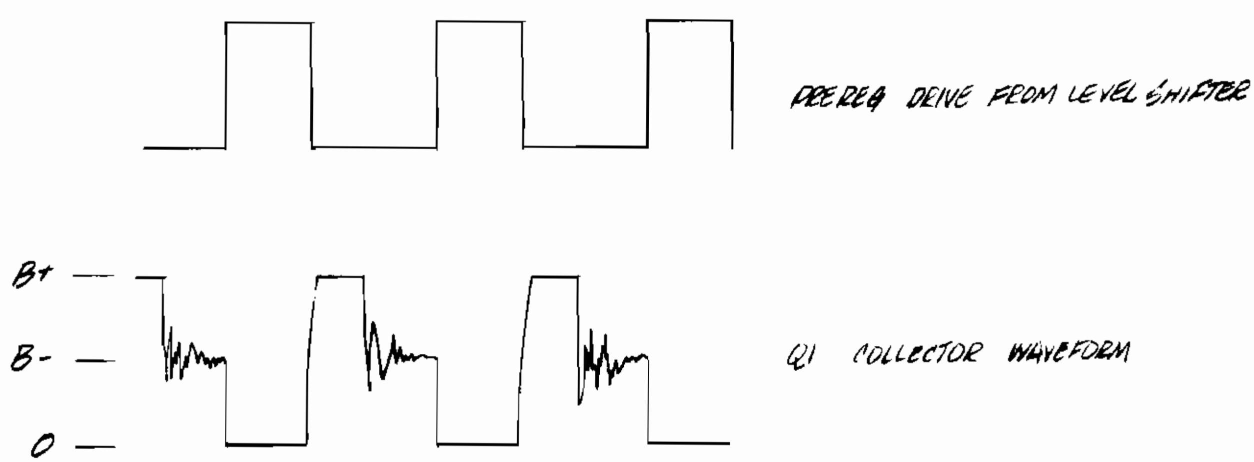


Figure 4. Q1 Collector Waveform

12. PREREGULATOR SLOW TURN-OFF

The requirement for slow turn-off is created by the basic properties of L1 in the preregulator circuit. As can be seen in figure 5, when Q1 is either fully on or fully off, very little power is consumed by it. However, a great deal of power is consumed by Q1 when making the transition from the 'on' state to the 'off' state. This is caused by the fact that as collector voltage is rising from ground to B+, current through Q1 still has the tendency to remain constant, because L1, as an inductor, opposes rapid changes in current through it. A method of minimizing this problem is achieved by creating another path for current to flow other than the transistor. This essentially describes the operation of the slow turn off circuit. The effect desired is created by current flowing through C6 and CR8 to B+. During the time Q1 is on, the side of C6 connected to CR8 is charged to 1/2 B+. As Q1 starts to switch off collector potential rises to 1/2 B+. At this point since the initial potential across C6 was 1/2 B+ and due to the fact that a capacitor opposes rapid changes in potential drop across it, the side of C6 connected to CR8 will have risen to B+ in order to maintain a 1/2 B+ potential drop across C6. At this point CR8 becomes forward biased and as Q1 collector voltage continues to rise current begins to flow through C6 which is trying to maintain its 1/2 B+ potential drop, and CR8 to B+; thus creating the second path for current needed. As can be seen in figure 5 with the

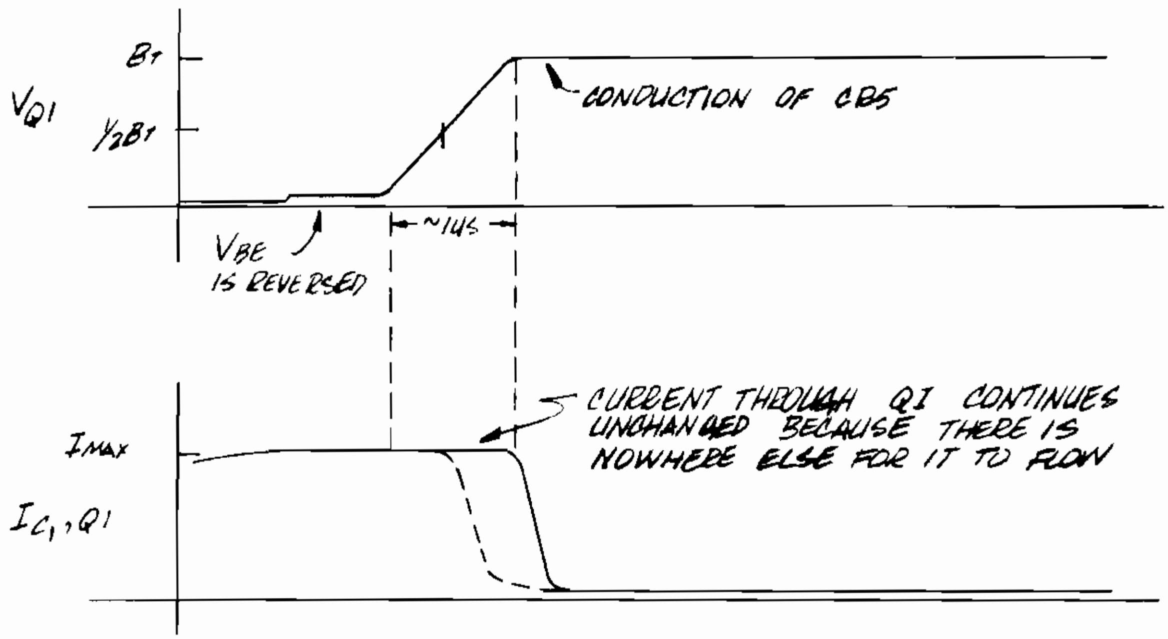


Figure 5. Q1 Power Consumption

dotted line over half of the peak power that would be dissipated in Q1 is diverted to B+. Charging of C6 is achieved in the on time of Q1 by T1 and CR7 connected to the junction of the C1 and C2 voltage doubler which acts as a supply for 1/2B+. As seen in the T1 voltage current graphs in figure 6 at the point where Q1 is about to switch on the voltage at the junction of C6 and CR8 has settled to ~ B+. As Q1 is turned on and collector potential begins to drop below B+ the potential at the junction of C6 and CR8 goes negative with respect to 1/2 B+ and current starts to flow through T1 to charge C6. This creates a back EMF in T1 which approaches -1/2 B+ as collector voltage approaches 0. As the EMF begins to break down to zero, C6 charge current through T1 reaches a maximum. EMF across T1 once again increases to 1/2 B+ until C6 is fully charged and capable of power diversion.

One problem that arises is that due to the periodic charging of C6 the potential at the junction of C1 and C2 will begin to drop, directly affecting the operation of slow turn off. This effect is compensated for by CR9, CR6 and C5. When Q1 is on the junction of CR6 and C5 is charged to ground potential. As Q1 turns off current flows to C5 and CR6 to the junction of C1 and C2 thus acting to return power lost.

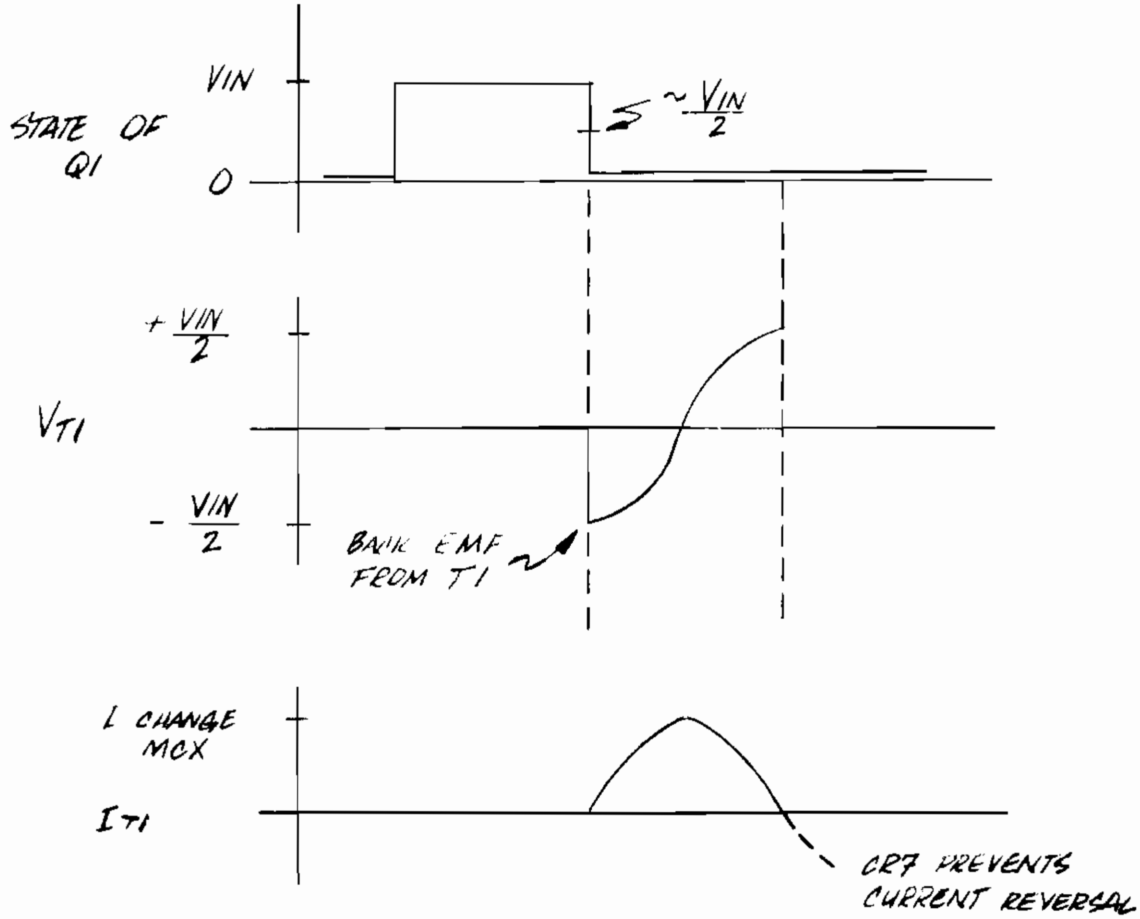


Figure 6. T1 Voltage — Current

13. HIGH VOLTAGE CROWBAR CIRCUIT

The lower board crowbar circuitry protects the power supply from excessive line voltages by shorting the input capacitors and blowing the line fuse whenever B+ exceeds 420V dc. When B+ equals 400V dc, zener diodes CR2 and CR3 begin to conduct, charging C53 through R10. When C53 is charged to approximately 20V dc, diode CR31 fires, discharging C53 into the gate of SCR4, and causing SCR4 to crowbar.

14. PREREGULATOR CURRENT SENSE

Preregulator current flowing through R1 causes a voltage drop. This voltage is passed through R15 and C20 which act as a filter circuit for current spikes. The resulting DC level is applied to Q8 via R16 and R18 divider, turning it on for excessive preregulator currents. Q8 then shorts the current sense line to ground, which clears the preregulator enable flip-flop U13B. The base of Q7 is also connected to the current sense line by R20 and C17 speed-up circuit. When the sense line goes to ground Q7 is turned off and collector voltage goes high. The high level is fed back through C16 and R17 to the base of Q8, keeping it on, and thus creating a hysteresis effect. U13B remains cleared, holding off Q1 until the end of the current 20 kHz cycle of U13A at which time U13B is cleared by a pulse from U12A.

15. LINE VOLTAGE SENSE

B+ generated by the input bridge-doubler circuit is sensed via the R36, R96, R97 and R120 divider network which is connected to a -4.2V potential created by CR55. CR56 acts as a voltage clamp, preventing the PUUP circuit from being enabled if +5V LB is low or missing and also preventing voltage at the junction of R36 — R96 from exceeding the 5V level during normal operation.

Before B+ rises to any significant level, U15A pin 4 is negative with respect to pin 5 and the output at pin 12 is consequently low. The low level at U15A results in a negative voltage appearing at U15B pin 10 via the R86 and R87 divider. This results in a high output from U15B which keeps the LED in photo-isolator U14 off. The output of U14 pin 5 is high due to a pull-up resistor on the upper board.

As B+ level increases the voltage at the junction of R96 and R97 approaches 0V. At the point where this voltage crosses above 0, the output of U15A goes high which in turn causes pin 10 of U15B to go positive, causing the output of U15B to go low. This turns on the LED in U14 causing the output at pin 5 to go low — thus resulting in the $\overline{\text{PUUP}}$ signal.

R93 connects the output of U15A to it's non-inverting input is to create hysteresis, preventing an internal oscillation. The resistor creates a large B+ voltage differential between the point where $\overline{\text{PUUP}}$ is enabled and the point where it is disabled. This is done in order to prevent the condition where the computer has a heavy load and line voltage is applied. On a soft line, line voltage level will drop significantly and if the feed back loop was not large enough to compensate for the fluctuation $\overline{\text{PUUP}}$ would be disabled, and the load would be removed — allowing the line voltage to rise and thus re-enabling $\overline{\text{PUUP}}$. This results in an oscillation condition where the CPU inverters would turn on and off approximately at 1 Hz rate.

C46 is used for slowing the switching of U14, reducing noise. R92 and C47 create a 20 ms delay before $\overline{\text{PUUP}}$ is switched low on power up but introduce no delay when line power is lost.

16. BATTERY CHARGE AND TEST LOAD

+18V rail from the memory inverter transformers is fed into the charge circuitry through R101 to R104 and CR60 which act as the positive supply for operational amplifier U16. +18V rail is also applied to R106 and R109, setting up the bias for Q15 and Q20. R101 acts as the current sense resistor for the 18V rail, limiting the output charge current to 400 mA ±50 mA. The voltage drop across R101 is applied to U16 inputs via divider network R102, R105, R108 and current source transistors Q17 and Q18. The output of U16 is connected via CR58 to the hase of Q20. Q20 acts as the driver for Q15 which is the primary current pass transistor. The circuit as can be seen above, has been designed as a constant current source.

In the battery test circuitry the test signal generated on the power fail recovery boards is applied to Q19 via R112. Q19 conducts, applying power through divider R110 and R111 to Q16. Q16 conducts which connects the R91 test load from battery V+ to ground. If the battery voltage should drop below approximately 12 VDC while this load is applied, a sense circuit on the power fail recovery boards will cause the front panel battery light to flash until the battery is sufficiently charged to remain above 12 VDC during a test period.

The battery test is automatically performed for a period of about 6 seconds every six minutes.

17. CPU AND MEMORY INVERTERS

(Only operation of the memory inverters will be explained due to the fact that CPU inverter construction and operation is the same except for two differences: CPU inverters are 180° out of phase with memory inverters to more evenly distribute load on the preregulator, and the existence of T4 bootstrap connected only to memory inverter.)

Memory inverter enable, generated on the upper board, is applied to U10 pin 2 and along with $\overline{\text{inverter}}$ enable causes pin 6 to go low. This low level is used by the two NOR gates or U7 to allow the ÷2 and $\overline{\div 2}$ square waves from the clock circuitry to toggle the output transistors within it. The two outputs of U7 are connected through T2A to +Vx (approximately 10 VDC). C15 is inserted to filter spikes created by T2A. The switching action through T2A primary is induced into the secondaries to be used as base drives for Q5 and Q6. The secondary windings exhibit a degree of mutual coupling in order to compensate for slight differences in switching speed between Q5 and Q6. Due to the coupling, as long as one transistor is on there will be opposition in the secondary winding to a change in state until the transistor has been turned off.

As Q5 and Q6 change states, the output line between the transistors switches from B+ to B– (inverter common). The other output line is biased halfway between B+ and B– and is capacitively isolated to prevent saturation of the inverter output transformer.

18. CONTROL LOOP CIRCUIT

The basic preregulator control loop is designed to operate under two conditions:

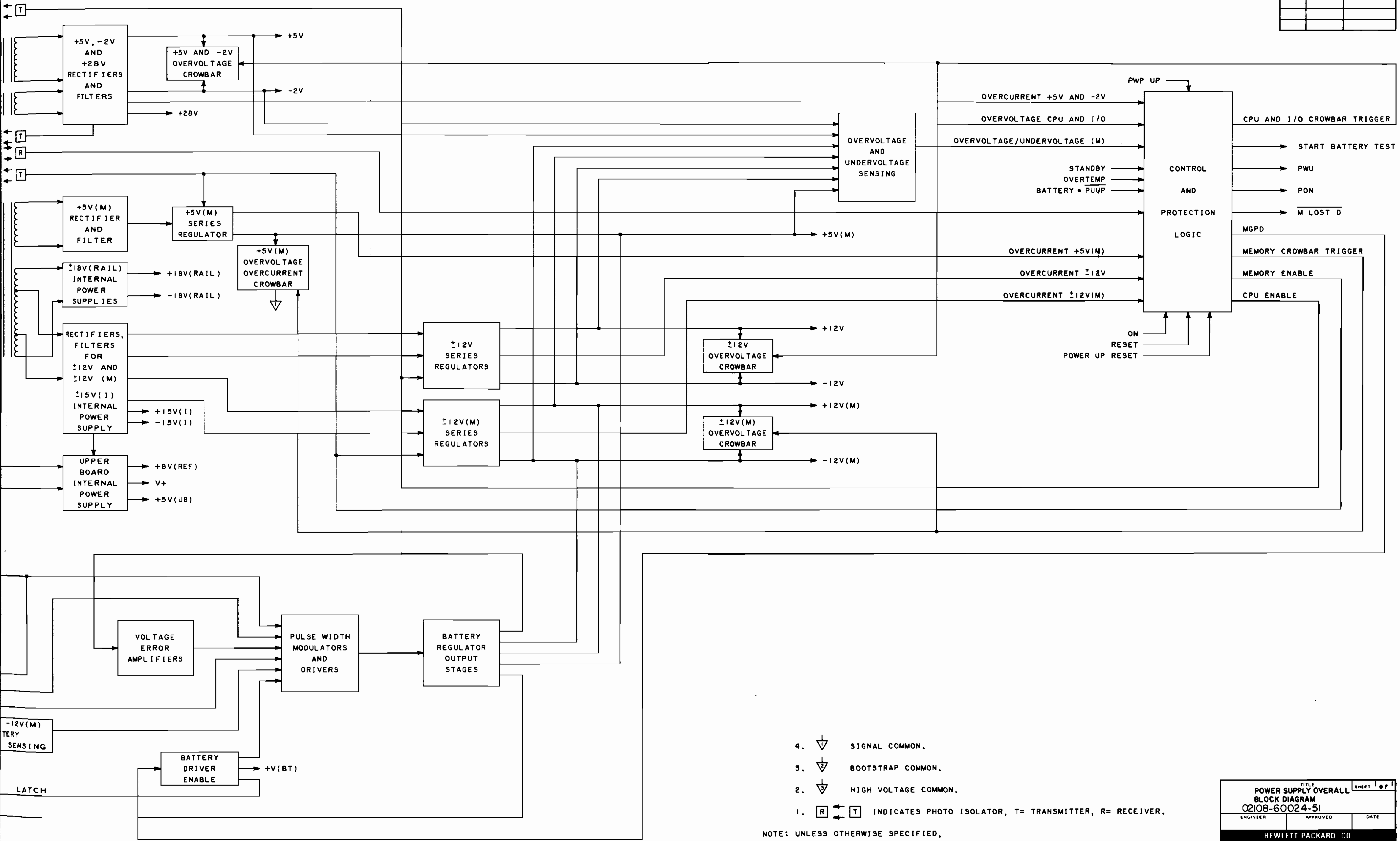
1. To maintain constant preregulator control level when CPU inverters are disabled, and
2. To perform basic regulation of 5V when CPU inverters are enabled.

+18V taken from the memory inverter transformer secondary is used as an output sense for preregulator control whenever CPU inverters are not enabled. +18V is applied across R37, R38 divider and the resultant DC level is passed to collector of Q10. If CPU inverter enable is low causing Q10 to be off, the signal passes through CR22 and is applied to pin 2 of U13 via R42. +5V CPU adjust, generated from +8 reference through R116, R115, R119 and CR61 divider is applied to pin 3 of U13. The output of U13 which represents an error signal is fed to Q11 which acts as an output buffer. The output of Q11 is then fed to U11 via R45 and R80 which acts as a current source for the LED in U11. The output of U11 then acts to couple +5V error signal into the pulse width modulator for direct control of preregulator. R43, R44 and C43, coupling the output of U13 to its inverting input, act as a negative feedback loop, decreasing overall gain of unit and preventing oscillation.

At the point when CPU inverters are enabled, the inverter enable signal is coupled through R39 and R40 which turns on Q10 and shuts off the +18V control signal to U13. With CPU inverters up, +5V CPU is coupled to U13 through R36 and CR21 thus shifting preregulator control. C44 is used for maintaining a relatively even transition between control sources during the point after +18V control line is disabled and before +5V rises sufficiently. C45 is inserted primarily for noise reduction on the +5V control adjust line.

During the condition of a memory alarm where there is neither +18V or +5V CPU, U13 turns on fully driving U11 fully on which allows preregulator to turn on fully. At this point the preregulator voltage clamp circuit comes on, limiting preregulator conduction, until the memory alarm is removed.

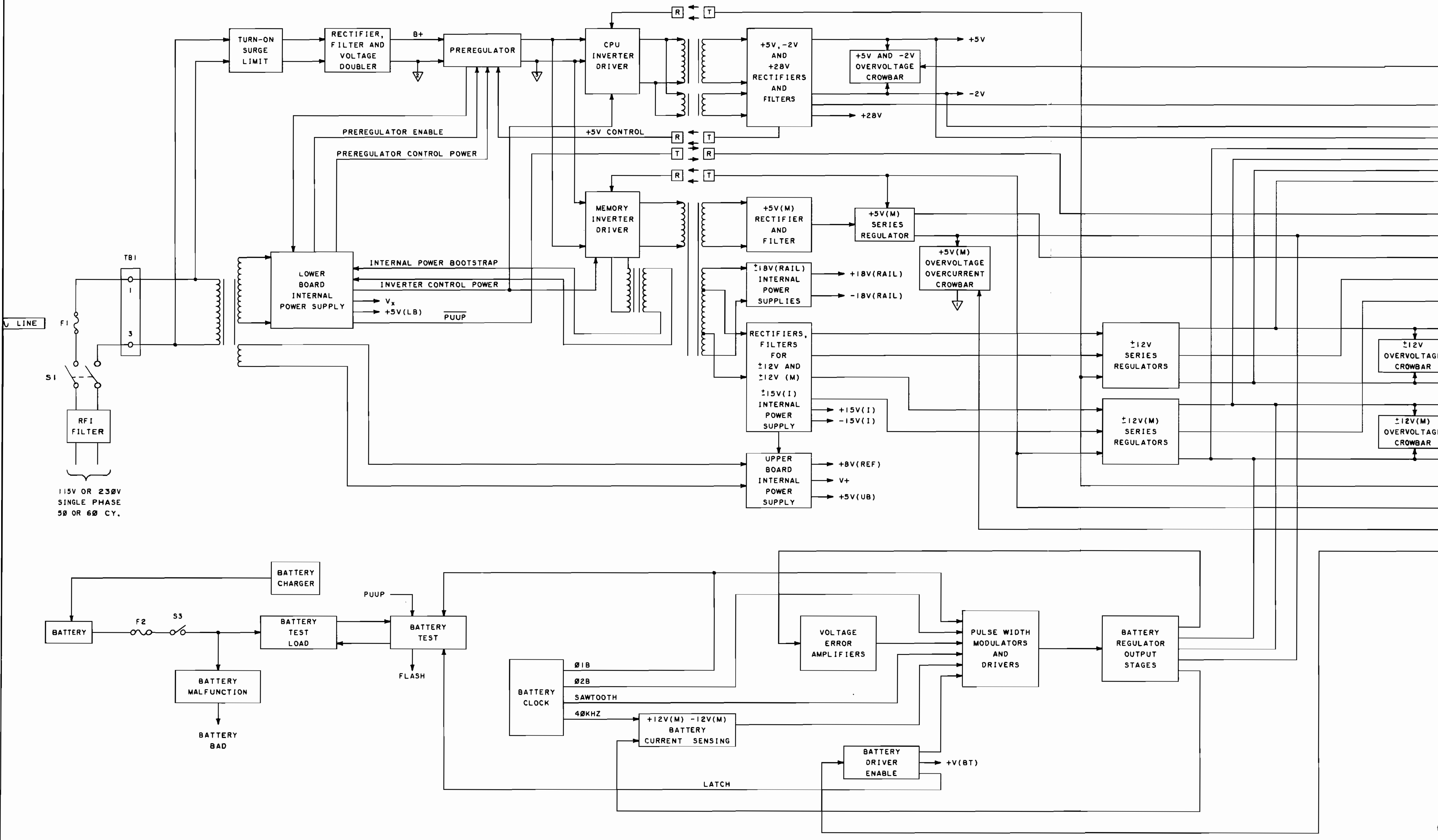
REV	REFERENCE	SERIES/PREFIX
A	ORIG	NA



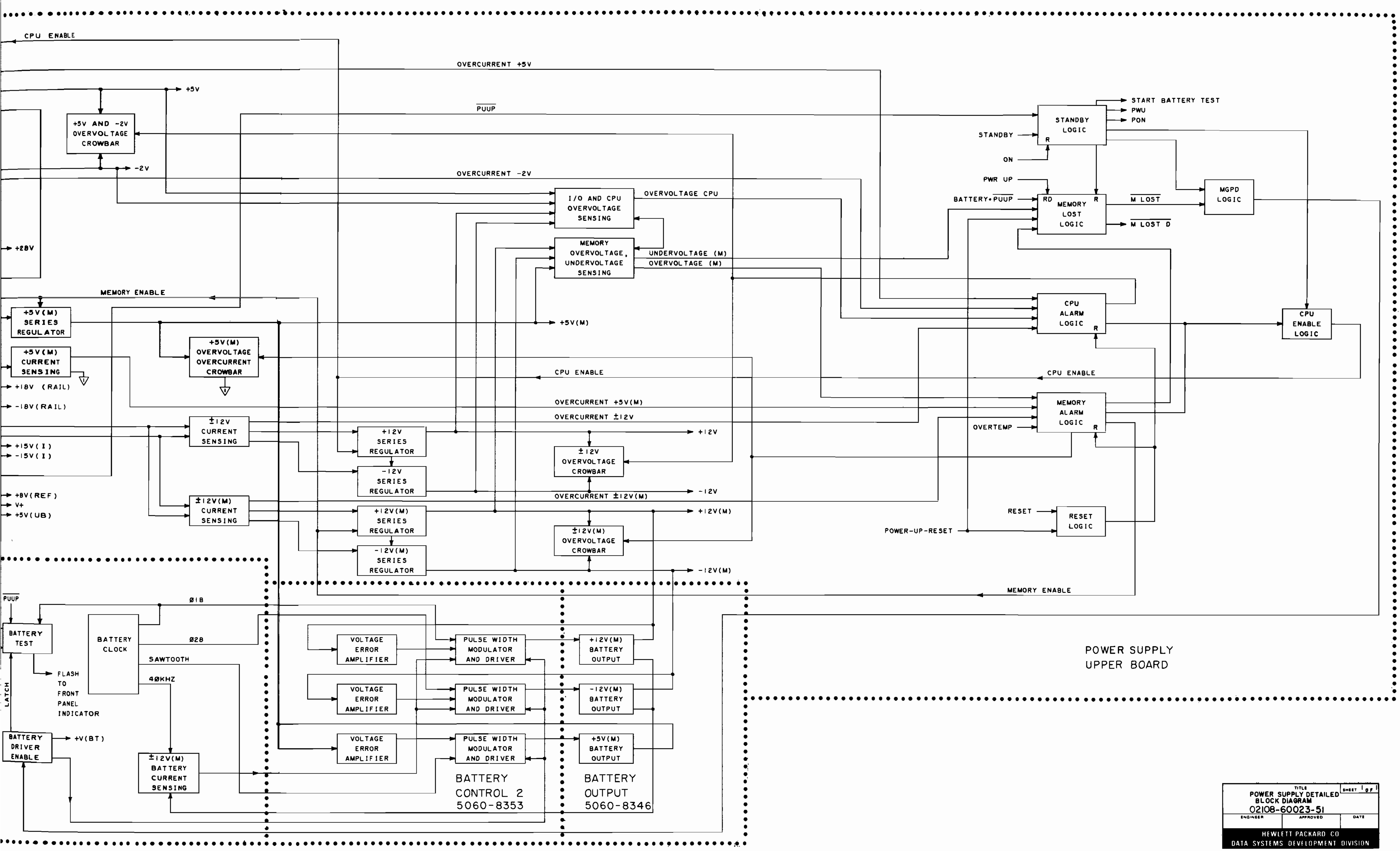
4. SIGNAL COMMON.
3. BOOTSTRAP COMMON.
2. HIGH VOLTAGE COMMON.
1. R ⇄ T INDICATES PHOTO ISOLATOR, T= TRANSMITTER, R= RECEIVER.

NOTE: UNLESS OTHERWISE SPECIFIED.

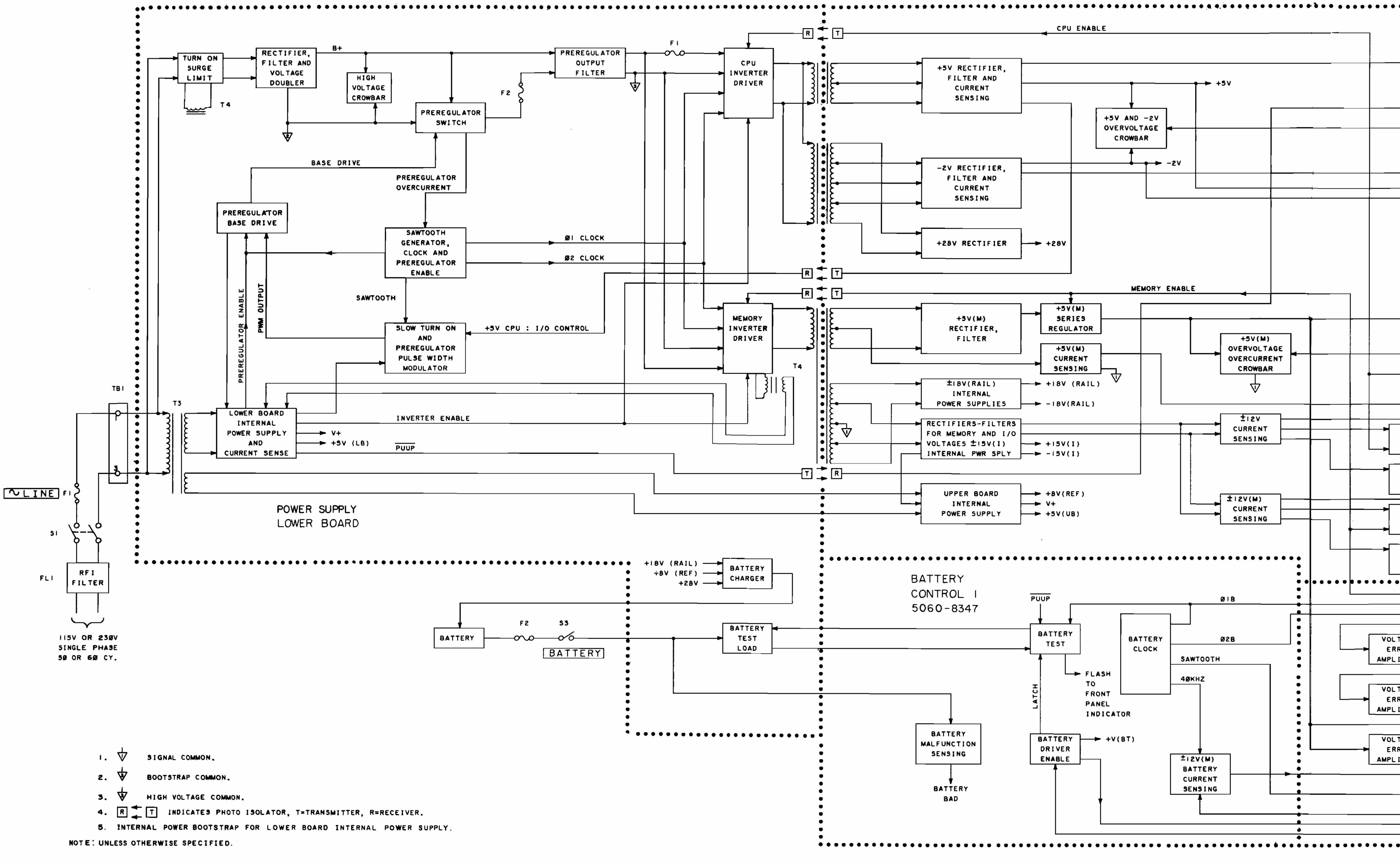
TITLE POWER SUPPLY OVERALL BLOCK DIAGRAM 02108-60024-51		SHEET 1 OF 1
ENGINEER	APPROVED	DATE
HEWLETT PACKARD CO DATA SYSTEMS DEVELOPMENT DIVISION		



AC LINE
F1
TB1
1
3
S1
RFI FILTER
115V OR 230V SINGLE PHASE 50 OR 60 CY.
TURN-ON SURGE LIMIT
RECTIFIER, FILTER AND VOLTAGE DOUBLER
B+
PREREGULATOR
CPU INVERTER DRIVER
+5V, -2V AND +28V RECTIFIERS AND FILTERS
+5V AND -2V OVERVOLTAGE CROWBAR
+5V
-2V
+28V
PREREGULATOR ENABLE
PREREGULATOR CONTROL POWER
+5V CONTROL
R
T
LOWER BOARD INTERNAL POWER SUPPLY
INTERNAL POWER BOOTSTRAP
INVERTER CONTROL POWER
V_x
+5V(LB)
PUUP
MEMORY INVERTER DRIVER
+5V(M) RECTIFIER AND FILTER
+5V(M) SERIES REGULATOR
+5V(M) OVERVOLTAGE OVERCURRENT CROWBAR
±18V(RAIL) INTERNAL POWER SUPPLIES
+18V(RAIL)
-18V(RAIL)
RECTIFIERS, FILTERS FOR ±12V AND ±12V (M) ±15V(I) INTERNAL POWER SUPPLY
+15V(I)
-15V(I)
UPPER BOARD INTERNAL POWER SUPPLY
+8V(REF)
V+
+5V(UB)
±12V SERIES REGULATORS
±12V(M) SERIES REGULATORS
±12V OVERVOLTAGE CROWBAR
±12V(M) OVERVOLTAGE CROWBAR
BATTERY CHARGER
BATTERY
F2
S3
BATTERY TEST LOAD
BATTERY MALFUNCTION
BATTERY BAD
PUUP
BATTERY TEST
FLASH
BATTERY CLOCK
Ø1B
Ø2B
SAWTOOTH
40KHZ
+12V(M) -12V(M) BATTERY CURRENT SENSING
VOLTAGE ERROR AMPLIFIERS
PULSE WIDTH MODULATORS AND DRIVERS
BATTERY REGULATOR OUTPUT STAGES
BATTERY DRIVER ENABLE
+V(BT)
LATCH



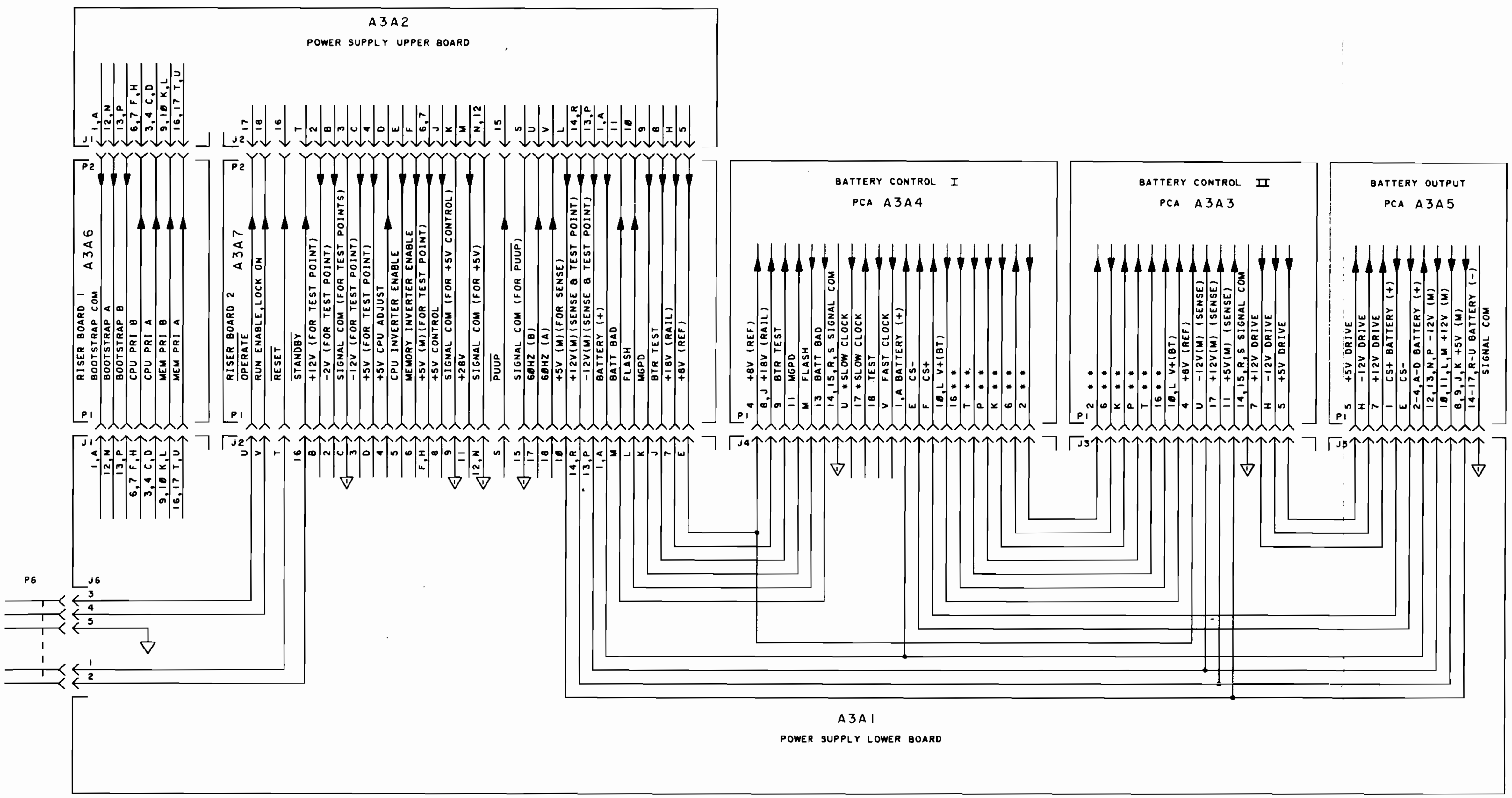
TITLE POWER SUPPLY DETAILED BLOCK DIAGRAM 02108-60023-51	SHEET 1 OF 1
ENGINEER / APPROVED / DATE	
HEWLETT PACKARD CO DATA SYSTEMS DEVELOPMENT DIVISION	



1. SIGNAL COMMON.
2. BOOTSTRAP COMMON.
3. HIGH VOLTAGE COMMON.
4. R ⇄ T INDICATES PHOTO ISOLATOR, T=TRANSMITTER, R=RECEIVER.
5. INTERNAL POWER BOOTSTRAP FOR LOWER BOARD INTERNAL POWER SUPPLY.

NOTE: UNLESS OTHERWISE SPECIFIED.

REV	REFERENCE	SERIES PREFIX
A	ORIG	NA



1. PIN CONNECTIONS NOT SHOWN ARE IDENTICAL TO THOSE OPPOSITE.

** THESE CONNECTIONS, AS SHOWN, ARE JUMPER WIRED BETWEEN J3 AND J4 ON PCA A3A1.

* SLOW CLOCK OUTPUT ON PIN U NORMALLY STRAPPED TO INPUT PIN 17.

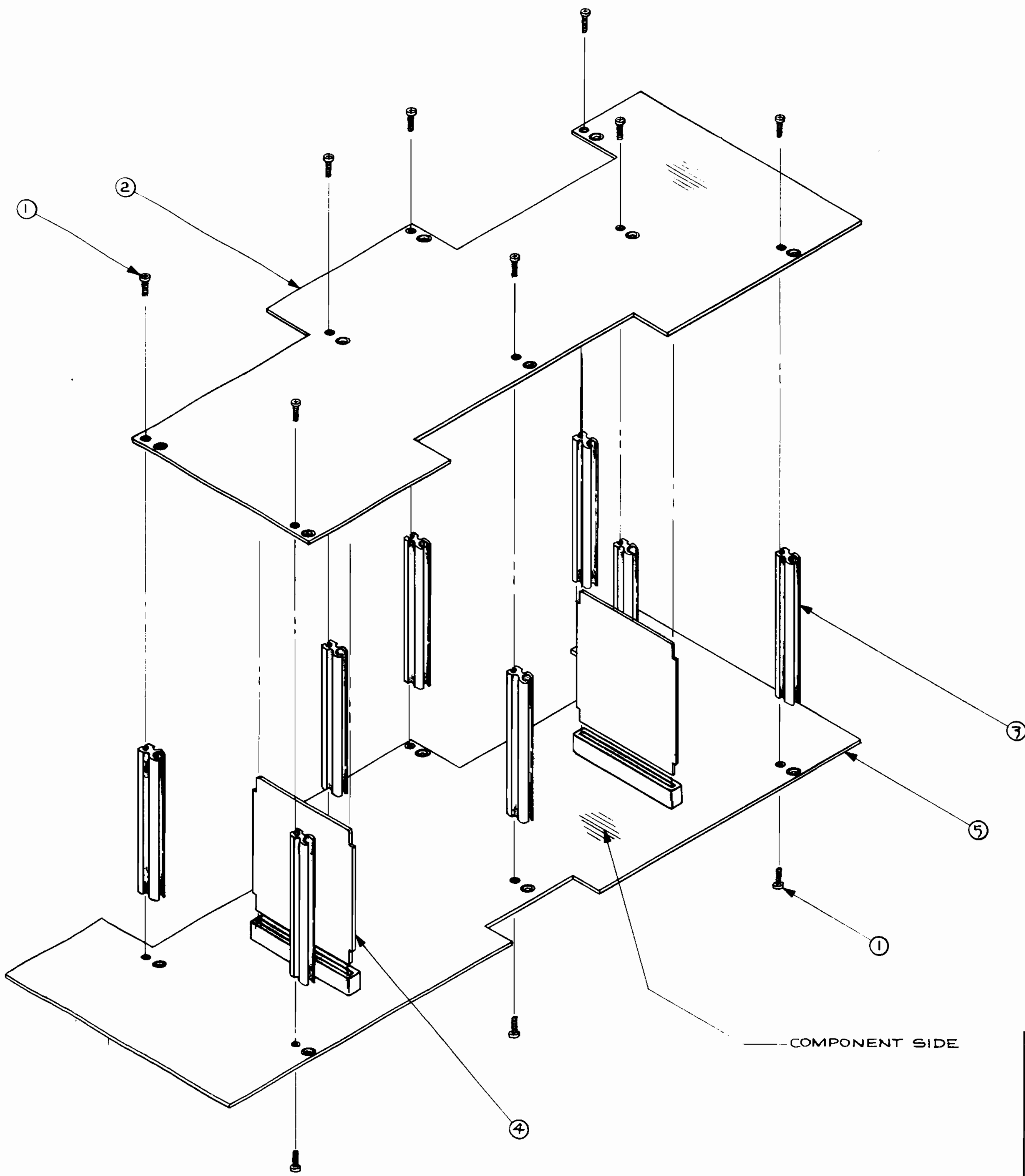
NOTE: UNLESS OTHERWISE SPECIFIED ALL CONNECTIONS TO/FROM J3, J4, AND J5 ARE TRACES ON PCA A3A1.

TITLE
POWER SUPPLY
INTERCONNECTION DIAGRAM
02108-90025

SHEET 1 OF 1

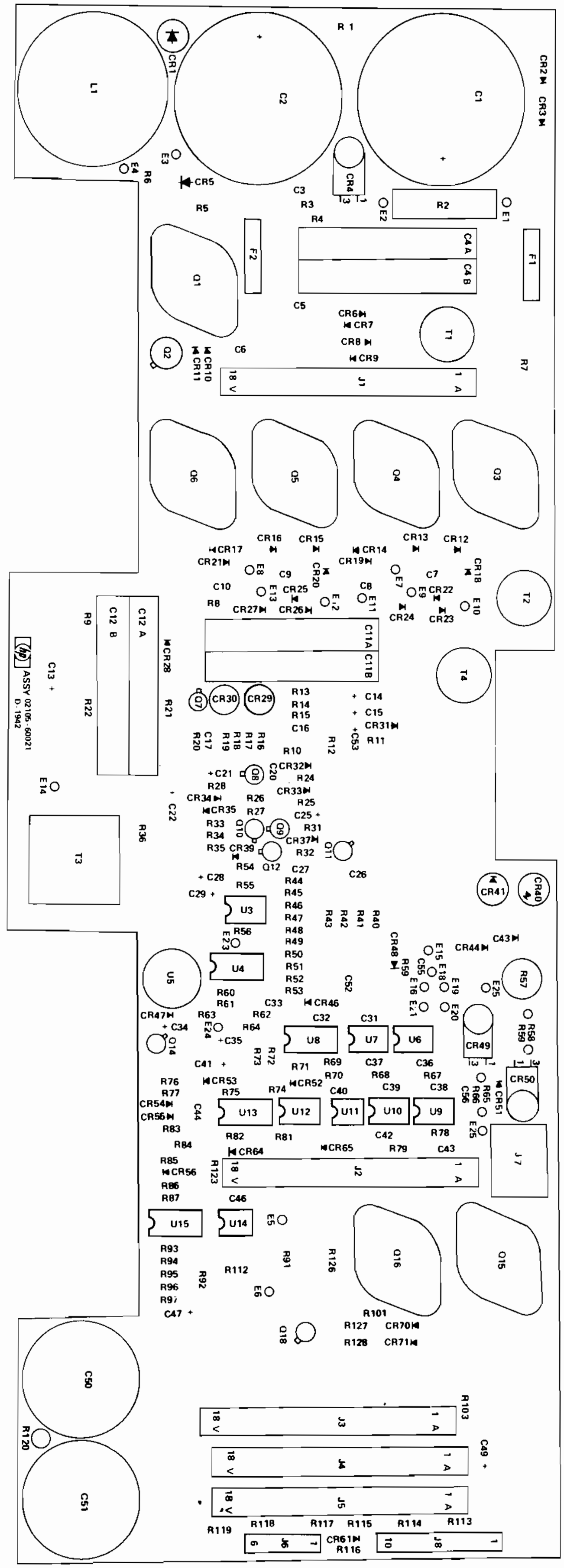
ENGINEER | APPROVED | DATE

HEWLETT PACKARD CO
DATA SYSTEMS DEVELOPMENT DIVISION



		COMPUTER	2105A	2108A/2109A
		COMPLETE POWER SUPPLY ASSY.	2105-60012	2108-60023
ITEM	QTY.	DESCRIPTION	PART NO.	PART NO.
1	16	SCREW 6-20 x .625	0624-0062	0624-0062
2	1	UPPER P.S. BD. ASSY.	02105-60022	5061-1355
3	8	STANDOFF	02105-20003	02108-20001
4	2	RISER BD.	02105-80003	5080-9744
5	1	LOWER P.S. BD. ASSY.	02105-60021	5061-1354
6	1	CROSSOVER WIRING KIT	02105-60023	—
7	1	CROSSOVER BD. ASSY.	5060-8345	—

2105A/2108A/2109A Power Supply
Main Assembly



2105 Power Supply Lower Assembly
02105-60021

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP 0.1UF		0150-0121		U	11	
01	C7-10,	31,33,38,						
03	39,42,	43,44						
		CAP .001UF 10%		0160-0153		U	2	
01	C16,17							
		CAP .47UF-20+80%		0160-0174		U	1	
01	C27							
		CAP .012UF 10%		0160-0301		U	1	
01	C26							
		CAP .01UF		0160-2055		U	5	
01	C3,36,	37,55,56						
		CAP 5000PF		0160-2145		U	1	
01	C20							
		CAP 100PF 5%		0160-2204		U	3	
01	C40,46	,52						
		CAP. 2400PF		0160-2227		U	1	
01	C32							
		CAP 3000PF		0160-2288		U	2	
01	C5,6							
		CAP FXD 2X5UF		0160-4142		U	1	
01	C12							
		CAP FXD 5UF		0160-4186		U	2	
01	C4,11							
		CAP 4.7UF 35WVDC		0180-0100		D	1	
01	C53							
		CAP 200UF-10+75%		0180-0104		U	3	
01	C13,22	,49						
		CAP 6.8UF 10%		0180-0116		D	2	
01	C14,15							
		CAP 2.2UF 10%		0180-0197		D	1	
01	C34							
		CAP 22UF 10%		0180-0228		D	1	
01	C47							
		CAP 1UF 10%		0180-0291		D	1	

2105A Power Supply Lower Assembly (02105-60021) Sht. 2 of 8

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0180-0291				
01	C28							
		CAP 780UF-10+75%		0180-0432		U	2	
01	C1,2							
		CAP 6.8UF 20%		0180-1701		U	2	
01	C21,29							
		CAP 47UF 10%		0180-1704		U	1	
01	C35							
		CAP 15UF 10%		0180-1746		D	1	
01	C25							
		CAP 68UF 20%		0180-1835		D	1	
01	C41							
		CAP 4000 UF 15V		0180-2385		U	2	
01	C50,51							
		PAD-MTG TO5		0340-0164		U	6	
		STUD SOLDER		0360-0090		U	17	
01	E7-16,	18-21,23-25						
		STUD SOLDER TERM		0360-0474		U	2	
		TERM STUD EKD		0360-1529		U	6	
01	E1-6							
		SPCR TAP #6X.125		0360-0383		U	17	
		CARD GUIDE		0403-0121		U	6	
		CMPOUND-NUT LOCK		0470-0231		U	0.01	BT
		ADH RTV CLEAR		0470-0251		U	0.01	TB
		RES 2.7 5% .25		0683-0275		D	3	
01	R13,14	,26						
		RES 47 5% .25		0683-4705		U	1	
01	R33							
		RES 464 1%.125		0698-0082		D	1	
01	R32							
		RES 2.15K 1%.125		0698-0084		D	16	
01	R18,28	,34,49,54,56,						
03	62,67	,69,71,73,74,						
05	77,81	,82,112						
		RES 2.37K 1%.125		0698-3150		D	1	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0698-3150				
01	R116							
		RES 3.48K 1%.125		0698-3152		U	1	
01	R119							
		RES 3.83K 1%.125		0698-3153		D	2	
01	R70,86							
		RES 4.22K 1%.125		0698-3154		D	1	
01	R52							
		RES 34.8 1% .50		0698-3395		U	2	
01	R42,43							
		RES 46.4 1% .50		0698-3398		U	2	
01	R40,41							
		RES 215 1% .50		0698-3401		U	1	
01	R84							
		RES 14.7K 1% .5W		0698-3414		U	5	
01	R7-9,22,127							
		RES 21.5 1%.125		0698-3430		U	1	
01	R11							
		RES 147 1%.125		0698-3438		D	1	
01	R85							
		RES 215 1%.125		0698-3441		D	6	
01	R78,79,83,113,114,123							
		RES 422 1%.125		0698-3447		D	1	
01	R21							
		RES 215K 1%.125		0698-3454		D	1	
01	R68							
		RES 200K 1% .5W		0757-0128		U	2	
01	R36,129							
		RES 21.5K 1%.125		0757-0199		D	3	
01	R12,63,76							
		RES 1.78K 1%.125		0757-0278		D	1	
01	R61							
		RES 1K 1%.125		0757-0280		D	18	
01	R10,16,19,24,27,35,							
03	51,58,60,64,66,75,							
05	94-96,103,117,118							
		RES 100 1%.125		0757-0401		D	6	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0757-0401				
01	R3,15,59,65,92,126							
		RES 511 1%.125		0757-0416		D	1	
01	R55							
		RES 825 1%.125		0757-0421		D	2	
01	R31,45							
		RES 1.1K 1%.125		0757-0424		D	1	
01	R97							
		RES 5.11K 1%.125		0757-0438		D	2	
01	R44,128							
		RES 7.5K 1%.125		0757-0440		D	1	
01	R93							
		RES 8.25K 1%.125		0757-0441		D	1	
01	R20							
		RES 10K 1%.125		0757-0442		D	8	
01	R17,25,46-48,50,72,87							
		RES 82.5K 1%.125		0757-0463		D	1	
01	R53							
		RES 10K 1% .50		0757-0839		D	1	
01	R5							
		RES 5 5% 20W		0811-1654		U	1	
01	R57							
		RES 4.7 5% 2W		0811-1674		U	1	
01	R101							
		RES 10 5% 10W PW		0811-1895		U	1	
01	R91							
		RES .12 3% 3W		0811-2616		U	1	
01	R1							
		RES 2 10%		0811-3108		U	1	
01	R2							
		RES 15K 3% 3W		0812-0051		U	2	
01	R4,6							
		TBG HS BLK .250D		0890-0312		U	0.70	FT
		HT DIS TO-5		1205-0033		U	1	
		HT DIS TO-3		1205-0275		U	7	
		CONNECTOR		1251-0674		U	1	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1251-0674				
01	J8							
		CONN PC2X18.156D		1251-2026		U	5	
01	J1-5							
		PIN ASSY		1251-3412		U	1	
01	J6							
		CONN UTIL 6PIN M		1251-3819		U	1	
01	J7							
		IC SN7474N		1820-0077		U	1	
01	U13							
		IC LM309H		1820-0429		U	1	
01	U5							
		IC SN75452P		1820-0799		U	1	
01	U3							
		IC SN75453P		1820-1016		U	3	
01	U6,7,12							
		IC D COMPTR 8K		1826-0175		U	2	
01	U8,15							
		XSTR PNP 2N2907A		1853-0281		U	4	
01	Q10,12,14,18							
		XSTR 2N3439 TO5		1854-0079		U	1	
01	Q2							
		XSTR 2N2222ATO18		1854-0477		U	3	
01	Q7,8,11							
		XSTR 2N3725 TO5		1854-0547		U	1	
01	Q9							
		XSTR 2N6055 TO3		1854-0611		U	2	
01	Q15,16							
		XSTR NPN TO3 10A		1854-0869		U	5	
01	Q1,3-6							
		XISTOR ARRAY		1858-0009		U	1	
01	U4							
		THYRISTOR SCR		1884-0233		U	1	
01	CR4							
		THYRISTOR-SCR		1884-0249		U	2	
01	CR49,50							
		THYRISTOR		1884-0258		U	1	

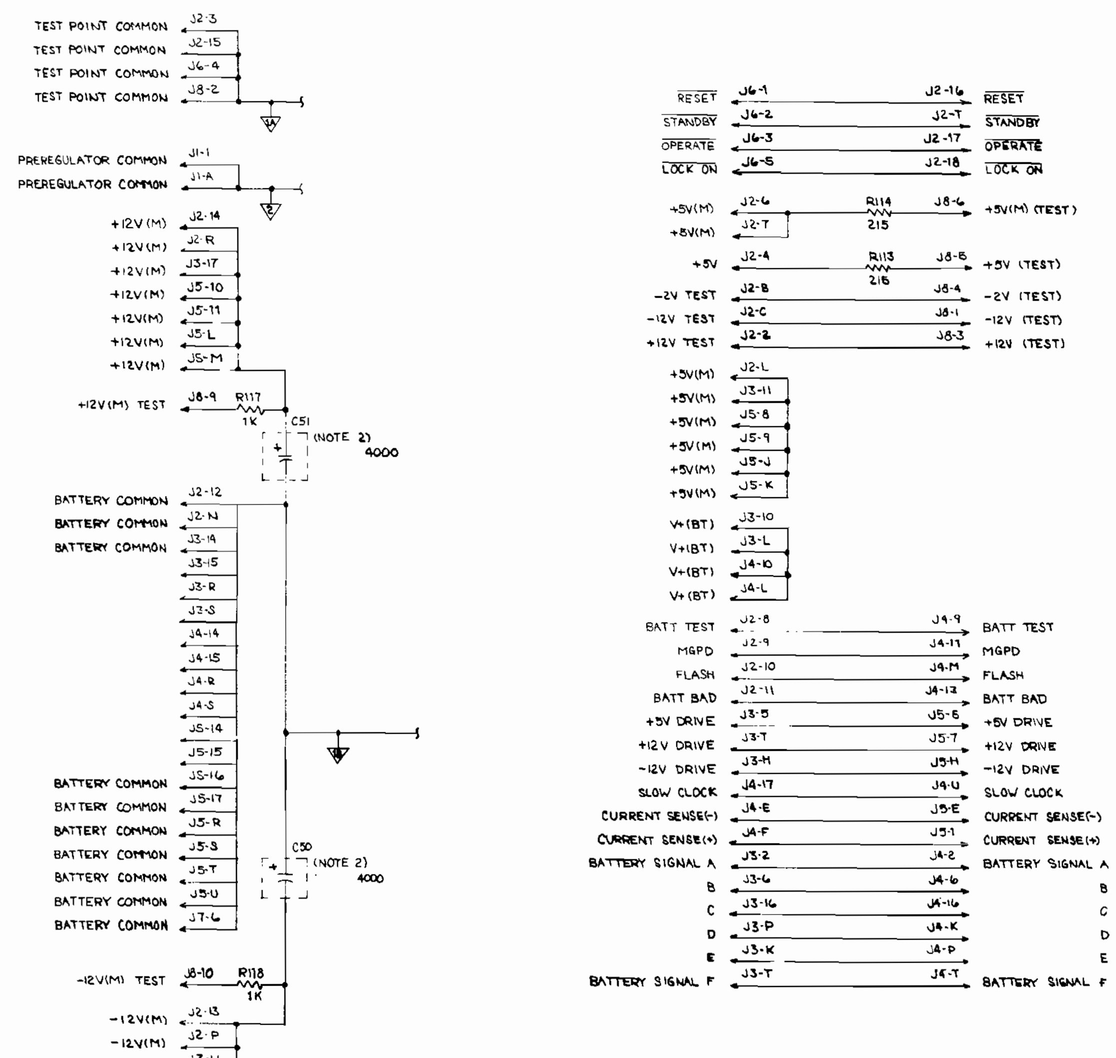
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1884-0258				
01	CR31							
		DIODE 1N2071		1901-0029		D	9	
01	CR14,17,21,22,25,26,							
03	34,43,44							
		DIODE SIL		1901-0040		D	11	
01	CR35,39,46-48,51-54,							
03	56,61							
		DIODE 3A 600V		1901-0420		U	3	
01	CR1,40,41							
		STABISTOR STB523		1901-0460		D	4	
01	CR32,33,65,70							
		DIODE IN4936		1901-1065		D	17	
01	CR6-13,15,16,18-20,							
03	23,24,27,28							
		RECTIFIER		1901-1087		D	1	
01	CR5							
		DIODE ZNR 16.2V		1902-0184		D	1	
01	CR71							
		DIODE 200V ZENER		1902-0668		D	2	
01	CR2,3							
		DIODE 3.16V		1902-3036		D	1	
01	CR64							
		DIODE ZNR 4.22V		1902-3070		D	2	
01	CR37,55							
		DIODE-FW BRIDGE		1906-0051		U	2	
01	CR29,30							
		ISOLATOR		1990-0429		U	2	
01	U9,10							
		OPTO ISOLATOR		1990-0537		U	2	
01	U11,14							
		RES VAR 1K		2100-1986		U	1	
01	R120							
		RES VAR 1K 10%		2100-3352		U	1	
01	R115							
		FUSE 4A NB		2110-0055		U	1	
01	F2							
		FUSE 2.5A NB		2110-0083		U	1	

2105A Power Supply Lower Assembly (02105-60021) Sht. 7 of 8

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	F1			2110-0083				
		FUSE CLIP .250D		2110-0483		U	4	
		LKWSHR 10 HEL		2190-0034		U	8	
		LKWSHR 6 HEL		2190-0851		U	1	
		SCR #4-40X.312L		2200-0141		U	3	
		NUT 4-40 W/LK		2260-0009		U	4	
		SCR #6-32X2.5L		2360-0221		U	1	
		SCR 6-32X.375		2360-0359		U	21	
		NUT 6-32 .312AF		2420-0002		U	1	
		NUT 8-32 .344AF		2580-0004		U	1	
		SCR 10-32X.375		2680-0099		U	8	
		WSHR #8 BRS		3050-0001		U	1	
		WSHR #10		3050-0006		U	2	
		WSHR #4 SS		3050-0222		U	4	
		WSHR #6 SS		3050-0227		U	6	
		WSHR #10 BRS		3050-0236		U	8	
		BEADS INDIAN		4330-0145		U	4	
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
		WIRE 18 BLK		8150-2890		C	1	FT
01	L2-5	COIL 56UH 10%		9100-2273		U	4	
01	T2	XFORMER		9100-2951		U	1	
01	T3	XFORMER		9100-2956		U	1	
01	L1	XFORMER		9100-2959		U	1	
01	T1	XFORMER		9100-2966		U	1	
		XFORMER-POWER		9100-3803		U	1	

2105A Power Supply Lower Assembly (02105-60021) Sht. 8 of 8

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				9100-3803				
01	T4							
		PC CARD GUIDE		02108-00009		W	2	
		HEAT SINK		02108-00030		W	3	



NOTES

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTANCE IN OHMS
   ALL CAPACITANCE IN MICROFARADS
   ALL RESISTORS ARE 1/8 WATT
2. COMPONENT LOADED IN FINAL ASSEMBLY

TEST POINT COMMON
BATTERY COMMON
PREREGULATOR COMMON
INVERTER COMMON

HIGHEST REFERENCE DESIGNATORS USED			
R128	C56	Q18	L5
U15	T4	CR71	J8

REFERENCE DESIGNATORS NOT USED	
R23, 29, 30, 37-39, 80, 88-90,	
R98-100, 102, 104-111, 121,	
R122, 124, 125	C18, 19, 23,
C24, 30, 45, 48, 54	Q13, 17
U1, 2	CR36, 38, 42, 45,
CR 57-60, 62, 63, 66-69	

REFERENCE DRAWINGS.
ASSY 02105-60021, D-1
C-2
C-3
C-4
D-5
C-6
C-7

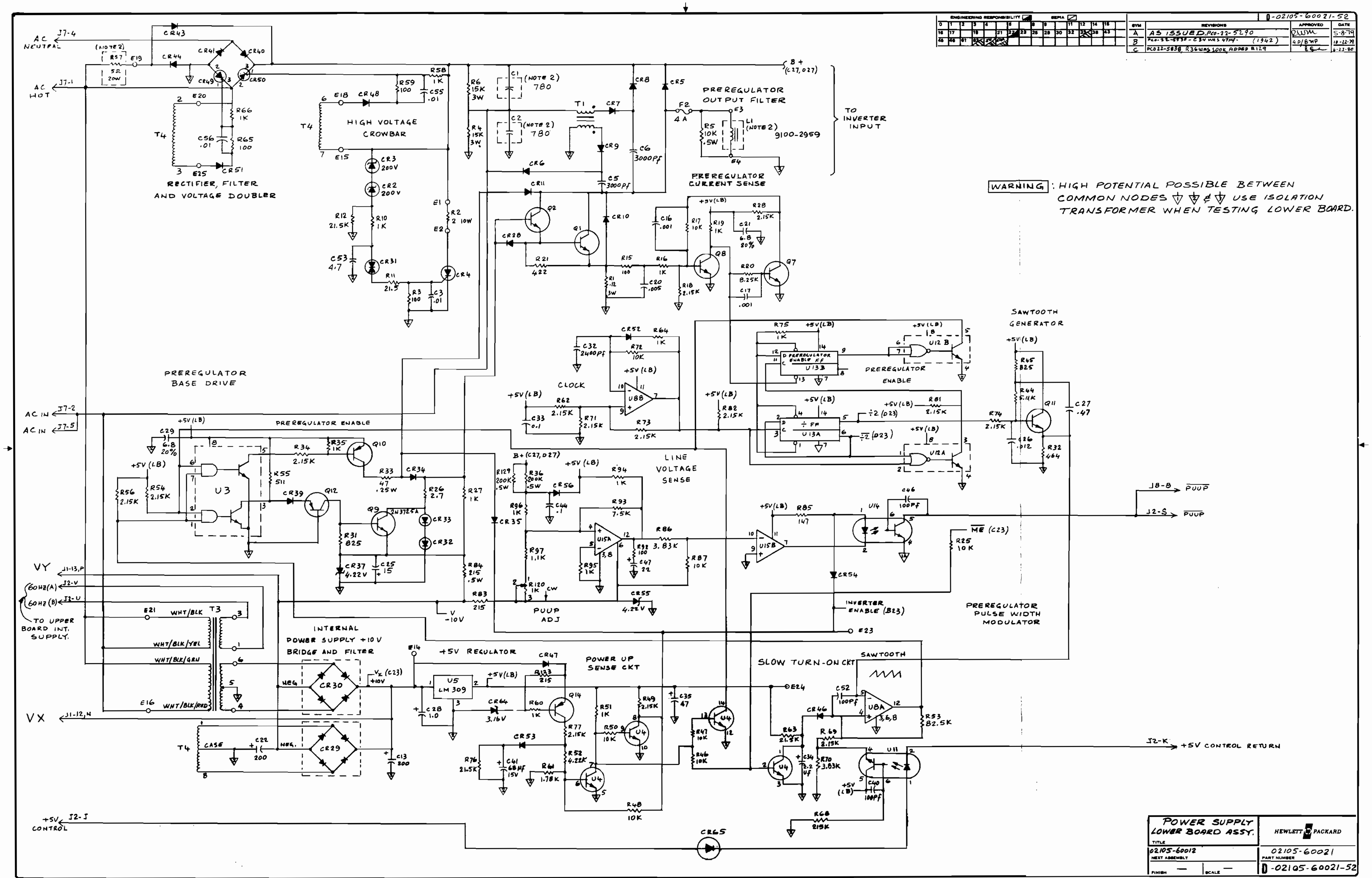
ENGINEERING RESPONSIBILITY SEPIA

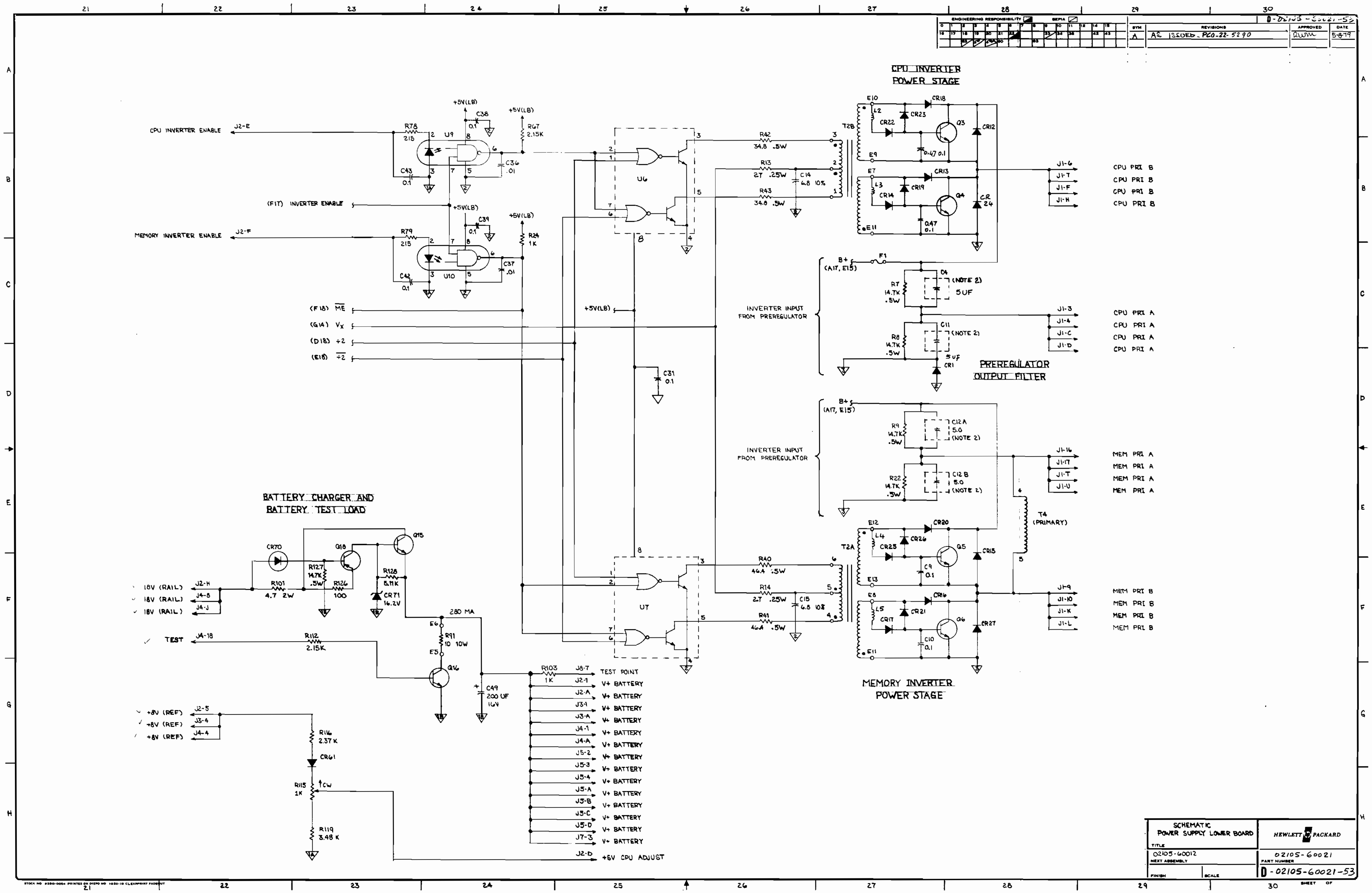
SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED, PLO-22-5290	RWM	5-8-79

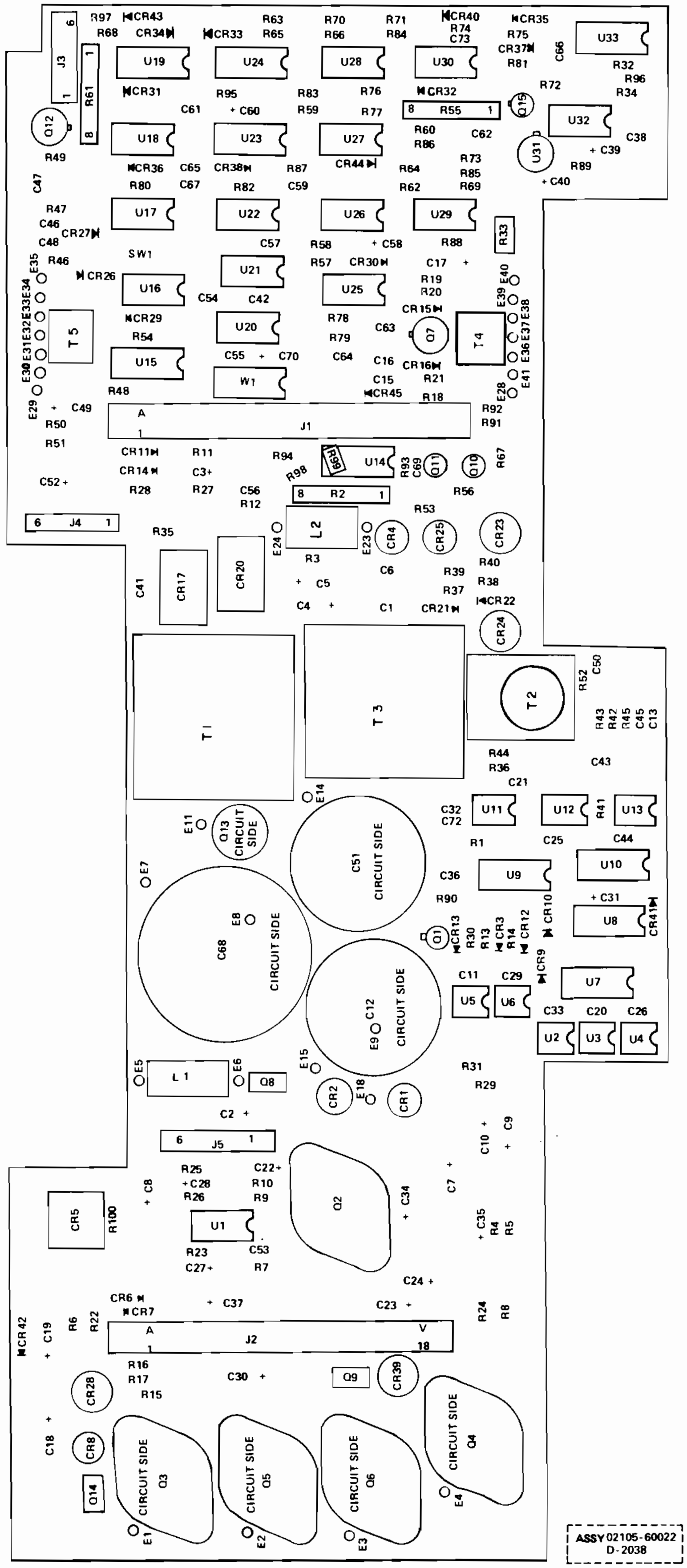
D-02105-60021-51

SCHEMATIC POWER SUPPLY LOWER BD
TITLE
02105-60012 / NEXT ASSEMBLY
FINISH / SCALE /
HEWLETT PACKARD
02105-60021 PART NUMBER
D-02105-60021-51
SHEET OF

STOCK NO. 9320-0665 PRINTED ON DIAPO NO. 1020-10 CLEARPRINT FADEOUT


WARNING : HIGH POTENTIAL POSSIBLE BETWEEN COMMON NODES USE ISOLATION TRANSFORMER WHEN TESTING LOWER BOARD.
RECTIFIER, FILTER AND VOLTAGE DOUBLER
HIGH VOLTAGE CROWBAR
PREREGULATOR OUTPUT FILTER
TO INVERTER INPUT
PREREGULATOR CURRENT SENSE
PREREGULATOR BASE DRIVE
PREREGULATOR ENABLE
CLOCK
LINE VOLTAGE SENSE
SAWTOOTH GENERATOR
PREREGULATOR PULSE WIDTH MODULATOR
PUUP ADJ
INVERTER ENABLE (B23)
INTERNAL POWER SUPPLY +10 V BRIDGE AND FILTER
+5V REGULATOR
POWER UP SENSE CKT
SLOW TURN-ON CKT
SAWTOOTH
+5V CONTROL RETURN
AC NEUTRAL
AC HOT
AC IN
VY
VX
TO UPPER BOARD INT. SUPPLY.
+5V CONTROL
A AS ISSUED PCO-22-5290
POWER SUPPLY LOWER BOARD ASSY.
HEWLETT PACKARD
02105-60012
02105-60021
D-02105-60021-52


CPU INVERTER
POWER STAGE
MEMORY INVERTER
POWER STAGE
PREREGULATOR
OUTPUT FILTER
BATTERY CHARGER AND
BATTERY TEST LOAD
INVERTER INPUT
FROM PREREGULATOR
CPU INVERTER ENABLE
MEMORY INVERTER ENABLE
(F17) INVERTER ENABLE
CPU PRI B
CPU PRI A
MEM PRI A
MEM PRI B
T4
(PRIMARY)
TEST POINT
V+ BATTERY
+6V CPU ADJUST
18V (RAIL)
TEST
+8V (REF)
SCHEMATIC
POWER SUPPLY LOWER BOARD
HEWLETT PACKARD
02105-60012
02105-60021
D-02105-60021-53



2105A Power Supply Upper Assembly
02105-60022

2105A Power Supply Upper Assembly (02105-60022) Sht. 1 of 9

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C1	CAP .01UF-20+80%		0150-0093		U	1	
01	C45,66,69	CAP 0.1UF		0150-0121		U	3	
01	C60,72	CAP 1.0UF 20%		0160-0127		U	2	
01	C54,55	CAP. 2.2UF		0160-0128		D	2	
01	C16,48,61	CAP .022UF 10%		0160-0162		U	3	
01	C59	CAP .033UF 10%		0160-0163		U	1	
01 03	C11,15,20,26,29, 33,47,57,63,64	CAP .01UF		0160-2055		U	10	
01	C43	CAP .33UF 20%		0160-2128		U	1	
01	C21,25,32,36	CAP 30PF 5%		0160-2199		U	4	
01	C38,65,67	CAP 100PF 5%		0160-2204		U	3	
01	C6	CAP 3000PF		0160-2288		U	1	
01	C13	CAP 470PF 5%		0160-2940		U	1	
01	C46,56	CAP 1000PF 10%		0160-3456		U	2	
01	C41,44,50	CAP .02UF 20%		0160-3459		U	3	
01	C2,37	CAP 100UF-10+50%		0180-0094		U	2	
01	C4,5,9,10	CAP 4.7UF 35WVDC		0180-0100		D	4	
		CAP 200UF-10+75%		0180-0104		U	4	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0180-0104				
01	C18,23,30,34							
		CAP 2.2UF 10%		0180-0197		D	1	
01	C70							
		CAP 22UF 10%		0180-0228		D	1	
01	C3							
		CAP 33UF 10%		0180-0229		U	2	
01	C39,40							
		CAP 1UF 10%		0180-0291		D	8	
01	C19,22,24,							
03	31,35,53,58,62							
		CAP 10000UF		0180-0435		U	1	
01	C68							
		CAP 8KUF FXD		0180-0460		U	1	
01	C51							
		CAP 5KUF		0180-0464		U	1	
01	C12							
		CAP 6.8UF 20%		0180-1701		U	1	
01	C42							
		CAP 47UF 10%		0180-1704		U	1	
01	C73							
		CAP 22UF 10%		0180-1794		U	2	
01	C17,49							
		CAP 200UF-10+75%		0180-1946		U	2	
01	C7,8							
		CAP 3.3UF 10%		0180-2141		U	1	
01	C52							
		CAP-TA 3.30F		0180-2690		D	2	
01	C27,28							
		PAD-MTG TO5		0340-0164		U	3	
		STUD SOLDER		0360-0090		U	20	
01	E11,14,15,18,23,24							
03	28-41							
		STUD SOLDER TERM		0360-0474		U	2	
		TERM STUD FKD		0360-1529		U	3	
01	E5,6,7							
		SPCR TAP #6X.125		0380-0383		U	17	

2105A Power Supply Upper Assembly (02105-60022) Sht. 3 of 9

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		STANDOFF		0380-0551		U	4	
01	CP1,2,	17,20						
		TAPE ELECTRICAL		0460-0955		U	0.01	RL
		ADH RTV CLEAR		0470-0251		U	0.01	TH
		RES 4.7 5% .25		0683-0475		U	1	
01	R89							
		RES FXD 5.6 OHM		0683-0565		U	2	
01	R94,96							
		RES 470 5% .25		0683-4715		D	1	
01	R54							
		RES 2.15K 1%.125		0698-0084		D	3	
01	R44,60	,78						
		RES 1.78K 1% .5		0698-0089		U	2	
01	R15,31							
		RES 2.37K 1%.125		0698-3150		D	1	
01	R67							
		RES 4.64K 1%.125		0698-3155		D	12	
01	R7,9,1	8,23,25,47,59						
01	63,66	,70,73,83						
		RES 31.6K 1%.125		0698-3160		U	1	
01	R75							
		RES 464K 1%.125		0698-3260		D	6	
01	R65,80	,82,97-99						
		RES 31.6 1% .50		0698-3394		U	1	
01	R35							
		RES 14.7 1%.125		0698-3428		U	2	
01	R4,5							
		RES 147 1%.125		0698-3438		D	3	
01	R62,84	,85						
		RES 215 1%.125		0698-3441		D	1	
01	R32							
		RES 348 1%.125		0698-3445		D	1	
01	R86							
		RES 422 1%.125		0698-3447		D	1	
01	R45							
		RES 28.7K 1%.125		0698-3449		U	1	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0698-3449				
01	R41							
		RES 42.2K 1%.125		0698-3450		D	2	
01	R10,26							
		RES 100 1% .50		0757-0198		U	1	
01	R72							
		RES 21.5K 1%.125		0757-0199		D	1	
01	R74							
		RES 1.21K 1%.125		0757-0274		D	2	
01	R21,49							
		RES 1.78K 1%.125		0757-0278		D	1	
01	R36							
		RES 6.19K 1%.125		0757-0290		D	2	
01	R34,37							
		RES 42.2 1%.125		0757-0316		U	4	
01	R50,51	,91,92						
		RES 1.33K 1%.125		0757-0317		D	1	
01	R77							
		RES 100 1%.125		0757-0401		D	8	
01	R16,17	,19,20,						
03	46,48	,56,93						
		RES 511 1%.125		0757-0416		D	1	
01	R64							
		RES 681 1%.125		0757-0419		D	1	
01	R71							
		RES 750 1%.125		0757-0420		D	1	
01	R76							
		RES 10K 1%.125		0757-0442		D	16	
01	R11-14	,27-30,39,40						
03	53,57	,79,88,90,95						
		RES 68.1K 1%.125		0757-0461		D	1	
01	R68							
		RES 100K 1%.125		0757-0465		D	5	
01	R43,58	,69,81,87						
		RES 10 1% .50		0757-0984		D	1	
01	R52							
		RES 51.1 1% .50		0757-1000		U	1	

2105A Power Supply Upper Assembly (02105-60022) Sht. 5 of 9

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0757-1000				
01	R3							
		RES 61.9 1% .50		0757-1002		U	1	
01	R1							
		RES 1.47K 1%.125		0757-1094		D	2	
01	R36,42							
		RES .12 3% 3W		0811-2616		U	4	
01	R6,8,2	2,24						
		SLEEVING FLEX.		0890-0064		U	1	FT
		TBG #20 TFE NAT		0890-0212		U	0.50	FT
		TBG HS BLK .375D		0890-0291		U	0.70	FT
		SOCKET 16 DIP LO		1200-0482		U	1	
01	W1							
		HT DIS PL PWR		1205-0219		U	1	
		HT DIS TO-3		1205-0275		U	5	
		CONN PC2X18.156D		1251-2026		U	1	
01	J2							
		CONN PC1X18.156T		1251-2346		U	1	
01	J1							
		PIN ASSY		1251-3412		U	3	
01	J3-5							
		JMPR PLUG .3"C-C		1258-0124		U	3	
		RES NET 7X4.7K		1810-0125		U	3	
01	R2,55,	61						
		RESISTOR NETWORK		1810-0185		U	1	
01	U10							
		RESISTOR NETWORK		1810-0187		U	1	
01	U15							
		RESISTOR NETWORK		1810-0188		U	1	
01	U14							
		RESISTOR NETWORK		1810-0199		U	1	
01	U9							
		NETWORK-RESISTOR		1810-0200		U	1	
01	U7							
		IC LM309H		1820-0429		U	1	

2105A Power Supply Upper Assembly (02105-60022) Sht. 6 of 9

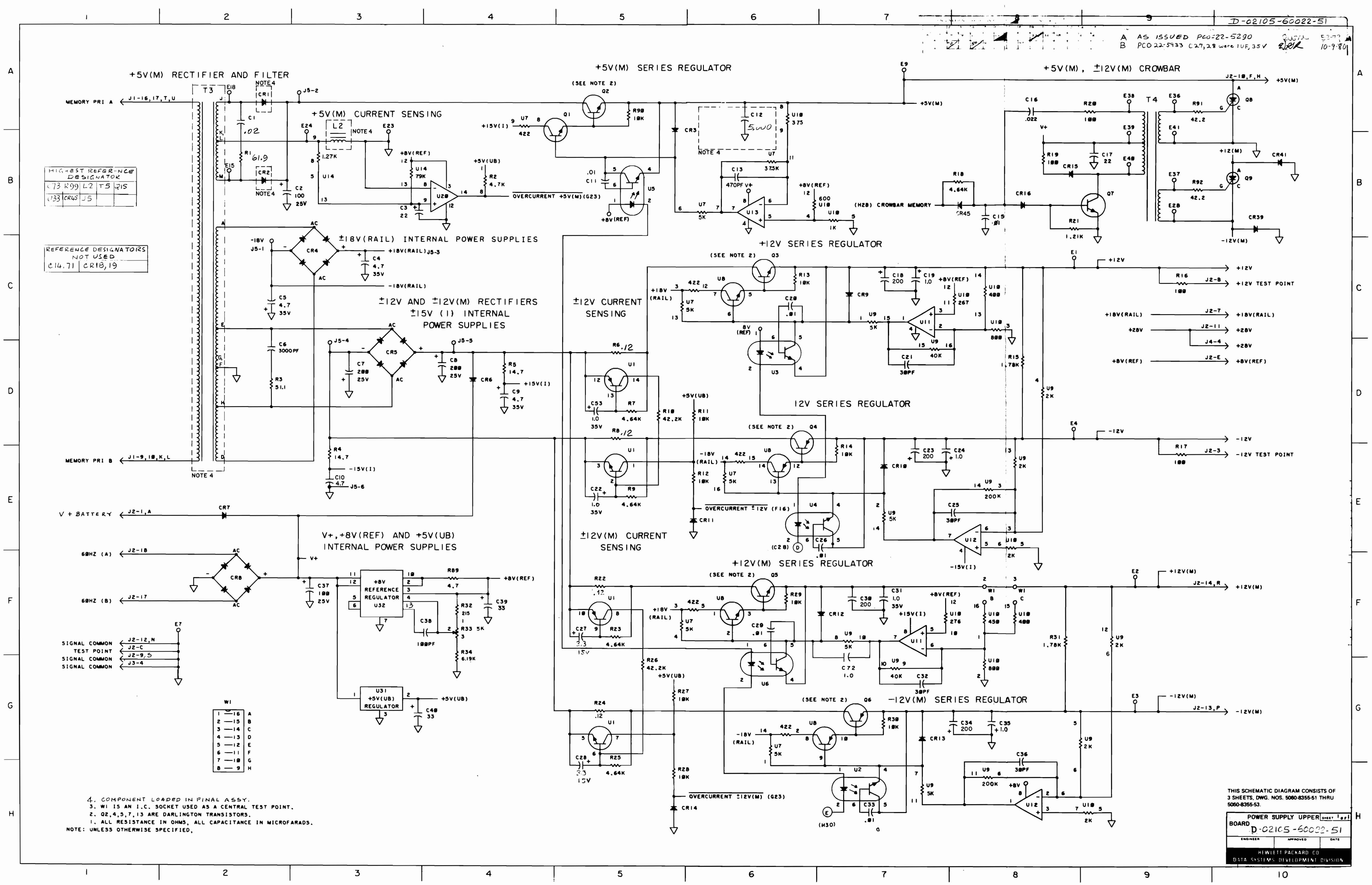
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1820-0429				
01	U31							
		IC U6E7723393		1820-0439		U	1	
01	U32							
		IC CD4043AY		1820-0941		U	1	
01	U23							
		IC CD4023AY		1820-0943		U	1	
01	U18							
		IC CD4001AY		1820-0946		U	2	
01	U22,29							
		IC CD4011AE		1820-0949		U	2	
01	U17,26							
		IC CD4012AE		1820-0950		U	1	
01	U25							
		IC 4049AE		1820-1145		U	2	
01	U19,24							
		IC CD4050AE		1820-1146		U	1	
01	U33							
		IC QUAD COMPTR		1826-0138		U	3	
01	U16,20,21							
		IC D OP AMP 20K		1826-0142		U	3	
01	U11-13							
		XSTR PNP 2N2907A		1853-0281		U	1	
01	Q15							
		XSTR 2N6053 TO3		1853-0351		U	2	
01	Q4,6							
		XSTR 2N3053 TO5		1854-0039		U	2	
01	Q7,12							
		XSTR NPN SI PL5		1854-0071		U	3	
01	Q1,10,11							
		XSTR 2N6055 TO3		1854-0611		U	3	
01	Q2,3,5							
		XISTOR ARRAY		1858-0008		U	3	
01	U1,8,30							
		XISTOR ARRAY		1858-0009		U	2	
01	U27,28							
		THYRISTOR 35AMPS		1884-0208		U	1	

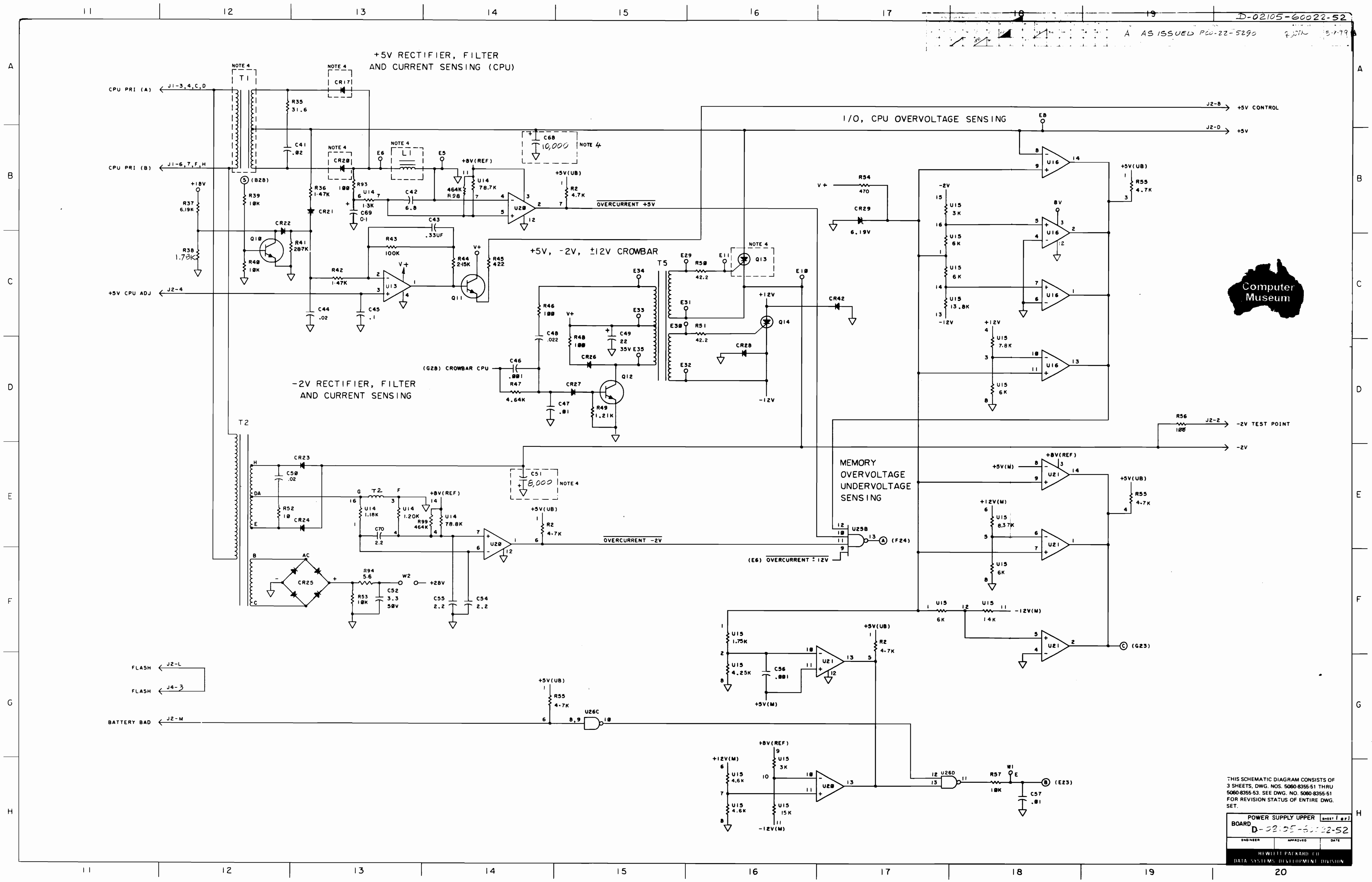
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1884-0208				
01	Q13							
		THYRISTOR-SCR		1884-0240		U	3	
01	Q8,9,1	4						
		DIODE 1N2071		1901-0029		D	11	
01	CR3,6,	7,9,10,12,						
03	13,4	1-44						
		DIODE SIL		1901-0040		D	17	
01	CR11,1	4-16,21,22,26						
03	27,3	0-34,36-38,45						
		DIODE-SI		1901-0415		U	2	
01	CR28,3	9						
		DIODE SILICONE		1901-0463		U	1	
01	CR40							
		DIO-PWR RECT		1901-0662		U	2	
01	CR23,2	4						
		DIODE-SCHOTTKY		1901-0792		U	2	
01	CR17,2	0						
		DIODE RECT SIL		1901-1036		U	2	
01	CR1,2							
		DIO-ZNR 6.19V 1%		1902-0588		U	1	
01	CR29							
		DIODE 4.64V		1902-3082		U	1	
01	CR35							
		DIODE-FW BRIDGE		1906-0051		U	3	
01	CR4,8,	25						
		BRIDGE RECTIF		1906-0053		U	1	
01	CR5							
		COUPLER-OPTICAL		1990-0403		U	5	
01	U2-6							
		RES 5KOHM 10%		2100-3207		U	1	
01	R33							
		LKWSHR 4 HEL		2190-0003		U	4	
		LKWSHR 6 HEL		2190-0006		U	1	
		LKWSHR 10 INT		2190-0011		U	4	
		LKWSHR 1/4 HEL		2190-0032		U	1	

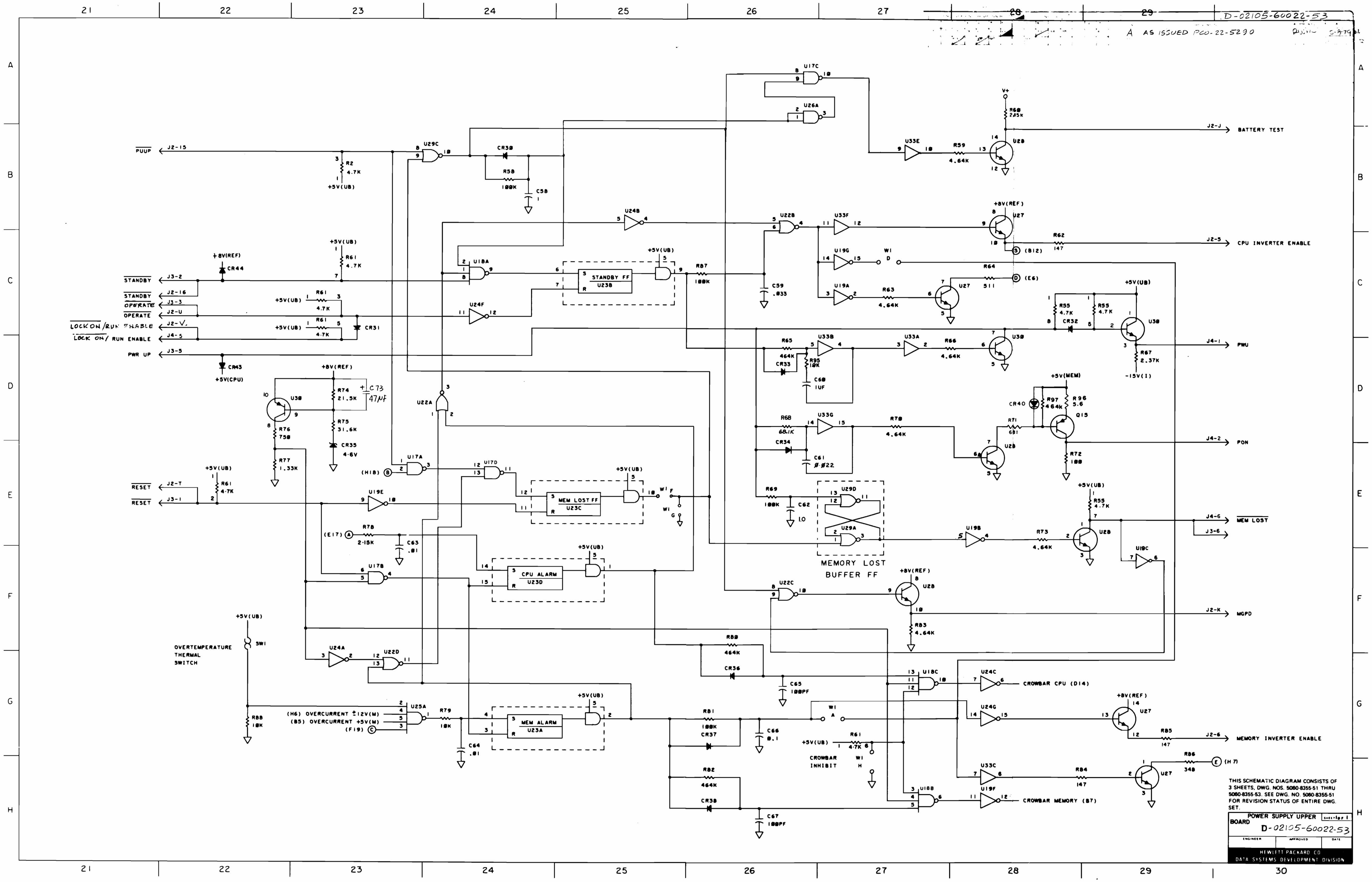
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		LKWSHR 10 HEL		2190-0034		U	6	
		LKWSHR 6 HEL		2190-0851		U	3	
		SCR #4-40X.312L		2200-0141		U	4	
		NUT 4-40 .250AF		2260-0001		U	4	
		NUT 4-40 W/LK		2260-0009		U	1	
		SCR #6-32X.500L		2360-0201		U	1	
		SCR #6-32X.625L		2360-0203		U	2	
		SCR 6-32X.375		2360-0359		U	14	
		NUT 6-32 .312AF		2420-0002		U	1	
		SCR 10-32X.375		2680-0099		U	1	
		SCR 10-32X.438		2680-0101		U	4	
		SCR 10-32X.500		2680-0103		U	1	
		NUT 1/4-28		2950-0036		U	1	
		WSHR #4 SS		3050-0222		U	1	
		WSHR #6 SS		3050-0228		U	3	
		WSHR #4 SS		3050-0229		U	5	
		WSHR #10 BRS		3050-0236		U	7	
		WSHR .267ID BRS		3050-0284		U	1	
		WASHER FLAT		3050-0665		U	1	
01	S1	SWITCH-THERMAL		3103-0033		U	1	
		BEADS INDIAN		4330-0145		U	6	
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
		WIRE 14 WHITE		8150-2470		C	0.70	FT
		WIRE 18 AWG BARE		8151-0011		U	1	FT
		XFMR-POWER		9100-0444		U	1	
01	T4,5	XFORMER-CROWBAR		9100-2953		U	2	
		XFORMER-5V CPU		9100-2957		U	1	

2105A Power Supply Upper Assembly (02105-60022) Sht. 9 of 9

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
				9100-2957			
01	L1						
		CHOKE		9100-2958		U	1
01	L2						
		XFORMER-POWER		9100-3802		U	1
01	T1						
		XFORMER-POWER		9100-3805		U	1
01	T3						
		BOARD-ETCHED		5080-9730		W	1
		HEAT SINK		02105-00018		W	2
		STRAP-GROUND		02108-00028		W	1


D-02105-60022-51
A AS ISSUED PCO22-5290
B PCO 22-5933 C27,28 were 1UF, 35V
10-9-80
+5V(M) RECTIFIER AND FILTER
+5V(M) CURRENT SENSING
+5V(M) SERIES REGULATOR
+5V(M), ±12V(M) CROWBAR
±18V(RAIL) INTERNAL POWER SUPPLIES
±12V AND ±12V(M) RECTIFIERS
±15V (I) INTERNAL
POWER SUPPLIES
±12V CURRENT
SENSING
+12V SERIES REGULATOR
12V SERIES REGULATOR
±12V(M) CURRENT
SENSING
+12V(M) SERIES REGULATOR
-12V(M) SERIES REGULATOR
V+,+8V(REF) AND +5V(UB)
INTERNAL POWER SUPPLIES
HIGHEST REFERENCE
DESIGNATOR
C73 R99 L2 T5 Q15
U33 CR45 J5
REFERENCE DESIGNATORS
NOT USED
C14,71 CR18,19
MEMORY PRI A
MEMORY PRI B
V + BATTERY
60HZ (A)
60HZ (B)
SIGNAL COMMON
TEST POINT
SIGNAL COMMON
SIGNAL COMMON
OVERCURRENT +5V(M)(G23)
OVERCURRENT ±12V (F16)
OVERCURRENT ±12V(M) (G23)
(H28) CROWBAR MEMORY
+12V
+12V TEST POINT
+18V(RAIL)
+28V
+8V(REF)
-12V
-12V TEST POINT
+12V(M)
-12V(M)
+5V(M)
4. COMPONENT LOADED IN FINAL ASSY.
3. W1 IS AN I.C. SOCKET USED AS A CENTRAL TEST POINT.
2. Q2,4,5,7,13 ARE DARLINGTON TRANSISTORS.
1. ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN MICROFARADS.
NOTE: UNLESS OTHERWISE SPECIFIED.
THIS SCHEMATIC DIAGRAM CONSISTS OF
3 SHEETS, DWG. NOS. 5060-8355-51 THRU
5060-8355-53.
POWER SUPPLY UPPER BOARD
D-02105-60022-51
ENGINEER
APPROVED
DATE
HEWLETT PACKARD CO
DATA SYSTEMS DEVELOPMENT DIVISION


+5V RECTIFIER, FILTER AND CURRENT SENSING (CPU)
-2V RECTIFIER, FILTER AND CURRENT SENSING
+5V, -2V, ±12V CROWBAR
I/O, CPU OVERVOLTAGE SENSING
MEMORY OVERVOLTAGE UNDERVOLTAGE SENSING
CPU PRI (A)
CPU PRI (B)
+5V CPU ADJ
FLASH
FLASH
BATTERY BAD
+5V CONTROL
+5V
-2V TEST POINT
-2V
OVERCURRENT +5V
OVERCURRENT -2V
(E6) OVERCURRENT ±12V
(G28) CROWBAR CPU
A AS ISSUED
D-02105-60022-52
THIS SCHEMATIC DIAGRAM CONSISTS OF 3 SHEETS, DWG. NOS. 5060-8355-51 THRU 5060-8355-53. SEE DWG. NO. 5060-8355-51 FOR REVISION STATUS OF ENTIRE DWG. SET.
POWER SUPPLY UPPER BOARD
HEWLETT PACKARD CO
DATA SYSTEMS DEVELOPMENT DIVISION

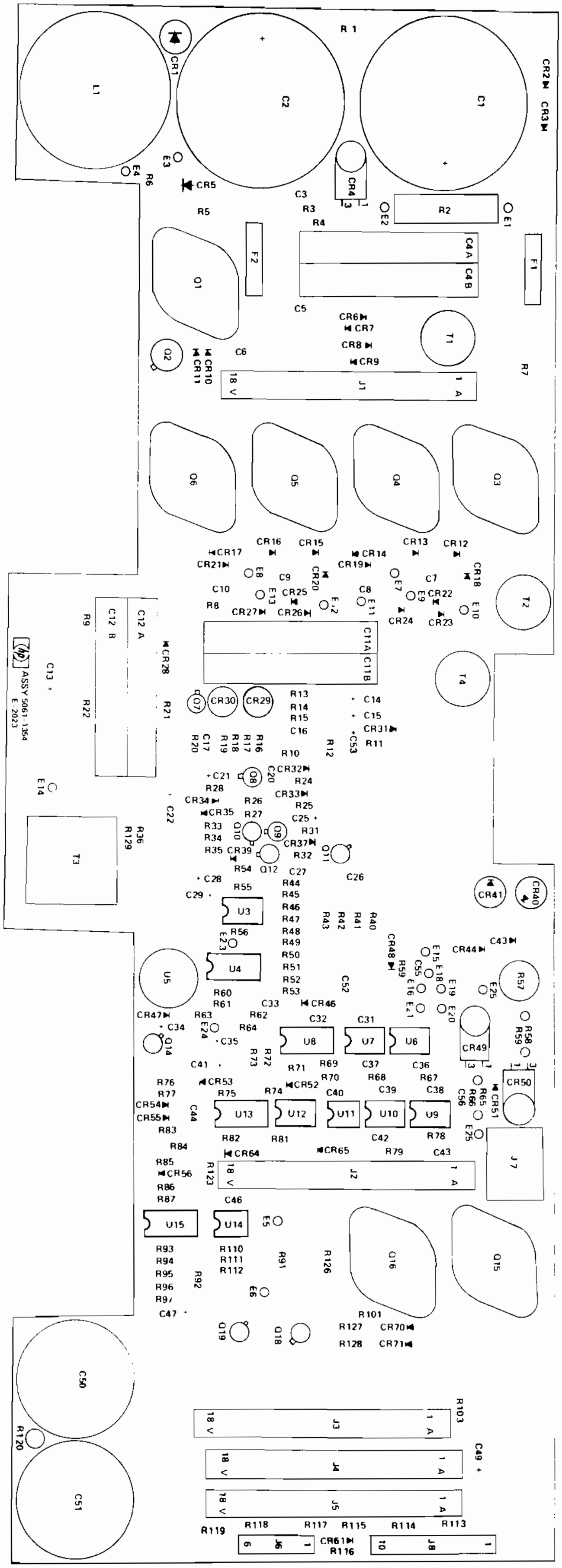


THIS SCHEMATIC DIAGRAM CONSISTS OF 3 SHEETS, DWG. NOS. 5080-8355-51 THRU 5080-8355-53. SEE DWG. NO. 5080-8355-51 FOR REVISION STATUS OF ENTIRE DWG. SET.

POWER SUPPLY UPPER BOARD

D-02105-60022-53

HEWLETT PACKARD CO
DATA SYSTEMS DEVELOPMENT DIVISION



2108A/2109A Power Supply Lower Assembly
5061-1354

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP 0.1UF		0150-0121		U	9	
01	C9,10,	31,33,38,39,						
03	42,43	,44						
		CAP .001UF 10%		0160-0153		U	2	
01	C16,17							
		CAP .47UF-20+80%		0160-0174		U	3	
01	C7,8,2	7						
		CAP .012UF 10%		0160-0301		U	1	
00	C26							
		CAP .01UF		0160-2055		U	5	
01	C3,36,	37,55,56						
		CAP 5000PF		0160-2145		U	1	
00	C20							
		CAP 100PF 5%		0160-2204		U	3	
01	C40,46	,52						
		CAP. 2400PF		0160-2227		U	1	
00	C32							
		CAP 3000PF		0160-2288		U	2	
00	C5,6							
		CAP FXD 2X5UF		0160-4142		U	3	
01	C4,11,	12						
		CAP 200UF-10+75%		0180-0104		U	3	
01	C13,22	,49						
		CAP 6.8UF 10%		0180-0116		D	2	
01	C14,15							
		CAP 22UF 10%		0180-0228		D	1	
00	C47							
		CAP 1UF 10%		0180-0291		D	4	
01	C25,28	,34,53						
		CAP 1150UF		0180-0431		U	2	
01	C1,2							
		CAP 8KUF		0180-0463		U	2	
01	C50,51							
		CAP 6.8UF 20%		0180-1701		U	2	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0180-1701				
01	C21,29							
		CAP 47UF 10%		0180-1704		U	1	
00	C35							
		CAP 68UF 20%		0180-1835		D	1	
00	C41							
		PAD-MTG TO5		0340-0164		U	5	
		STUD SOLDER		0360-0090		U	17	
01	E7-16,	18-21,23-25						
		STUD SOLDER TERM		0360-0474		U	4	
		TERM STUD FKD		0360-1529		U	6	
00	E1-6							
		SPCR TAP #6X.125		0380-0383		U	17	
		CARD GUIDE		0403-0121		U	6	
		CMPOUND-NUT LOCK		0470-0231		U	0.001	BT
		ADH RTV CLEAR		0470-0251		U	0.001	TB
		RES 2.7 5% .25		0683-0275		D	2	
01	R13,14							
		RES 47 5% .25		0683-4705		U	1	
00	R33							
		RES 464 1%.125		0698-0082		D	1	
00	R32							
		RES 2.15K 1%.125		0698-0084		D	17	
01	R18,28	,34,49,54,56,						
03	62,67	,69,71,73,74,						
05	77,81	,82,110,112						
		RES 2.37K 1%.125		0698-3150		D	1	
01	R116							
		RES 3.48K 1%.125		0698-3152		U	1	
00	R119							
		RES 3.83K 1%.125		0698-3153		D	2	
01	R70,86							
		RES 4.22K 1%.125		0698-3154		D	1	
00	R52							
		RES 34.8 1% .50		0698-3395		U	2	

2108A/2109 Power Supply Lower Assembly Parts List (5061-1354) Sht. 3 of 7

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0698-3395				
01	R42,43							
		RES 46.4 1% .50		0698-3398		U	2	
01	R40,41							
		RES 215 1% .50		0698-3401		U	1	
00	R84							
		RES 14.7K 1% .5W		0698-3414		U	5	
01	R7,8,9,22,127							
		RES 21.5 1%.125		0698-3430		U	1	
00	R11							
		RES 147 1%.125		0698-3438		D	1	
00	R85							
		RES 215 1%.125		0698-3441		D	6	
01	R78,79,83,113							
03	114,123							
		RES 422 1%.125		0698-3447		D	1	
00	R21							
		RES 215K 1%.125		0698-3454		D	1	
00	R68							
		RES 200K 1% .5W		0757-0128		U	2	
01	R36,129							
		RES 21.5K 1%.125		0757-0199		D	3	
01	R12,63,76							
		RES 1.78K 1%.125		0757-0278		D	1	
00	R61							
		RES 1K 1%.125		0757-0280		D	19	
01	R10,16,19,24,27,35,							
03	51,58,60,64,66,75,							
05	94-96,103,111,117,							
07	118							
		RES 10 1%.125		0757-0346		D	1	
00	R26							
		RES 100 1%.125		0757-0401		D	6	
01	R3,15,59,65,92,126,							
		RES 511 1%.125		0757-0416		D	1	
00	R55							
		RES 825 1%.125		0757-0421		D	2	
01	R31,45							

2108A/2109 Power Supply Lower Assembly Part List (5061-1354) Sht. 4 of 7

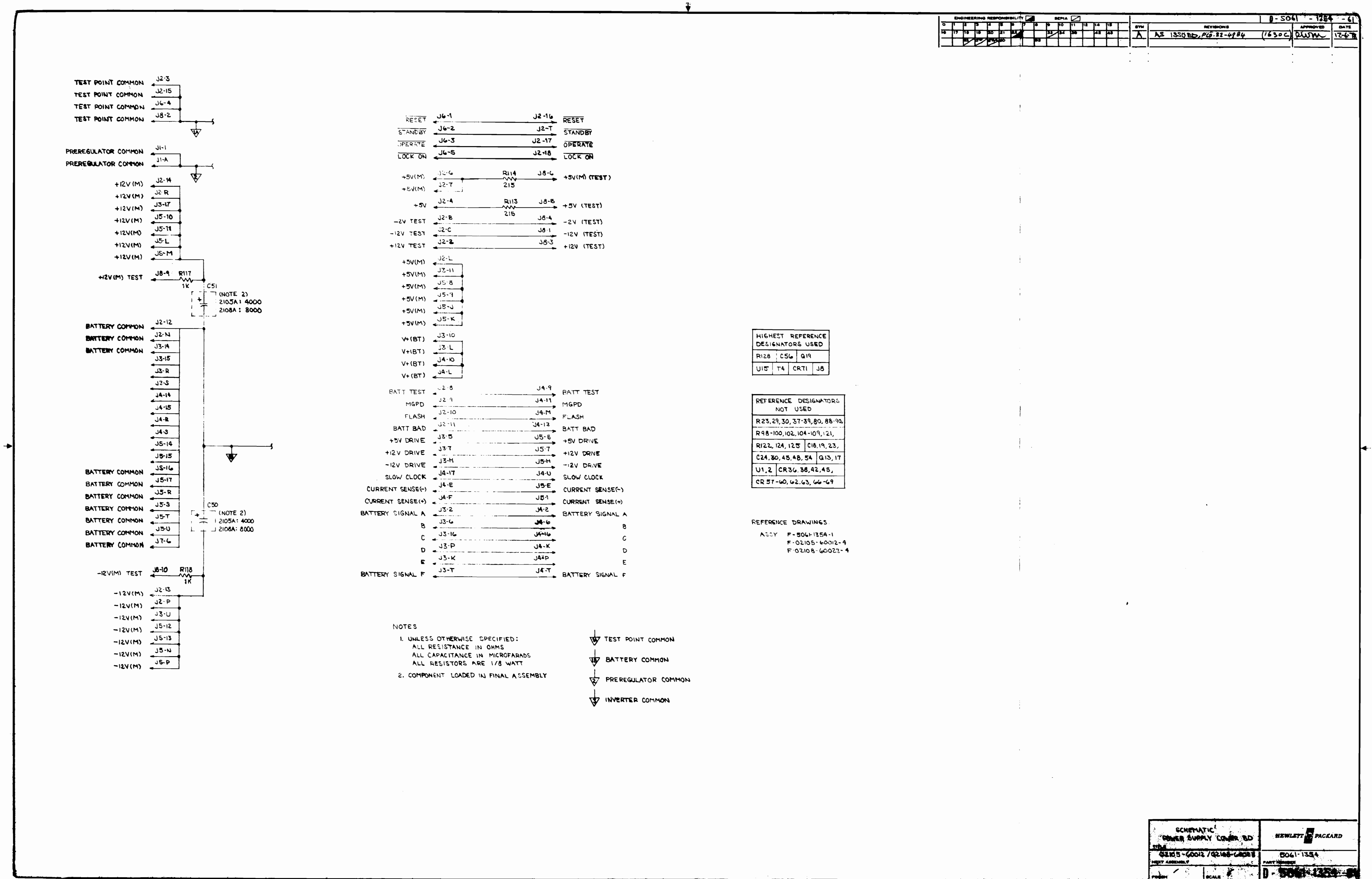
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	R97	RES 1.1K 1%.125		0757-0424		D	1	
01	R44,128	RES 5.11K 1%.125		0757-0438		D	2	
00	R93	RES 7.5K 1%.125		0757-0440		D	1	
00	R20	RES 8.25K 1%.125		0757-0441		D	1	
01 03	R17,25,46-48,50,72, 87	RES 10K 1%.125		0757-0442		D	8	
00	R53	RES 82.5K 1%.125		0757-0463		D	1	
01	R100	RES 68.1 1% .50		0757-0794		U	1	
00	R5	RES 10K 1% .50		0757-0839		D	1	
01	R57	RES 5 5% 20W		0811-1654		U	1	
00	R101	RES 4.7 5% 2W		0811-1674		U	1	
00	R91	RES 10 5% 10W PW		0811-1895		U	1	
00	R1	RES .12 3% 3W		0811-2616		U	1	
00	R2	RES 2 10%		0811-3108		U	1	
00	R4,6	RES 15K 3% 3W		0812-0051		U	2	
		TBG HS BLK .250D		0890-0312		U	0.35	FT
		HT DIS TO-5		1205-0033		U	1	
		HT DIS TO-3		1205-0275		U	7	
00	J8	CONNECTOR		1251-0674		U	1	
00	J1-5	CONN PC2X18.156D		1251-2026		U	5	

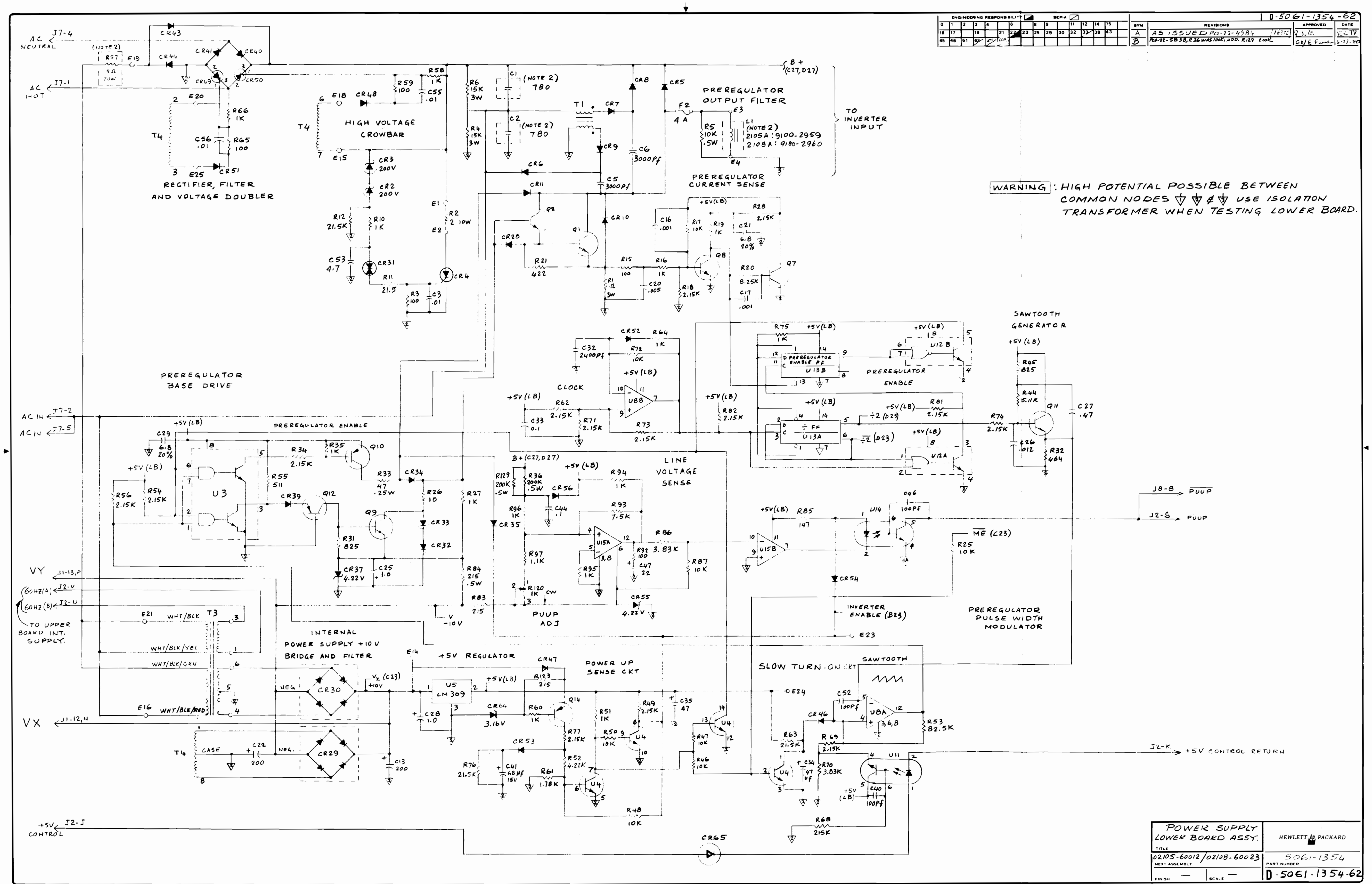
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	J6	PIN ASSY		1251-3412		U	1
01	J7	CONN UTIL 6PIN M		1251-3819		U	1
		CA TIE 3.6L		1400-0249		U	2
00	U13	IC SN7474N		1820-0077		U	1
00	U5	IC LM309H		1820-0429		U	1
00	U3	IC SN75452P		1820-0799		U	1
01	U6,7,12	IC SN75453P		1820-1016		U	3
00	U8,15	IC D COMPTR 8K		1826-0175		U	2
01	Q10,12,14,18	XSTR PNP 2N2907A		1853-0281		U	4
00	Q2	XSTR 2N3439 TO5		1854-0079		U	1
01	Q7-9,11,19	XSTR 2N2222ATO18		1854-0477		U	5
01	Q15,16	XSTR 2N6055 TO3		1854-0611		U	2
00	Q1	XSTR 2N6308 TO3		1854-0624		U	1
01	Q3-6	XSTR NPN TO3		1854-0790		U	4
00	U4	XISTOR ARRAY		1858-0009		U	1
00	CR4	THYRISTOR SCR		1884-0233		U	1
01	CR49,50	THYRISTOR-SCR		1884-0249		U	2
00	CR31	THYRISTOR		1884-0258		U	1
		DIODE 1N2071		1901-0029		D	9

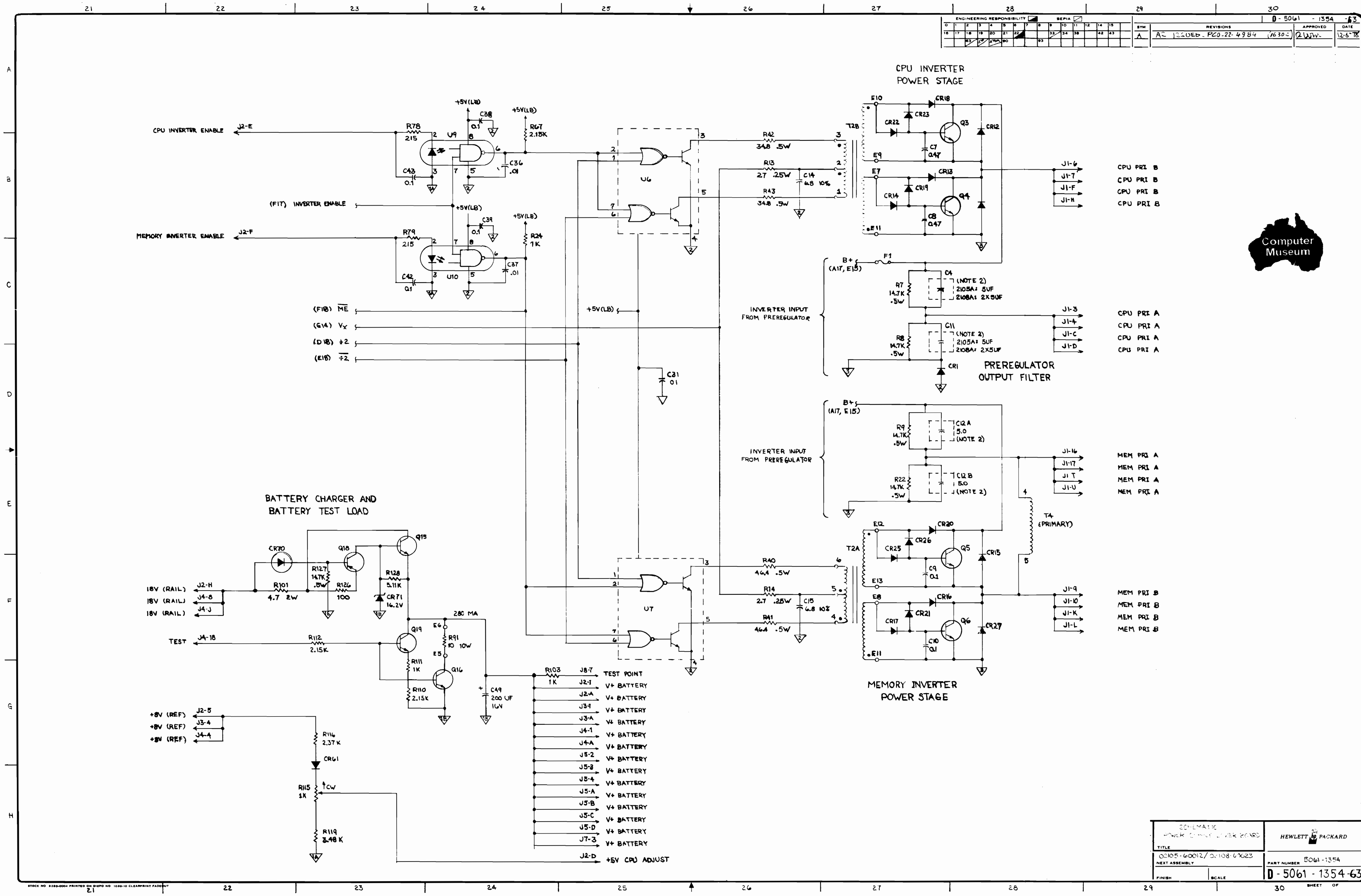
2108A/2109 Power Supply Lower Assembly Parts List (5061-1354) Sht. 6 of 7

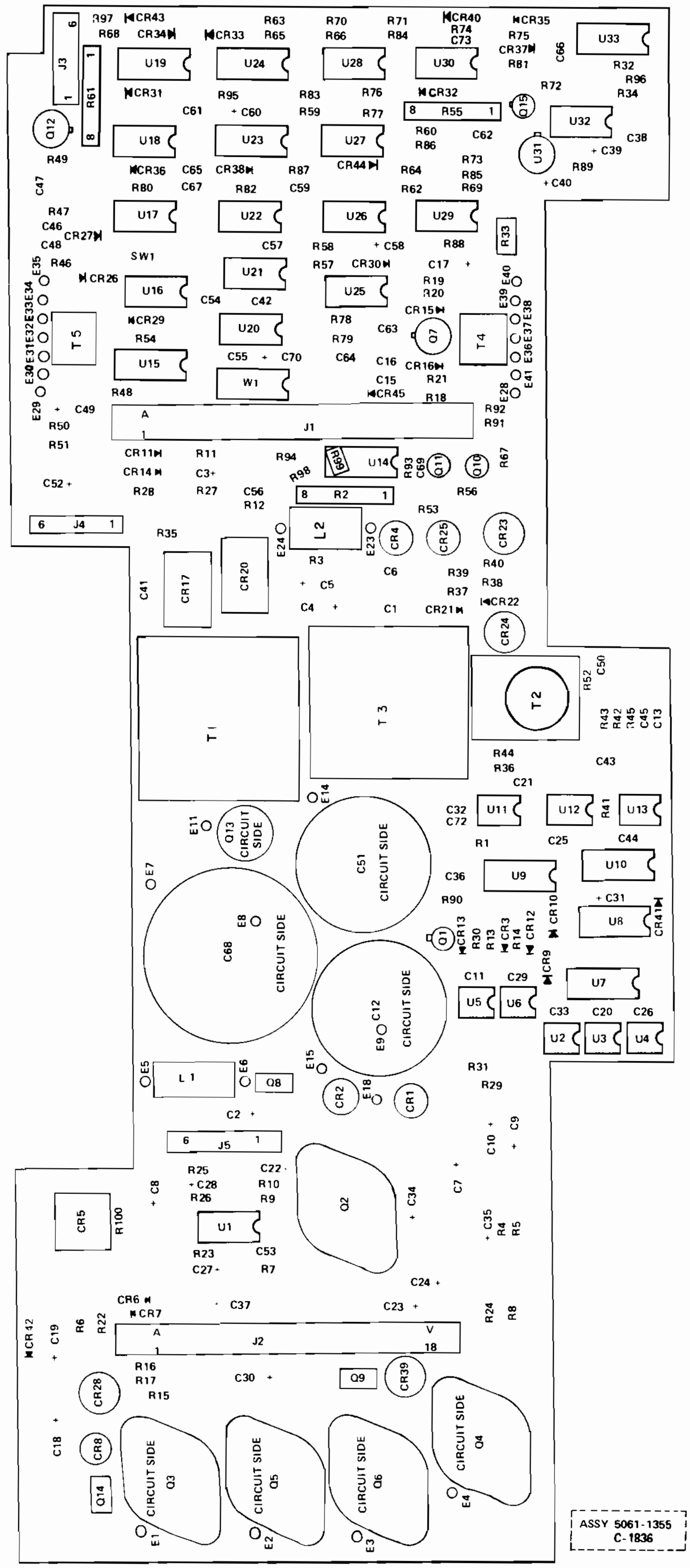
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
				1901-0029				
01 03	CR14,17,21,22,25,26, 34,43,44							
		DIODE SIL		1901-0040		D	11	
01 03	CR35,39,46-48,51-54, 56,61							
		DIODE 3A 600V		1901-0420		U	3	
01	CR1,40,41							
		STARISTOR STB523		1901-0460		D	4	
01	CR32,33,65,70							
		DIODE IN4936		1901-1065		D	17	
01 03	CR6-13,15,16,18,19, 20,23,24,27,28							
		RECTIFIER		1901-1087		D	1	
00	CR5							
		DIODE ZNR 5.11V		1902-0041		D	1	
00	CR64							
		DIODE ZNR 16.2V		1902-0184		D	1	
00	CR71							
		DIODE 200V ZENER		1902-0668		D	2	
00	CR2,3							
		DIODE ZNR 4.22V		1902-3070		D	2	
01	CR37,55							
		DIODE-FW BRIDGE		1906-0051		U	2	
01	CR29,30							
		ISOLATOR		1990-0429		U	2	
00	U9,10							
		OPTO ISOLATOR		1990-0537		U	2	
01	U11,14							
		RES VAR 1K		2100-1986		U	1	
00	R120							
		RES VAR 1K 10%		2100-3352		U	1	
00	R115							
		FUSE 2.5A NB		2110-0083		U	2	
00	F1,2							
		FUSE CLIP .250D		2110-0483		U	4	
		LKWSHR 10 HEL		2190-0034		U	8	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		LKWSHR 6 HEL		2190-0851		U	1	
		SCR #4-40X.375L		2200-0143		U	3	
		NUT 4-40 W/LK		2260-0009		U	4	
		SCR #6-32X.375L		2360-0197		U	4	
		SCR #6-32X2.5L		2360-0221		U	1	
		SCR 6-32X.375		2360-0359		U	21	
		NUT 6-32 .312AF		2420-0002		U	1	
		NUT 8-32 .344AF		2580-0004		U	1	
		SCR 10-32X.375		2680-0099		U	8	
		WSHR #8 BRS		3050-0001		U	1	
		WSHR #10		3050-0006		U	2	
		WSHR #4 SS		3050-0222		U	4	
		WSHR #6 SS		3050-0227		U	6	
		WSHR #10 BRS		3050-0236		U	8	
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
		WIRE 18 BLK		8150-2890		C	1	FT
		WIRE JUMPERS		8159-0005		D	4	
00	T2	XFORMER		9100-2951		U	1	
00	T3	XFORMER		9100-2956		U	1	
01	L1	CHOKE		9100-2960		U	1	
00	T1	XFORMER		9100-2966		U	1	
00	T4	XFORMER-POWER		9100-3803		U	1	
		PC CARD GUIDE		02108-00009		W	2	
		HEAT SINK		02108-00030		W	3	


TEST POINT COMMON
PREREGULATOR COMMON
+12V (M)
+12V(M) TEST
BATTERY COMMON
-12V(M) TEST
-12V(M)
RESET
STANDBY
OPERATE
LOCK ON
+5V(M)
+5V(M) (TEST)
+5V
+5V (TEST)
-2V TEST
-12V TEST
+12V TEST
V+(BT)
BATT TEST
MGPD
FLASH
BATT BAD
+5V DRIVE
+12V DRIVE
-12V DRIVE
SLOW CLOCK
CURRENT SENSE(-)
CURRENT SENSE(+)
BATTERY SIGNAL A
BATTERY SIGNAL F
HIGHEST REFERENCE DESIGNATORS USED
R128 C56 Q19
U15 T4 CRT1 J8
REFERENCE DESIGNATORS NOT USED
R23,29,30,37-39,80,88-90,
R98-100,102,104-109,121,
R122,124,125 C18,19,23,
C24,30,45,48,54 Q13,17
U1,2 CR36,38,42,45,
CR57-60,62,63,66-69
REFERENCE DRAWINGS
ASSY F-5061-1354-1
F-02105-60012-4
F-02108-60023-4
NOTES
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN MICROFARADS
ALL RESISTORS ARE 1/8 WATT
2. COMPONENT LOADED IN FINAL ASSEMBLY
TEST POINT COMMON
BATTERY COMMON
PREREGULATOR COMMON
INVERTER COMMON
SCHEMATIC POWER SUPPLY CONTR BD
HEWLETT PACKARD
5061-1354


PREREGULATOR OUTPUT FILTER
TO INVERTER INPUT
HIGH VOLTAGE CROWBAR
RECTIFIER, FILTER AND VOLTAGE DOUBLER
PREREGULATOR CURRENT SENSE
WARNING: HIGH POTENTIAL POSSIBLE BETWEEN COMMON NODES USE ISOLATION TRANSFORMER WHEN TESTING LOWER BOARD.
SAWTOOTH GENERATOR
PREREGULATOR BASE DRIVE
PREREGULATOR ENABLE
CLOCK
LINE VOLTAGE SENSE
PUUP ADJ
PREREGULATOR PULSE WIDTH MODULATOR
INVERTER ENABLE (B23)
INTERNAL POWER SUPPLY +10V BRIDGE AND FILTER
+5V REGULATOR
POWER UP SENSE CKT
SLOW TURN-ON CKT
SAWTOOTH
+5V CONTROL RETURN
TO UPPER BOARD INT. SUPPLY
POWER SUPPLY LOWER BOARD ASSY.
HEWLETT PACKARD
02105-60012/02108-60023
5061-1354
D-5061-1354-62
A ISSUED PO-22-4381
B R2-22-5B3B, R36 WAS 100K, ADD. R129 200K


CPU INVERTER
POWER STAGE
MEMORY INVERTER
POWER STAGE
BATTERY CHARGER AND
BATTERY TEST LOAD
PREREGULATOR
OUTPUT FILTER
INVERTER INPUT
FROM PREREGULATOR
CPU INVERTER ENABLE
MEMORY INVERTER ENABLE
(F17) INVERTER ENABLE
+5V CPU ADJUST
TEST POINT
V+ BATTERY
CPU PRI A
CPU PRI B
MEM PRI A
MEM PRI B
18V (RAIL)
+8V (REF)
TEST
HEWLETT PACKARD
5061-1354
D-5061-1354-63
A ADDED, PC0-22-4984



2108A/2109 Power Supply Upper Assembly
5061-1355

2108A/2109 Power Supply Upper Assembly Parts List (5061-1355) Sht. 1 of 8

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
01	C45,66,69	CAP 0.1UF		0150-0121		U	3	
01	C60,72	CAP 1.0UF 20%		0160-0127		U	2	
01	C54,55	CAP. 2.2UF		0160-0128		D	2	
01	C16,48,61	CAP .022UF 10%		0160-0162		U	3	
00	C59	CAP .033UF 10%		0160-0163		U	1	
01 03	C11,15,20,26,29 33,47,57,63,64	CAP .01UF		0160-2055		U	10	
00	C43	CAP .33UF 20%		0160-2128		U	1	
01	C21,25,32,36	CAP 30PF 5%		0160-2199		U	4	
01	C38,65,67	CAP 100PF 5%		0160-2204		U	3	
00	C6	CAP 3000PF		0160-2288		U	1	
00	C13	CAP 470PF 5%		0160-2940		U	1	
01	C46,56	CAP 1000PF 10%		0160-3456		U	2	
01	C41,44,50	CAP .02UF 20%		0160-3459		U	3	
00	C1	CAP .05UF-20+80%		0160-3460		U	1	
00	C2,37	CAP 100UF-10+50%		0180-0094		U	2	
01	C4,5,9,10	CAP 4.7UF 35WVDC		0180-0100		D	4	
01	C18,23,30,34	CAP 200UF-10+75%		0180-0104		U	4	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP 2.2UF 10%		0180-0197		D	1	
00	C70							
		CAP 22UF 10%		0180-0228		D	1	
00	C3							
		CAP 33UF 10%		0180-0229		U	2	
01	C39,40							
		CAP 1UF 10%		0180-0291		D	10	
01	C19,22	,24,27,28						
03	31,35	,53,56,62						
		CAP 24KUF		0180-0461		U	1	
01	C68							
		CAP 17KUF		0180-0462		U	1	
		CAP 6.8UF 20%		0180-1701		U	1	
00	C42							
		CAP 22UF 10%		0180-1794		U	2	
01	C17,19							
		CAP 68UF 20%		0180-1835		D	1	
00	C71							
		CAP 200UF-10+75%		0180-1946		U	2	
00	C7,8							
		CAP 3.3UF 10%		0180-2141		U	1	
00	C52							
		CAP 10 KUF		0180-2360		U	1	
01	C12							
		PAD-MTG TO5		0340-0164		U	3	
		STUD SOLDER		0360-0090		U	20	
01	E11,14	,15,18,23						
03	24,28	-41						
		TERM STUD FKD		0360-1529		U	3	
01	E5,6,7							
		SPCR TAP #6X.125		0380-0383		U	17	
		STANDOFF		0380-0551		U	4	
01	CP1,2,	17,20						
		TAPE-ELECTRICAL		0460-0042		U	0.01	FL
		TAPE ELECTRICAL		0460-0955		U	0.01	PL
		ADH RTV CLEAR		0470-0251		U	0.01	TB

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	R89	RES 4.7 5% .25		0683-0475		U	1	
01	R94,96	RES FXD 5.6 OHM		0683-0565		U	2	
00	R54	RES 470 5% .25		0683-4715		D	1	
01	R38,44,60,78	RES 2.15K 1%.125		0698-0084		D	4	
01	R15,31	RES 1.78K 1% .5		0698-0089		U	2	
00	R67	RES 2.37K 1%.125		0698-3150		D	1	
01 03	R7,9,18,23,25,47,59 63,66,70,73,83	RES 4.64K 1%.125		0698-3155		D	12	
00	R75	RES 31.6K 1%.125		0698-3160		U	1	
01	R65,80,82,97,98,99	RES 464K 1%.125		0698-3260		D	6	
00	R1,35	RES 31.6 1% .50		0698-3394		U	2	
00	R4,5	RES 14.7 1%.125		0698-3428		U	2	
01	R62,84,85	RES 147 1%.125		0698-3438		D	3	
00	R32	RES 215 1%.125		0698-3441		D	1	
00	R86	RES 348 1%.125		0698-3445		D	1	
00	R45	RES 422 1%.125		0698-3447		D	1	
00	R41	RES 28.7K 1%.125		0698-3449		U	1	
01	R10,26	RES 42.2K 1%.125		0698-3450		D	2	
00	R72	RES 100 1% .50		0757-0198		U	1	

2108A/2109 Power Supply Upper Assembly Parts List (5061-1355) Sht. 4 of 8

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
		RES 21.5K 1%.125		0757-0199		D	1	
00	R74							
		RES 1.21K 1%.125		0757-0274		D	2	
01	R21,49							
		RES 6.19K 1%.125		0757-0290		D	2	
01	R34,37							
		RES 42.2 1%.125		0757-0316		U	4	
01	R50,51	,91,92						
		RES 1.33K 1%.125		0757-0317		D	1	
00	R77							
		RES 100 1%.125		0757-0401		D	8	
01	R16,17	,19,20,46,48						
03	56,93							
		RES 511 1%.125		0757-0416		D	1	
00	R64							
		RES 681 1%.125		0757-0419		D	1	
00	R71							
		RES 750 1%.125		0757-0420		D	1	
00	R76							
		RES 10K 1%.125		0757-0442		D	16	
01	R11-14	,27-30,39						
03	40,53	,57,72,88						
05	90,95							
		RES 68.1K 1%.125		0757-0461		D	1	
00	R68							
		RES 100K 1%.125		0757-0465		D	5	
01	R43,58	,69,81,87						
		RES 10 1% .50		0757-0984		D	1	
00	R52							
		RES 51.1 1% .50		0757-1000		U	1	
00	R3							
		RES 1.47K 1%.125		0757-1094		D	2	
01	R36,42							
		RES .12 3% 3W		0811-2616		U	2	
01	R22,24							
		RES 0.22 OHM 2W		0811-3294		U	2	
00	R6,8							
		SLEEVING FLEX.		0890-0064		U	1	FT

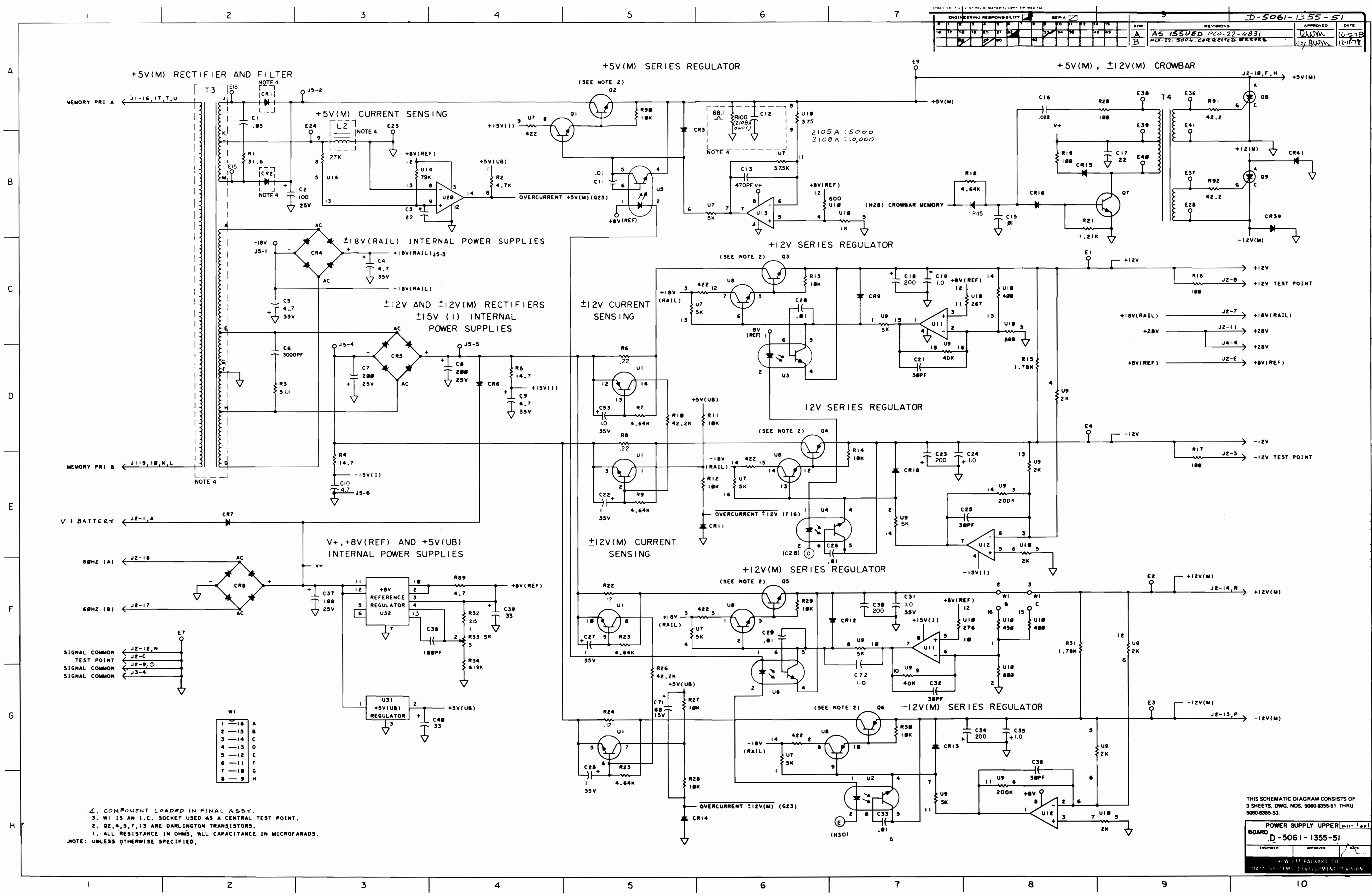
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		TBG HS BLK .375D		0890-0291		U	0.50	FT
00	W1	SOCKET 16 DIP LO		1200-0482		U	1	
		HT DIS PL PWR		1205-0219		U	1	
		HT DIS TO-3		1205-0275		U	5	
00	J2	CONN PC2X18.156D		1251-2026		U	1	
01	J1	CONN PC1X18.156T		1251-2346		U	1	
00	J3-5	PIN ASSY		1251-3412		U	3	
		JMPR PLUG .3"C-C		1258-0124		U	2	
01	R2,55,61	RES NET 7X4.7K		1810-0125		U	3	
00	U10	RESISTOR NETWORK		1810-0185		U	1	
00	U15	RESISTOR NETWORK		1810-0187		U	1	
00	U14	RESISTOR NETWORK		1810-0188		U	1	
00	U9	RESISTOR NETWORK		1810-0199		U	1	
00	U7	NETWORK-RESISTOR		1810-0200		U	1	
00	U31	IC LM309H		1820-0429		U	1	
00	U32	IC U6E7723393		1820-0439		U	1	
00	U23	IC CD4043AY		1820-0941		U	1	
00	U18	IC CD4023AY		1820-0943		U	1	
01	U22,29	IC CD4001AY		1820-0946		U	2	
		IC CD4011AE		1820-0949		U	2	

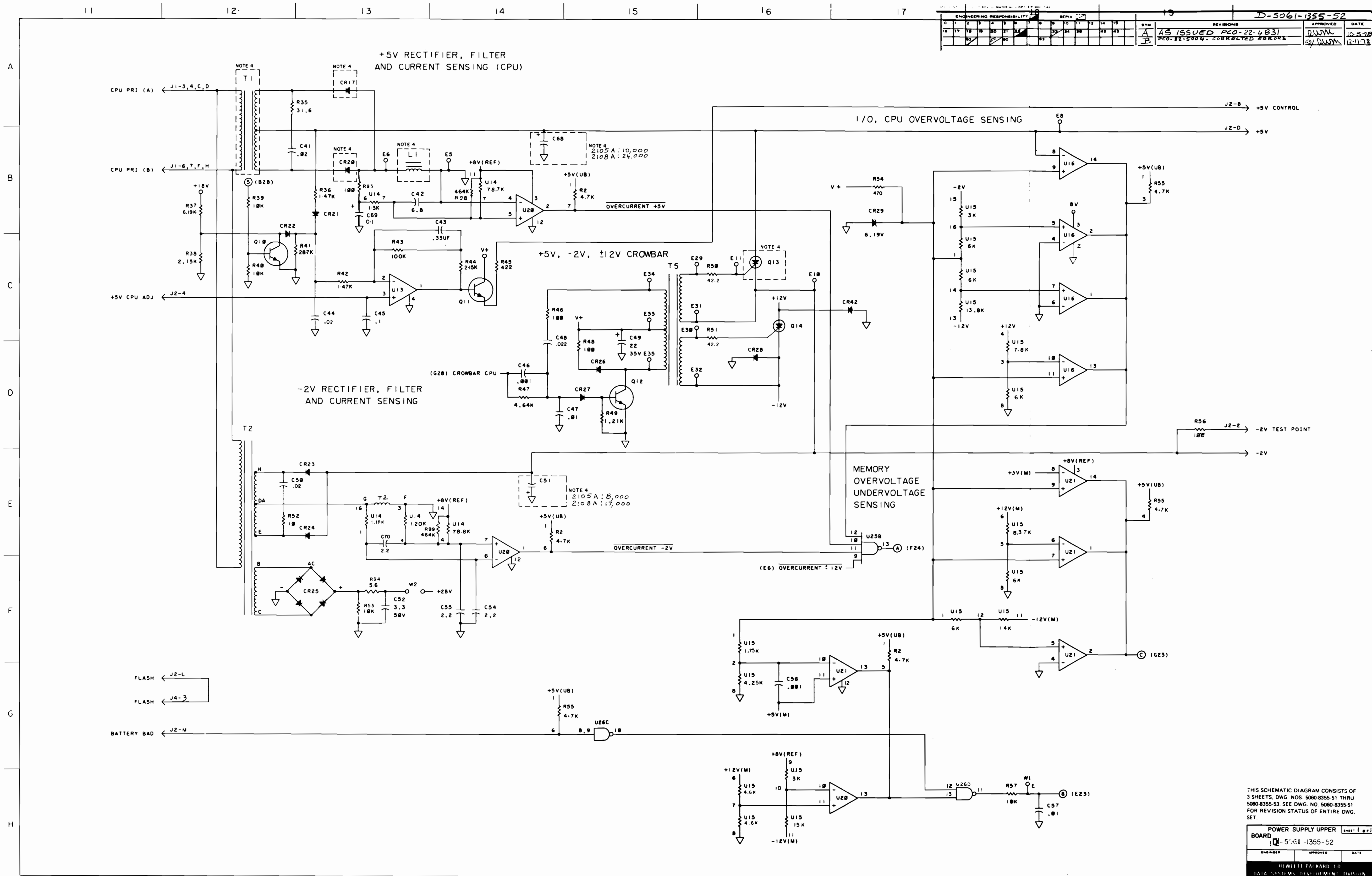
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1820-0949				
01	U17,26							
		IC CD4012AE		1820-0950		U	1	
00	U25							
		IC 4049AE		1820-1145		U	2	
01	U19,24							
		IC CD4050AE		1820-1146		U	1	
00	U33							
		IC QUAD COMPTR		1826-0138		U	3	
01	U16,20	,21						
		IC D OP AMP 20K		1826-0142		U	3	
01	U11-13							
		XSTR PNP 2N2907A		1853-0281		U	1	
00	Q15							
		XSTR 2N6053 TO3		1853-0351		U	2	
00	Q4,6							
		XSTR 2N3053 TO5		1854-0039		U	2	
00	Q7,12							
		XSTR NPN SI PL5		1854-0071		U	3	
01	Q1,10,	11						
		XSTR 2N6055 TO3		1854-0611		U	3	
01	Q2,3,5							
		XISTOR ARRAY		1858-0008		U	3	
01	U1,8,3	0						
		XISTOR ARRAY		1858-0009		U	2	
01	U27,28							
		THYRISTOR 35AMPS		1884-0208		U	1	
		THYRISTOR-SCR		1884-0240		U	3	
01	Q8,9,1	4						
		DIODE 1N2071		1901-0029		D	11	
01	CR3,6,	7,9,10,12,13						
03	41-44							
		DIODE SIL		1901-0040		D	17	
01	CR11,1	4-16,21,22						
03	26,27	,30-34						
05	36-38,	45						
		DIODE-SI		1901-0415		U	2	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1901-0415				
01	CR28,39							
		DIODE SILICONE		1901-0463		U	1	
00	CR40							
		DIO-PWR RECT		1901-0662		U	2	
01	CR23,24							
		DIODE-SCHOTTKY		1901-0792		U	2	
01	CR17,20							
		DIODE RECT SIL		1901-1036		U	2	
		DIO-ZNR 6.19V 1%		1902-0588		U	1	
01	CR29							
		DIODE 4.64V		1902-3082		U	1	
00	CR35							
		DIODE-FW BRIDGE		1906-0051		U	3	
01	CR4,8,25							
		BRIDGE RECTIF		1906-0053		U	1	
00	CR5							
		COUPLER-OPTICAL		1990-0403		U	5	
00	U2-6							
		RES 5KOHM 10%		2100-3207		U	1	
00	R33							
		LKWSHR 4 HEL		2190-0003		U	4	
		LKWSHR 6 HEL		2190-0006		U	1	
		LKWSHR 10 INT		2190-0011		U	4	
		LKWSHR 1/4 HEL		2190-0032		U	1	
		LKWSHR 10 HEL		2190-0034		U	6	
		LKWSHR 6 HEL		2190-0851		U	4	
		SCR #4-40X.312L		2200-0141		U	4	
		NUT 4-40 .250AF		2260-0001		U	4	
		NUT 4-40 W/LK		2260-0009		U	1	
		SCR #6-32X.500L		2360-0201		U	1	
		SCR #6-32X.625L		2360-0203		U	2	
		SCR 6-32X.375		2360-0359		U	10	

2108A/2109 Power Supply Upper Assembly Parts List (5061-1355) Sht. 8 of 8

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		NUT 6-32 .312AF		2420-0002		U	1	
		SCR 10-32X.375		2680-0099		U	4	
		SCR 10-32X.438		2680-0101		U	1	
		SCR 10-32X.500		2680-0103		U	1	
		NUT 1/4-28		2950-0036		U	1	
		WSHR #6 SS		3050-0228		U	4	
		WSHR #4 SS		3050-0229		U	5	
		WSHR #10 BRS		3050-0236		U	8	
		WSHR .267ID BRS		3050-0284		U	2	
		WASHER FLAT		3050-0665		U	1	
		SWITCH-THERMAL		3103-0033		U	1	
00	S1							
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
		WIRE 14 WHITE		8150-2470		C	0.75	FT
		WIRE 18 AWG BARE		8151-0011		U	0.25	FT
		WIRE JUMPERS		8159-0005		D	1	
00	W3							
		XFMR-POWER		9100-0444		U	1	
		XFORMER-CROWBAR		9100-2953		U	2	
00	T4,5							
		XFORMER-5V CPU		9100-2957		U	1	
		CHOKE		9100-2958		U	1	
01	L2							
		XFORMER-POWER		9100-3802		U	1	
		XFORMER-POWER		9100-3805		U	1	
		BOARD-ETCHED		5080-9730		W	1	
		STRAP-GROUND		02108-00028		W	1	
		HEAT SINK		02108-00029		W	2	


+5V(M) RECTIFIER AND FILTER
+5V(M) CURRENT SENSING
+5V(M) SERIES REGULATOR
+5V(M), ±12V(M) CROWBAR
±18V(RAIL) INTERNAL POWER SUPPLIES
±12V AND ±12V(M) RECTIFIERS
±15V (I) INTERNAL
POWER SUPPLIES
±12V CURRENT
SENSING
+12V SERIES REGULATOR
12V SERIES REGULATOR
±12V(M) CURRENT
SENSING
+12V(M) SERIES REGULATOR
−12V(M) SERIES REGULATOR
V+, +8V(REF) AND +5V(UB)
INTERNAL POWER SUPPLIES
MEMORY PRI A
MEMORY PRI B
V + BATTERY
60HZ (A)
60HZ (B)
SIGNAL COMMON
TEST POINT
SIGNAL COMMON
SIGNAL COMMON
+12V TEST POINT
−12V TEST POINT
2105A : 5000
2108A : 10,000
4. COMPONENT LOADED IN FINAL ASSY.
3. W1 IS AN I.C. SOCKET USED AS A CENTRAL TEST POINT.
2. Q2,4,5,7,13 ARE DARLINGTON TRANSISTORS.
1. ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN MICROFARADS.
NOTE: UNLESS OTHERWISE SPECIFIED.
D-5061-1355-51
A AS ISSUED PCO-22-4831
THIS SCHEMATIC DIAGRAM CONSISTS OF 3 SHEETS, DWG. NOS. 5060-8355-51 THRU 5060-8355-53.
POWER SUPPLY UPPER BOARD
D-5061-1355-51
HEWLETT PACKARD CO.



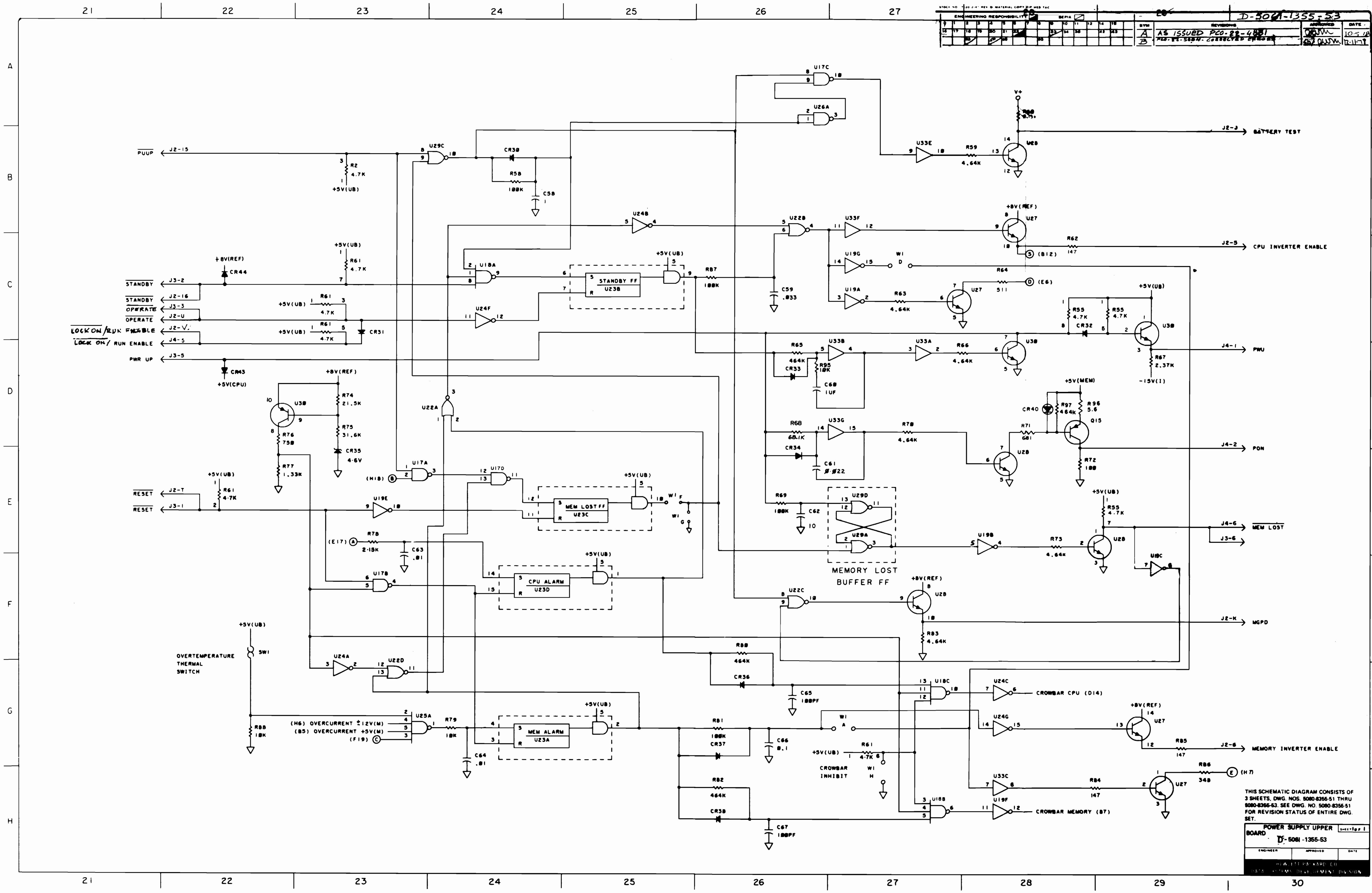
D-5061-1355-52

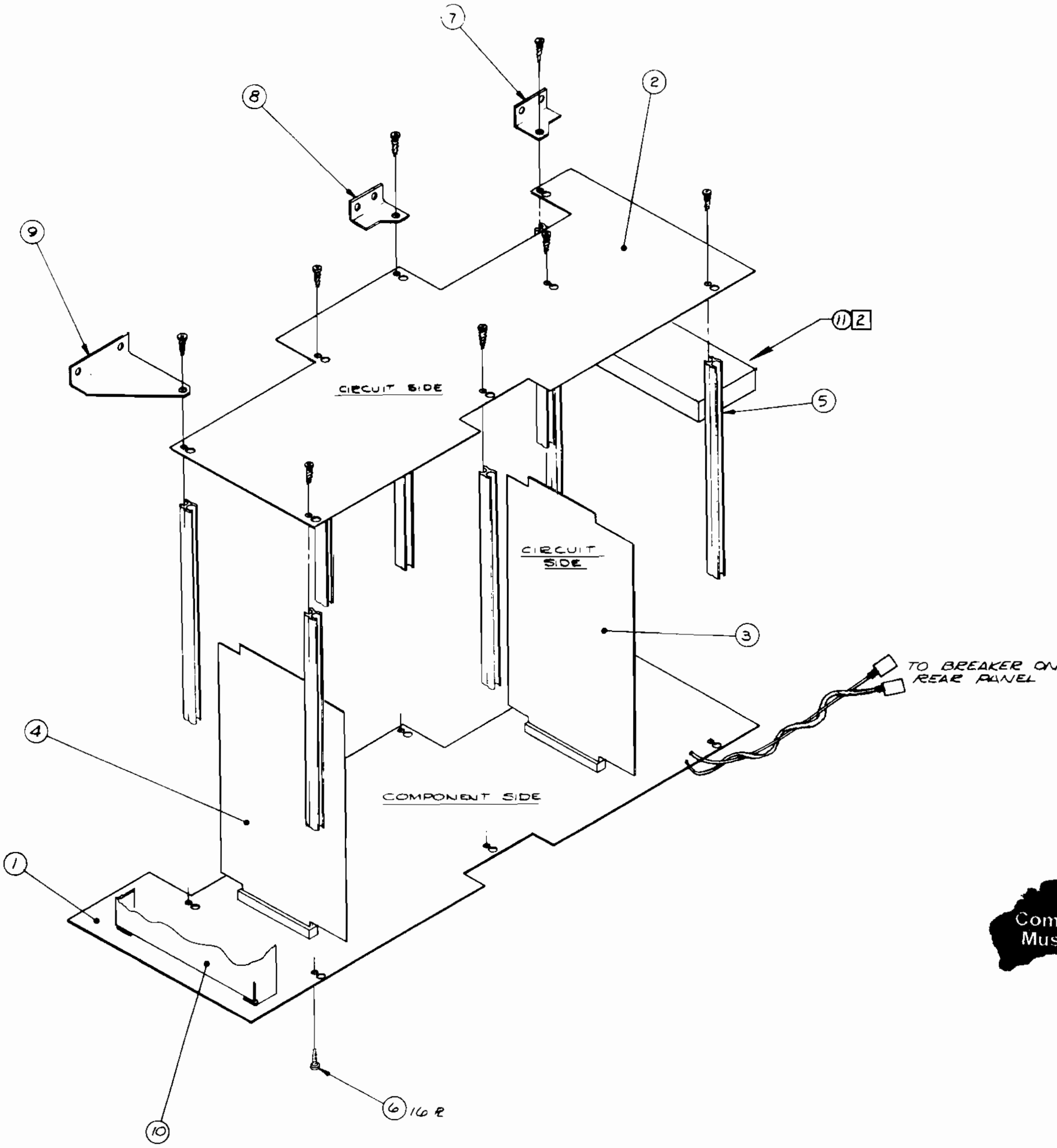
SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PCO-22-4831	DWM	10-5-78
B	PCO-22-5004. CORRECTED ERRORS	DWM	12-11-78

THIS SCHEMATIC DIAGRAM CONSISTS OF 3 SHEETS, DWG. NOS. 5060-8355-51 THRU 5060-8355-53. SEE DWG. NO. 5060-8355-51 FOR REVISION STATUS OF ENTIRE DWG. SET.

POWER SUPPLY UPPER BOARD
D-5061-1355-52
SHEET 1 of 1

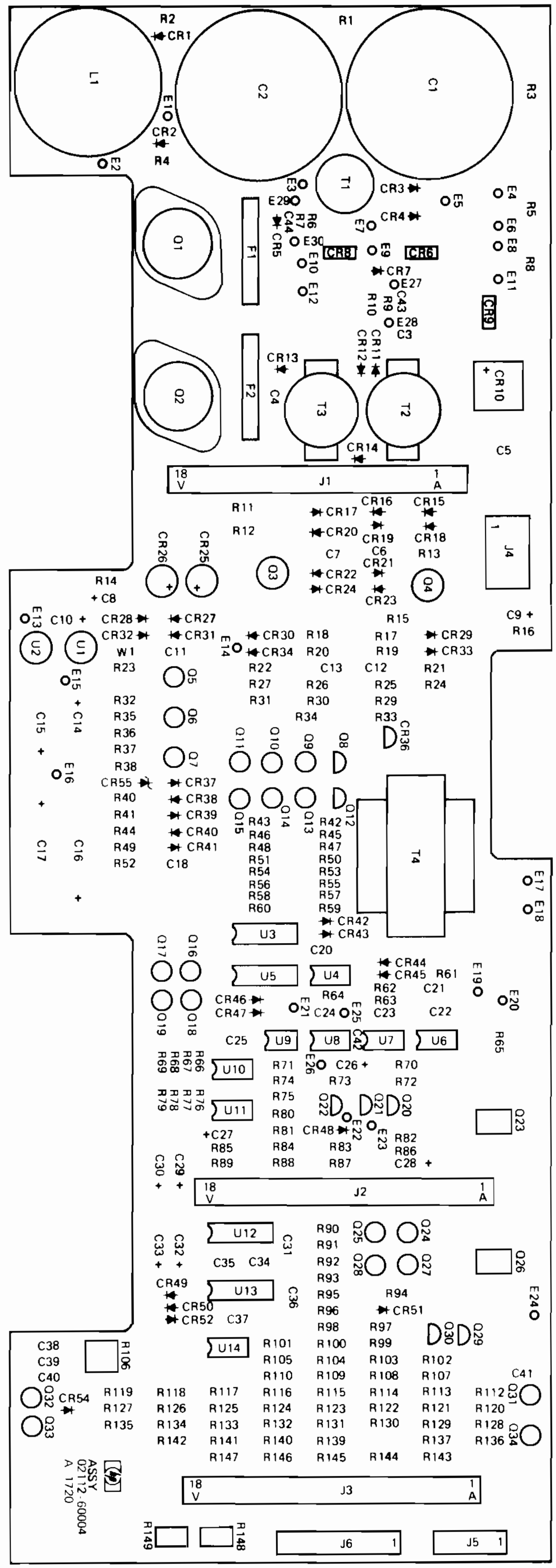
HEWLETT PACKARD CO.
DATA SYSTEMS DEVELOPMENT DIVISION


D-5061-1355-53
A AS ISSUED PCO-88-4881
THIS SCHEMATIC DIAGRAM CONSISTS OF 3 SHEETS, DWG. NOS. 5080-8356-51 THRU 5080-8356-53. SEE DWG. NO. 5080-8356-51 FOR REVISION STATUS OF ENTIRE DWG. SET.
POWER SUPPLY UPPER BOARD
D-5061-1355-53
PUUP
STANDBY
OPERATE
LOCK ON/RUN ENABLE
PWR UP
RESET
BATTERY TEST
CPU INVERTER ENABLE
PWU
PON
MEM LOST
MGPD
CROWBAR CPU (D14)
MEMORY INVERTER ENABLE
CROWBAR MEMORY (B7)
STANDBY FF
MEM LOST FF
CPU ALARM
MEM ALARM
MEMORY LOST BUFFER FF
OVERTEMPERATURE THERMAL SWITCH
(H6) OVERCURRENT ±12V(M)
(B5) OVERCURRENT +5V(M)
CROWBAR INHIBIT



ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
11	1	PAD-FOAM	4208-0111
10	1	BRACKET, P.C. BOARD	02112-00008
9	1	TIE BRKT, FRONT	02112-00020
8	1	TIE BRKT, CENTER	02112-00021
7	1	TIE BRKT, REAR	02112-00022
6	16	SCREW #6-20 x .625	0624-0062
5	8	STANDOFF	02112-20001
4	1	RISER BOARD	02112-80007
3	1	RISER BOARD LOADED	02112-60008
2	1	UPPER P.S. BOARD ASS'Y	02112-60005
1	1	LOWER P.S. BOARD ASS'Y	02112-60004

2112A/13A Power Supply Main Assembly
02112-60006



2112A/2113A Power Supply Lower Assembly
02112-60004

2112A/2113A Power Supply Lower Assembly (02112-60004) Sht. 1 of 7

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C11,38	CAP 0.1UF		0150-0121		U	2	
00	C5,42	CAP .01UF 20%		0150-0123		U	2	
01	C21,37	CAP 1.0UF 20%		0160-0127		U	2	
01	C36,40	CAP .0022UF 10%		0160-0154		U	2	
01	C43,44	CAP .022UF 10%		0160-0162		U	2	
00	C25	CAP .47UF-20+80%		0160-0174		U	1	
00	C39	CAP .015UF 10%		0160-0194		U	1	
01	C18,20,22-24,34,35	CAP .01UF		0160-2055		U	7	
00	C31	CAP. 2400PF		0160-2227		U	1	
01	C3,4,6,7	CAP 3000PF 5%		0160-2229		U	4	
00	C41	CAP 470PF 10%		0160-3455		U	1	
01	C12,13	CAP 5000PF 10%		0160-3458		U	2	
01	C14,15	CAP 100UF 20%		0180-0098		U	2	
01	C16,17	CAP 200UF-10+75%		0180-0104		U	2	
01	C8,9	CAP 6.8UF 10%		0180-0116		D	2	
00	C27	CAP 1UF 10%		0180-0291		D	1	
01	C26,28	CAP 6.8UF 20%		0180-1701		U	2	
		CAP 15UF 10%		0180-1746		D	6	

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
				0180-1746				
01	C10,29,30,32,33,45							
		PAD-MTG TO5		0340-0164		U	2	
		STUD SOLDER		0360-0090		U	20	
		STUD SOLDER TERM		0360-0474		U	9	
		TERM STUD FKD		0360-1529		U	4	
		SPCR TAP #6X.125		0380-0383		U	7	
		RES 56 5% .25		0683-5605		U	2	
00	R7,9							
		RES 464 1%.125		0698-0082		D	6	
01	R25,26,61,63,123,64							
		RES 2.15K 1%.125		0698-0084		D	10	
01	R40,42,43,75,80,							
03	113,114,133							
05	145,105							
		RES 261 1%.125		0698-3132		D	1	
00	R131							
		RES 4.22K 1%.125		0698-3154		D	1	
00	R130							
		RES 4.64K 1%.125		0698-3155		D	1	
00	R41							
		RES 26.1K 1%.125		0698-3159		D	1	
00	R52							
		RES 464K 1%.125		0698-3260		D	1	
00	R81							
		RES 147 1%.125		0698-3438		D	1	
00	R146							
		RES 215 1%.125		0698-3441		D	4	
01	R 67,69,77,79							
		RES 422 1%.125		0698-3447		D	6	
01	R17,18,38,70,72,73							
		RES 28.7K 1%.125		0698-3449		U	1	
01	R115,							
		RES 1.21K 1%.125		0757-0274		D	1	
00	R118							
		RES 3.16K 1%.125		0757-0279		D	2	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0757-0279				
01	R134,126							
		RES 1K 1%.125		0757-0280		D	13	
01	R6,10,21,22,33,49							
03	91,96,98,100							
05	103,141,147							
		RES 9.09K 1%.125		0757-0288		D	1	
00	R116							
		RES 13.3K 1%.125		0757-0289		U	1	
00	R110							
		RES 6.19K 1%.125		0757-0290		D	2	
01	R36,109							
		RES 10 1%.125		0757-0346		D	2	
01	R24,27							
		RES 100 1%.125		0757-0401		D	16	
01	R13,16,19,20,							
03	45-48,62,66,68,74							
05	76,78,119,129							
		RES 511 1%.125		0757-0416		D	4	
01	R14,95,122,127							
		RES 619 1%.125		0757-0418		D	3	
01	R29,31,32							
		RES 681 1%.125		0757-0419		D	1	
00	R99							
		RES 825 1%.125		0757-0421		D	1	
00	R71							
		RES 1.1K 1%.125		0757-0424		D	1	
00	R44							
		RES 1.62K 1%.125		0757-0428		U	4	
01	R57-60							
		RFS 5.11K 1%.125		0757-0438		D	10	
01	R23,35,37,55,56,102,							
03	135,137,143,148							
		RES 10K 1%.125		0757-0442		D	24	
01	R30,53,54,82-84,							
03	86,90,93,97,101,107							
05	108,112,117,120,							
07	121,124,125,128,132							
09	136,142,144							
		RES 68.1K 1%.125		0757-0461		D	1	

2112A/2113A Power Supply Lower Assembly (02112-60004) Sht. 4 of 7

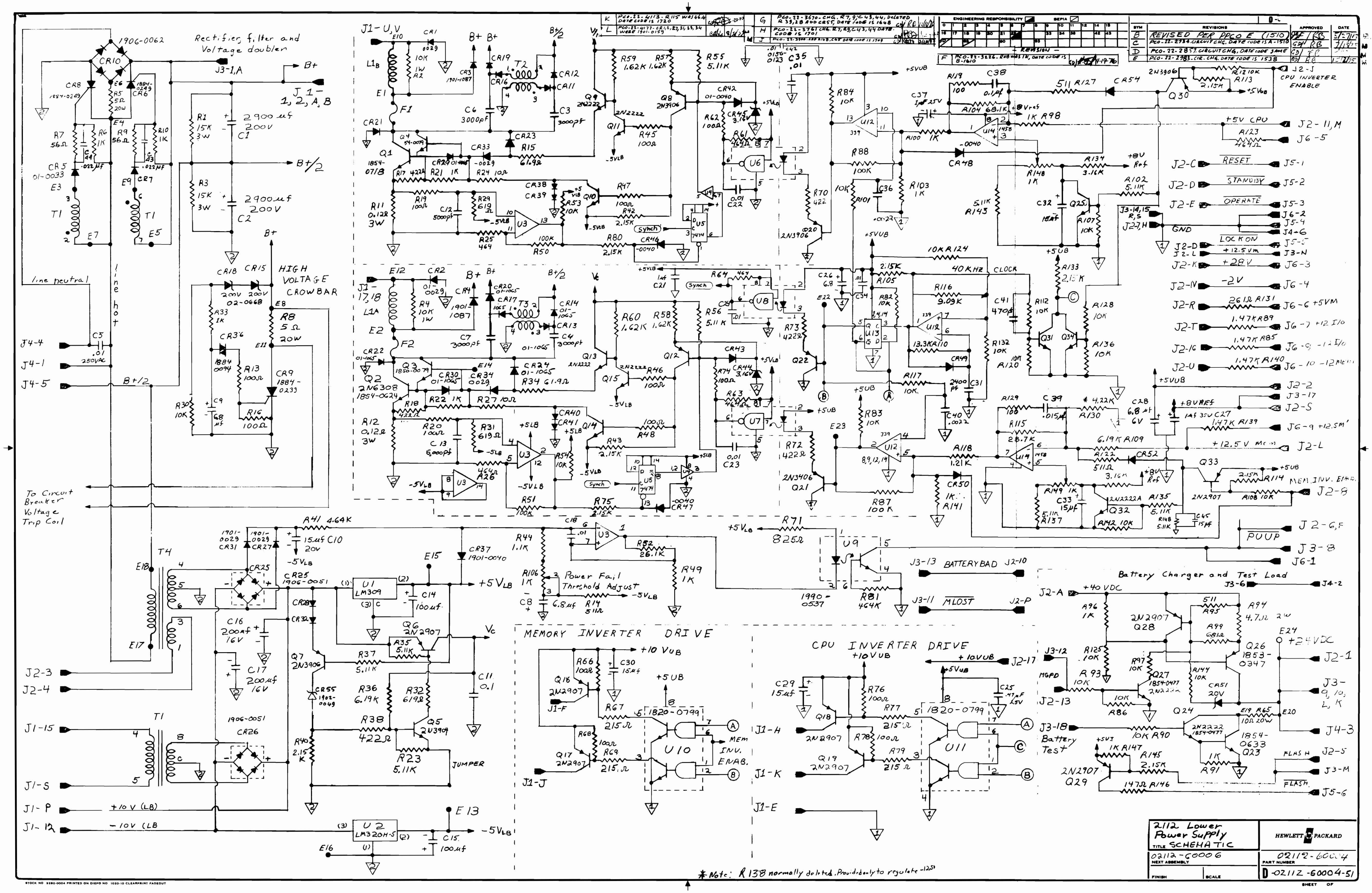
ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0757-0461				
00	R104							
		RES 100K 1%.125		0757-0465		D	5	
01	R50,51	,87,88,92						
		RES 10K 1% .50		0757-0839		D	2	
00	R2,4							
		RES 61.9 1% .50		0757-1002		U	2	
01	R15,34							
		RES 1.47K 1%.125		0757-1094		D	4	
01	R89,85	,139,140						
		RES 4.7 5% 2W		0811-1674		U	1	
00	R94							
		RES .12 3% 3W		0811-2616		U	2	
01	R11,12							
		RES 15K 3% 3W		0812-0051		U	2	
00	R1,3							
		HT DIS PL PWR		1205-0219		U	3	
		HT DIS TO-3		1205-0275		U	2	
		HEAT SINK TO5		1205-0315		U	2	
00	U1,2							
		CONNECTOR		1251-0674		U	1	
00	J6							
		CONN PC2X18.156D		1251-2026		U	3	
01	J1,2,3							
		PIN ASSY		1251-3412		U	1	
00	J5							
		CONN UTIL 6PIN M		1251-3819		U	1	
00	J4							
		IC SN7474N		1820-0077		U	2	
00	U5,13							
		IC LM309H		1820-0429		U	1	
00	U1							
		IC SN75452P		1820-0799		U	3	
01	U4,10,	11						
		IC QUAD COMPTR		1826-0138		U	2	
00	U3,12							

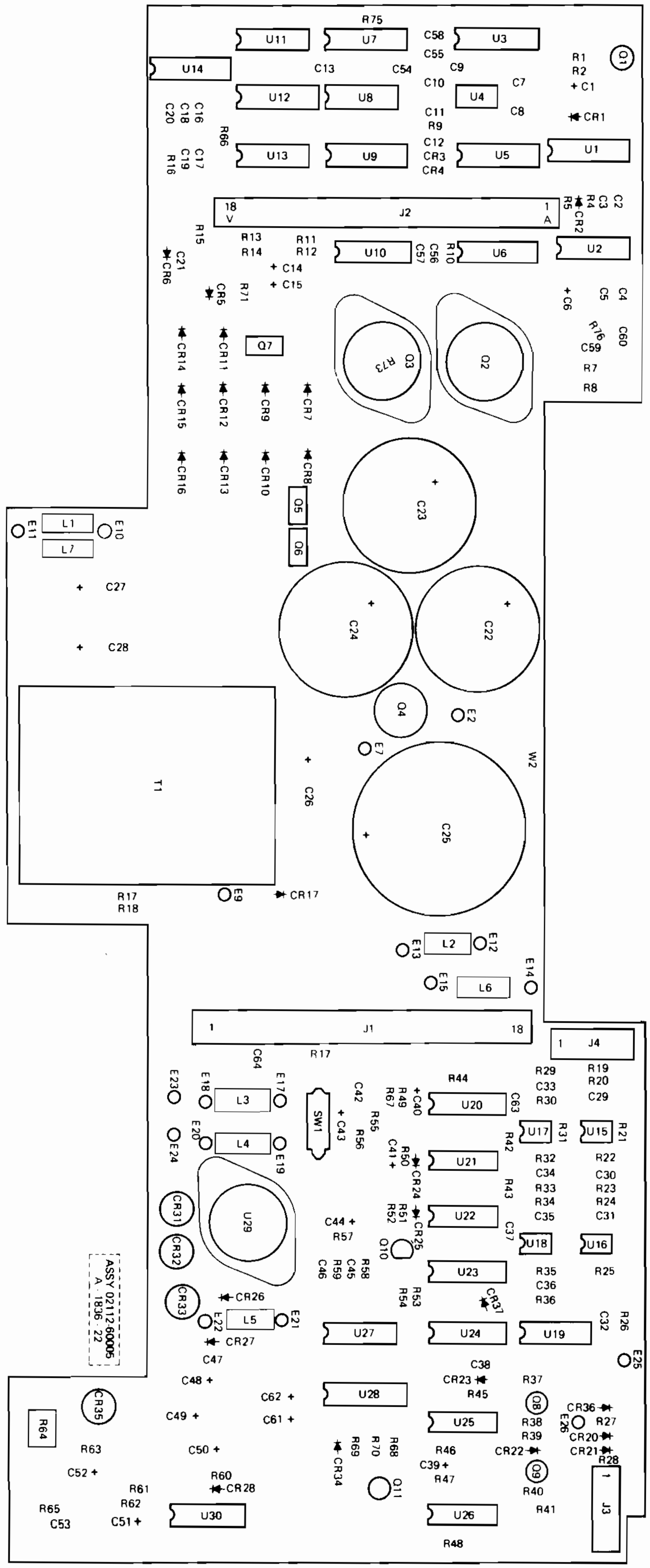
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		IC D OP AMP 20K		1826-0142		U	1	
00	U14							
		IC V REG -5V		1826-0220		U	1	
00	U2							
		XSTR 2N3906 PL18		1853-0036		U	7	
01	Q8,12,	20,21,22,29,30						
		XSTR PNP 2N2907A		1853-0281		U	8	
01	Q 6,7,	16-19,33,28						
		XSTR PNPSI DARL		1853-0347		U	1	
00	Q26							
		XSTR 2N3439 TO5		1854-0079		U	2	
00	Q3,4							
		XSTR 2N2222ATO18		1854-0477		U	13	
01	Q5,9,1	0,11,13,14,15						
03	24,25	,27,31,32,34						
		XSTR 2N6308 TO3		1854-0624		U	1	
00	Q2							
		XSTR NPN SI DARL		1854-0633		U	1	
00	Q23							
		XSTR 2N6251 TO-3		1854-0718		U	1	
00	Q1							
		THYRISTOR SCR		1884-0233		U	1	
00	CR9							
		THYRISTOR-SCR		1884-0249		U	2	
00	CR6,8							
		THYRISTOR		1884-0258		U	1	
00	CR36							
		DIODE 1N2071		1901-0029		D	6	
01	CR34,2	7,1,2,31,33						
		RECTIFIER SIL		1901-0033		U	4	
01	CR5,7,	28,32						
		DIODE SIL		1901-0040		D	10	
01	CR37,4	2,43,46-50						
03	52,54							
		STARISTOR ST8523		1901-0460		D	4	
01	CR38-4	1						
		DIODE IN4936		1901-1065		D	14	

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
				1901-1065				
01	CR11-14,17,19-24,							
03	16,29,30							
		RECTIFIER		1901-1087		D	2	
00	CR3,4							
		DIODE 6.19V		1902-0049		U	1	
00	CR55							
		DIODE		1902-0556		D	1	
00	CR51							
		DIODE 200V ZENER		1902-0668		D	2	
01	CR15,18							
		DIODE 3.16V		1902-3036		D	3	
01	CR35,44,45							
		DIODE-FW BRIDGE		1906-0051		U	2	
01	CR25,26							
		RECTIFIER		1906-0080		U	1	
00	CR10							
		ISOLATOR		1990-0429		U	3	
00	U6-8							
		OPTO ISOLATOR		1990-0537		U	1	
00	U9							
		RES VAR 1K		2100-3211		U	1	
00	R106							
		RES VAR 1K 10%		2100-3352		U	2	
01	R148,149							
		FUSE 2.5A NB		2110-0083		U	2	
00	F1,2							
		FUSE CLIP .250D		2110-0483		U	4	
		LKWSHR 6 HEL		2190-0006		U	1	
		SCR #4-40X.375L		2200-0143		U	3	
		SCR #4-40X.500L		2200-0147		U	2	
		NUT 4-40 W/LK		2260-0009		U	5	
		SCR #6-32X.750L		2300-0205		U	1	
		SCR 6-32X.375		2360-0359		U	7	
		NUT 6-32 .312AF		2420-0002		U	1	

2112A/2113A Power Supply Lower Assembly (02112-60004) Sht. 7 of 7

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WSHR #10		3050-0006		U	1	
		WSHR #4 SS		3050-0222		U	10	
		WSHR #6 SS		3050-0227		U	2	
		COMPOUND-THERMAL		6040-0239		U	0.01	TR
		WIRE JUMPERS		8159-0005		D	1	
00	W1							
		TRANSFORMER		9100-0665		U	1	
00	T4							
		XFORMER		9100-2966		U	2	
00	T2,3							
		XFORMER-POWER		9100-3803		U	1	
00	T1							
		HEAT SINK		02108-00030		W	3	


Rectifier filter and Voltage doubler
HIGH VOLTAGE CROWBAR
To Circuit Breaker Voltage Trip Coil
Power Fail Threshold Adjust
MEMORY INVERTER DRIVE
CPU INVERTER DRIVE
Battery Charger and Test Load
*Note: R138 normally deleted. Provided only to regulate -12.5V
2112 Lower Power Supply
TITLE SCHEMATIC
02112-60006
NEXT ASSEMBLY
02112-60004
PART NUMBER
D-02112-60004-51
HEWLETT PACKARD
REVISED PER PPCO E (1510)



2112A/2113A Power Supply Upper Assembly
02112-60005

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP 0.1UF		0150-0121		U	9	
01	C4,29,33,35,45,46							
03	56,57,63							
		CAP 1.0UF 20%		0160-0127		U	4	
01	C3,5,38,59							
		CAP. 2.2UF		0160-0128		D	4	
01	C2,16,18,20							
		CAP .01UF		0160-2055		U	13	
01	C7,8,10-13,17,19							
03	37,54,55,58,60							
		CAP 1000PF 10%		0160-3456		U	1	
00	C53							
		CAP .02UF 20%		0160-3459		U	1	
00	C21							
		CAP .0001UF		0160-3466		U	4	
01	C30,31,34,36							
		CAP .027UF 10%		0170-0066		U	1	
00	C32							
		CAP 47UF 10%		0180-0097		U	1	
00	C47							
		CAP 4.7UF 35WVDC		0180-0100		D	2	
00	C39,48							
		CAP 200UF-10+75%		0180-0104		U	1	
00	C50							
		CAP 6.8UF 10%		0180-0116		D	3	
01	C1,61,62							
		CAP 50UF -10+75%		0180-0141		U	1	
00	C52							
		CAP 33UF 10%		0180-0229		U	3	
01	C40,43,51							
		CAP 1UF 10%		0180-0291		D	3	
		CAP 5UF -10+75%		0180-0301		D	1	
00	C49							
		CAP 440UF-10+75%		0180-0595		U	3	
01	C26-28							

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP 47UF 10%		0180-1704		U	1	
00	C15							
		CAP .1UF 10%		0180-1743		D	1	
00	C44							
		CAP 15UF 10%		0180-1746		D	1	
00	C14							
		STUD SOLDER		0360-0090		U	5	
		STUD SOLDER TERM		0360-0474		U	3	
		TERM STUD FKD		0360-1529		U	12	
		SPCR TAP #6X.125		0380-0383		U	11	
		STANDOFF		0380-0689		U	2	
		RES 2.7 5% .25		0683-0275		D	2	
01	R17,18							
		RES 4.7 5% .25		0683-0475		U	1	
00	R61							
		RES FXD 5.6 OHM		0683-0565		U	1	
00	R40							
		RES 1.0K 5% .25		0683-1025		D	3	
01	R9,16,	43						
		RES 10K 5% .25		0683-1035		D	6	
01	R4,29,	53,58,59,63						
		RES 1200 5% .25		0683-1225		U	1	
00	R52							
		RES 150 5% .25		0683-1515		U	2	
01	R21,31							
		RES 22K 5% .25		0683-2235		U	1	
00	R48							
		RES 390 5% .25		0683-3915		D	1	
00	R60							
		RES 4700 5% .25		0683-4725		D	12	
01	R5,10-	12,19						
03	28,37	,38,42						
05	47,49	,56						
		RES 47K 5% .25		0683-4735		D	4	
01	R22,24	,32,35						
		RES 560 5% .25		0683-5615		U	4	

2112A/2113A Power Supply Upper Assembly (02112-60005) Sht. 3 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0683-5615				
01	R23,25,33,36							
		RES 680 5% .25		0683-6815		D	2	
01	R39,51							
		RES 464 1%.125		0698-0082		D	2	
01	R20,34							
		RES 14.7K 1%.125		0698-3156		D	2	
01	R66,67							
		RES 464K 1%.125		0698-3260		D	1	
00	R45							
		RES 31.6 1% .50		0698-3394		U	1	
01	R15							
		RES 147 1%.125		0698-3438		D	1	
00	R30							
		RES 422 1%.125		0698-3447		D	1	
00	R62							
		RES 196K 1%.125		0698-3453		U	1	
00	R75							
		RES 100 1% .50		0757-0198		U	1	
00	R41							
		RES 21.5K 1%.125		0757-0199		D	3	
01	R54,68,70							
		RES 1K 1%.125		0757-0280		D	4	
01	R1,13,14,73							
		RES 6.19K 1%.125		0757-0290		D	1	
00	R65							
		RES 100 1%.125		0757-0401		D	1	
00	R2							
		RES 619 1%.125		0757-0418		D	1	
00	R71							
		RES 10K 1%.125		0757-0442		D	1	
00	R44							
		RES 51.1K 1%.125		0757-0458		D	1	
00	R69							
		RES 56.2K 1%.125		0757-0459		D	1	
00	R76							
		RES 100K 1%.125		0757-0465		D	4	

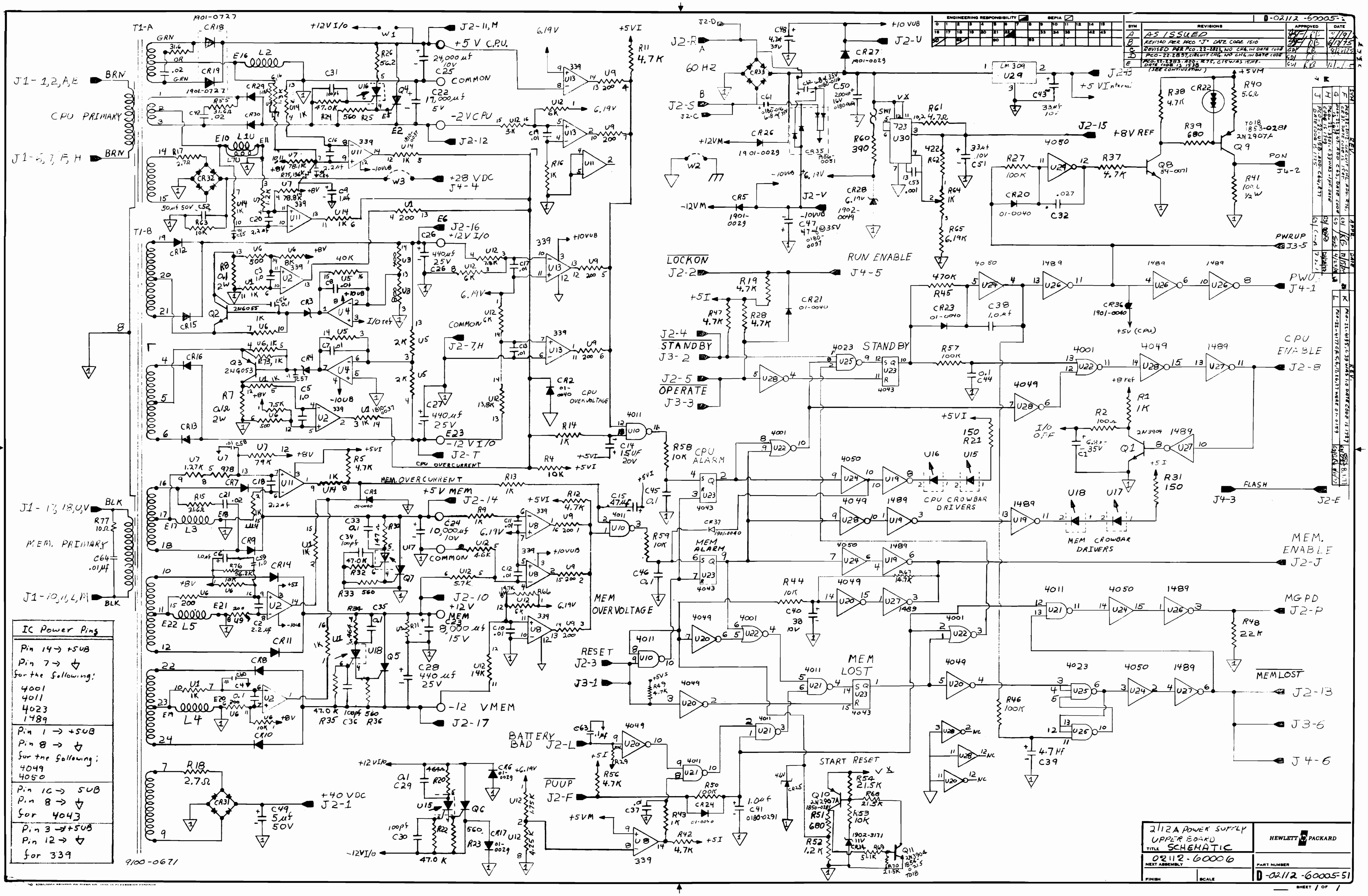
2112A/2113A Power Supply Upper Assembly (02112-60005) Sht. 4 of 6

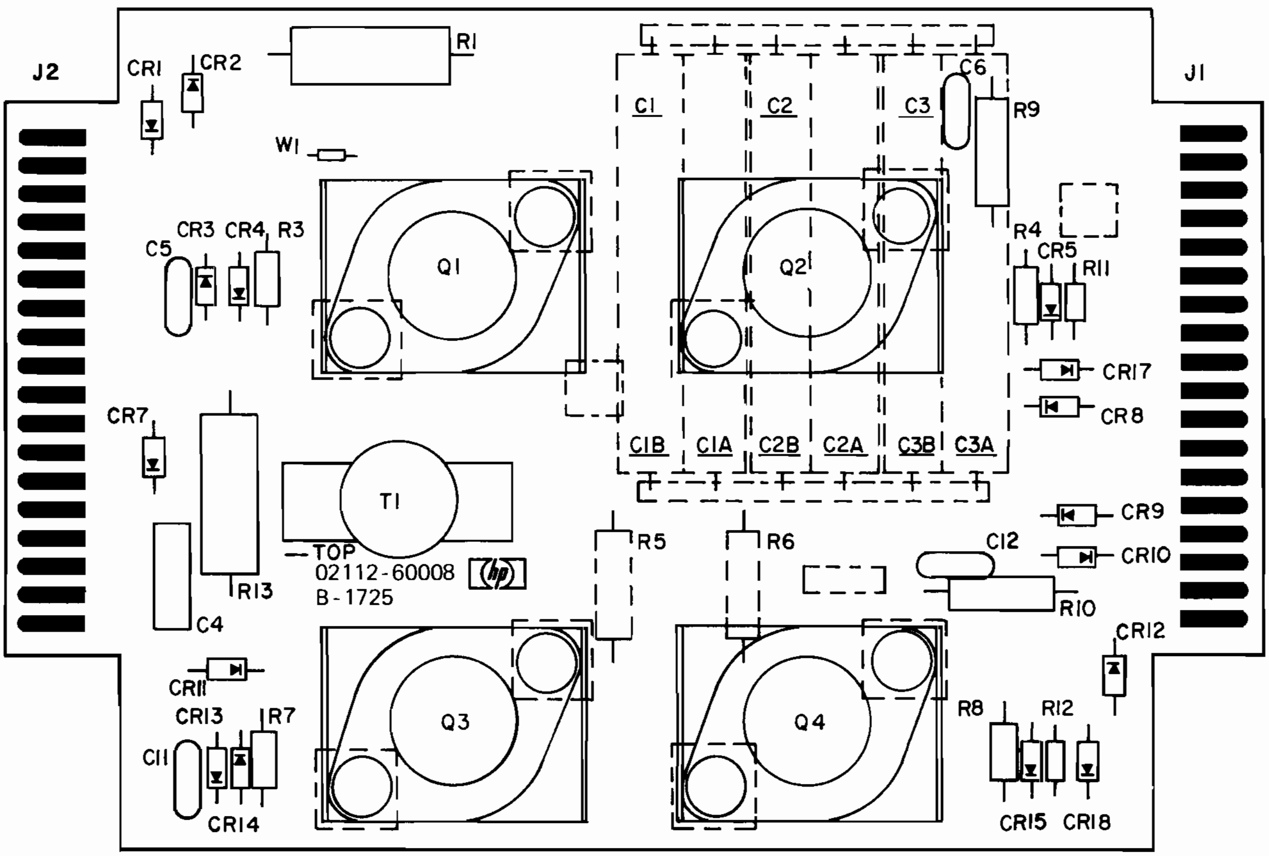
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				0757-0465				
01	R27,46,50,57							
		RES 56.2 1% .75		0757-1001		U	1	
00	R26							
		RES 0.15%2W PW		0811-3290		U	2	
00	R7,8							
		TBG #20 TFE NAT		0890-0212		U	0.30	FT
		HT DIS TO-3		1205-0275		U	2	
		CONN PC2X18.156D		1251-2026		U	1	
00	J2							
		PIN ASSY		1251-3412		U	2	
00	J3,4							
		RES NET 8X1K DIP		1810-0037		U	2	
00	U1,14							
		RES NET 8X200DIP		1810-0124		U	1	
00	U9							
		RESISTOR NETWORK		1810-0185		U	1	
00	U13							
		RESISTOR NETWORK		1810-0187		U	1	
00	U12							
		RESISTOR NETWORK		1810-0188		U	1	
00	U17							
		RESISTOR NETWORK		1810-0199		U	1	
00	U5							
		NETWORK-RESISTOR		1810-0222		U	1	
00	U6							
		IC LM309K		1820-0430		U	1	
00	U29							
		IC U6E7723393		1820-0439		U	1	
00	U30							
		IC CD4043AY		1820-0941		U	1	
00	U23							
		IC CD4023AY		1820-0943		U	1	
00	U25							
		IC CD4001AY		1820-0946		U	1	
00	U22							

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	U10,21	IC CD4011AE		1820-0949		U	2	
01	U19,26,27	IC MC1489AL		1820-0990		U	3	
01	U20,28	IC 4049AE		1820-1145		U	2	
00	U24	IC CD4050AE		1820-1146		U	1	
01	U2,8,11,13	IC QUAD COMPTR		1826-0138		U	4	
00	U14	IC D OP AMP 20K		1826-0142		U	1	
00	Q9,10	XSTR PNP 2N2907A		1853-0281		U	2	
00	Q3	XSTR 2N6053 TO3		1853-0351		U	1	
00	Q1,8	XSTR NPN SI PL5		1854-0071		U	2	
00	Q11	XSTR 2N3904 PL5		1854-0215		U	1	
00	Q2	XSTR 2N6055 TO3		1854-0611		U	1	
01	Q5,6,7	THYRISTOR-SCR		1884-0240		U	3	
01	CR5,6,17,26,27	DIODE 1N2071		1901-0029		D	5	
01 03	CR1,2,20,21,23,24 C36,37	DIODE SIL		1901-0040		D	8	
00	CR22	STABISTOR STB523		1901-0460		D	1	
01	CR7,9	DIO-PWR RECT		1901-0662		U	2	
01	CR8,10-16	DIODE		1901-1086		U	8	
01	CR3,4,28	DIODE 6.19V		1902-0049		U	3	

2112A/2113A Power Supply Upper Assembly (02112-60005) Sht. 6 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	CR25	DIODE 4.64V		1902-3082		U	1	
00	CR34	DIODE BD 11V		1902-3171		D	1	
01	CR31-33,35	DIODE-FW BRIDGE		1906-0051		U	4	
01	U15-18	ISOLATOR OPTO		1990-0431		U	4	
00	R64	RES VAR 1K		2100-3211		U	1	
		SCR 6-32X.375		2360-0359		U	6	
		NUT 6-32 W/LK		2420-0001		U	1	
		WSHR #6 BRS		3050-0100		U	1	
00	SW1	SWITCH-THERMAL		3103-0033		U	1	
		COMPOUND-THERMAL		6040-0239		U	0.001	TB
		WIRE 30AWG WHT		8150-3426		C	0.25	FT
		WIRE 22GA BARE		8151-0013		C	0.30	FT
00	W2	WIRE JUMPERS		8159-0005		D	1	
		GROUND STRAP		02112-00004		W	1	
		GROUND STRAP		02112-00005		W	1	


2112A Power Supply
UPPER BOARD
SCHEMATIC
02112-60006
HEWLETT PACKARD
D-02112-60005-51
SHEET 1 OF 1
IC Power Pins
Pin 14 → +5UB
Pin 7 → ⏚
for the following:
4001
4011
4023
1489
Pin 1 → +5UB
Pin 8 → ⏚
for the following:
4049
4050
Pin 16 → 5UB
Pin 8 → ⏚
for 4043
Pin 3 → +5UB
Pin 12 → ⏚
for 339
J1-1,2,A,E
CPU PRIMARY
J1-13,18,U,V
MEM. PRIMARY
+5 V C.P.U.
-2 V CPU
+28 VDC
-12 V I/O
+5V MEM
MEM OVERCURRENT
CPU OVERCURRENT
CPU OVERVOLTAGE
MEM OVERVOLTAGE
-12 VMEM
+40 VDC
BATTERY BAD
PUUP
START RESET
RESET
MEM LOST
MEM ALARM
CPU ALARM
LOCKON
RUN ENABLE
STANDBY
OPERATE
CPU CROWBAR DRIVERS
MEM CROWBAR DRIVERS
CPU ENABLE
MEM. ENABLE
MGPD
MEMLOST
FLASH
+8V REF
PON
PWRUP
PWU
60 HZ
AS ISSUED



2112A/2113A Power Supply Riser Assembly
02112-60008

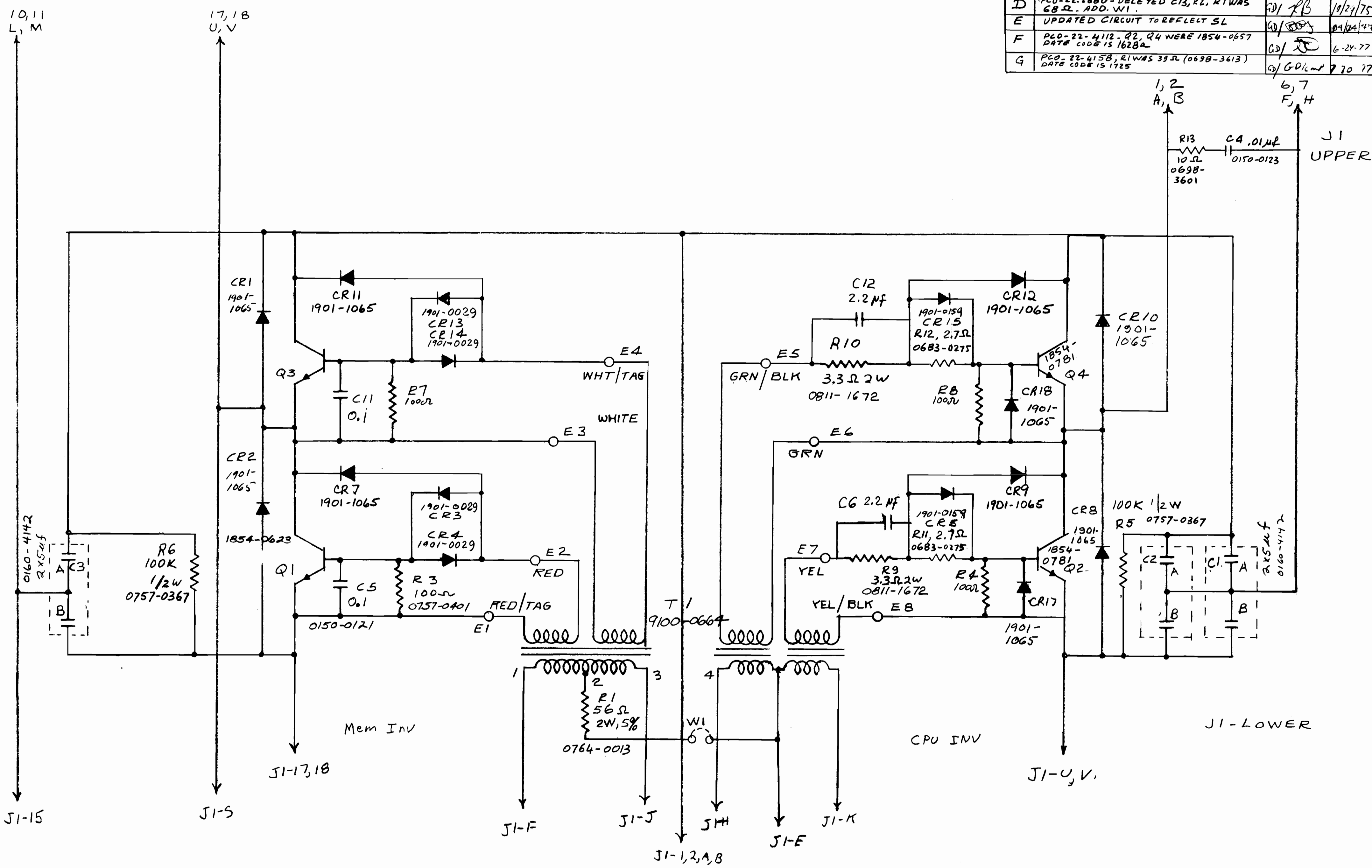
2112A/2113A Power Supply Riser Assembly Parts List (02112-60008) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	C5,11	CAP 0.1UF		0150-0121		U	2	
00	C4	CAP .01UF 20%		0150-0123		U	1	
00	C6,12	CAP. 2.2UF		0160-0128		D	2	
00	C1-3	CAP FXD 2X5UF		0160-4142		U	3	
00	E1-8	STUD SOLDER TERM		0360-0294		U	8	
00	E9	STUD SOLDER TERM		0360-0474		U	1	
00	E10	STUD SOLDER TERM		0360-1047		U	1	
		EYELET BRASS		0361-0534		U	1	
		SPCR TAP #6X.125		0380-0305		U	8	
		STANDOFF		0380-0886		U	2	
01	R11,12	RES 2.7 5% .25		0683-0275		D	2	
00	R13	RES 10 5% 2W		0698-3601		D	1	
00	R5,6	RES 100K 1% .50		0757-0367		U	2	
01	R3,4,7,8	RES 100 1%.125		0757-0401		D	4	
01	R1	RES 56 5% 2W		0764-0013		U	1	
00	R9,10	RES 3.3 5% 2W		0811-1672		U	2	
		TBG HS BLK .750D		0890-0301		U	0.0001	FT
		HT DIS TO-3		1205-0275		U	4	
01	Q2,4	XSTR-NPN POWER		1854-0781		U	2	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	Q1,3	XSTR NPN TO3		1854-0790		U	2	
01	CR3,4,	DIODE 1N2071 13,14		1901-0029		D	4	
01 03	CR1,2, 17,1	DIODE IN4936 5,7-12,15, 8		1901-1065		D	12	
		SCR #4-40X.312L		2200-0141		U	2	
		SCR #6-32X.375L		2360-0117		U	8	
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
		WIRE JUMPERS		8159-0005		D	1	
		INSULATOR RISER		02112-00024		W	1	

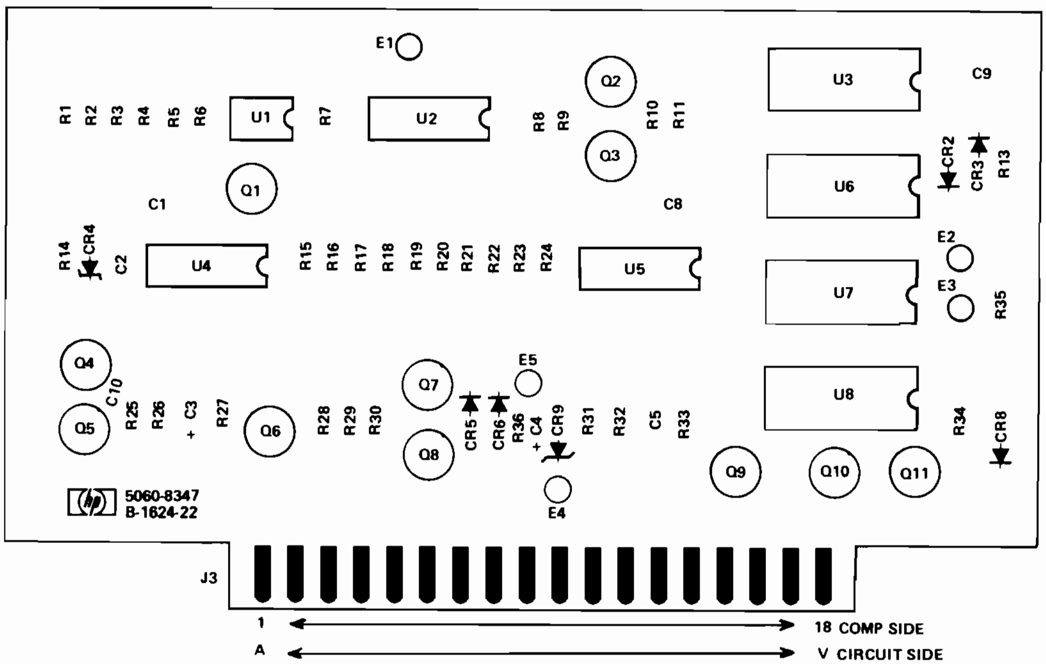
H	PCO-22-4177, CR3,4,13,14 WERE 1901-0154

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		3-15-75
B	CHANGED WIRE COLOR CALLOUT (DATE CODE 1510) PPCO 'F'		5/14/75
C	PCO-22-2734 - PILOT RUN MODS, DATE CODE 15A-1510	RB	7/15/75
D	PCO-22-2880 - DELETED C13, R2, R1 WAS 68Ω. ADD. W1.	RB	10/21/75
E	UPDATED CIRCUIT TO REFLECT SL		04/04/77
F	PCO-22-4112, Q2, Q4 WERE 1854-0657 DATE CODE IS 1628A		6-24-77
G	PCO-22-4158, R1 WAS 39Ω (0698-3613) DATE CODE IS 1725		7 20 77



TITLE: 2112 POWER SUPPLY SCHEMATIC/RISER	HEWLETT hp PACKARD
NEXT ASSEMBLY	PART NUMBER C-02112-60008-51
FINISH — SCALE —	SHEET 1 OF 1

STOCK NO. 9280-0003 PRINTED ON DIEPO NO. 1030-10 CLEARPRINT FADEOUT



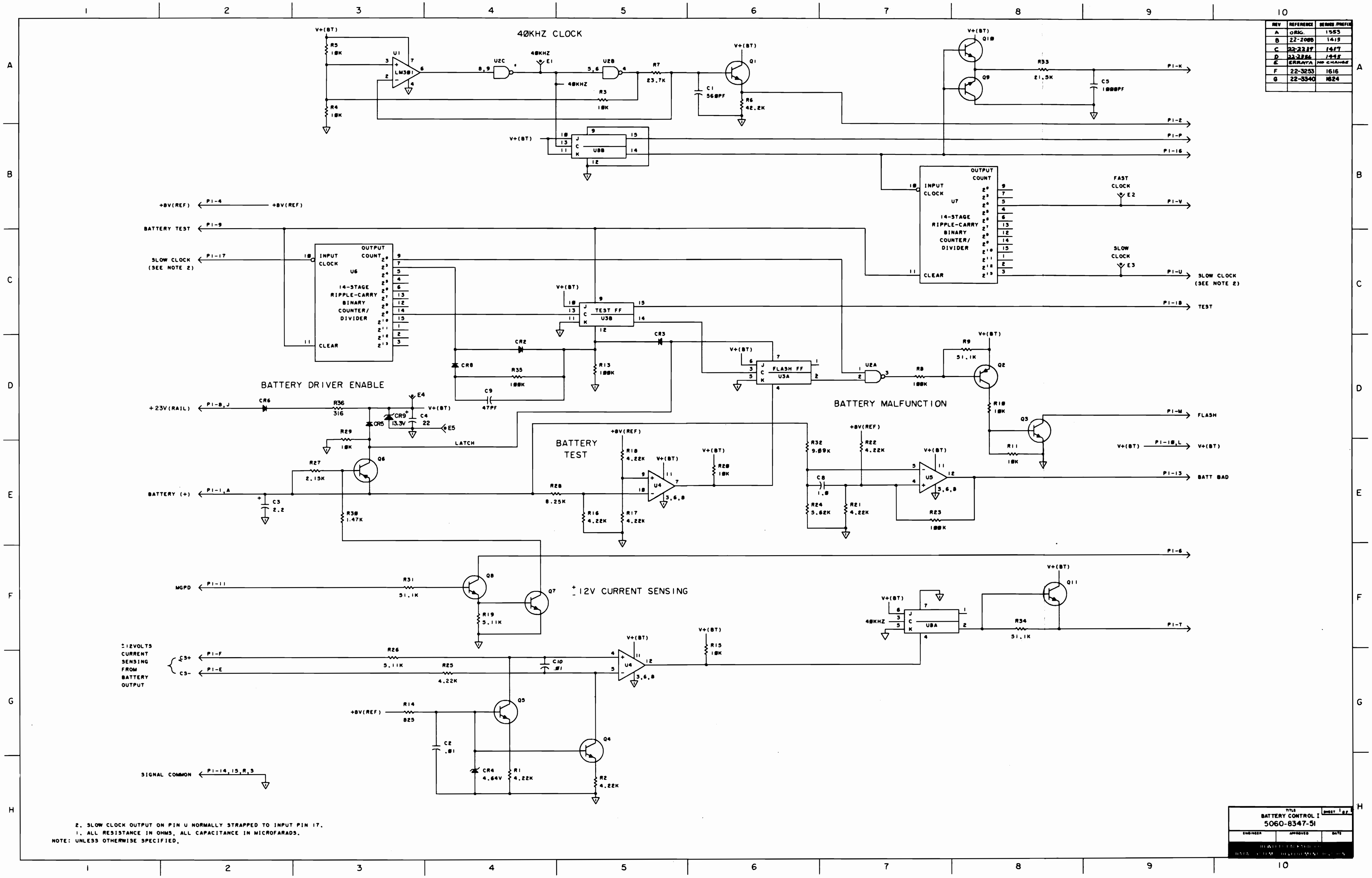
Battery Control I Assy
5060-8347

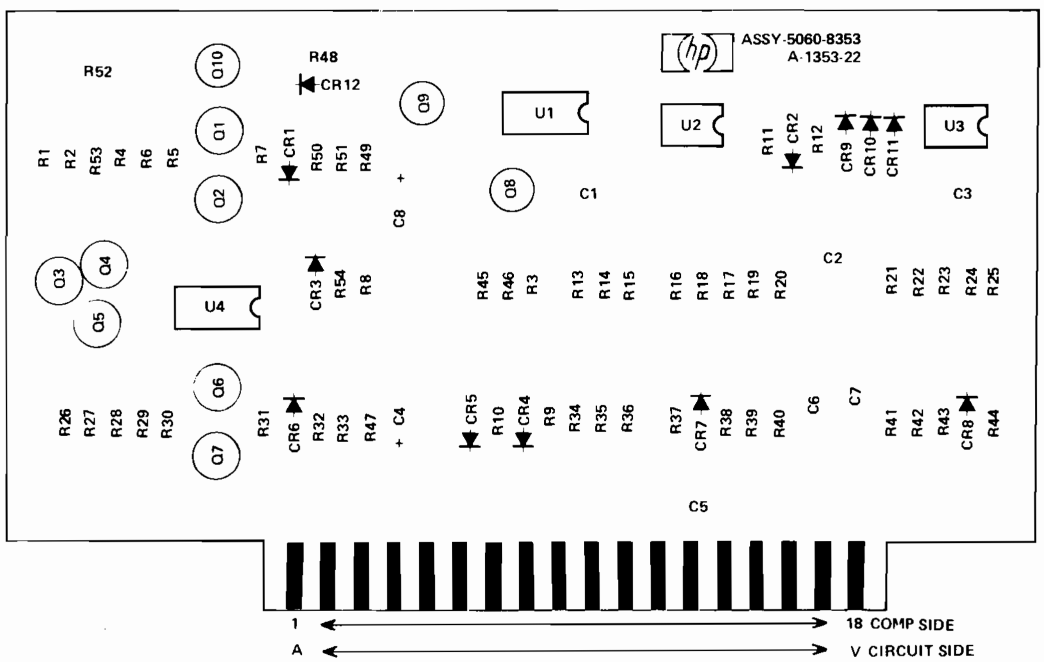
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	C8	CAP 1.0UF 20%		0160-0127		U	1	
00	C5	CAP 1000PF 5%		0160-0938		U	1	
00	C2,10	CAP .01UF		0160-2055		U	2	
00	C9	CAP 47PF 5%		0160-2307		U	1	
00	C1	CAP 560PF 5%		0160-3535		U	1	
00	C3	CAP 2.2UF 10%		0180-0197		D	1	
00	C4	CAP 22UF 10%		0180-0228		D	1	
00	E1-3	STUD SOLDER TERM		0360-0294		U	3	
00	E4,5	STUD SOLDER TERM		0360-0474		U	2	
00	R27	RES 2.15K 1%.125		0698-0084		D	1	
01 03	R1,2,16-18,21, 22,25	RES 4.22K 1%.125		0698-3154		D	8	
00	R7	RES 23.7K 1%.125		0698-3158		D	1	
00	R36	RES 316 1% .50		0698-3402		D	1	
00	R6	RES 42.2K 1%.125		0698-3450		D	1	
00	R33	RES 21.5K 1%.125		0757-0199		D	1	
00	R24	RES 5.62K 1%.125		0757-0200		D	1	
00	R32	RES 9.09K 1%.125		0757-0288		D	1	
		RES 825 1%.125		0757-0421		D	1	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	R14			0757-0421				
01	R19,26	RES 5.11K 1%.125		0757-0438		D	2	
00	R28	RES 8.25K 1%.125		0757-0441		D	1	
01 03	R3-5,10,11,15, 20,29	RES 10K 1%.125		0757-0442		D	8	
01	R9,31,34	RES 51.1K 1%.125		0757-0458		D	3	
01	R8,13,23,35	RES 100K 1%.125		0757-0465		D	4	
00	R30	RES 1.47K 1%.125		0757-1094		D	1	
00	U1	IC LM301AN		1820-0477		U	1	
00	U6,7	IC CD4020AY		1820-0935		U	2	
00	U3,8	IC CD4027AD		1820-0938		U	2	
00	U2	IC CD4011AE		1820-0949		U	1	
00	U4,5	IC D COMPTR 8K		1826-0175		U	2	
00	Q2,9	XSTR 2N3906 PL18		1853-0036		U	2	
00	Q6	XSTR PNP 2N2907A		1853-0281		U	1	
01	Q1,3-5,7,8,10,11	XSTR 2N3904 PL5		1854-0215		U	8	
00	CR5,6	RECTIFIER SIL		1901-0033		U	2	
01	CR2,3,8	DIODE SIL		1901-0040		D	3	
00	CR9	DIODE-ZENER 13V		1902-0555		U	1	

12994A Battery Back-up Control I Assembly Parts List (5060-8347) Sht. 3 of 3

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	CR4	DIODE 4.64V		1902-3082		U	1	
		BOARD-ETCHED		5080-9738		W	1	


40KHZ CLOCK
BATTERY DRIVER ENABLE
BATTERY TEST
BATTERY MALFUNCTION
±12V CURRENT SENSING
+8V(REF)
BATTERY TEST
SLOW CLOCK (SEE NOTE 2)
+23V(RAIL)
BATTERY (+)
MGPD
±12VOLTS CURRENT SENSING FROM BATTERY OUTPUT
SIGNAL COMMON
INPUT CLOCK
OUTPUT COUNT
14-STAGE RIPPLE-CARRY BINARY COUNTER/ DIVIDER
CLEAR
TEST FF
FLASH FF
LATCH
FAST CLOCK
SLOW CLOCK (SEE NOTE 2)
TEST
FLASH
BATT BAD
V+(BT)
NOTE: UNLESS OTHERWISE SPECIFIED,
1. ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN MICROFARADS.
2. SLOW CLOCK OUTPUT ON PIN U NORMALLY STRAPPED TO INPUT PIN 17.
BATTERY CONTROL I
5060-8347-51



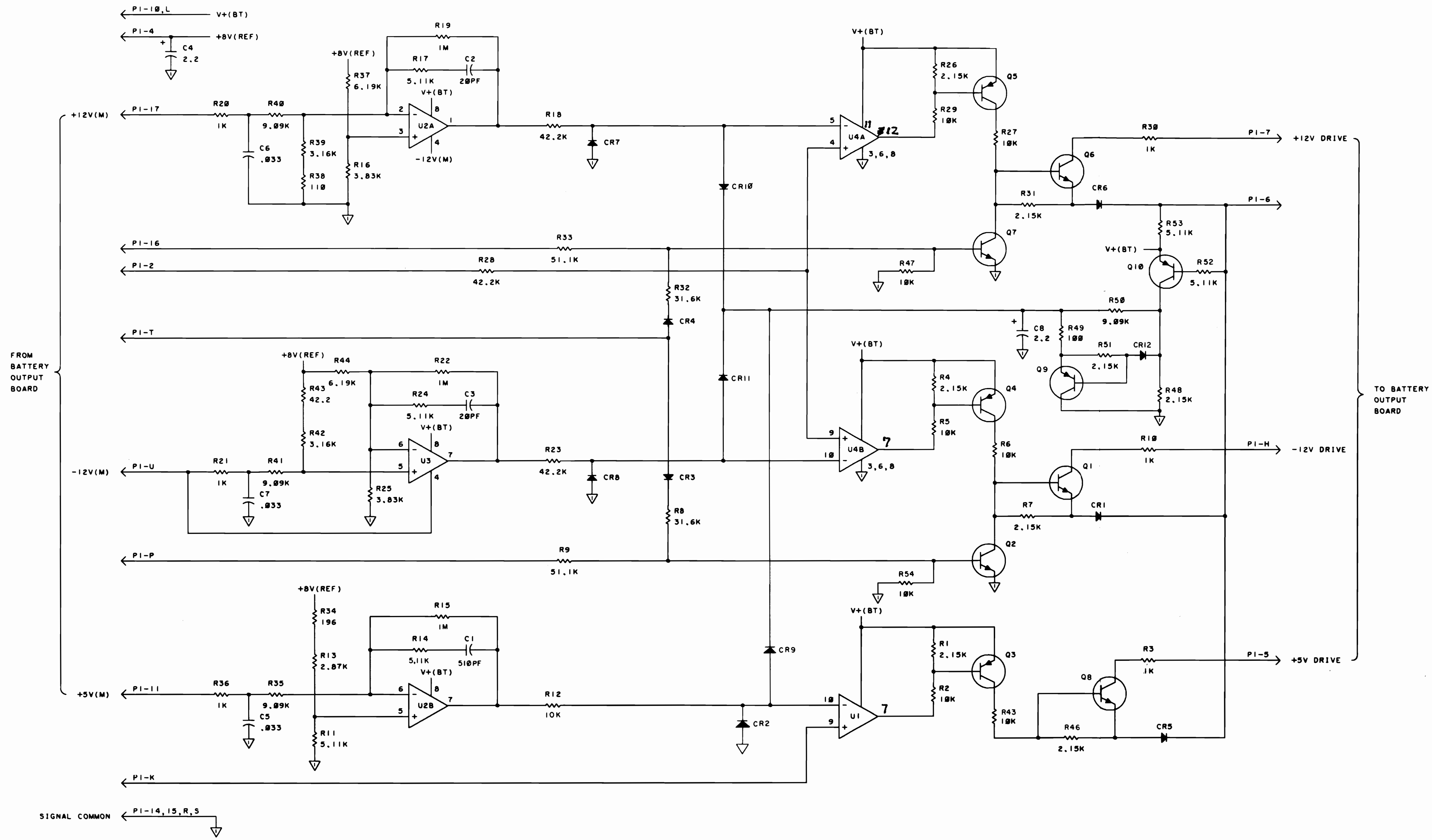
Battery Control II Assy.
5060-8353

12944A Battery Back-up Control II Assembly Parts List (5060-8353) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	C5-7	CAP .033UF 10%		0160-0163		U	3	
00	C2,3	CAP 20PF 5%		0160-2198		U	2	
00	C1	CAP 510PF 10%		0160-3534		U	1	
00	C4,8	CAP 2.2UF 10%		0180-0197		D	2	
01	R15,19,22	RES 1M 5% .25		0683-1055		D	3	
01 03	R1,4,7,26,31 46,48,51	RES 2.15K 1%.125		0698-0084		D	8	
00	R13	RES 2.87K 1%.125		0698-3151		D	1	
01	R16,25	RES 3.83K 1%.125		0698-3153		D	2	
00	R8,32	RES 31.6K 1%.125		0698-3160		U	2	
00	R34	RES 196 1%.125		0698-3440		D	1	
01	R18,23,28	RES 42.2K 1%.125		0698-3450		D	3	
01	R39,42	RES 3.16K 1%.125		0757-0279		D	2	
01 03	R3,10,20,21 30,36	RES 1K 1%.125		0757-0280		D	6	
01	R35,40,41,50	RES 9.09K 1%.125		0757-0288		D	4	
01	R37,44	RES 6.19K 1%.125		0757-0290		D	2	
00	R43	RES 42.2 1%.125		0757-0316		U	1	
00	R49	RES 100 1%.125		0757-0401		D	1	

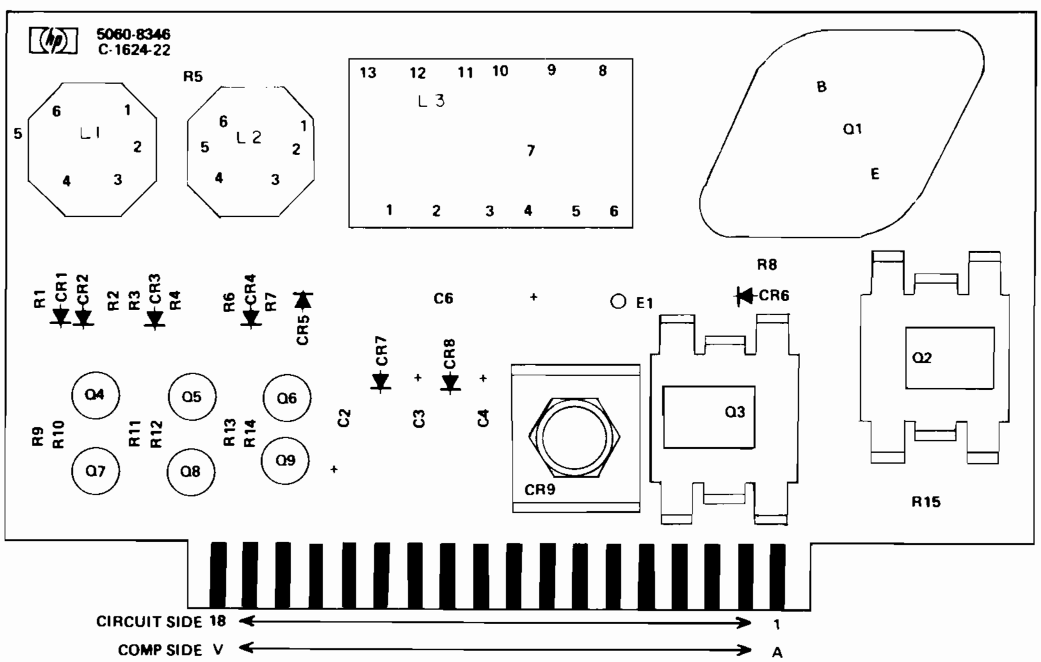
12944A Battery Back-up Control II Assembly Parts List (5060-8353) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	R38	RES 110 1%.125		0757-0402		U	1	
01 03	R11,14,17,24 52,53	RES 5.11K 1%.125		0757-0438		D	6	
01 03	R2,5,6,12,27,29, 45,47,54	RES 10K 1%.125		0757-0442		D	9	
00	R9,33	RES 51.1K 1%.125		0757-0458		D	2	
00	U2,3	IC MC1458 P1		1826-0139		U	2	
00	U1,4	IC D COMPTR 8K		1826-0175		U	2	
01	Q3-5,9,10	XSTR 2N3906 PL18		1853-0036		U	5	
01	Q1,2,6-8	XSTR 2N3904 PLS		1854-0215		U	5	
01	CR1-12	DIODE SIL		1901-0040		D	12	



NOTE: UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN MICROFARADS.

TITLE	SHEET 1 OF 1
BATTERY CONTROL II 5060-8353-51	
ENGINEER / APPROVED	DATE
HEWLETT PACKARD CO DATA SYSTEMS DEVELOPMENT DIVISION	



Battery Output Assy
5060-8346

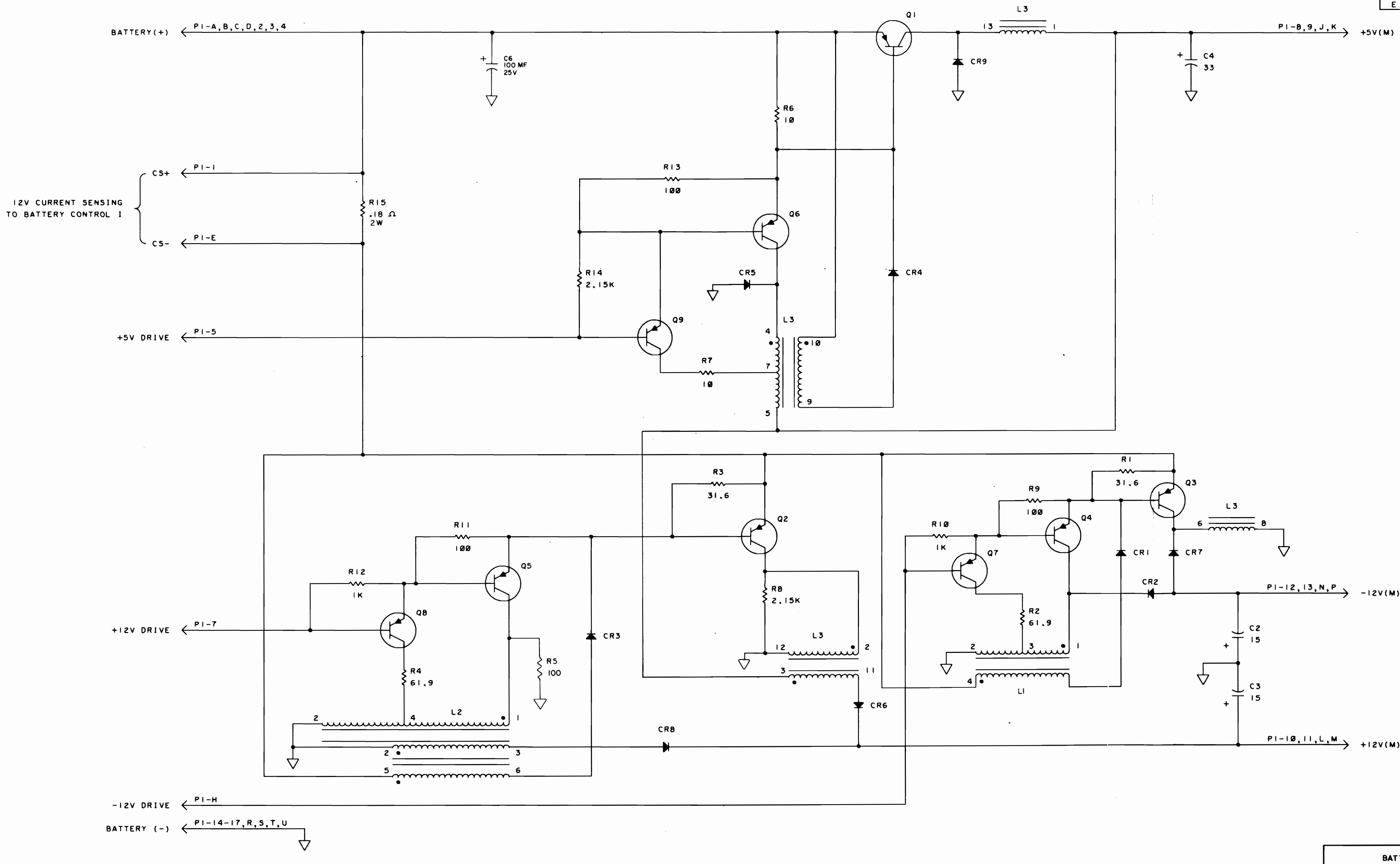
12944A Battery Back-up Output Assembly Parts List (5060-8346) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		0A						
00	C6	CAP 100UF-10+50%		0180-0094		U	1	
00	C4	CAP 33UF 10%		0180-0229		U	1	
00	C2,3	CAP 15UF 10%		0180-1746		D	2	
		STUD SOLDER TERM		0360-0294		U	1	
		SPCR TAP #6X.125		0380-0305		U	2	
00	F8,14	RES 2.15K 1%.125		0698-0084		D	2	
00	R1,3	RES 31.6 1%.125		0757-0180		D	2	
00	R5	RES 100 1% .50		0757-0198		U	1	
00	R2,4	RES 61.9 1%.125		0757-0276		D	2	
01	R10,12	RES 1K 1%.125		0757-0280		D	2	
00	R6,7	RES 10 1%.125		0757-0346		D	2	
01	R9,11,13	RES 100 1%.125		0757-0401		D	3	
00	R15	RES 0.18 OHM WW		0811-3293		U	1	
		SLEEVING FLEX.		0890-0064		U	0.25	FT
		HT DIS PL PWR		1205-0219		U	2	
		HT DIS TO-3		1205-0275		U	1	
01	Q7,8,9	XSTR 2N3906 PL18		1853-0036		U	3	
00	Q2,3	XSTR 2N5194 X58		1853-0212		U	2	
		XSTR 2N4236 TO5		1853-0213		U	1	

12944A Battery Back-up Output Assembly Parts List (5060-8346) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
				1853-0213				
00	Q6							
		XSTR PNP 2N2907A		1853-0281		U	2	
00	Q4,5							
		XSTR 2N4398 TO3		1853-0310		U	1	
00	Q1							
		DIODE-RECTIFIER		1901-0699		U	2	
00	CR6,7							
		DIODE		1901-1062		U	1	
00	CR9							
		DIODE IN4936		1901-1065		D	6	
01	CR1-5,	8						
		LKWSHR 10 HEL		2190-0034		U	1	
		LKWSHR 6 HEL		2190-0851		U	1	
		SCR #4-40X.500L		2200-0147		U	2	
		NUT 4-40 W/LK		2260-0009		U	2	
		SCR #6-32X.437L		2360-0199		U	2	
		NUT 10-32 .375AF		2740-0002		U	1	
		WSHR #4 SS		3050-0229		U	6	
		WSHR #10 BRS		3050-0236		U	1	
		COMPOUND-THERMAL		6040-0239		U	0.0012	TB
		WIRE 18 AWG BARE		8151-0011		U	2	FT
		CHOKE		9100-2962		U	1	
00	L2							
		CHOKE		9100-2963		U	1	
00	L1							
		CHOKE		9100-2964		U	1	
00	L3							
		BOARD-ETCHED		5080-9737		W	1	
		HEAT SINK		02108-00024		W	1	

REV	REFERENCE	SERIES/PREFIX
A	ORIG.	1353
B	ERRATA	NO CHANGE
C	22-2386	1445
D	ERRATA	NO CHANGE
E	22-3312	1624



1. ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN MICROFARADS.
NOTE: UNLESS OTHERWISE SPECIFIED.

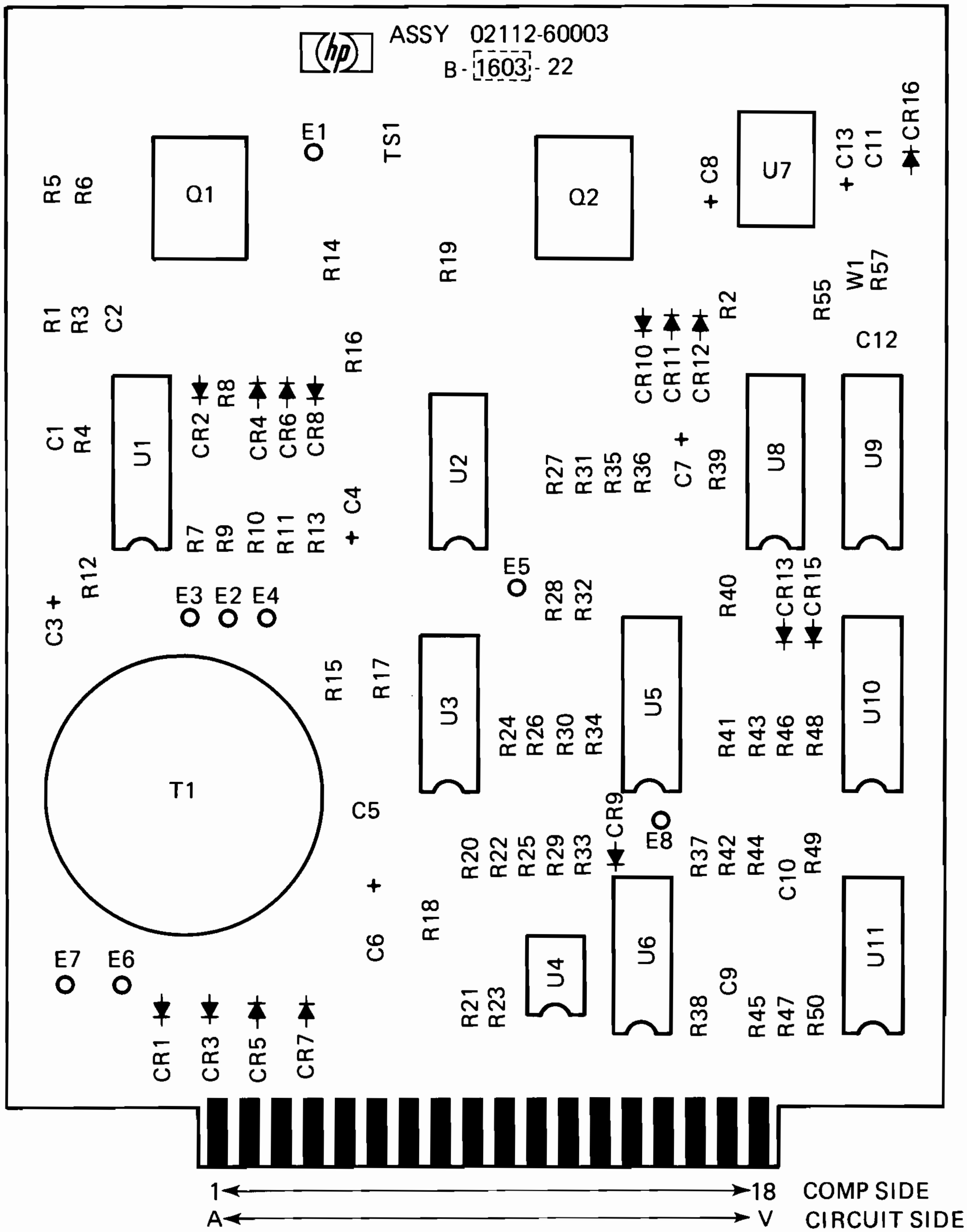
TITLE
BATTERY OUTPUT
5060-8346-51

SHEET OF

ENGINEER | APPROVED | DATE

HEWLETT PACKARD CO
DATA SYSTEMS DEVELOPMENT DIVISION

IXA - 131/ -132



Battery Inverter Assembly
02112-60003

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C10,11	CAP 0.1UF		0150-0121		U	2	
00	C9	CAP 1.0UF 20%		0160-0127		U	1	
00	C12	CAP 47PF 5%		0160-2307		U	1	
00	C1,2	CAP 1000PF 10%		0160-3456		U	2	
00	C5	CAP 820PF 5%		0160-3539		U	1	
00	C6	CAP 50UF -10+75%		0180-0141		U	1	
00	C3	CAP 2.2UF 10%		0180-0197		D	1	
00	C8,13	CAP 1UF 10%		0180-0291		D	2	
00	C4,7	CAP 15UF 10%		0180-1746		D	2	
00	E1-8	STUD SOLDER TERM		0360-0294		U	8	
00	R12	RES 10K 5% .25		0683-1035		D	1	
01	R2,3,23,28,31	RES 2.15K 1%.125		0698-0084		D	5	
01	R38,44-47,49	RES 4.22K 1%.125		0698-3154		D	6	
01	R11,39	RES 4.64K 1%.125		0698-3155		D	2	
00	R57	RES 14.7K 1%.125		0698-3156		D	1	
00	R22	RES 23.7K 1%.125		0698-3158		D	1	
00	R20	RES 147 1%.125		0698-3438		D	1	

12991A Battery Back-up Inverter Assembly Parts List (02112-60003) Sht. 2 of 4

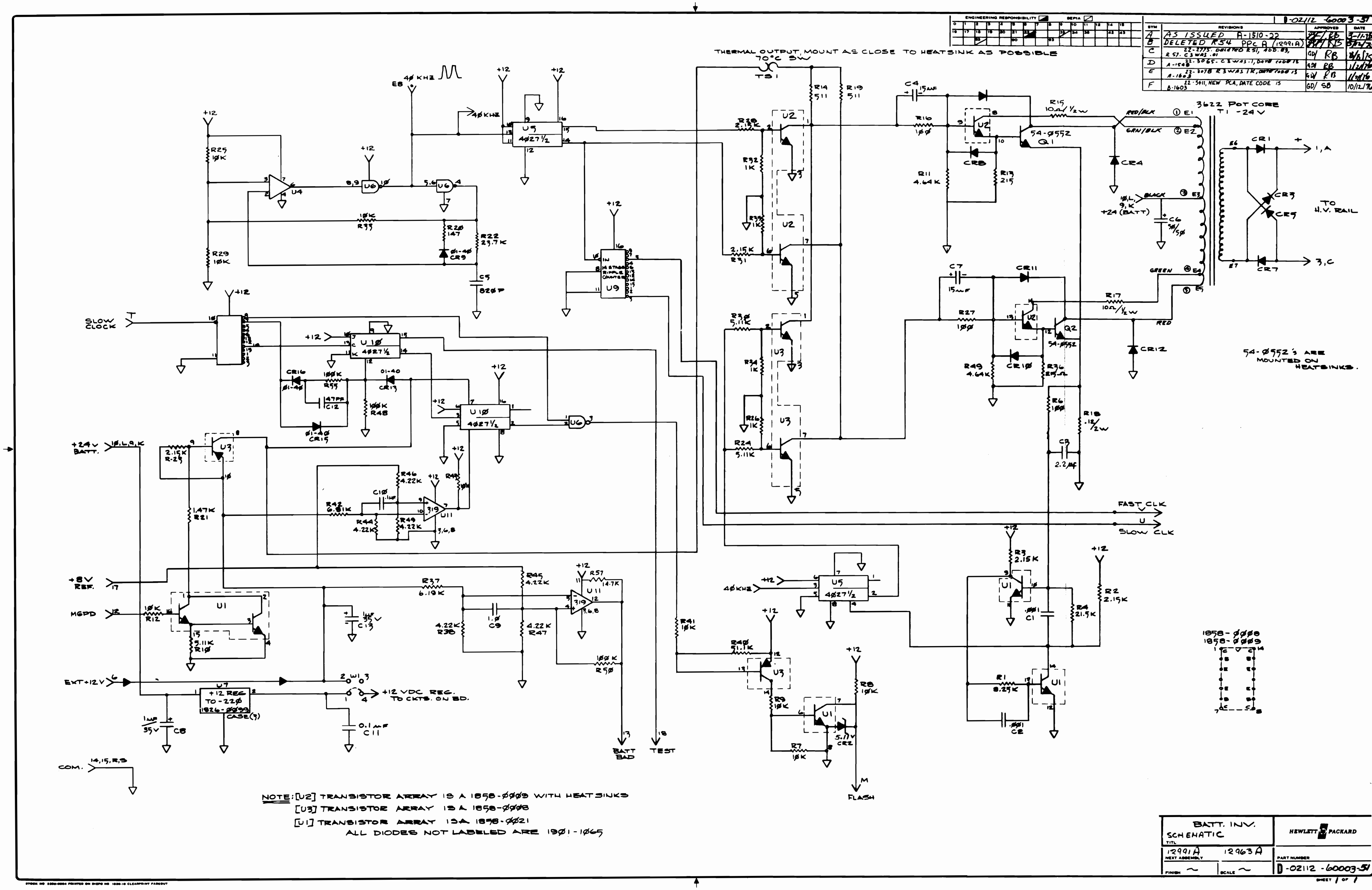
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R13,36	RES 215 1%.125		0698-3441		D	2	
00	R4	RES 21.5K 1%.125		0757-0199		D	1	
01	R5,26,32,34,35	RES 1K 1%.125		0757-0280		D	5	
00	R37	RES 6.19K 1%.125		0757-0290		D	1	
01	R6,16,27	RES 100 1%.125		0757-0401		D	3	
01	R14,19	RES 511 1%.125		0757-0416		D	2	
01	R10,24,30	RES 5.11K 1%.125		0757-0438		D	3	
00	R42	RES 6.81K 1%.125		0757-0439		D	1	
00	R1	RES 8.25K 1%.125		0757-0441		D	1	
01	R7-9,25,29,33,41-43	RES 10K 1%.125		0757-0442		D	8	
00	R40	RES 51.1K 1%.125		0757-0458		D	1	
01	R48,50,55	RES 100K 1%.125		0757-0465		D	3	
01	R15,17	RES 10 1% .50		0757-0984		D	2	
00	R21	RES 1.47K 1%.125		0757-1094		D	1	
00	R18	RES .12 5%2WPW		0811-3291		U	1	
		HT DIS PL PWR		1205-0284		U	2	
00	U4	IC LM301AN		1820-0477		U	1	
00	U8,9	IC CD4020AY		1820-0935		U	2	
		IC CD4027AD		1820-0938		U	2	

12991A Battery Back-up Inverter Assembly Parts List (02112-60003) Sht. 3 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
00	U5,10			1820-0938				
00	U6	IC CD4011AE		1820-0949		U	1	
00	U7	IC V REG 12V		1826-0099		U	1	
00	U11	IC D COMPTR 8K		1826-0175		U	1	
00	Q1,2	XSTR NPN X58		1854-0552		U	2	
00	U3	XISTOR ARRAY		1858-0008		U	1	
00	U2	XISTOR ARRAY		1858-0009		U	1	
00	U1	XSTR ARRAY 5 NPN		1858-0021		U	1	
01	CR9,13,15,16	DIODE SIL		1901-0040		D	4	
01	CR1,3-8,10-12	DIODE IN4936		1901-1065		D	10	
00	CR2	DIODE ZNR 5.11V		1902-0041		D	1	
		LKWSHR 6 HFL		2190-0851		U	6	
		SCR #6-32X.312L		2300-0195		U	1	
		SCR #6-32X.375L		2300-0197		U	2	
		SCR #6-32X.500L		2360-0201		U	2	
		NUT 6-32 .312AF		2420-0002		U	6	
		NUT 6-32 .250AF		2420-0003		U	6	
		WSHR #6 SS		3050-0228		U	14	
00	TS1	SWITCH-THERMAL		3103-0033		U	1	
		COMPOUND-THERMAL		6040-0239		U	0.01	TB
00	W1	WIRE JUMPERS		8159-0005		D	1	

12991A Battery Back-up Inverter Assembly Parts List (021120-60003) Sht. 4 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		TRANSFORMER-PWR		9100-0666		U	1	


THERMAL OUTPUT, MOUNT AS CLOSE TO HEATSINK AS POSSIBLE
70°C SW
3622 POT CORE T1 -24V
TO H.V. RAIL
54-0552's ARE MOUNTED ON HEATSINKS.
FAST CLK
SLOW CLK
SLOW CLOCK
+24V BATT.
+8V REF.
MGPD
EXT +12V
COM.
+12 VDC REG. TO CKTS. ON BD.
BATT BAD
TEST
FLASH
NOTE: [U2] TRANSISTOR ARRAY IS A 1858-0009 WITH HEATSINKS
[U3] TRANSISTOR ARRAY IS A 1858-0008
[U1] TRANSISTOR ARRAY IS A 1858-0021
ALL DIODES NOT LABELED ARE 1901-1065
1858-0008
1858-0009
REVISIONS
A AS ISSUED A-1510-22
B DELETED R54 PPC A (12991A)
C 22-2775, DELETED R51, ADD. R53, R57. C3 WAS .01
D A-1568 22-3065. C3 WAS .1, DATE CODE 15
E A-1603 22-3078 R3 WAS 1K, DATE CODE 15
F B-1603 22-3411, NEW PCA, DATE CODE 15
BATT. INV. SCHEMATIC
12991A
12963A
HEWLETT PACKARD
D-02112-60003-51
SHEET 1 OF 1

POWER SUPPLY

Part Number 5061-1356

FOR HP 1000 "B" MODEL COMPUTERS AND EXTENDERS

(2108B, 2109B, 2111F, 2112B, 2113B, 2117F, 12979B, AND 12990B)

THEORY OF OPERATION

(Computer Serial Prefix Prior to 2108)

NOTE

This document is part of the HP 1000 M, E, and F-Series Computers Engineering and Reference Documentation and is not available separately.

Table of Contents

INTRODUCTION	SECTION I

This document is the Theory of Operation for the 5061-1356 Power Supply and describes the operation of the various circuits and their interconnection in the power supply. The description is conducted on a functional level using block level diagrams and references to the schematic diagrams. Understanding the theory of operation is essential for performing detailed troubleshooting and repair of the power supply. Power supply schematics and parts location diagrams are included at the rear of this section.

The 5061-1356 Power Supply is covered on nine sheets of schematics and nine sheets of assembly drawings. The drawings and schematics are listed in table 2-1. The electronic design is illustrated in the schematics and the assembly drawings show the component locations. Parts lists are provided at the rear of this section with the assembly drawings and schematic diagrams.

Table 2-1. Assembly and Schematic Numbers.

Sheet No.	Ref. Desig.	Drawing No.	Title
	A3	B-5061-1350-1	Rear Panel Assembly Drawing
		D-5061-1356-1	Power Supply Assembly Drawing
1		02109-90024	Line (Mains) Power Distribution Schematic Diagram
	A3A1	C-5061-1374-1	Pre-regulator Board Assy Dwg
2		C-5061-1347-51	Pre-regulator Board Schematic
	A3A2	D-5061-1344-1	Inverter Board Assembly Drawing
3		C-5061-1344-51	Inverter Board Schematic
	A3A4	C-5061-1351-1	Jumper Board Assembly Drawing
4		B-5061-1351-51	Jumper Board Schematic
	A3A5	D-5061-1345-2	Control Board Assembly Drawing
5		C-5061-1345-51	Control Board Schematic
	*A3A3	C-5061-1348-1	Battery Charger Board Assy Dwg
6		C-5061-1348-51	Battery Charger Board Schematic
	*A3A4	C-5061-1349-1	Battery Backup Board Assy Dwg
7		C-5061-1349-51	Battery Backup Board Schematic
	A3A6	F-5061-1371-1	Mother Board Assembly Drawing
		C-5061-1371-5	Mother Board Heatsink Assy Dwg
8		C-5061-1371-51	Mother Board Assembly Schematic
	----	02109-90024	Battery/Status Assembly Wiring Diagram
9		B-12944-90004 -51	Battery/Status Assy Schematic
	A3A6A1	C-5061-3403-1	Output Regulator Board Assy Dwg
10		B-5061-3403-51	Output Regulator Board Schematic
* p/o optional PFRS (Power Fail Recovery System)			

2-1. Binary Signal Levels

Most of the logic used in the power supply is implemented with standard or Schottky TTL devices. High logic levels are approximately +2.5 to +4.5 Vdc. Low logic levels are approximately 0.0 to +0.8 Vdc. The actual values measured will vary due to the type of device, the load, and the condition of the device. When using postive logic, a high is "true" and a low is "false".

2-2. Schematic Reading

Logic symbols are drawn to aid in understanding the logical funtions being represented. A circle or bubble at an input or output indicates an active low logic level. A circle or bubble on the clock input of a flip-flop indicates that a negative-going edge of the clock signal is used to clock the flip-flop.

2-3. Signal Names

Signal names are alphanumeric isentifiers selected to aid in the understanding of the signal function. Not all signals are labelled, but all signals running between schematic sheets are labelled. Any signal mnemonic on the schematic may have a "not" bar over it to indicate that the signal is active low (in text, a minus sign suffix to the mnemonic will be used in place of the "not" bar). For example, the ABC- signal is low only when the ABC button is pressed. When the ABC button is not pressed, the ABC- signal is high.

2-4. Cross References

There are many signals that run from sheet to sheet in the schematics. The destination of signals leaving one sheet to other sheets are coded with the sheet number(s) adjacent to the signal name. For example, a signal leaving sheet 1 for sheet 7 would be coded as follows: ABC (7). A signal coming from sheet 7 to sheet 1 would be coded as follows: (7) DEF. If the signal is going to several sheets from sheet 1, it would be coded as follows: XYZ (3,4,5,7). If the signal is coming from several sheets to sheet 1, it would be coded as follows: (7,8) WXY.

THEORY OF OPERATION	SECTION III

3-1. Introduction

The overall power supply can be functionally separated into three individual units:

a. An ac to dc supply that converts the line (mains) voltage into a +325 Vdc bus;

b. A dc to dc supply that converts the +325 Vdc bus into +5V and -2V (CPU), +12V, -12V, and +30V (I/O), and 18Vac; and

c. An ac supply that converts the 18Vac into +5VM, +12.5VM and -12VM.

The overall functional block diagram of the power supply is shown in Figure 3-1. The two configurations for the power supply are shown in Figures 3-2 and 3-3. Figure 3-2 illustrates a power supply with the optional Power Fail Recovery System (PFRS). It should be noted that the CPU and the I/O voltages are developed from the +325 Vdc bus via the Preregulator and Inverter circuits. The 18 Vac bus is also developed from the +325 Vdc bus via the Inverter and Preregulator circuits. This 18 Vac bus is converted into a +18 Vdc by the Battery Charger Board A3A3. The Battery Backup board A3A4 and the Battery Charger board A3A3 develop the memory voltages from either the +18 Vdc or from the external battery (+14 Vdc). If the +18 Vdc is lost, the +14 Vdc battery will maintain the memory voltages. The Battery Charger board A3A3 charges the batery while the ac power is applied.

Figure 3-3 represents a power supply without a power fail recovery system. In this mode the Jumper board A3A4 performs the function of developing the memory voltages directly from the CPU voltages. The +5VM is tied directly to the +5V (CPU). The -12VM is tied directly to the -12V (I/O). The 18 Vac bus is rectified into +18 Vdc and regulated via a series pass regulator to +12.5 VM.

3-2. Primary Input Power Circuits (sheets 1,8)

For the following paragraphs, schematics of the Line (Mains) Power Distribution (sheet 1) and the Mother Board A6 (sheet 8) are required.

The line (mains) power, either 115 Vac or 230 Vac, is applied to the power supply through the Line Filter FL1 to remove line induced noise, etc. and to prevent noise from leaving the power supply and going out on the ac lines (mains). The Circuit Breaker CB1 also acts as the POWER OFF/ON switch. Terminal Block TB1 is used to configure the power supply for operation from either 115 Vac or 230 Vac line power. the configuration of the power supply consists of moving jumper wires on TB1 and making the appropriate connections on CB1. This sets the fans, the bias transformer, and the power supply input for operation with the proper voltage. Since it is desirable to develop the same bus voltage (B+) at 115 Vac and at 230 Vac, a voltage doubler circuit on the Mother board A3A6 is employed for 115 Vac operation. Therefore, the dc input voltage to the Inverter and Preregulator circuits is twice the peak of the ac input waveform.

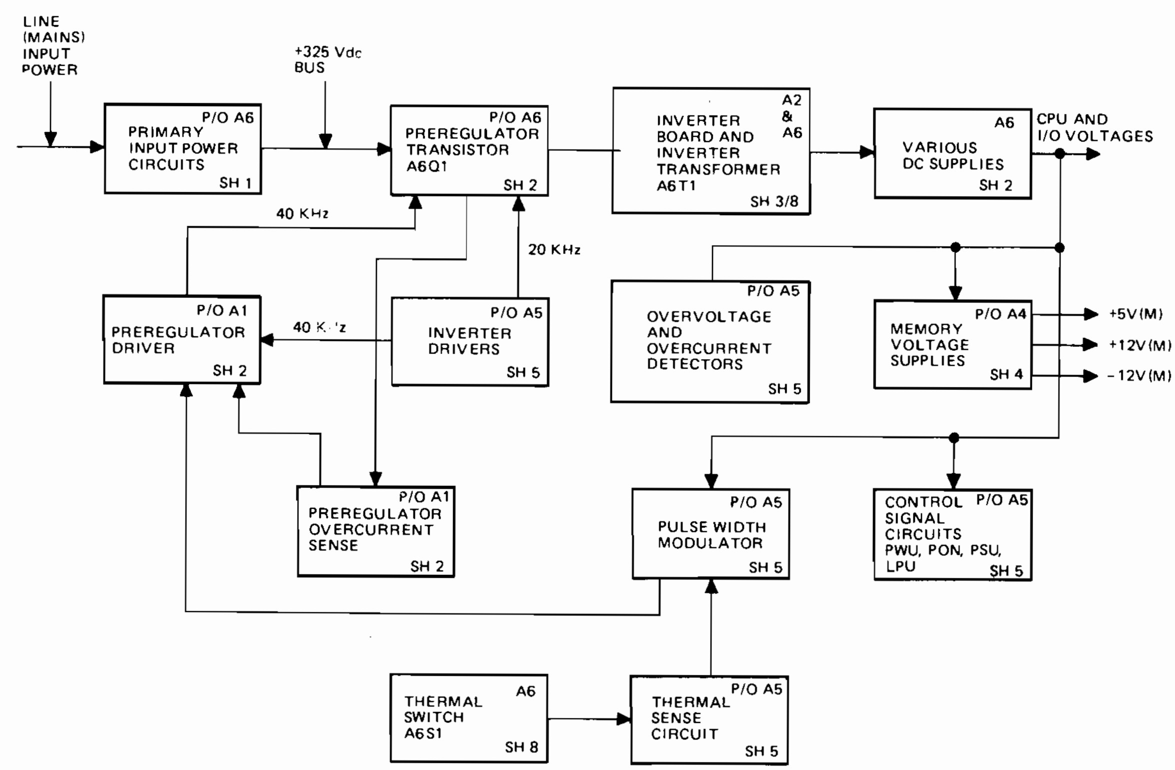


Figure 3-1. Power Supply Overall Block Diagram

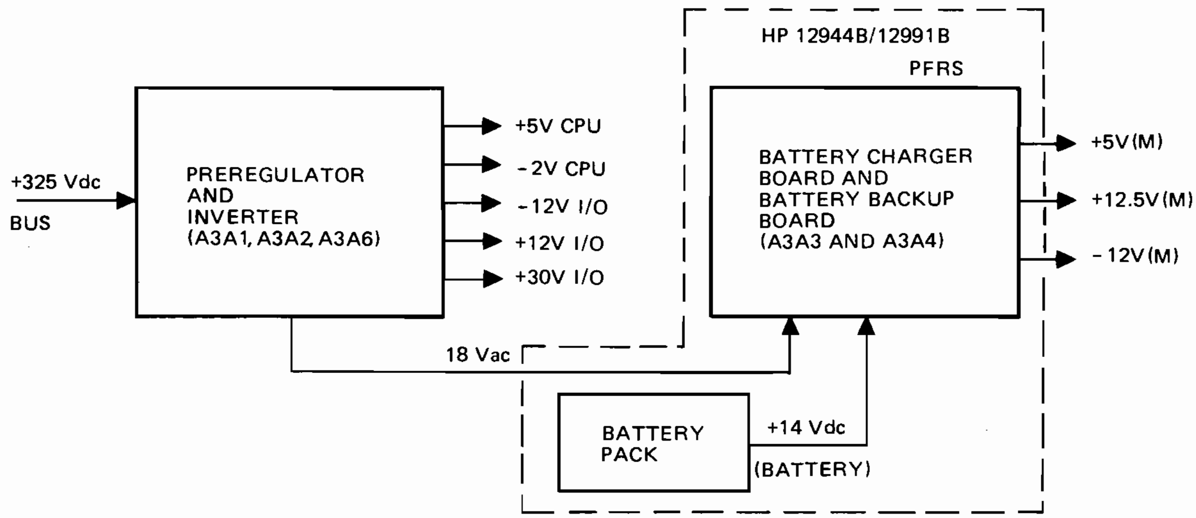


Figure 3-2. Power Supply with Optional PFRS

For example, 115 Vac develops a bus voltage of +325 Vdc as shown in the formula: 115 Vrms X 1.414 X 2 = +325 Vdc.

The 230 Vac operation does not employ a voltage doubler circuit. Therefore, its bus voltage is simply equal to the peak of the 230 Vac input waveform X 1.414.

It should be noted that the ac input waveform MUST BE a sinusoidal waveform for these formulas to be accurate.

To operate the power supply from 115 Vac, the C/T terminal must be connected to the N (neutral) terminal. This forms a voltage doubler circuit comprised of capacitors C12 and C13 and the diode bridge CR15. To change from 115 Vac operation to 230 Vac operation, the C/T terminal must be left unconnected. This allows capacitors C12 and C13 and the diode bridge CR15 to function strictly as a rectifier and filtering circuit.

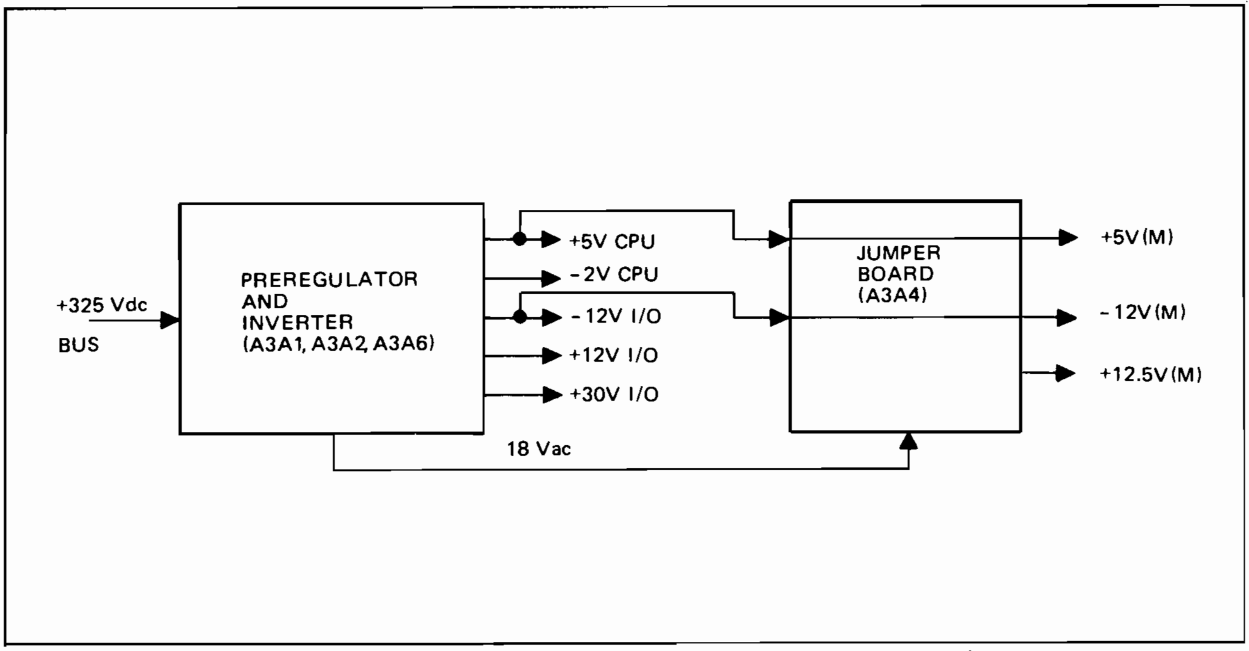


Figure 3-3. Power Supply Without PFRS

On initial power turn on, the input capacitors C12 and C13 are dishcarged and thermistors R5 and R6 are cold. The cold resistance of the thermistors is approximately 2.5 ohms each. The input capacitors charge through this resistance, thus limiting the input surge current. After a few cycles of the input power, the input current heats up the thermistors, allowing their resistance to decrease. Therefore, the capacitors are allowed to charge through a much lower resistance. Since the resistance of the thermistors decreases as the input current increases, the losses across the thermistors at low line voltage decrease to aid regulation.

The cooling time constant required for the thermistors to go from their hot (low resistance) to their cold (high resistance) is equal to the time required to discharge the input capacitors C12 and C13 through R10 and R11. This ensures that if the ac input power is lost the thermistors will cool down at the same rate that the capacitors C12 and C13 are discharging.

3.3 Preregulator A3A1 and Inverter A3A2 Boards (sheets 2,3)

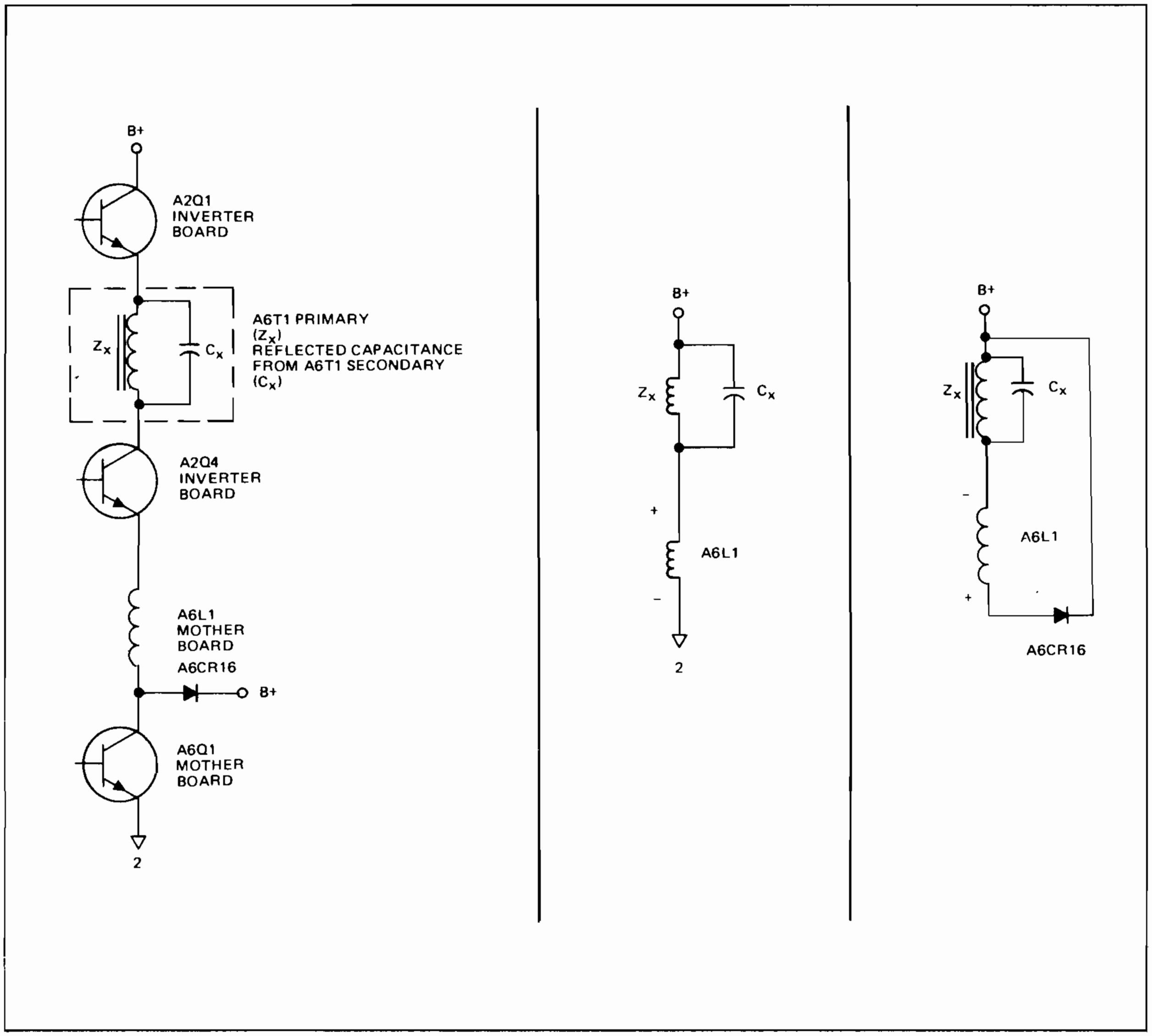
The Preregulator Board A1 (sheet 2), the Inverter Board A2 (sheet 3), and the Mother Board A6 (sheet 8) schematics are required for understanding this section.

The purpose of the Preregulator and the Inverter Boards is to apply a square wave to the primary of transformer A6T1 (sheet 8). Neglecting all circuit losses, the amplitude across the primary of A6T1 should remain constant under all load conditions on the secondary of A6T1. If the primary voltage remains constant, the +5V (CPU) supply from the secondary of A6T1 is also constant. The +5V (CPU) supply is the sensed output. The -2Vdc supply has a closed loop regulation on the output regulator board consisting of op amp U1 and output pass transistor Q3. A three terminal regulator on the output regulator board (Q2) is utilized to regulate the +12V I/O supply. The -12V I/O supply utilizes output amp U1 for feedback to a Darlington pair pass transistor Q1. The 18Vac bus is also derived from the secondary of A6T1.

To control the voltage across the primary of A6T1, the preregulator transistor A6Q1 controls the amount of current going through the the primary of A6T1 (see Figure 3-4). Figure 3-5 is a simplified diagram of Figure 3-4 when transistors A2Q1 and A2Q4 and A6Q1 are conducting. When A6Q1 starts to conduct, the impedance in series with A6Q1 is infinite due to the inductance of A6L1 and the current is zero. At a finite time later, the dc resistance of the primary of A6T1 and the inductor A6L1 reaches a minimum value and are the only impedance in series with A6Q1. Therefore, the current through A6Q1 is maximum at this time. Using these two facts, the current through A6L1 and the primary of A6T1 is a function of the inductance of A6L1 and the primary of A6T1 added together, the value of B+, and the length of time that A6Q1 conducts. Since the inductance of A6L1 and the primary of A6T1 is constant and B+ is held constant, the only variable factor that controls the current through the primary of A6T1 is the length of time that A6Q1 is allowed to conduct. Figure 3-10A represents the base drive to A6Q1. The frequency of this waveform is 40 kHz. The "on time" of A6Q1 is directly proportional to the duty cycle of this waveform.

The power supply monitors the +5V (CPU) output and determines the duty cycle from its value. Also, if the value of B+ is changed, it will effect the on time of A6Q1. If the load on the secondary of A6T1 is increased, the duty cycle will increase. This is due to the decrease in the impedance on the secondary of A6T1 being reflected back to the primary of A6T1. Since the impedance is less on the primary, the current through the primary of A6T1 must increase to maintain a constant voltage across the primary. To do this the on time of A6Q1 must increase. If the load is decreased on the +5V (CPU), the duty cycle will decrease. This is due to the impedance increasing on the secondary of A6T1. Therefore, the reflected impedance at the primary of A6T1 will increase and reduce the current through the primary of A6T1. In order to decrease the current through the primary, the on time for A6Q1 will have to decrease.

Since the preregulator transistor A6Q1 is turned on and off at a 40 kHz rate, the signal at the primary of A6T1 has a 40 kHz ripple. The current waveform through the primary of A6T1 and A6L1 is shown in Figure 3-10D. At times T1 and T3 the current through the primary of A6T1 is going through A6Q1. This may be noted in Figures 3-5 and 3-8. At times T2 and T4 the current is supplied by the collapsing field of A6L1 and the continuing current flow through the commutating diode A6CR16. This action is shown in Figures 3-6 and 3-9. Since A6Q1 and A6L1 work together to maintain a constant current through the primary of A6T1, the ripple is held to a minimum and the current through A6L1 can be considered dc current. The purpose of the Inverter Board A2 is to change the direction of this dc current flow through the primary of A6T1. Figures 3-4 and 3-7 illustrate this action (note the polarity). The dc current through A6L1 becomes the ac current of A6T1.



Figures 3-4, 3-5, and 3-6. Preregulator Circuit (Time T1)

The remainder of this section covers the interaction of the Inverter and the preregulator boards at four time intervals (see Figure 3-10). It also covers the Inverter and the preregulator boards in detail (duty cycle control).

a. Time T1 (see Figure 3-10).

The preregulator transistor A6Q1 is conducting at this time and the inverter transistors A2Q1 and A2Q4 are conducting. Figure 3-4 shows the components involved and Figure 3-5 is a simplified version of Figure 3-4. From Figure 3-5 it is shown that A6Q1 is building up a field around A6L1, with the polarity of the voltage drop as indicated. Zx represents the reflected impedance of the secondary of A6T1 to the primary of A6T1. The preregulator current is determined by the on time of A6Q1 and must be sufficient to develop the required voltage at the secondary of A6T1 for an output of +5V (rectified)

b. Time T2 (see Figure 3-10).

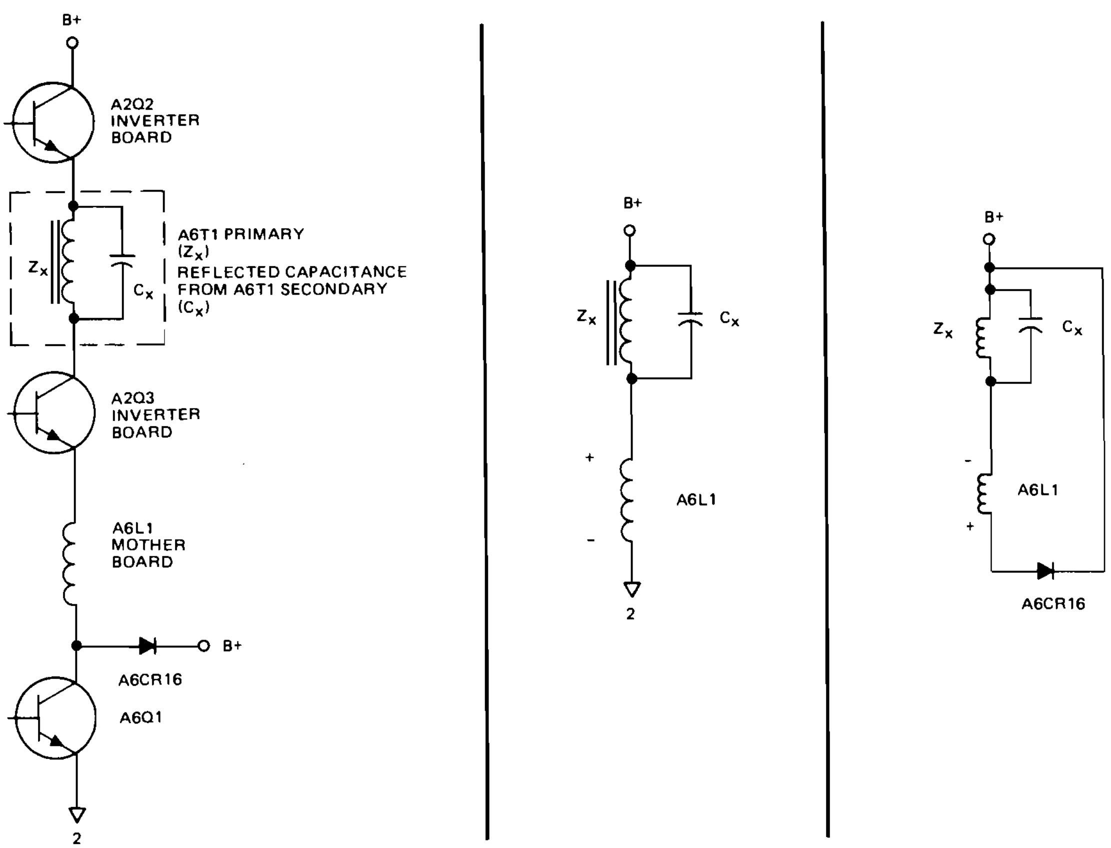
At this time A6Q1 turns off and A2Q1 and A2Q4 are still conducting. The field of A6L1 begins to collapse and the voltage drop across A6L1 is indicated in Figure 3-6. A6L1 tends to maintain the current constant through the primary of A6T1 during this time interval. It should be noted that during this time interval the field of A6L1 is never allowed to collapse fully before T3 occurs. The induced voltage across A6L1 due to the collapsing field is enough to cause the + end of A6L1 to go to B+ plus the forward drop of A6CR16, thus developing the current path from A6L1 through A6CR16 through the primary of A6T1 back to A6L1.

c. Time T3 (see Figure 3-10).

At this time A6Q1 is conducting. The inverter transistors A2Q1 and A2Q4 are turned off, but A2Q2 and A2Q3 are now conducting. Figure 3-7 shows the components involved. Figure 3-8 is a simplified version of Figure 3-7. It should be noted that the voltage drop across the primary of A6T1 is reversed as indicated by the polarity. Therefore, the current through the primary of A6T1 is reversed at this time. A6Q1 builds up the field of A6L1 and develops the desired voltage across Zx. Cx represnts the reflected capacitance from the secondary of A6T1. This capacitance is necessary to prevent ringing or high voltage spikes.

d. Time T4 (see Figure 3-10).

Figure 3-9 is a simplified diagram showing the components involved during T4. During this time period the field of A6L1 begins to collapse as A6Q1 turns off inducing the indicated voltage drop across A6L1. The voltage at the + end of A6L1 reaches a value of B+ plus the forward voltage drop of A6CR16. This forward biases A6CR16 and allows the current through Zx to remain constant. The current path is from the + end of A6L1 through A6CR16 and Zx, then back to the - end of A6L1. Inverter transistors A2Q2 and A2Q4 are still conducting during this period. It should be noted that if the commutating diode A6CR16 were not in the circuit, the voltage at the + end of A6L1 would go much higher than B+ plus the forward drop of A6CR16. A6CR16 is also fundamental in providing a current path for A6L1 as it tries to maintain current in the loop of A6L1, A6CR16, and Zx when A6Q1 is off.



Figures 3-7, 3-8, and 3-9. Preregulator Circuit (Time T3)

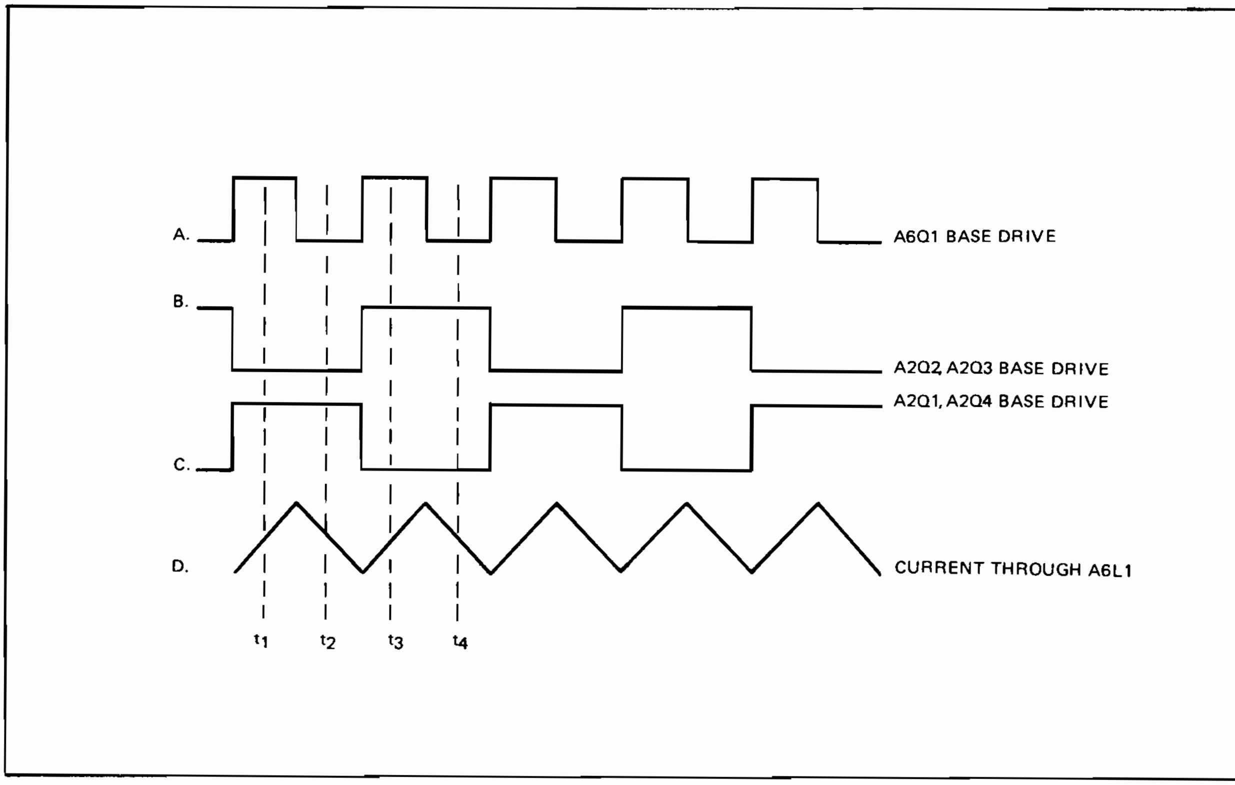


Figure 3-10. Timing Waveforms

3-4. Inverter Stage

The inverter transistors are arranged in an "H" configuration (see Figure 3-11) and are driven at a 20 kHz rate. As shown in Figure 3-11 the inverter transistors are driven by the 20 kHz output from the control board A5 (sheet 5) and are synchronized with the preregulator board A1 (sheet 2). The inverter transistors are driven by the inverter driver transformer A2T1 at a constant 50% duty cycle. Due to the fact that the inverter transistors are in series with A6L1, there is no need for "dead time". "Dead time" refers to the amount of time that both pairs of inverter transistors are not conducting. Since it takes longer to turn off the inverter transistor pair than to turn them on, due to storage time of the transistors, an RC time delay network is usually incorporated to delay the turn on time. This delay is used to make sure that both pairs of transistors are not conducting at the same time. This results in "dead time" because the RC turn on delay is longer than the turn off time. Since A6L1 is in series with the inverter transistors, it acts to limit current during the time that both pairs of transistors are conducting.

The inverter transformer A6T1 reflects the inductance of A6L1 from its primary to its secondary to produce the required inductance for filtering in the secondary. A6T1 also reflects the required capacitance from its secondary to its primary to produce filtering in the primary. Resistor A6R14 and capacitor A6C17 form a snubber network to shape the load so that the primary of A6T1 looks resistive.

The remainder of this section discusses the inverter drive at the component level. The schematic for the control board A5 (sheet 5) will be needed along with previously listed schematics.

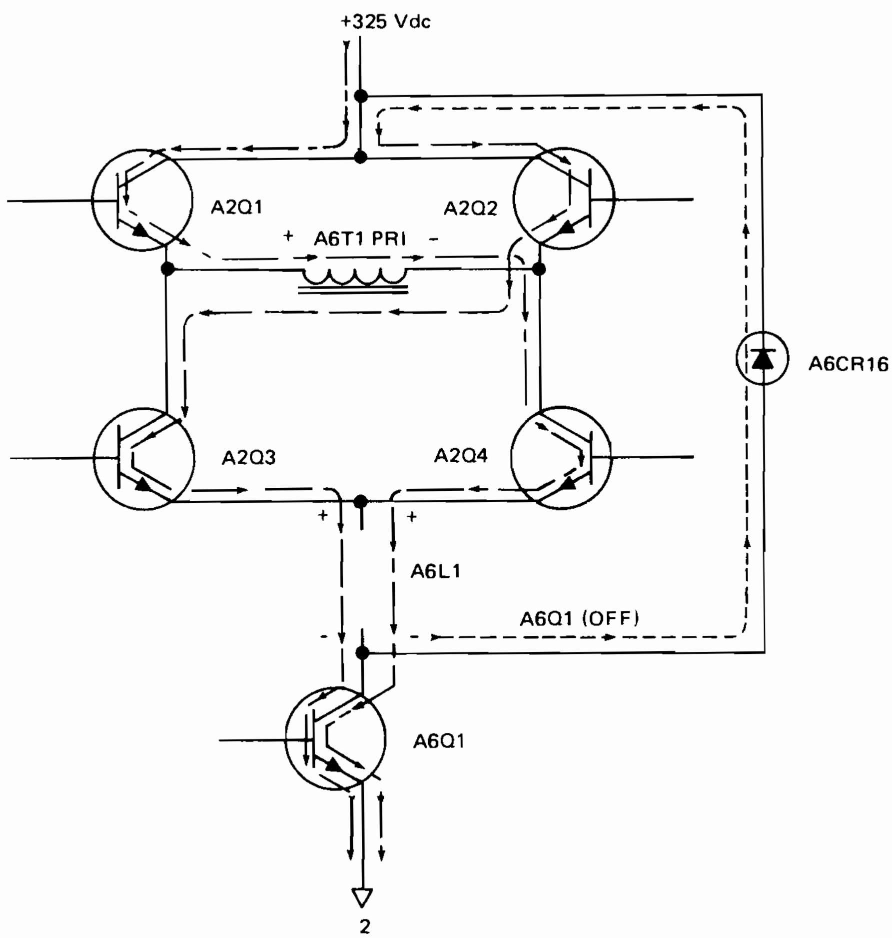


Figure 3-11. H Configuration of the Inverter Transistors

3-5. Control Board A3A5 (Sheet 5)

The comparator (U1A) and associated components form a 40 kHz oscillator. The square wave output of U1A-2 is integrated by R3 and C2. This integrated waveform (a triangle waveform) is applied U1B-6. A dc level is applied to U1B-7. The interaction of this dc level and the integrated waveform produces a square wave at the output pin 1 of U1B. This square wave output is buffered by Q4 and drives the clock input of the negative-edged triggered J-K flip-flop U2, a 74S112. The configuration of U2A and U2B is shown in figure 3-12. Since U2B is held in a constant reset state, the Q output (U2-7) is high at all times. The high at U2-7 holds the J and K inputs of U2A pins 3 and 4 high. Thus the outputs of U2A pins 5 and 6 will toggle (change state) for each clock input. This divides the clock input frequency by 2 (40 kHz/2 = 20 kHz). The two outputs of U2A are 180 degrees out of phase and have a 50% duty cycle. The output at U2-5 drives Q9 which pulls the primary of A2T1A (pin 6) to ground. A2T1A (pin 4) returns to the control board through J2-S and is tied to the +8V through R48. The output at U2-6 drives Q8 which pulls the primary of A2T1B (pin 3) to ground. A2T1B pin 1 returns to the control board through J2-P and is tied to the +8V through R49. During one half of the 20 kHz cycle Q9 is conducting and Q8 is cut off. When Q9 is conducting, it drives off the inverter transistors A2Q1 and A2Q4. When Q9 is conducting, Q8 and the inductive flyback of the primary of A2T1B turn on A2Q2 and A2Q3. On the other half cycle Q9 turns off allowing the inductive flyback of the primary of A2T1A to turn on A2Q1 and A2Q4. At this time Q8 is driving off A2Q2 and A2Q3. Since the inductive flyback turns the inverter transistors on, and Q8 and Q9 turn off the inverter transistors. Therefore, the turn on energy is less than the turn off energy. At this frequency of operation the flyback action has just enough energy to keep an inverter pair turned on for a half cycle. This removes the need for anti-saturation diodes because the transistors are falling out of saturation at the end of their on time. They are about to fall out of saturation just in time to be driven off.

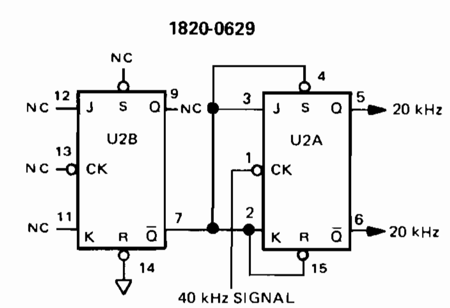


Figure 3-12. Divider Circuit

3-6. Inverter Board A3A2 (sheet 3)

Current sharing resistors A2R2, A2R3, A2R5, and A2R8 prevent one transistor in an inverter pair from passing all the current. When one transistor has a lower Vbe than the other transistor the impedance of the one ohm resistor is enough added impedance to ensure that one secondary of A2T1 has enough reflected impedance into the other secondary to develop the required voltage to turn on both inverter transistors. If the resistors were not used, the base-emitter junction of the transistor with the lower Vbe, would be the only impedance reflected back to the other secondary. The result would be one transistor stealing the base drive from the other transistor of the pair.

3-7. Preregulator Drive Circuitry

The purpose of the preregulator drive circuitry is to monitor the +5V (CPU) and determine a corresponding duty cycle for the preregulator transistor A6Q1. The preregulator drive circuitry consists of an error amplifier (A5U3), a pulse width modulator (A5U1C), and circuitry to develop enough drive current to turn on and off A6Q1. The following schematics are required for the remainder of this discussion: control board A5 (sheet 5), preregulator board A1 (sheet 2), and mother board A6 (sheet 8).

The error amplifier is A5U3 on the control board. It is a 723 type voltage regulator and is shown in Figure 3-13. Pin 6 is the output of an internal voltage reference amplifier and has a constant 7V output. This voltage is divided down to approximately +5 volts and is applied to pin 5, the non-inverting input of an internal operational amplifier. Pin 4 is the inverting input to the same amplifier and has the +5V (CPU) applied to it. The output of this internal operational amplifier drives an emitter follower stage. The collector of the emitter follower stage is tied to pin 11 and the emitter is tied to pin 10. If the +5V (CPU) output increases, the output of the internal operational amplifier decreases. This decreases the voltage on the emitter (pin 10) of the internal emitter follower stage. This also decreases the voltage at A5U1-9, the pulse width modulator. In conclusion the error amplifier A5U3 acts as an inverting amplifier producing an output that is directly proportional to the differential between the +5V CPU and the internal voltage reference at A5U3-6.

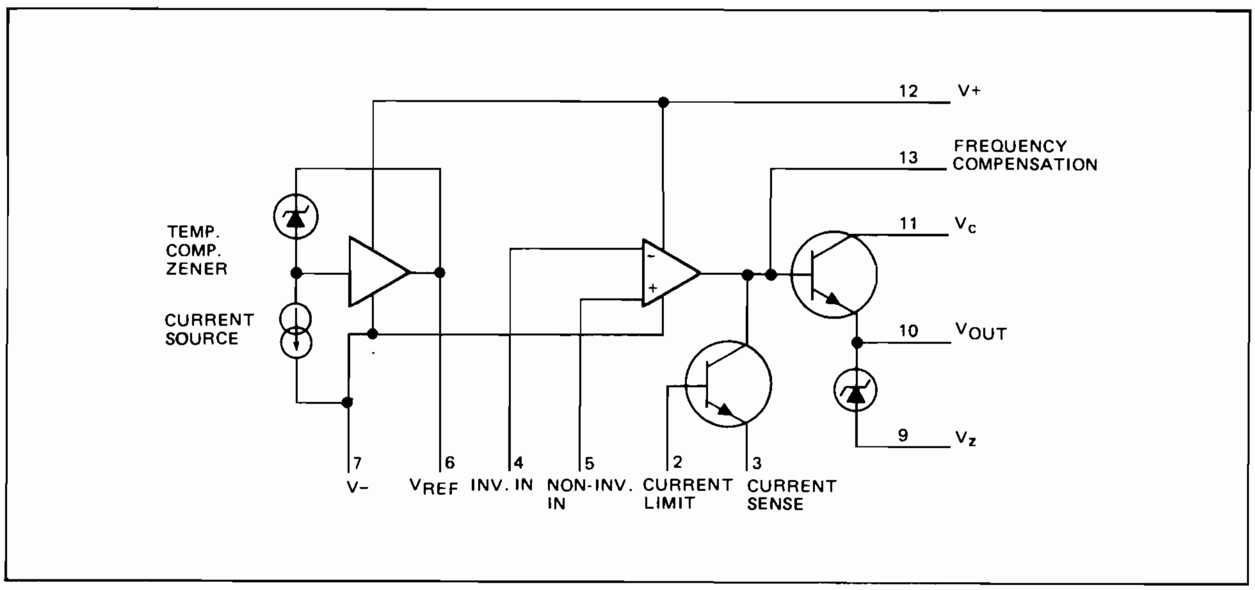
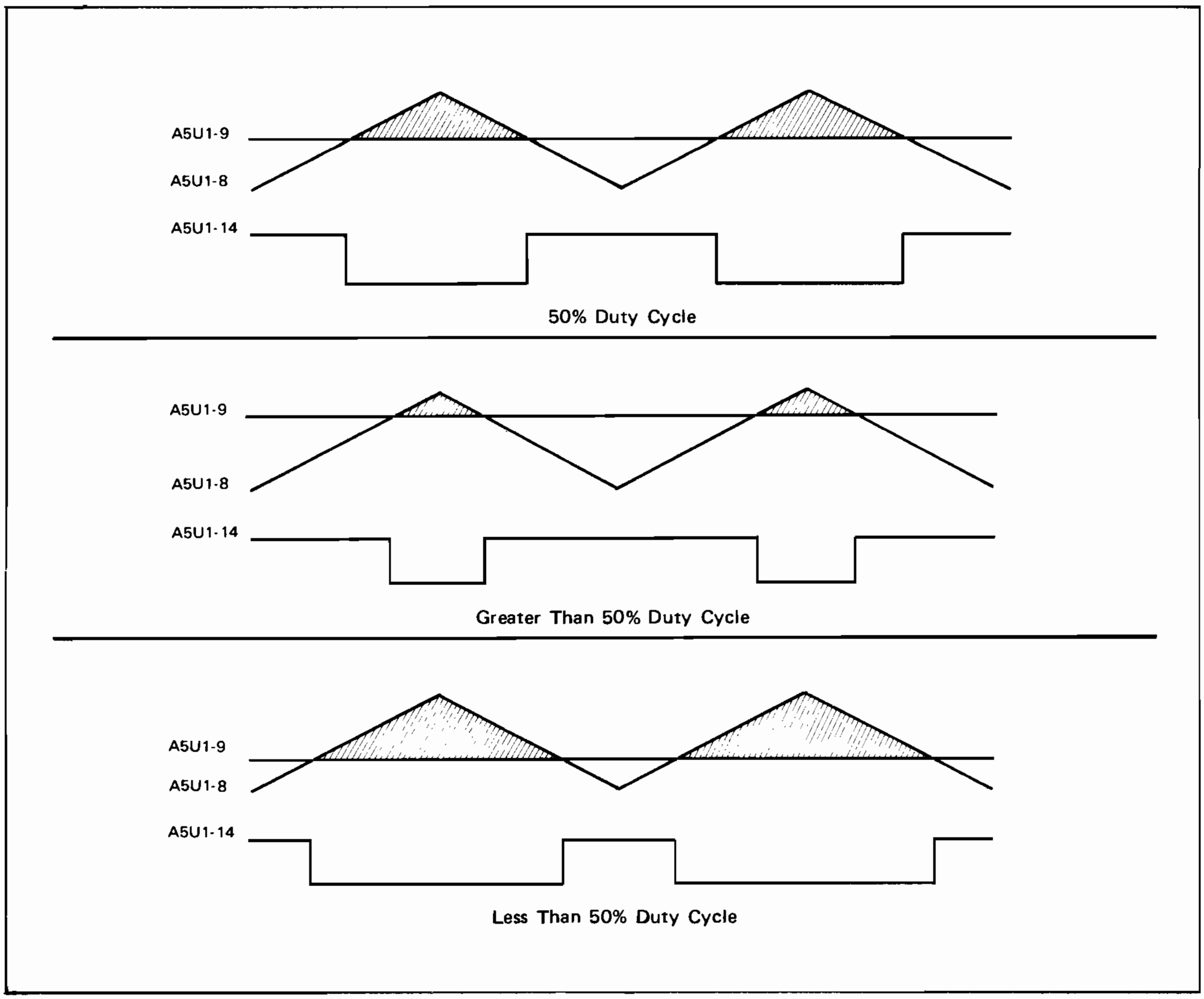


Figure 3-13. Typical 723 Voltage Regulator Functional Block Diagram

The pulse width modulator (A5U1C) takes the output of the error amplifier A5U3 and compares it with an integrated waveform (triangle waveform) from the 40 kHz clock (U1-4). The dc level of the error amplifier intersects with the integrated waveform to produce an appropriate duty cycle (typically 50%) square wave at A5U1-14 under normal operating conditions. Varying the dc level changes the level of intersection with the integrated waveform, thus changing the duty cycle. The triangle waveform is applied to A5U1-8. The dc output of the error amplifier is applied to A5U1-9. A5U1-14 produces the corresponding duty cycle output. Figures 3-14 through 3-16 illustrate this action.



Figures 3-14 through 3-16. Preregulator Drive Circuit Waveforms

Combining the operation of the pulse width modulator and the error amplifier produces the following conclusion: The interaction between the +5V (CPU) and the duty cycle is inversely proportional, i.e. if the +5V (CPU) output level decreases, the duty cycle goes up. It should be noted that the duty cycle can be determined either at A5U1-14 or at the base of A6Q1 because both of these signals are in phase. As a proof a detailed description of the A6Q1 base drive will now be discussed.

When A5U1-14 is high, A5Q5 turns on pulling A1U2-3 to ground (GND). A1U2-2 returns via A1R9 to +5V (L) on the mother board. This turns on U2, an OPTO-isolator, causing A1U2-6 to the pulled low to REF GND (A1U2-5). Note the change in references. REF GND is the reference for the preregulator drive and GND is the reference for the control board. The action of the OPTO-isolator allows this shift in references. The configuration for U1 and U2 are shown in Figure 3-17.

WARNING

DO NOT CONNECT REF COMMON 2 TO GND 1 AS THERE IS APPROXIMATELY 150 VOLTS DIFFERENCE.

CAUTION

Any measurements using REF COMMON must be made using test instruments with a floating input.

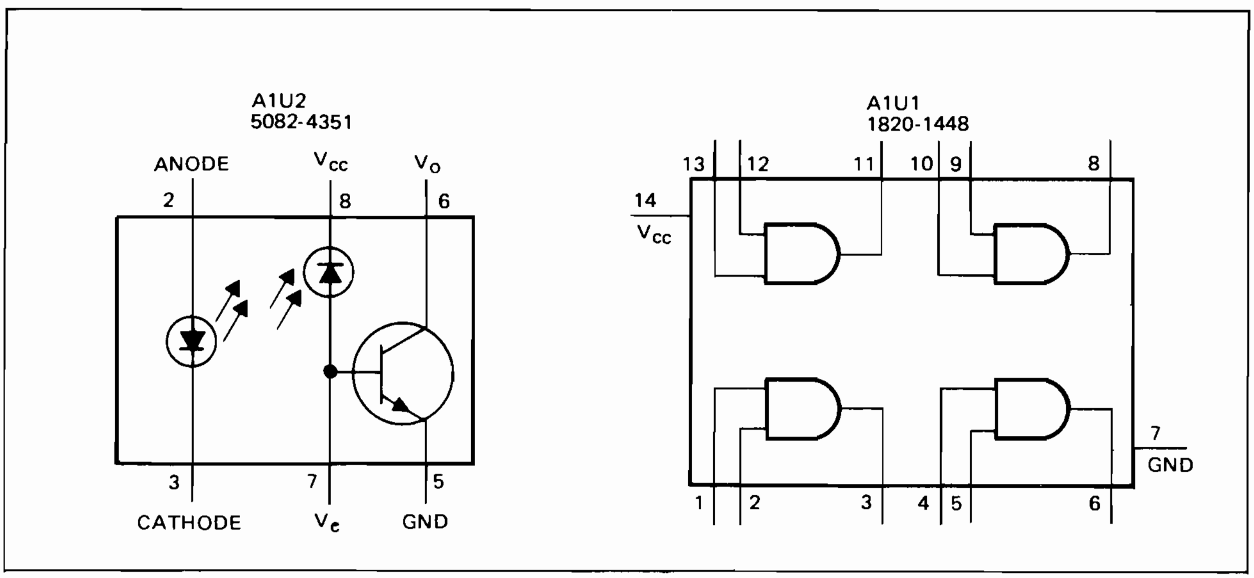


Figure 3-17. A1U1 and A1U2 Configurations

Table 3-1 shows the conditions that exist for the two states of A5U1-14.

Table 3-1. Preregulator Drive Conditions

A5U1-14	HIGH	LOW
A1U2-6	LOW	HIGH
A1U1-1	LOW	HIGH
A1U1-3	LOW	HIGH
A1Q7	OFF	ON
A1Q8	OFF	ON
A1Q9	ON	OFF
A1U1-10	HIGH	LOW
A1U1-8	HIGH	LOW
A1Q5	ON	OFF
A1Q6	ON	OFF
A1Q3	OFF	ON
A6Q1	ON	OFF

3-8. Jumper Board A3A4 (sheet 4)

The jumper board A3A4 develops the memory voltage directly from the CPU voltages. J4-F,6 the +5V M is tied directly to the +5V CPU at J4-9,10. The -12V CPU at J4-12 ties directly to the -12VM. The 18 Vac bus from the secondary of A6T1, is applied to J4-L,N. Diodes A4CR4 and A4CR5 and capacitor A6C9 (mounted on the mother board A3A6) rectify and filter the 18 Vac into +18 Vdc. A4U2, a 723 type voltage regulator, and A4Q1 form a series pass regulator for the +12.5VM. A4U2 provides voltage regulation and current protection. Overvoltage protection is provided by the circuit composed of A6CR3, A6CR4, A6R4, A6C7, and A6C8 mounted on the mother board A3A6. A4R12 adjusts the +12.5VM output at J4-P,13.

3-9. Power Fail Recovery System (PFRS)

The optional Power Fail Recovery System (HP 12944B for the HP 2108B/2109B or the HP 12991B for the HP2112B/2113B/2111F/2117F) consists of one battery charger board (A3A3), one battery backup board (A3A4), and the appropriate battery/status assembly. A battery load simulator plug must be connected to the BAT.INPUT connector A3J2 on the rear of the power supply, if the battery cable is not connected. The battery charger board (A3A3) and the battery backup board (A3A4) convert the 18 Vac bus into the various memory voltages. This section will discuss the operation of the battery backup and charger boards under two conditions:

a. Line power down with a good battery.
b. Line power up.

3-10. Battery Charger Board A3A3 (sheet 6)

Figure 3-18 is a simplified diagram of the switching network used to switch from +18 Vdc to the +14 Vdc battery. When line power is up, the inverter and preregulator stages supply +18 Vdc to point X. This voltage is regulated via a series pass regulator on the battery charger board and forward biases A3CR5 to charge the battery. A4CR10 is forward biased and goes to point Y which feeds the battery backup board which in turn develops the memory voltages. At this point A3CR4 is reversed biased. When the line power goes down, the inverter and preregulator stages cut off and the +18 Vdc goes to zero volts. The battery then forward biases A3CR4 as point Y is approximately +13.7 Vdc. This voltage powers the battery backup board A3A4 until the battery discharges down to +12.5 Vdc (80% discharged). Diodes A3CR5 and A4CR10 are reverse biased when the battery is supplying the memory voltages.

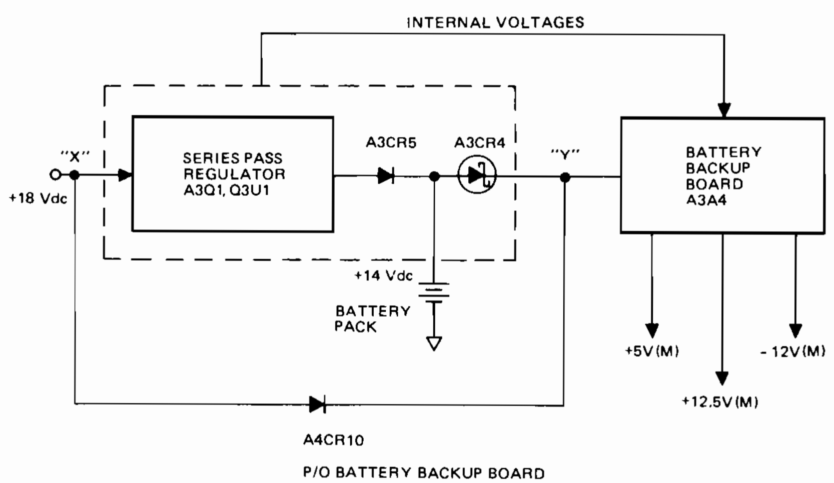


Figure 3-18. Power Fail Recovery System (PFRS) Simplified Block Diagram

3-11. Battery Backup Board A3A4 (Sheet 7)

The battery backup board A3A4 operation is described in the following paragraphs. The input to the battery backup board is a dc voltage at J4-D,4. Transistor A4Q5, transformer A4T1, and capacitor A6C10 form the major components for the switching supply (buck switching regulator) that produces the +5V and the -12VM outputs.

A4U2, a 723 type voltage regulator, operates as an error amplifier. A4U3A and its associated components form a 20 kHz oscillator. The output of A4U3A (pin 2) is applied to the inverting input of A4U3B (pin 6) through A4R29 and the output of A4U2 (pin 10) is applied to the non-inverting input (pin 7) of A4U3B. A4U3B forms a pulse width modulator circuit so that the output pulses at A4U3-1 vary in width inversely to the level of the +5VM output. As the

+5VM decreases, the pulse width increases in width, when the +5VM increases, the pulse width decreases in width. The reason for this is apparent from the following circuit description.

A4U3-1 drives A4Q8 which in turn drives A4Q7 and A4Q5. As A4U3-1 goes high, A4Q5, and A4Q7 are turned on by A4Q8. When A4Q7 turns on, it effectively places the voltage of the primary of A4T1 across A4Q5's base-emitter junction, thus supplying more drive current than A4Q8 could supply by itself. This drive current supplied by A4Q7 is limited by A4R25 and A4Q6. If the base drive for A4Q5 is too high, A4R25 developes enough voltage to turn on A4Q6, which diverts some of the base current from A4Q7, thus decreasing the base current to A4Q5. The action of A4Q6 and A4R25 provides a constant drive to A4Q5 regardless of the voltage at J4-D,4.

The -12VM output is developed by the secondary winding of A4T1. The +12.5VM output is developed by a series pass regulator consisting of A4Q2, A4Q3, and A4U1A and B. A4Q3 is the series pass transistor. A4U1A is an error amplifier with A4Q2 providing drive for A4Q3. A4U1-3 is an adjustable reference that determines the output voltage of the series pass regulator. If the voltage output A4U1-2 decreases, this causes A4U1-1 to increase, which increases the conduction of A4Q2. This increases the base drive to A4Q3, which in turn increases the output voltage back to the correct level.

3-12. Battery/Status Assembly (sheet 9)

The Battery/Status Assembly operation is described in the following paragraphs. The description will be given only for the HP 12991B because the only difference between the HP 12991B and the HP 12944B is that the HP 12944B contains only one battery pack.

The two parallel battery packs, BT1 and BT2, provide +14Vdc to the BAT.INPUT connector A3J2 through the battery switch S1, and through the 6A fuse, F1. Diode CR1 provides protection against reverse voltage being applied to the power supply.

When the battery switch S1 is in the OFF position, the +14Vdc supplied by the external or internal batteries is removed from the power supply. When the battery switch S1 is in the EXT (external) position, the internal batteries are disconnected and an external dc supply is connected to the terminal block TB1. Diode CR1 and fuse F1 still provide their protection. The battery status board A1 (5061-1352) and R1, a 3 ohm 50 watt resistor form a circuit to test the condition of the batteries, external or internal.

CAUTION

> Do not push the battery test switch A1S1 while the computer is in the RUN mode, if switch S1 is not in the INT (internal) position, memory contents will be altered and system failures will occur.

"B" Power Supply

When the battery test switch A1S1 is pressed, the LED A1CR3 will light and remain lit as long as A1S1 is held in the TEST position, if the batteries are fully charged. If the batteries have a low charge, the LED A1CR3 may or may not light and extinguish even though the battery test switch is still in the TEST position. Refer to the Troubleshooting Flowchart in Appendix A for further information on this problem.

PROTECTION CIRCUITS	SECTION IV

The overcurrent, overvoltage, and overtemperature protection circuits are located on several different board assemblies in the power supply. The description of the circuits will be broken into four parts:

a. The CPU and I/O overcurrent circuits.
b. The memory overcurrent circuits.
c. The overvoltage circuits.
d. The overtemperature circuits.

The schematics for the mother board (sheet 8), the preregulator board (sheet 2), the control board (sheet 5), the battery backup board (sheet 7), and the battery/status assembly (sheet 9) are needed for this section.

4-1. CPU and I/O Overcurrent Circuits

The overcurrent sense resistors for the -2V (CPU), -12V (I/O), and +12V (I/O) are located on the mother board A3A6.

When the +12V (I/O) supply draws excessive current, A6R7 develops a voltage drop greater than 0.7V causing A5Q15 to conduct. When A5Q15 conducts, there is approximately +12V on its collector. This puts a positive level on A5U4-11 and causes the output A5U4-13 to swing positive. A5R39 provides positive feedback to latch A5U4's output high. This action turns on A5Q14 which pulls A5U1-9, the non-inverting input, low causing the duty cycle to be reduced. This action removes all the CPU and I/O voltages.

When the -12V (I/O) supply draws excessive current, the voltage drop across A6R2 exceeds 0.7V causing A5Q12 to conduct. This causes A5Q2 to turn on presenting a positive level to A5U4-11. The same chain of events that occurred for the +12V (CPU) overcurrent will follow for the -12V (I/O) when it draws excessive current.

When the -2V (I/O) supply draws excessive current the voltage drop across A6R3 exceeds 0.7V, this will turn on A5Q13. This action turns on A5Q2. The collector of A5Q2 goes high presenting a positive level on A5U4-11. The remaining chain of events are the same as those for +12V (I/O) and -12V (I/O).

It should be noted here that there is not any current sense resistor in the secondary of A6T1 to sense an overcurrent condition in the +5V (CPU) supply. In order to decrease the voltage loss across a sense resistor for the +5V (CPU) supply, this resistor is placed in the primary circuit of the inverter transformer A6T1. Therefore, an overcurrent condition in the secondary on the

+5V (CPU) is reflected back to the primary, causing an overcurrent shutdown to occur. This type of overcurrent condition in referred to as a preregulator overcurrent, even though it is the +5V (CPU) causing the overcurrent condition. It is important to note that anything drawing too much current through A6Q1 will cause a preregulator overcurrent condition to occur. Examples of this are shorted inverter transistors or any short in the primary or the secondary of A6T1 that can draw enough current through A6Q1 to be considered an overcurrent condition.

A1L2 and A1C3 filter the 20 kHz voltage across A6R13 into a negative dc voltage with respect to REF GND 2. When the voltage across A1C3 reaches a level of -1.4 Vdc, an overcurrent condition exists in the preregulator circuit. The voltage across A1C3 forward biases A1CR1 and turns on A1Q1. A1Q1 turns on A1Q2 causing A1Q2's collector to be approximately -5V. A1CR3 and A1CR4 are three junction stabsistors, each with a voltage drop of about 2.1V. The -5V on the collector of A1Q2 forward biases A1CR2, A1CR3, and A1CR4. A1CR2 and A1R5 latch A1Q1 and A1Q2 on. A1CR3 and A1CR4 pull A1U2-7 low causing A1U2's internal transistor to turn off and allowing A1U2-6 to go high. Table 3-1 in Section 3 Preregulator Drive, shows that if the opto isolator (A1U2) is off, a condition similar to the internal transistor being off, the preregulator transistor A6Q1 is also off. This action removes all the CPU and I/O voltages.

Under all overcurrent conditions for the -2V (CPU), +5V (CPU), -12V (I/O), and +12V (I/O) the memory voltages remain unchanged if a power fail recovery system is being used. If a power fail recovery system is not used, the memory voltages will go down on any of the described overcurrent conditions.

4.2 Memory Overcurrent Circuits

The +5VM supply does not have an overcurrent shutdown circuit, but it incorporates a current limit circuit. Some of the internal components of A4U2 are shown in the dashed lines of figure 4-1. As the current through A4R20 reaches a value high enough to turn on Qx, which decreases the base drive to Qy, which in turn decreases the voltage drop across A4R23. The decrease in the voltage across A4R23 decreases the duty cycle output of the pulse width modulator A4U3B, thus decreasing the output voltage +5VM. If the load is too high, the voltage across A4R20 keeps Qx turned on, limiting the output current until the overcurrent condition is removed.

The +12.5VM supply incorporates an overcurrent shutdown circuit. A4U1B monitors the voltage across A4R5. When the current through A4R5 is large enough to be considered an overcurrent condition , the output A4U1-7 turns on A4CR12. Since A4CR12 is an SCR, it remains conducting until the bias voltages are removed from the board. A4CR12 turns off A4Q2, which turns off A4Q3. This action removes the +12.5VM.

If the +5VM current limits or if the +12.5VM latches, the CPU and I/O voltages remain at their respective levels. The +30V (I/O) and -12VM do not have any overcurrent protection.

4-3. Overvoltage Protection Circuits

Since the action of all the overvoltage protection circuits is the same, only the +5V (CPU) overvoltage protection circuit will be explained here.

When the output level of the +5V (CPU) reaches the value to cause A6CR9, a 5.62 volt zener, to conduct plus 0.7V to turn on A6CR18, the +5V (CPU) output is tied to ground by the SCR, A6CR18. This action produces an overcurrent condition and shuts down the supply just as if an overcurrent condition had occurred.

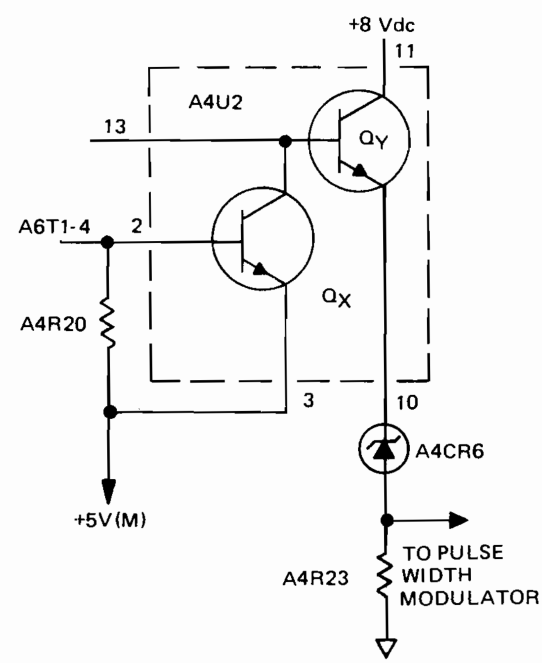


Figure 4-1. Partial Schematic of the Voltage Regulator A4U2

All voltages that have overvoltage protection convert an overvoltage condition into an overcurrent condition by shorting the output voltage to ground.

The +30V (I/O), -2V (CPU), and -12VM supplies do not have overvoltage protection circuits.

4-4. Overtemperature Protection Circuits

The overtemperature protection circuit consists of the Thermal Switch A6S1 on the Mother Board. The thermal switch will open at 212 degrees F to shut down operation of the power supply. After cooling down to 162 degrees F, the switch will close and the power supply will continue operation.

When the thermal switch A6S1 opens due to an overtemperature condition, the inverting input A5U1D-10 is pulled high through R50. The noninverting input has a dc voltage of approximately +2.14 volts. Capacitor C16 acts as a noise filter, and when A5U1D-10 goes above +2.14V, the output A5U1D-13 goes low. This action applies a low level to A5U3-5 (noninverting input) causing A5U3-10 (output) to go to zero. The comparator's output A5U1-14 is forced to zero, reducing the pulse width and the duty cycle to zero, thus shutting down the power supply. When the temperature returns to normal, the thermal switch A6S1 closes and A5U1D-10 is grounded. The low level is removed from A5U3-5 when A5U1D-13 goes high as a result of A5U1D-10 being grounded, and the power supply returns to normal operation.

POWER FAILURE/AUTO RESTART CIRCUITS	SECTION V

The following definitions of signals are fundamental to the understanding of this section.

PWU (Power Up)	:	This signal indicates that the ac line (mains) input voltage is at a level that will provide enough input energy to the power supply for it to supply all of the outputs at their maximum ratings. This signal "communicates with the CPU.
PON (Power On)	:	This signal indicates that the +5V CPU and +5VM dc output voltages are operating. This signal "communicates" with the CPU.
LPU (Line Power Up)	:	This is an OR tied signal that indicates the same things as the PWU signal. This is the basic signal for communicating from power supply to power supply, whereas the PWU signal communicates to the CPU.
PSU (Power Supply Up)	:	This is an OR tied signal that indicates the same thing as the PON signal. This signal communicates from power supply to power supply.
MLOST- (Memory Lost)	:	This signal indicates that the memory voltages are lost and not capable of sustaining the memory, therefore, memory is lost. This signal communicates with the CPU.
MLO- (Memory Lost OR)	:	This is an OR tied signal that indicates the same thing as the MLOST- signal. This signal communicates from power supply to power supply.

5-1. Power Up Sequence

The signals and timing involved during a power up sequence are shown in Figure 5-1. In a power up sequence the timing between PWU and PON is unimportant. PON should go high as soon as possible after all of the dc voltages are valid. When PON goes high, the CPU checks the status of the MLOST- signal. If MLOST- is high this means that the memory was not lost during a power down sequence, therefore, the CPU will not perform a clear memory routine. If MLOST- is low, the CPU will perform a clear memory routine. It is very important that MLOST- stay low for at least 50 us after PON goes high on a power up sequence (where memory was lost) so that the CPU has time to check the status of the MLOST- signal. If MLOST- went high as soon as PON went high, a clear memory routine could not be initiated. The components that produce the 50 us delay for the MLOST- signal are A3C7 and A3R23 on the battery charger board. On a power up sequence with low battery voltage (below +12.5V), initially the +16.45V bus is low (below +12.5V). When the ac line (mains) power is applied the +16.45V bus goes high. The inverting input of A3U2A (pin 4) is at a lower voltage level than the noninverting input of A3U2A (pin 5). Therefore, the output of A3U2A (pin 2) is high. As A3C2 charges through A3R5 raising the voltage level at A3U2-4 to a value where A3U2-2 goes low. This action turns on A3Q5, A3Q7, and A3Q6. A3Q6 is a three terminal voltage regulator that supplies the internal bias voltages to the Battery Backup Board. Shortly after the bias voltages are applied to the Battery Backup Board, the +5VM is applied to J3-F and becomes valid. A3C7 and A3R23 provide a delay at A3U2-7. Therefore, as A3U2-7 goes high MLO- goes high, turning on A3Q10 and causing MLOST- to go high.

If a valid battery voltage had been present at the +16.45V bus, A3U2-2 would have remained low and the MLOST- and MLO- signals would have remained high. The circuitry for PON and PWU is found on the control board A3A5.

A5U4B monitors the voltage of the bias transformer T2 point "Y". A5R2 is adjusted so that A5U4-1 goes high when the ac line (mains) input voltage reaches 88 Vac. It may be noted that the voltage at point "Y" depends on the value of the ac line (mains) input voltage. When the line (mains) reaches 88 Vac, A5U4-1 goes high and turns on A5Q7. This action pulls LPU and PWU high. When PWU goes high, A5U4-14 goes high, and as soon as the +5V (CPU) tied to A5R19 at point "X" and the +5VM tied to A5R42 at J5-7 go high, then A5U4-2 goes high asserting PSU. This turns on A5Q17, A5Q18, and A5Q19, thus pulling PON high.

5-2. Power Down Sequence

The signals and timing involved for a power down sequence are shown in Figure 5-1. As can be seen from the figure, MLOST- is a "don't care" condition on a power down sequence. When the ac line (mains) input voltage is less than 88 Vac, that is, not high enough to maintain the power supply operation, A5U4-1 goes low. This pulls LPU and PWU low. The low PWU signal initializes a power fail routine and the CPU interrupts its operation to perform this routine. At this time it is important to notice that PWU is low and PON is high. This means that the ac line (mains) input is invalid, but that the dc voltages are still valid. As PWU goes low, A5U4-14 goes low. This pulls A5U4-5 low via a time delay developed by A5C12 and A5R22. This time delay is approximately 500 us and delays A5U4-2 from going low, causing PON and PSU to go low. The time delay of 500 us from PWU going low until PON goes low is long enough for the CPU to perform a power fail routine. The power fail routine is halted when PON goes low because about 50 us after PON goes low, the dc voltages are considered to be invalid. The reason the dc voltages can stay up as long as they do is because of the energy stored in the input capacitors, A6C12 and A6C13.

5-3. Interconnections of the Power Supplies

When several power supplies are connected together, the LPU, PSU, and MLO- are all OR tied from power supply to power supply. Therefore, if any one of the signals goes low, it pulls the same signal low on all the power supplies (i.e., when LPU goes low on one power supply, it pulls LPU low on all the power supplies). When any of these signals go low, they in turn cause the signals in the supply that communicates with the CPU (PWU, PON, and MLOST-) to go low.

An example would be two supplies tied together and one supply lost ac line (mains) input power. If the supply that lost the ac line (mains) power was in an extender (memory or I/O), it would pull PWU low on the other supply that communicates with the CPU via LPU. This action would cause a power fail routine to be initiated.

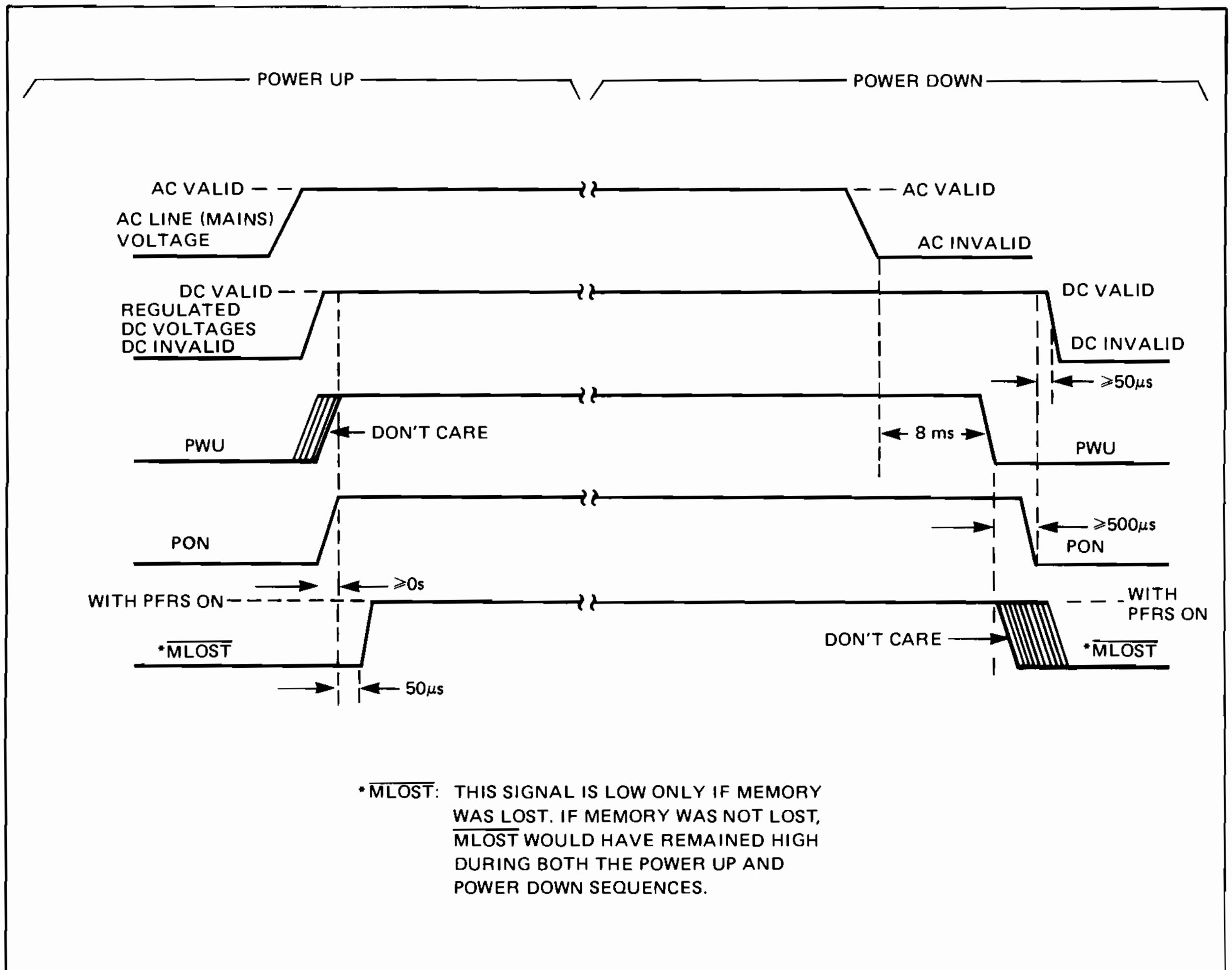


Figure 5-1. Signals and Timing Diagram for Power Up and Power Down Sequences

"B" Power Supply

For simplification, Figure 5-2 shows the connections between a CPU power supply, a memory extender power supply, and an I/O extender power supply.

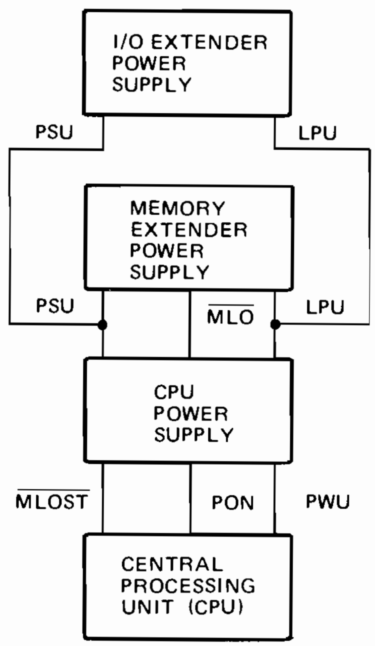
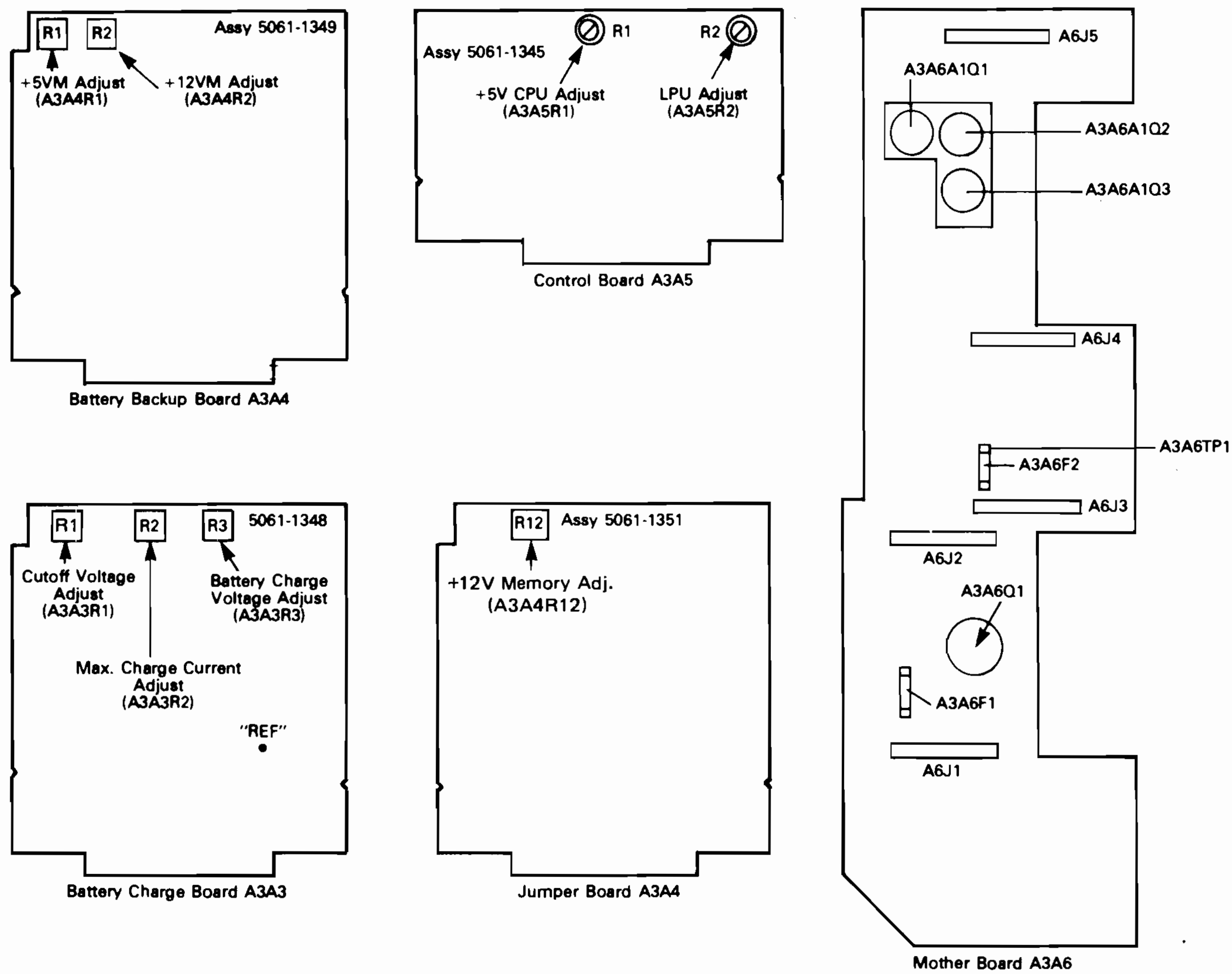


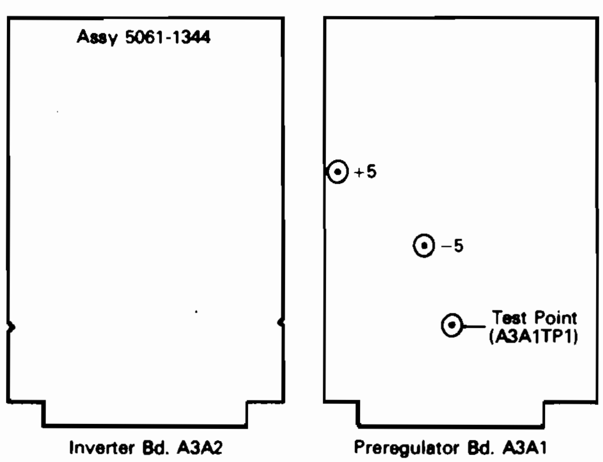
Figure 5-2. Interconnection of Power Supplies.

POWER SUPPLY TROUBLESHOOTING — APPENDIX A

This appendix contains the power supply trouble shooting flowchart and a parts location diagram. The flowchart can be used to isolate a failure to a particular subassembly. The parts location diagram also shows the location of the power supply adjustments.

PARTS LOCATION FOR THE POWER SUPPLY





Description	New Part #	
Preregulator BD, A3A1	5061-1347	Power Supply A3. 5061-1356
Inverter Bd, A3A2	5061-1344	
Jumper Bd, A3A4	5061-1351	
Control Bd, A3A5	5061-1345	
Mother Bd, A3A6	5061-1371	
Output Regulator Bd, A3A6A1 (Mother Bd subassembly	5061-3403	
A3A6A1Q3-2V I/O Transistor	1854-0063	
A3A6A1Q1-12V I/O Transistor	1854-0611	
A3A6A1Q2 +12V Regulator	1813-0093	
Battery Charge Bd, A3A3	5061-1348	Power Fail 12991B/12944B
Battery Backup Bd, A3A4	5061-1349	

Figure A-1. Parts Location Diagram

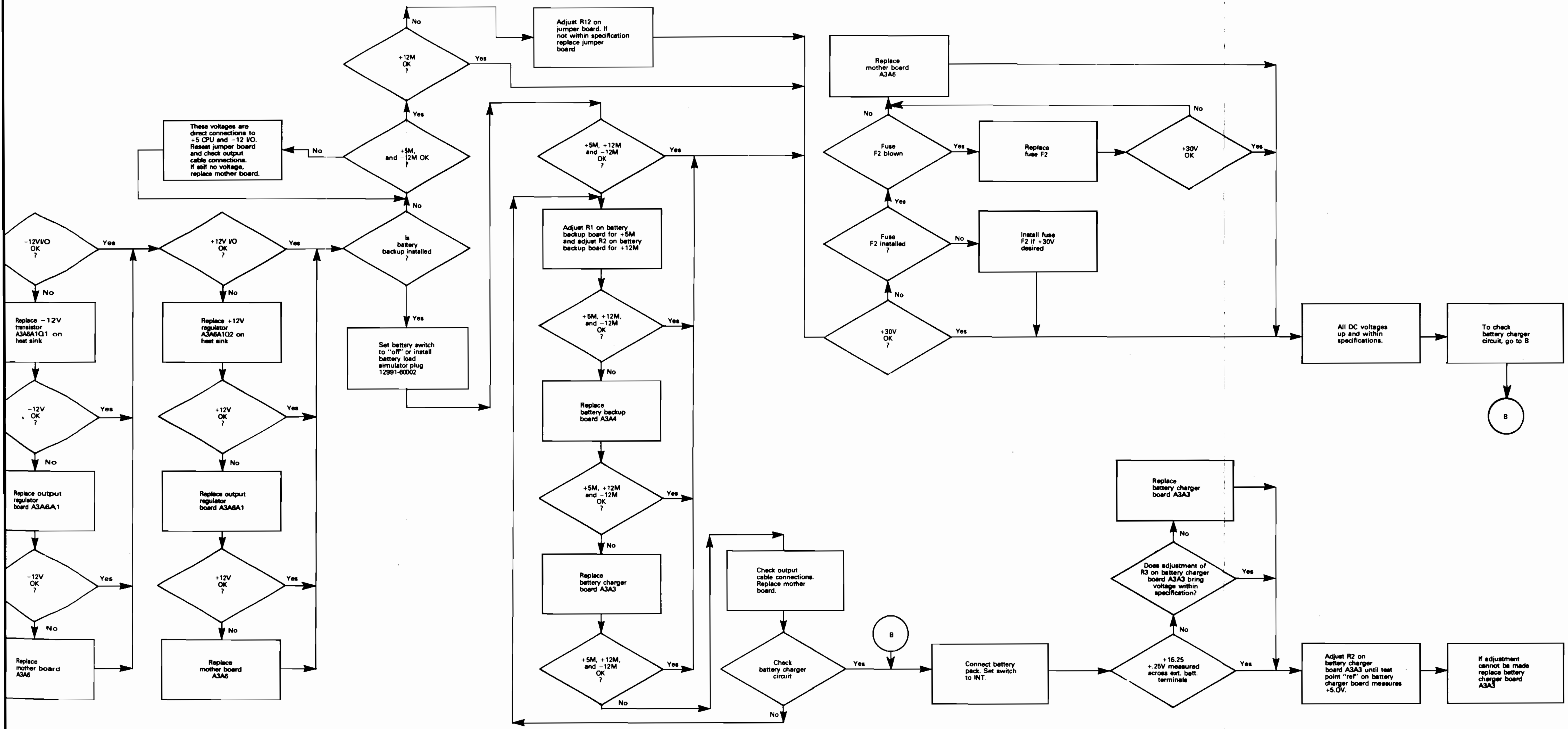
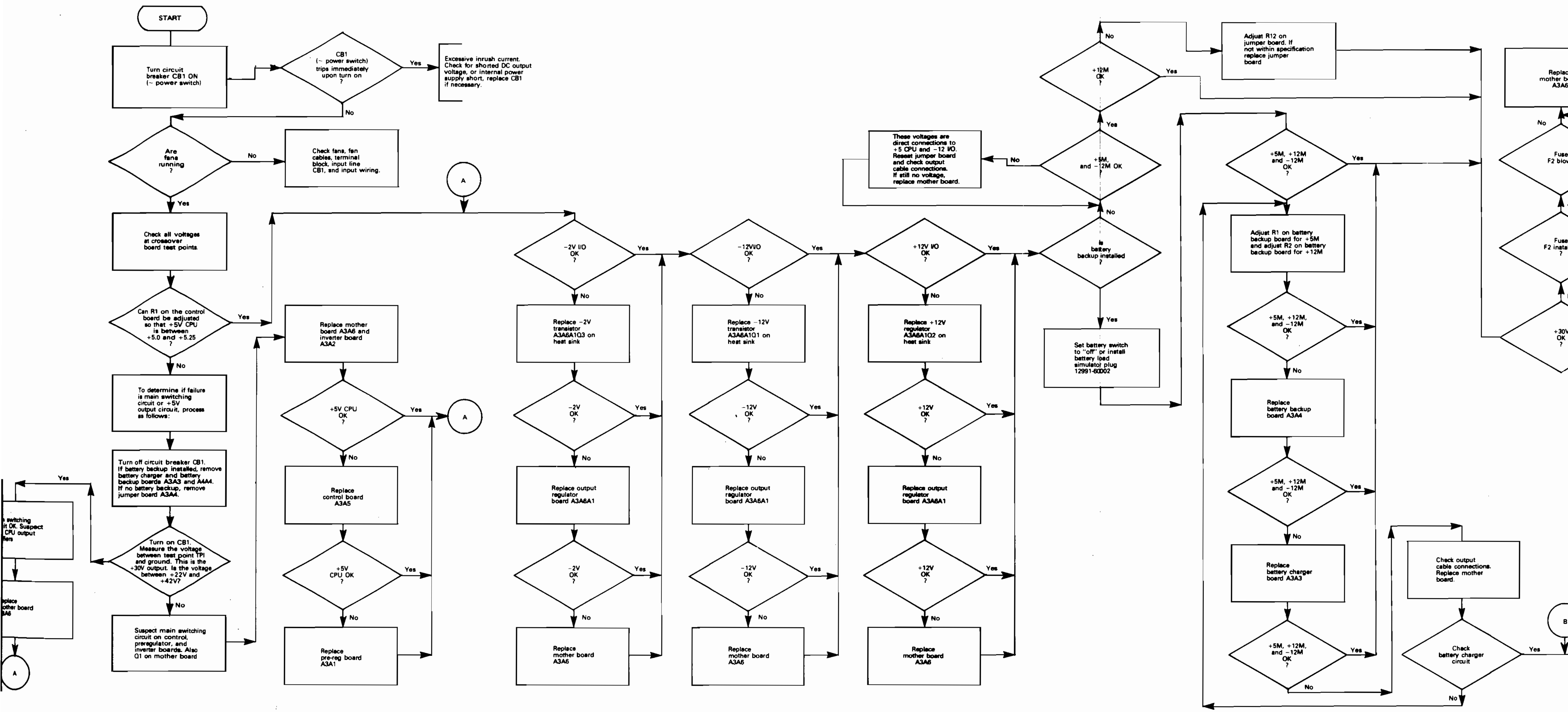
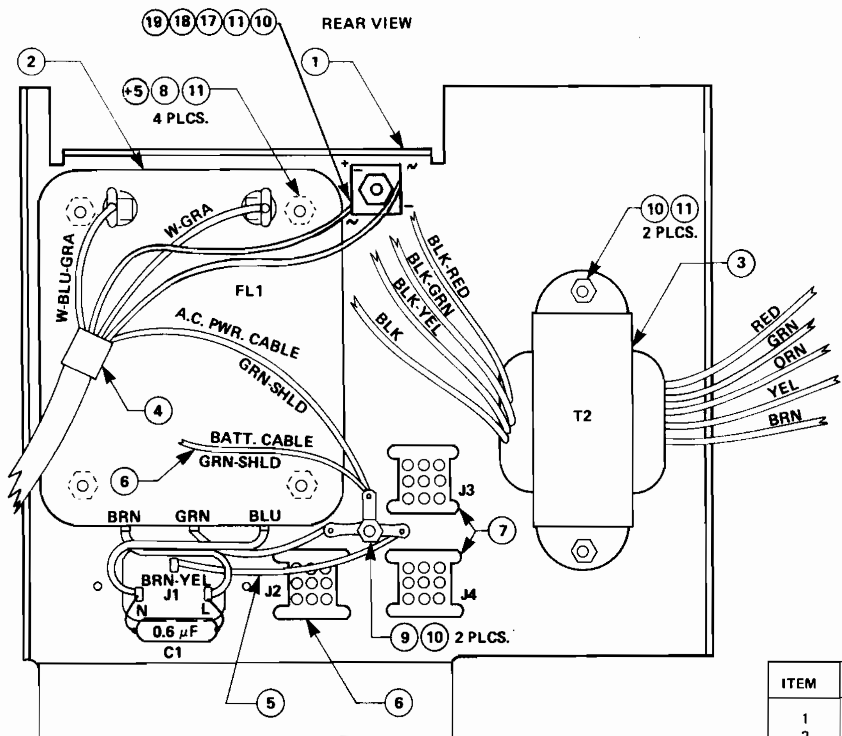
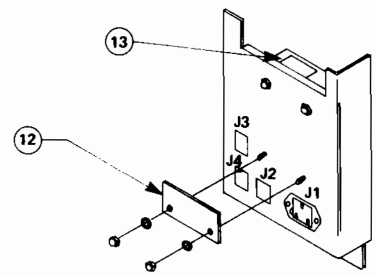


Figure A-2. Power Supply Troubleshooting Flowchart


START
Turn circuit breaker CB1 ON (~ power switch)
CB1 (~ power switch) trips immediately upon turn on ?
Yes
Excessive inrush current. Check for shorted DC output voltage, or internal power supply short, replace CB1 if necessary.
No
Are fans running ?
No
Check fans, fan cables, terminal block, input line CB1, and input wiring.
Yes
Check all voltages at crossover board test points.
Can R1 on the control board be adjusted so that +5V CPU is between +5.0 and +5.25 ?
Yes
No
To determine if failure is main switching circuit or +5V output circuit, process as follows:
Turn off circuit breaker CB1. If battery backup installed, remove battery charger and battery backup boards A3A3 and A4A4. If no battery backup, remove jumper board A3A4.
Turn on CB1. Measure the voltage between test point TPI and ground. This is the +30V output. Is the voltage between +22V and +42V?
Yes
No
Suspect main switching circuit on control, preregulator, and inverter boards. Also Q1 on mother board
switching it OK. Suspect CPU output ers
eplace other board A6
A
Replace mother board A3A6 and inverter board A3A2
+5V CPU OK ?
Yes
A
No
Replace control board A3A5
+5V CPU OK ?
Yes
No
Replace pre-reg board A3A1
A
−2V I/O OK ?
Yes
No
Replace −2V transistor A3A6A1Q3 on heat sink
−2V OK ?
Yes
No
Replace output regulator board A3A6A1
−2V OK ?
Yes
No
Replace mother board A3A6
−12V I/O OK ?
Yes
No
Replace −12V transistor A3A6A1Q1 on heat sink
−12V OK ?
Yes
No
Replace output regulator board A3A6A1
−12V OK ?
Yes
No
Replace mother board A3A6
+12V I/O OK ?
Yes
No
Replace +12V regulator A3A6A1Q2 on heat sink
+12V OK ?
Yes
No
Replace output regulator board A3A6A1
+12V OK ?
Yes
No
Replace mother board A3A6
Is battery backup installed ?
Yes
Set battery switch to "off" or install battery load simulator plug 12991-60002
No
+5M, and −12M OK ?
No
These voltages are direct connections to +5 CPU and −12 I/O. Reseat jumper board and check output cable connections. If still no voltage, replace mother board.
Yes
+12M OK ?
Yes
No
Adjust R12 on jumper board. If not within specification replace jumper board
+5M, +12M and −12M OK ?
Yes
Adjust R1 on battery backup board for +5M and adjust R2 on battery backup board for +12M
+5M, +12M, and −12M OK ?
Yes
No
Replace battery backup board A3A4
+5M, +12M and −12M OK ?
Yes
No
Replace battery charger board A3A3
+5M, +12M, and −12M OK ?
Yes
No
Check output cable connections. Replace mother board.
Check battery charger circuit
Yes
No
B
Replac mother b A3A6
No
Fuse F2 blov
Fuse F2 insta
+30V OK ?





ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	BACK PANEL	5001-2659
2	1	FILTER	9135-0097
3	1	TRANSFORMER	9100-3949
4	1	CABLE ASSY AC PWR	5061-1358
5	0.25'	WIRE - 18 GRN/YEL	8150-2919
6	1	BATT. CABLE ASSY.	5061-1357
7	1	CABLE ASSY. CONTROL	5061-1360
8	4	ACORN NUTS	0510-0110
9	2	LUG SOLDER	0360-0268
10	6	NUT HEX NO.	2420-0003
11	7	LOCKWASHER SPLIT NO. 6	2190-0851
12	1	INFO TAG	5001-2632
13	1	LABEL-WARNING	7120-4626
14	1	CAP 0.6 uF	0160-4413
15	B	WASHER FLAT # 6	3050-0228
16	1"	TUBING HEAT SHRINK	0890-1159
17	1	DIODE BRIDGE	1906-0225
18	4/R	THERMAL COMPD.	6040-0239
19	1	SCREW 6-32X.625	2360-0202

5061-1356 Power Supply Rear Panel Assembly
5061-1350

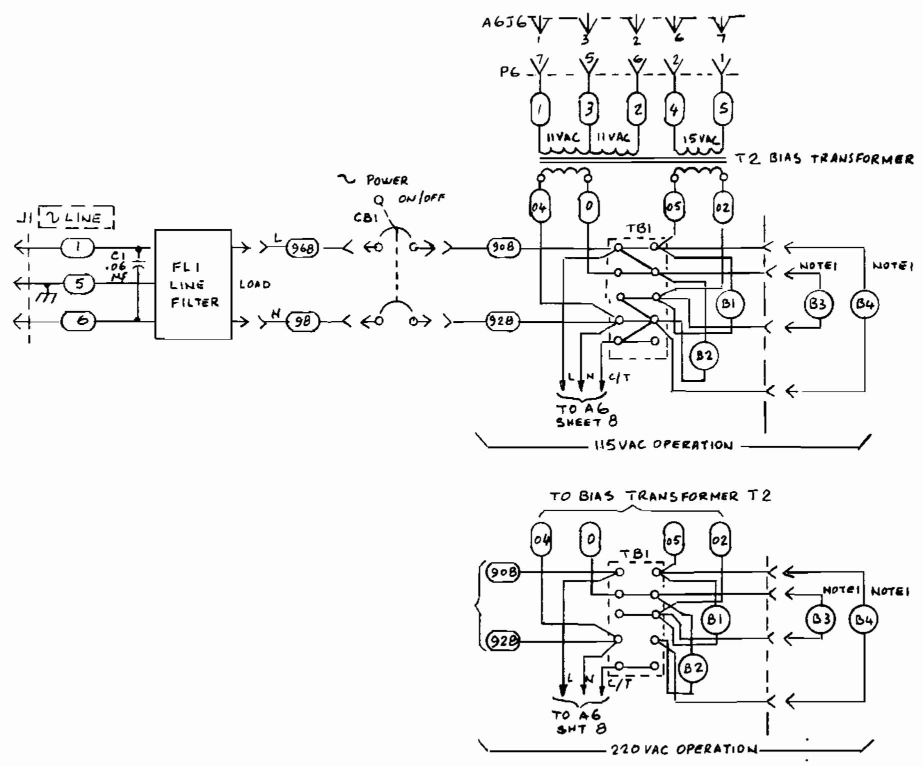
"B" Model Power Supply Rear Panel Assembly Parts List (5061-1350)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	
01	C1	CAPACITOR-FIXED		0160-4413		U	1	
		LUG SOLDER #6LKG		0360-0268		U	2	
		LUG CRP22-18RT6		0362-0321		U	4	
		NUT-CAP		0510-0110		U	4	
		TBG-HS 1.5 DIA		0890-1159		U	0.08	FT
		CONTACT FEMALE		1251-3411		U	5	
		CONN POST 7POS F		1251-4358		U	1	
		CA TIE 3.6L		1400-0249		U	5	
		DIODE BRDG 15A		1906-0225		U	1	
		LKWSHR 6 HEL		2190-0851		U	7	
		SCP #6-32X.625L		2360-0202		U	1	
		NUT 6-32 .250AF		2420-0003		U	6	
		WSHR #6 SS		3050-0228		U	8	
		PICTR-REAR PANEL		4040-1742		U	1	
		COMPOUND-THERMAL		6040-0239		U	0.01	TR
		LABEL-WARNING		7120-4626		U	1	
		LABEL-USA		7120-6830		L	1	
		WIRE 18 GRN-YEL		8150-2919		C	0.25	FT
		TRANSFORMER		9100-3949		U	1	
		FILTER-LINE		9135-0097		U	1	
		INFO TAG		5001-2632		W	1	
		PANEL-REAR,LCPS		5001-2659		W	1	
		ASSY-CABLE BATT		5061-1357		1	1	
		ASSY-CABLE AC		5061-1358		1	1	
		ASSY-CBL CONTROL		5061-1360		1	1	

REF. DWG: B-5061-1356-5 A.C. INPUT 115/230 WIRING.

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PER PCO-22-5704	PX-1	5/28/80
B	ADD. NOTE 3	CD PPM	8-26-80

B-5061-1356-51



WARNING.
HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY! BEFORE CHANGING FROM 110 VAC TO 220 VAC CONFIGURATION, OR VICE VERSA, SET ~ POWER AND BATTERY SWITCHES TO OFF AND DISCONNECT THE POWER CORD! FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY.

NOTES:

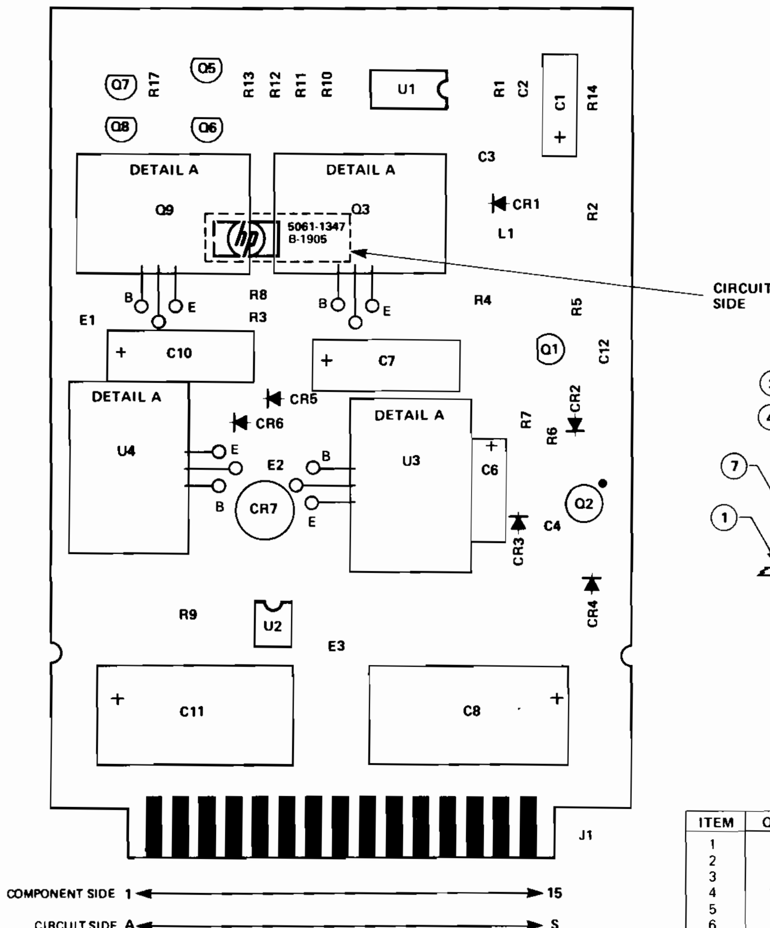
1. FANS B3 & B4 ARE REQUIRED ONLY FOR THE HP 2113 B, HP2112B, 2111F, 2117F
2. ENCLOSED WIRE COLOR CODE ( ). CODE USED IS THE SAME AS THE RESISTOR COLOR CODE. FIRST NO. IDENTIFIES THE BASE COLOR, SECOND NO. IDENTIFIES THE WIDE STRIP AND THE THIRD NO. IDENTIFIES THE NARROW STRIP e.g. 947 DENOTES WHITE BASE, YELLOW WIDE STRIPE, AND VIOLET NARROW STRIPE.

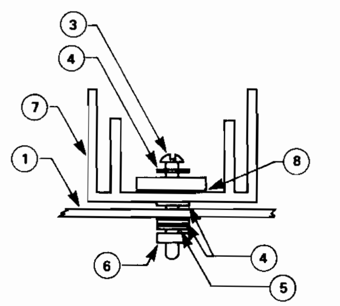
B [3] SEE ENGINEERING & REF. DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHEET NOS.

B [3] SHEET 1 OF 10

L.C.P.S. LINE (MAINS) POWER DISTRIBUTION SCHEMATIC (TITLE)	HEWLETT PACKARD
NEXT ASSEMBLY	5061-1356 (PART NUMBER)
FINISH / SCALE	B-5061-1356-51

STOCK NO. 9280-0002 PRINTED ON DIEPO NO. 1020-10 CLEARPRINT FADEOUT





DETAIL A

ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	PC BOARD, ETCHED	5080-9799
2	3	TERMINAL, E1-E3	0360-0294
3	4	SCREW, 4-40 X 3/8	2200-0143
4	12	WASHER FLAT 4-40	3050-0229
5	4	WASHER, SPLIT LOCK	2190-010B
6	4	NUT, 4-40	2260-0001
7	4	HEAT SINK	1205-0219
8	1	THERMAL COMP.	6040-0239

A1 Pre-regulator Assembly
5061-1347

A1 Pre-regulator Assembly Parts List (5061-1347) Sht. 1 of 3

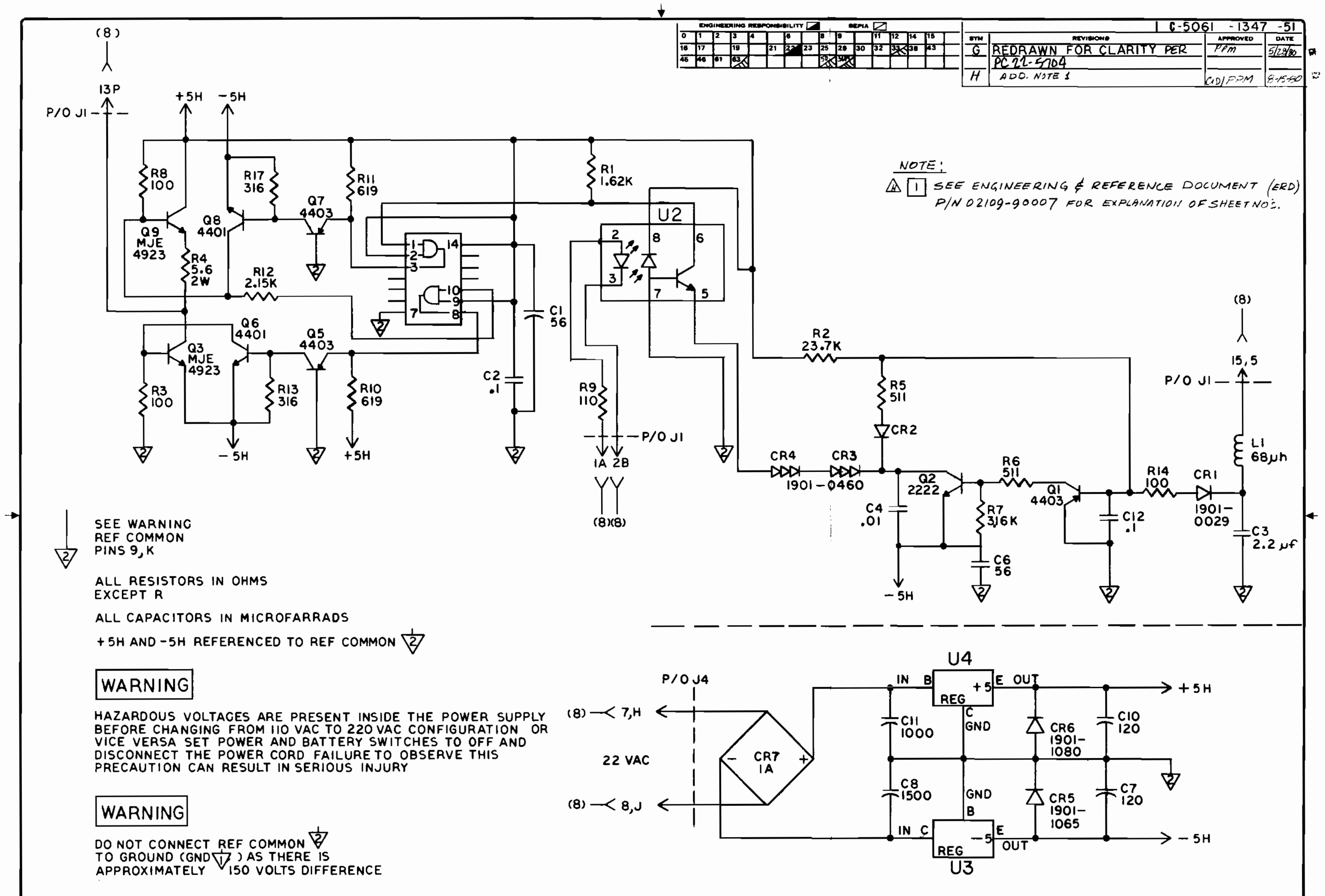
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
01	C4	CAP .01UF		0160-2055		U	1
01	C3	CAP 2.2UF 20%		0160-3901		U	1
01	C2,12	CAPACITOR-FIXED		0160-5054		U	2
01	C1,6	CAP 56UF 6VDC		0180-0548		U	2
00	C7,10	CAP 120UF 10%		0180-2145		U	2
00	C8	C-F 1500UF 16V		0180-2500		U	1
00	C11	CAP 1000UF 16V		0180-2732		U	1
00	E1-3	STUD SOLDER TERM		0360-0294		U	3
		ADH RTV CLEAR		0470-0251		U	0.01
01	R12	RES 2.15K 1%.125		0698-0084		U	1
00	R2	RES 23.7K 1%.125		0698-3158		D	1
01	R13,17	RES 316 1%.125		0698-3444		D	2
00	R7	RES 3.16K 1%.125		0757-0279		U	1
01	R3,8,14	RES 100 1%.125		0757-0401		D	3
00	R9	RES 110 1%.125		0757-0402		U	1
00	R5,6	RES 511 1%.125		0757-0416		D	2
01	R10,11	RES 619 1%.125		0757-0418		U	2

A1 Pre-regulator Assembly Parts List (5061-1347) Sht. 2 of 3

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	R1	RES 1.62K 1%.125		0757-0428		U	1
00	R4	RES 5.6 5% 2W		0811-1675		U	1
		HT DIS PL PWR		1205-0219		U	4
00	U1	IC SN74S 09 N		1820-1448		U	1
00	U4	IC RGLTR +5V		1826-0144		U	1
00	U3	IC LINEAR 5V		1826-0294		U	1
01	Q1,5,7	XSTR 2N4403 TO92		1853-0271		U	3
00	Q6,8	XSTR 2N4401 TO92		1854-0467		U	2
00	Q2	XSTR 2N2222ATO18		1854-0477		U	1
00	Q3,9	XSTR MJE4923		1854-0683		U	2
00	CR1	DIODE 1N2071		1901-0029		D	1
01	CR2	DIODE SIL		1901-0040		D	1
01	CR3,4	STABISTOR STB523		1901-0460		D	2
00	CR5	DIODE IN4936		1901-1065		D	1
00	CR6	DIODE 1N5817		1901-1080		D	1
00	CR7	DIODE-FW BRIDGE		1906-0051		U	1
00	U2	OPTO ISOLATOR		1990-0444		U	1
		LKWSHR 4 HEL		2190-0108		U	4
		SCR #4-40X.375L		2200-0143		U	4
		NUT 4-40 .250AF		2260-0001		U	4

A1 Pre-regulator Assembly Parts Lists List (5061-1347) Sht. 3 of 3

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
		WSHR #4 SS		3050-0229		U	12
		COMPOUND-THERMAL		6040-0239		U	0.01
		LABEL-USA		7120-6830		L	1
		COIL-FXD 68UH		9100-1633		U	1
00	L1						



NOTE:
1 SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHEET NO'S.

SEE WARNING
REF COMMON
PINS 9,K

ALL RESISTORS IN OHMS
EXCEPT R

ALL CAPACITORS IN MICROFARRADS

+5H AND -5H REFERENCED TO REF COMMON

WARNING

HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY BEFORE CHANGING FROM 110 VAC TO 220 VAC CONFIGURATION OR VICE VERSA SET POWER AND BATTERY SWITCHES TO OFF AND DISCONNECT THE POWER CORD FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY

WARNING

DO NOT CONNECT REF COMMON TO GROUND (GND) AS THERE IS APPROXIMATELY 150 VOLTS DIFFERENCE

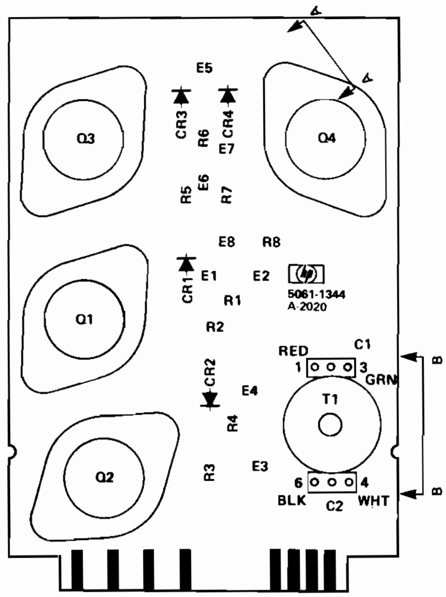
CAUTION

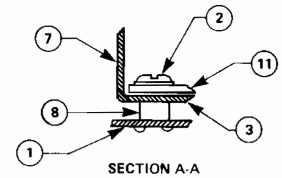
ANY MEASUREMENTS USING REF COMMON MUST BE MADE USING TEST INSTRUMENTS WITH A FLOATING INPUT

SYM	REVISIONS	APPROVED	DATE
G	REDRAWN FOR CLARITY PER PC 22-5704	FPM	5/12/80
H	ADD. NOTE 1	CD/FPM	8-15-80

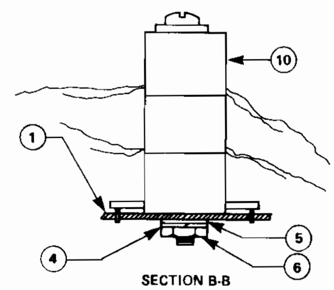
DATE 9-27-79	PRE-REGULATOR BOARD POWER SUPPLY A3A1 LCPS
NEXT ASSEMBLY 5061-1356	PART NUMBER 5061-1347
FINISH NONE	SCALE NONE
HEWLETT PACKARD	C-5061-1347-51

SHEET 1 OF 1





SECTION A-A



SECTION B-B

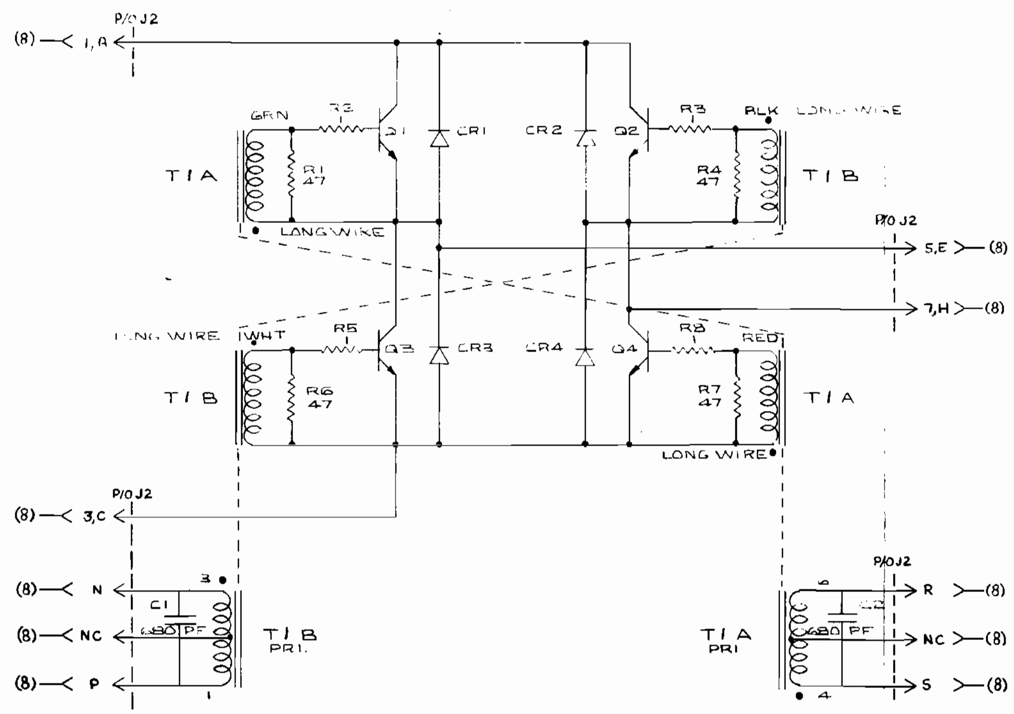
WIRE LIST		
RED	(LONG)	E7
RED	(SHORT)	E8
GREEN	(LONG)	E1
GREEN	(SHORT)	E2
WHITE	(LONG)	E6
WHITE	(SHORT)	E5
BLACK	(LONG)	E3
BLACK	(SHORT)	E4

ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	P.C. BOARD, ETCHED	5080-9796
2	8	SCREW 6-32 X 3/8 WITH LK	2360-0119
3	1	COMPOUND-THERMAL	6040-0239
4	1	LOCK WASHER # 4	2190-0108
5	1	FLAT WASHER # 4	3050-0229
6	1	NUT 4-40	2260-0001
7	4	HEAT SINK TO-3	1205-0312
8	8	STAND OFF	0380-0745
9	8	TERMINAL E1-EB	0360-0294
10	1	XFORMER	9100-2951
11	4	XSTR (TO-3)	1854-0869

A2 Inverter Assembly
5061-1344

A2 Inverter Assembly Parts List (5061-1344)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	C1,2	CAP 680PF 10%		0160-3573		U	2
00	E1-8	STUD SOLDER TERM		0360-0294		U	8
00	E9-16	SPCR TAP #6X.187		0380-0745		U	8
01	R1,4,6,7	RES 47 5% .25		0683-4705		U	4
01	R2,3,5,8	[illegible]		[illegible]		U	4
		HEAT SINK		1205-0312		U	4
01	Q1-4	XSTR NPN T03 10A		1854-0869		U	4
00	CR1-4	DIODE IN4936		1901-1065		D	4
		LKWSHR 4 HEL		2190-0108		U	1
		NUT 4-40 .250AF		2260-0001		U	1
		SCR #6-32X.437L		2360-0119		U	8
		WSHR #4 SS		3050-0229		U	1
		LABEL-USA		7120-6830		L	1
00	T1	XFORMER		9100-2951		U	1



Q1,2,3,4	1854-0369
CR1,2,3,4	1901-1065
R2,3,5,8	0811-3438
R1,4,6,7	0683-4705
C1,2	0160-3573
T1	9100-2951

NOTE:

1. SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02103-90007 FOR EXPLANATION OF SHEET NO'S.

SYM	REVISIONS
A	AS ISSUED

TITLE: INVERTER BD. POWER SUPPLY A3A2

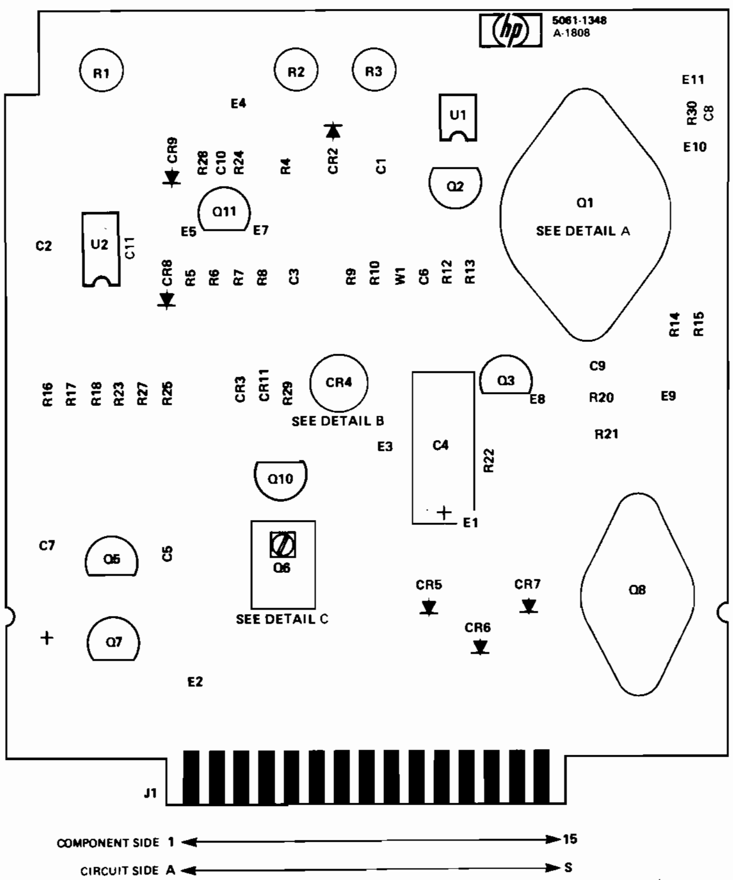
HEWLETT PACKARD

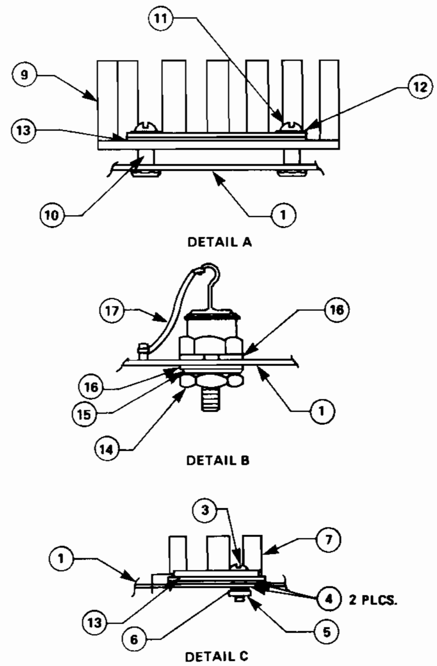
NEXT ASSEMBLY 5061-1356

PART NUMBER 5061-1344

C-5061-1344-51

SHEET 1 OF 1





ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	P.C. BOARD ETCHED	5080-9800
2	3	TERMINAL, E1-3	0360-0294
3	2	# 4-40 x 3/8 SCREW	2200-0143
4	2	# 4-40 WASHER, FLAT	3050-0229
5	1	# 4-40 NUT	2260-0001
6	1	LK WASHER 4 HEL	2190-0108
7	1	HEATSINK	1205-0219
8	-	—	—
9	-	—	—
10	4	SPACER	0380-0305
11	2	SCREW	2360-0117
12		DELETED	
13	.05TB	THERMAL COMPOUND	6040-0239
14	1	NUT	2740-0002
15	1	WASHER, LOCK	2190-0034
16	2	WASHER, FLAT	3050-0236
17	2.5"	WIRE 18 GA. YEL	8150-0577
18	2	SCREW 6-32 x .250 LG	2360-0113
19	1	JUMPER W1	8159-0005
20	B	STUD SOLD. TERM. E4-E11	0360-0474
21	1	EYELET	0361-1076

*A3 Battery Charger (PFRS) Assembly
5061-1348

A3 Battery Charger (PFRS) Assembly Parts List (5061-1348) Sht. 1 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
01							
03							
05							
07							
01	C10	CAP 0.1UF		0150-0121		U	1
01	C11	CAP .1UF 20% 50V		0160-0576		U	1
00	C1	CAP .01UF		0160-2055		U	1
01	C8,9	CAPACITOR .01MF		0160-3451		U	2
01	C4	CAP 100UF 20%		0180-0098		U	1
00	C2	CAP 6.8UF 10%		0180-0116		U	1
01	C3,5,6	CAP 1UF 10%		0180-0291		U	3
00	C7	CAP 330UF 10%		0180-1714		U	1
00	F1-3	STUD SOLDER TERM		0360-0294		U	3
01	F4-11	STUD SOLDER TERM		0360-0474		U	8
		EYELET		0361-1076		U	1
		SPCR TAP #6X.125		0380-0305		U	4
		ADHESIVE		0470-0409		U	0.01
00	R6	RES 470K 5% .25		0683-4745		U	1
00	R24	RES 2.15K 1%.125		0698-0084		U	1
00	R25	RES 2.61K 1%.125		0698-0085		U	1
00	R10	RES 3.83K 1%.125		0698-3153		U	1
		RES 23.7K 1%.125		0698-3158		D	1

A3 Battery Charger (PFRS) Assembly Parts List (5061-1348) Sht. 2 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
				0698-3158			
00	R27						
		RES 26.1K 1%.125		0698-3159		D	1
00	R18						
		RES 46.4K 1%.125		0698-3162		U	2
00	R7,16						
		RES 348 1% .50		0698-3403		U	1
00	R20						
		RES 287 1%.125		0698-3443		U	1
00	R29						
		RES 261K 1%.125		0698-3455		U	1
00	R5						
		RES 287K 1%.125		0698-3456		U	1
01	R8						
		RES 1.21K 1%.125		0757-0274		U	1
00	R28						
		RES 3.16K 1%.125		0757-0279		U	1
00	R12						
		RES 1K 1%.125		0757-0280		U	1
00	R15						
		RES 1.33K 1%.125		0757-0317		U	2
00	R4,23						
		RES 100 1%.125		0757-0401		D	1
00	R14						
		RES 511 1%.125		0757-0416		D	2
01	R13,22						
		RES 750 1%.125		0757-0420		U	1
00	R9						
		RES 10K 1%.125		0757-0442		D	1
01	R17						
		RES 11K 1%.125		0757-0443		U	1
01	R30						
		RES .27 5% 2W		0811-1659		U	1
00	R21						
		HT DIS PL PWR		1205-0219		U	1
		HT DIS TO-3		1205-0289		U	1

A3 Battery Charger (PFRS) Assembly Parts List (5061-1348) Sht. 3 of 4

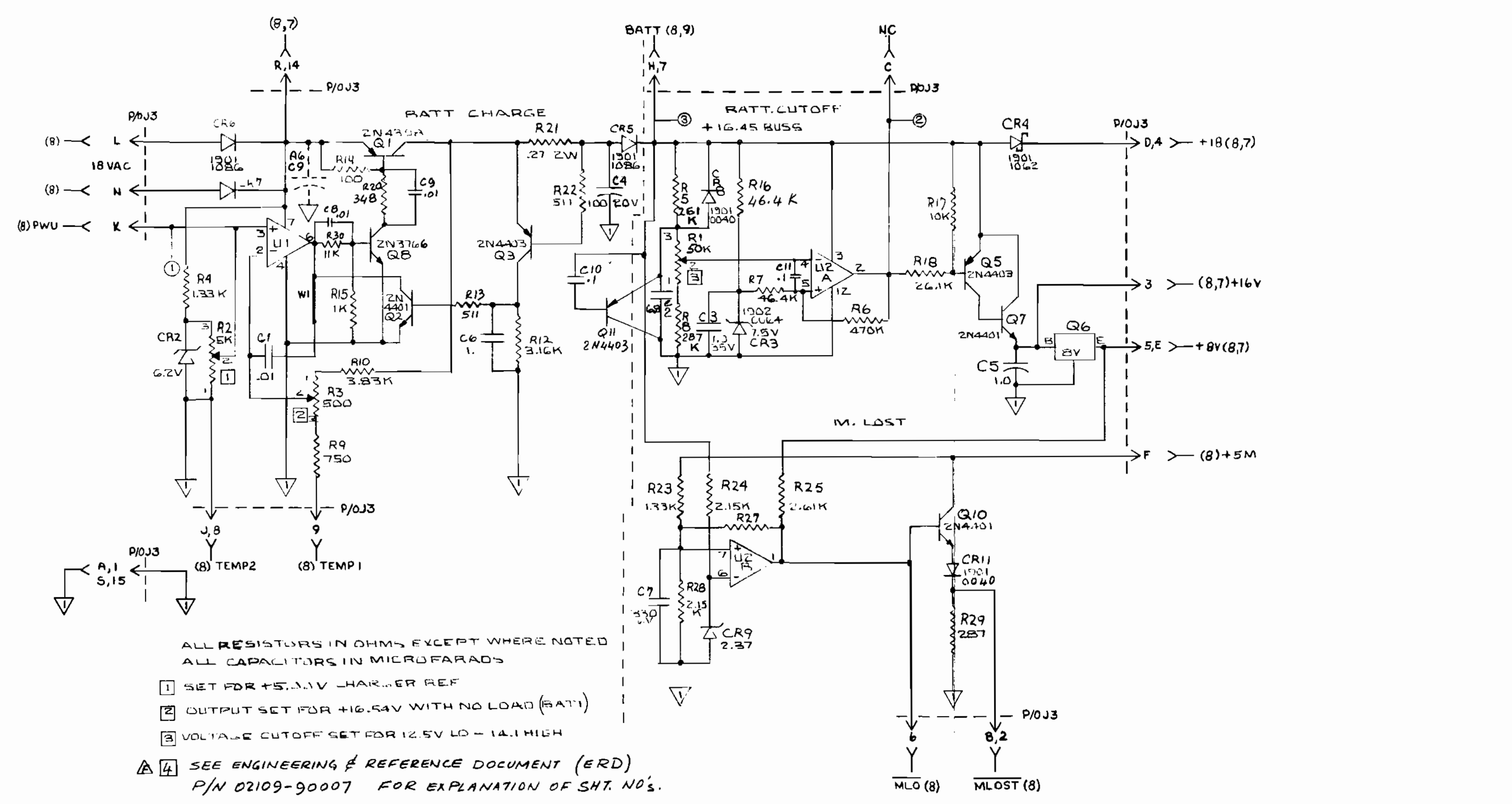
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	Q6	IC 7808C		1826-0146		U	1
00	U2	I.C. MC 3302		1826-0174		U	1
00	U1	IC UA 741C		1826-0271		U	1
01	Q3,5,11	XSTR 2N4403 TO92		1853-0271		U	3
00	Q1	XSTR 2N4398 TO3		1853-0421		U	1
00	Q8	XSTR 2N3766 TO66		1854-0259		U	1
01	Q2,7,10	XSTR 2N4401 TO92		1854-0467		U	3
01	CR8,11	DIODE SIL		1901-0040		D	2
00	CR4	DIODE		1901-1062		U	1
01	CR5-7	DIODE		1901-1086		U	3
00	CR3	DIODE		1902-0064		D	1
00	CR2	DIO-ZNR 1N827		1902-0680		D	1
00	CR9	DIODE 2.37V 5%		1902-3002		U	1
00	R2	RES 5KOHM 10%		2100-3207		U	1
00	R3	RES VAR 500 OHM		2100-3351		U	1
01	R1	RES 50KOHM 10%		2100-3354		U	1
		LKWSHR 10 HEL		2190-0034		U	1
		LKWSHR 4 HEL		2190-0108		U	1
		SCR #4-40X.375L		2200-0143		U	2
		NUT 4-40 .250AF		2260-0001		U	1

A3 Battery Charger (PFRS) Assembly Parts List (5061-1348) Sht. 4 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
		SCR #6-32X.250L		2360-0113		U	2
		SCR #6-32X.375L		2360-0117		U	2
		NUT 10-32 .375AF		2740-0002		U	1
		WSHR #4 SS		3050-0229		U	2
		WSHR #10 BRS		3050-0236		U	2
		DUPE ORN		6010-0015		U	0.001
		COMPOUND-THERMAL		6040-0239		U	0.05
		LABEL-USA		7120-6830		L	1
		WIRE 18 YEL		8150-0577		C	0.21
		WIRE JUMPERS		8159-0005		D	1
01	W1						

C-5061-1348-51

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		10/20/76
B	PCO-22-4318. CIRCUIT CHG. DATE CODE		10/7/77
C	PCO-22-4350. ADD. C8, C9, C10, Q11, R30. DELETED CR1 & R11. DATE CODE 1S1742		11.14.77
D	PCO-22-4522. ADD. C11, DATE CODE 1S1838		3.13.78
E	PCO-22-5704 ADD. SHT. 6 OF 10	PPM	6/27/85
F	ADD. NOTE 4	PPM	8-15-90



ALL RESISTORS IN OHMS EXCEPT WHERE NOTED
ALL CAPACITORS IN MICROFARADS

1. SET FOR +5.1V CHARGER REF
2. OUTPUT SET FOR +16.54V WITH NO LOAD (BATT)
3. VOLTAGE CUTOFF SET FOR 12.5V LO – 14.1 HIGH
4. SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHT. NO's.

BATTERY CHARGER BOARD (PFRS) A3A3

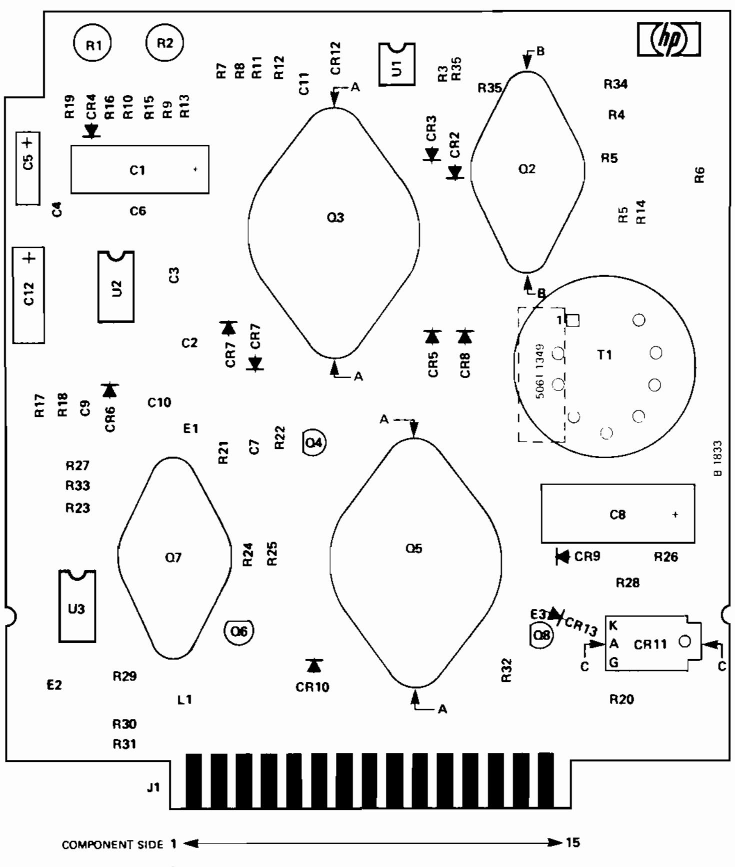
HEWLETT PACKARD

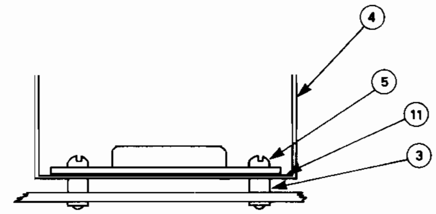
NEXT ASSEMBLY: 12944B, 12991B

PART NUMBER: 5061-1348

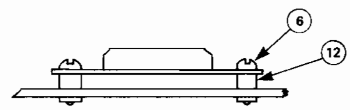
C-5061-1348-51

SHEET 1 OF 1

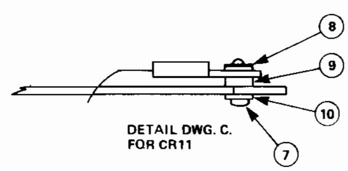




DETAIL DWG. A
FOR Q3, 5



DETAIL DWG. B.
FOR Q2, 7



DETAIL DWG. C.
FOR CR11

ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	BOARD ETCHED	5081-2301
2	3	TERMINAL E1, E2, E3	0360-0474
3	4	SPACER	0380-0305
4	2	HEATSINK	1205-0289
5	4	SCREW 6-32 x .438	2360-0117
6	4	SCREW 4-40 x .25	2200-0103
7	1	SCREW	2200-0143
8	1	NUT	2260-0009
9	1	WASHER-FLAT	3050-0229
10	1	WASHER-FIBER	3050-0080
11	.05TB	THERMAL COMP.	6040-0239
12	4	SPACER	0380-0886
13		DELETED	
14	1.2"	WIRE	8150-3426
15		DELETED	

*A4 Battery Backup Assembly
5061-1349

A4 Battery Backup Assembly Parts List (5061-1349) Sht. 1 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	C7	CAP .0022UF 10%		0160-0154		U	1
01	C4,9,11	CAP .1UF 20% 50V		0160-0576		U	3
00	C3	CAP 100PF 5%		0160-2204		U	1
00	C10	CAP 1500PF 5%		0160-2222		U	1
00	C6	CAP 5000PF 10%		0160-3458		U	1
00	C2	CAP .05UF-20+80%		0160-3460		U	1
00	C1,8	CAP 100UF 20%		0180-0098		U	2
00	C5	CAP 1UF 10%		0180-0291		U	1
00	C12	CAP 39UF 10%		0180-0393		D	1
01	E1-3	STUD SOLDER TERM		0360-0474		U	3
		SPCR TAP #6X.125		0380-0305		U	4
		STANDOFF		0380-0886		U	4
		ADHESIVE		0470-0409		U	0.01
00	R16	RES 2.15K 1%.125		0698-0084		U	1
00	R9	RES 2.61K 1%.125		0698-0085		U	1
00	R10	RES 3.83K 1%.125		0698-3153		U	1
00	R19	RES 4.64K 1%.125		0698-3155		D	1
		RES 14.7K 1%.125		0698-3156		D	1

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
				0698-3156			
00	R12						
		RES 19.6K 1%.125		0698-3157		U	1
00	R7						
		RES 22 5% 2W		0698-3609		U	1
00	R28						
		RES 120 5% 2W		0698-3622		U	1
00	R6						
		RES 1K 1%.125		0757-0280		U	3
00	R4,34						
01	3						
		RES 42.2 1%.125		0757-0316		U	1
00	R26						
		RES 100 1%.125		0757-0401		D	2
01	R14,24						
		RES 511 1%.125		0757-0416		D	2
01	R22,32						
		RES 5.11K 1%.125		0757-0438		D	1
00	R33						
		RES 10K 1%.125		0757-0442		D	8
01	R8,17,	18,21,23,27					
03	30,31						
		RES 20K 1%.125		0757-0449		D	1
00	R29						
		RES 51.1K 1%.125		0757-0458		D	1
00	R13						
		RES 100K 1%.125		0757-0465		D	1
00	R35						
		RES 1.47K 1%.125		0757-1094		D	2
00	R15,11						
		RES .05 10% 3W		0811-1826		U	1
00	R5						
		RES .07 5% 5W PW		0811-3174		U	1
01	R20						
		RES 1 10% .40W		0811-3438		U	1
01	R25						
		HT DIS TO-3		1205-0289		U	2

A4 Battery Backup Assembly Parts List (5061-1349) Sht. 3 of 4

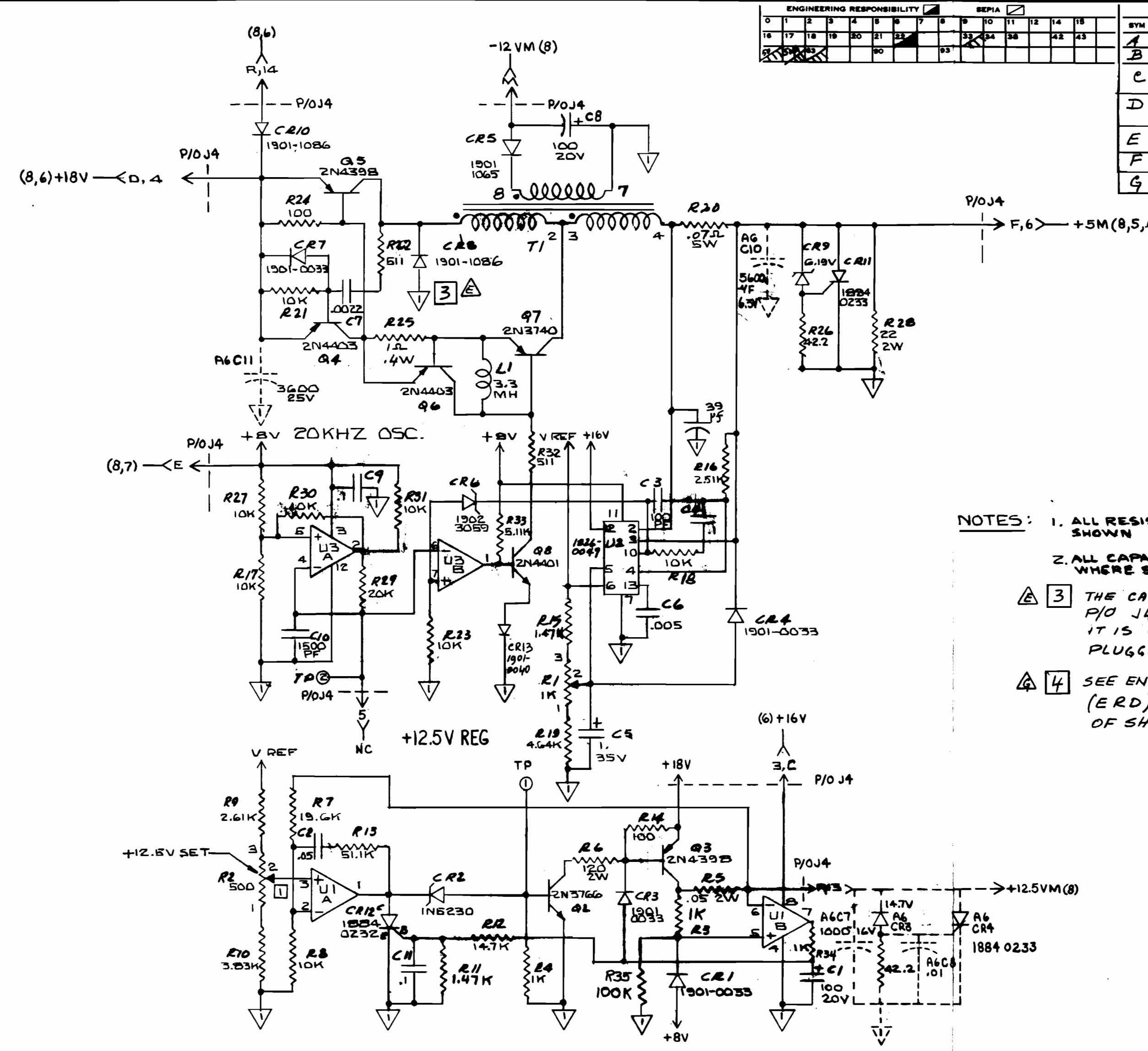
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	U2	IC V REG		1826-0049		U	1
00	U1	IC MC1458 P1		1826-0139		U	1
00	U3	I.C. MC 3302		1826-0174		U	1
00	Q7	XSTR 2N3740 TO66		1853-0052		U	1
00	Q4,6	XSTR 2N4403 TO92		1853-0271		U	2
00	Q3,5	XSTR 2N4398 TO3		1853-0421		U	2
00	Q2	XSTR 2N3766 TO66		1854-0259		U	1
00	Q8	XSTR 2N4401 TO92		1854-0467		U	1
00	CR12	SCR 2N5062		1884-0232		U	1
00	CR11	THYRISTOR SCR		1884-0233		U	1
01	CR1,3,4,7	RECTIFIER SIL		1901-0033		U	4
01	CR13	DIODE SIL		1901-0040		D	1
00	CR5	DIODE IN4936		1901-1065		D	1
00	CR8,10	DIODE		1901-1086		U	2
00	CR9	DIODE 6.19V		1902-0049		U	1
00	CR6	DIODE 3.83V		1902-3059		U	1
00	CR2	DIODE 4.64V		1902-3082		U	1
00	R2	RES VAR 500 OHM		2100-3351		U	1
		RES VAR 1K 10%		2100-3352		U	1

A4 Battery Backup Assembly Parts List (5061-1349) Sht. 4 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
				2100-3352			
00	R1						
		SCR 4-40X.25		2200-0103		U	4
		SCR #4-40X.375L		2200-0143		U	1
		NUT 4-40 W/LK		2260-0009		U	1
		SCR #6-32X.375L		2360-0117		U	4
		WSHR #5		3050-0080		U	1
		WSHR #4 SS		3050-0229		U	1
		COMPOUND-THERMAL		6040-0239		U	0.01
		LABEL-USA		7120-6830		L	1
		WIRE 30AWG WHT		8150-3426		C	0.10
		COIL CHK 3300UH		9100-1665		U	1
00	L1						
		TRANSFORMER-PULS		9100-4069		U	1
01	T1						

C-5061-1349-51

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		12/8/76
B	PCO-22-4350. ADD. CR13. DATE CODE IS 1742		11-14-77
C	PCO-22-4443, R20 WAS .1Ω, R25 WAS 2.7Ω ¼W. DATE CODE IS 1750	GD/	1.27.78
D	PCO-22-4679, CR8 WAS 1901-1087, T1 WAS 9100-0669, DATE CODE IS 1833	GD/	6-6-78
E	ADD. NOTE 3	GD/ PPM	3/19/80
F	PCO-22-5704 ADD. SHT. 7 OF 10	GD/ PPM	6/27/80
G	ADD. NOTE 4	GD/ PPM	8-15-80



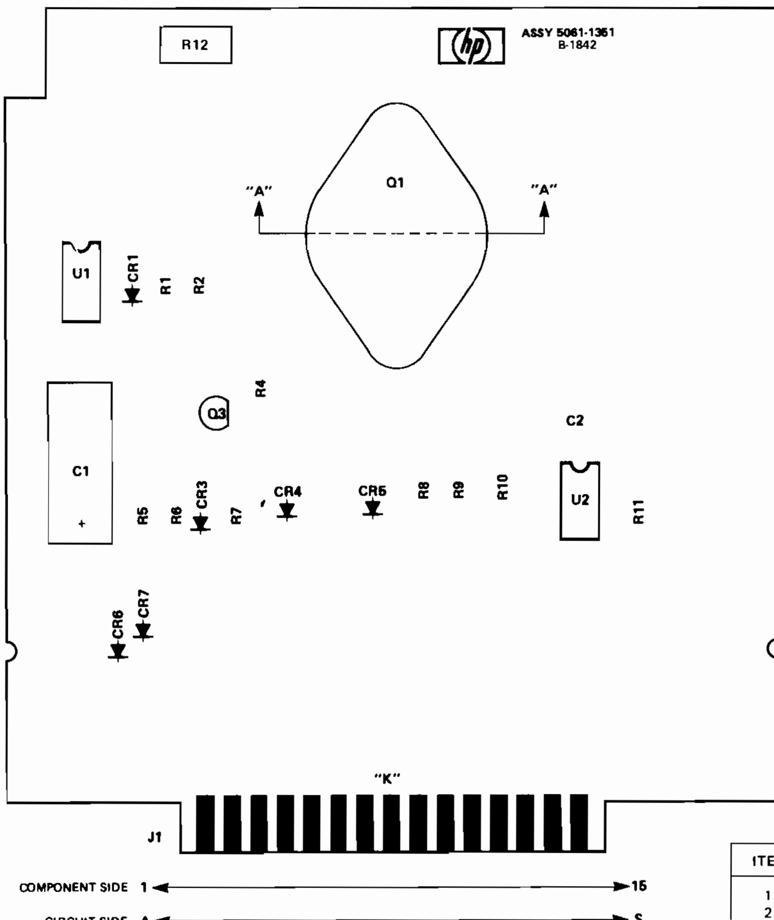
NOTES:
1. ALL RESISTORS IN OHMS EXCEPT WHERE SHOWN
2. ALL CAPACITORS IN MICROFARADS EXCEPT WHERE SHOWN
3. THE CATHODE OF CR8 IS CONNECTED TO P/O J4, PIN 1 OF THIS BATTERY BACKUP BOARD. IT IS CONNECTED TO ⏚ ONLY WHEN PLUGGED INTO MOTHER BOARD.
4. SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHEET NO'S.

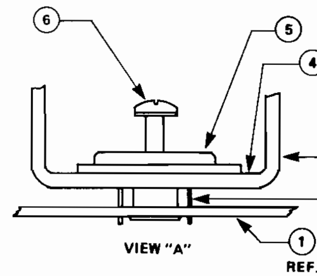
BATTERY BACKUP BOARD A3A4

HEWLETT PACKARD

PART NUMBER 5061-1349

C-5061-1349-51





ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	PC BOARD-ETCHED	5081-2302
2	2	SPACER 6-32 x .125	0380-0342
3	1	HEAT SINK	1205-0289
4	.01TB	THERMAL COMPOUND	6040-0239
5	1	TRANSISTOR Q1	1853-0421
6	2	SCREW 6-32 x .375	2360-0117
7		DELETED	

** A4 Jumper Board Assembly
5061-1351

A4 Jumper Board Assembly Parts List (5061-1351) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	C2	CAP 100PF 5%		0160-2204		U	1
00	C1	CAP 330UF 10%		0180-1714		U	1
		SPCR TAP #6X.125		0380-0342		U	2
		ADHESIVE		0470-0409		U	0.01
01	R1,2,5	RES 2.15K 1%.125		0698-0084		U	3
01	R4	RES 2.61K 1%.125		0698-0085		U	1
00	R9	RES 3.83K 1%.125		0698-3153		U	1
00	R7	RES 287 1%.125		0698-3443		U	1
00	R11	RES 61.9 1%.125		0757-0276		U	1
00	R6	RES 1.33K 1%.125		0757-0317		U	1
00	R8	RES 5.11K 1%.125		0757-0438		D	1
00	R10	RES .27 5% 2W		0811-1659		U	1
		HT DIS TO-3		1205-0289		U	1
00	U2	IC V REG		1826-0049		U	1
00	U1	I.C. MC 3302		1826-0174		U	1
00	Q1	XSTR 2N4398 TO3		1853-0421		U	1
00	Q3	XSTR 2N4401 TO92		1854-0467		U	1
00	CR6,7	DIODE SIL		1901-0040		D	2

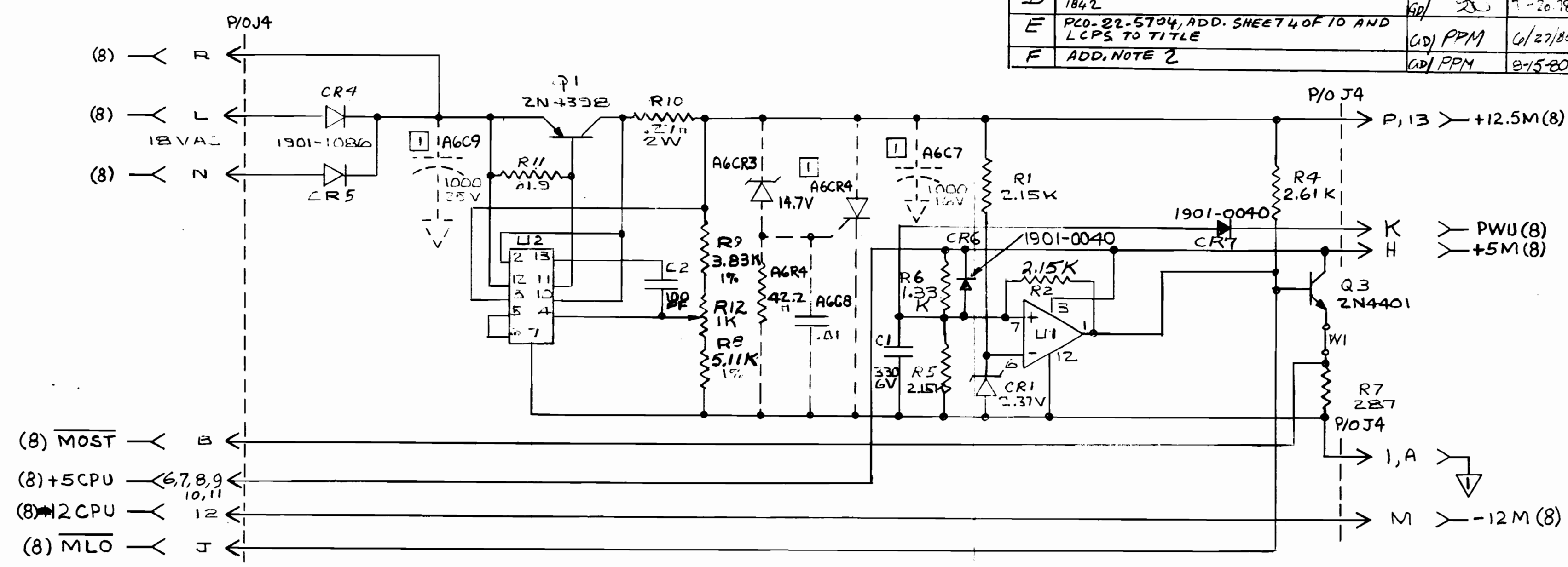
A4 Jumper Board Assembly Parts List (5061-1351) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
00	CR4,5	DIODE		1901-1086		U	2
00	CR1	DIODE 2.37V 5%		1902-3002		U	1
00	R12	RES VAR 1K 10%		2100-3352		U	1
		SCR #6-32X.375L		2360-0117		U	2
		COMPOUND-THERMAL		6040-0239		U	0.01
		LABEL-USA		7120-6830		L	1
01	W1	WIRE JUMPERS		8159-0005		D	1

B-5061-1351-51

ENGINEERING RESPONSIBILITY SEPIA

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		10/30/76
B	CHANGED R2 From 23.7K TO 2.15K PRCR C		5/20/77
C	PCO-22-4471. REMOVED F1 DATECODE IS 1750	GD/	1.26.78
D	PCO-22-4820, CIRCUIT CHG. DATE CODE IS 1842	GD/	9-20-78
E	PCO-22-5704, ADD. SHEET 4 OF 10 AND LCPS TO TITLE	GD/ PPM	6/27/80
F	ADD. NOTE 2	GD/ PPM	8/5/80



NOTES:

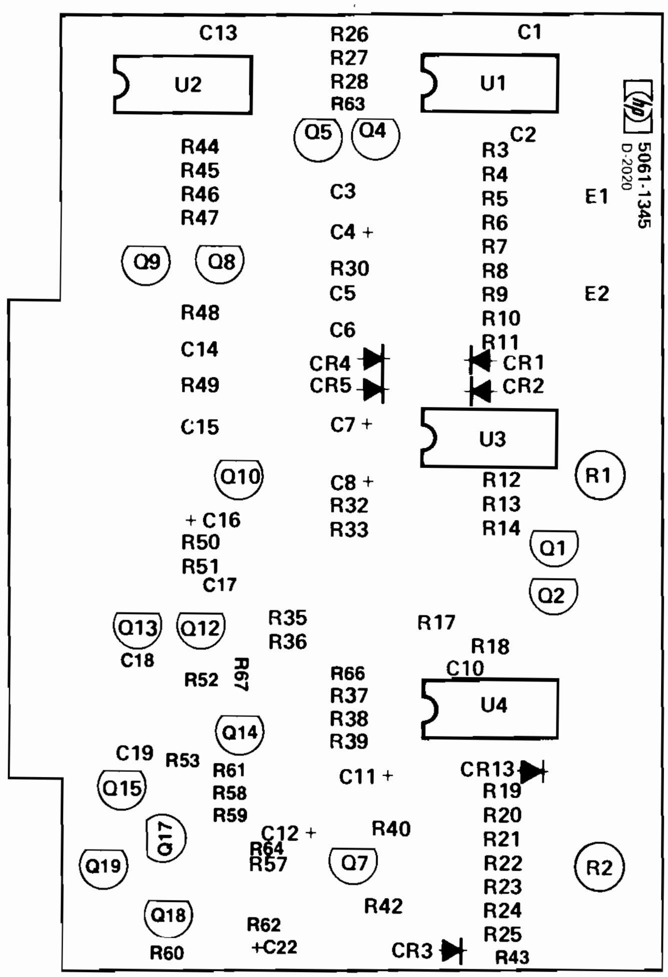
1. COMPONENTS IN BROKEN LINE ARE LOCATED ON MOTHER BD.

2. SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHT. NO'S.

TITLE: JUMPER BOARD LCPS A3A4	HEWLETT PACKARD
NEXT ASSEMBLY: 5061-1356	PART NUMBER: 5061-1351
FINISH	SCALE	B-5061-1351-51

SHEET 1 OF 1

STOCK NO. 9280-0002 PRINTED ON DIEPO NO. 1030-10 CLEARPRINT FADEOUT



A5 Control Board Assembly
5061-1345

A5 Control Board Assembly Parts List (5061-1345) Sht. 1 of 3

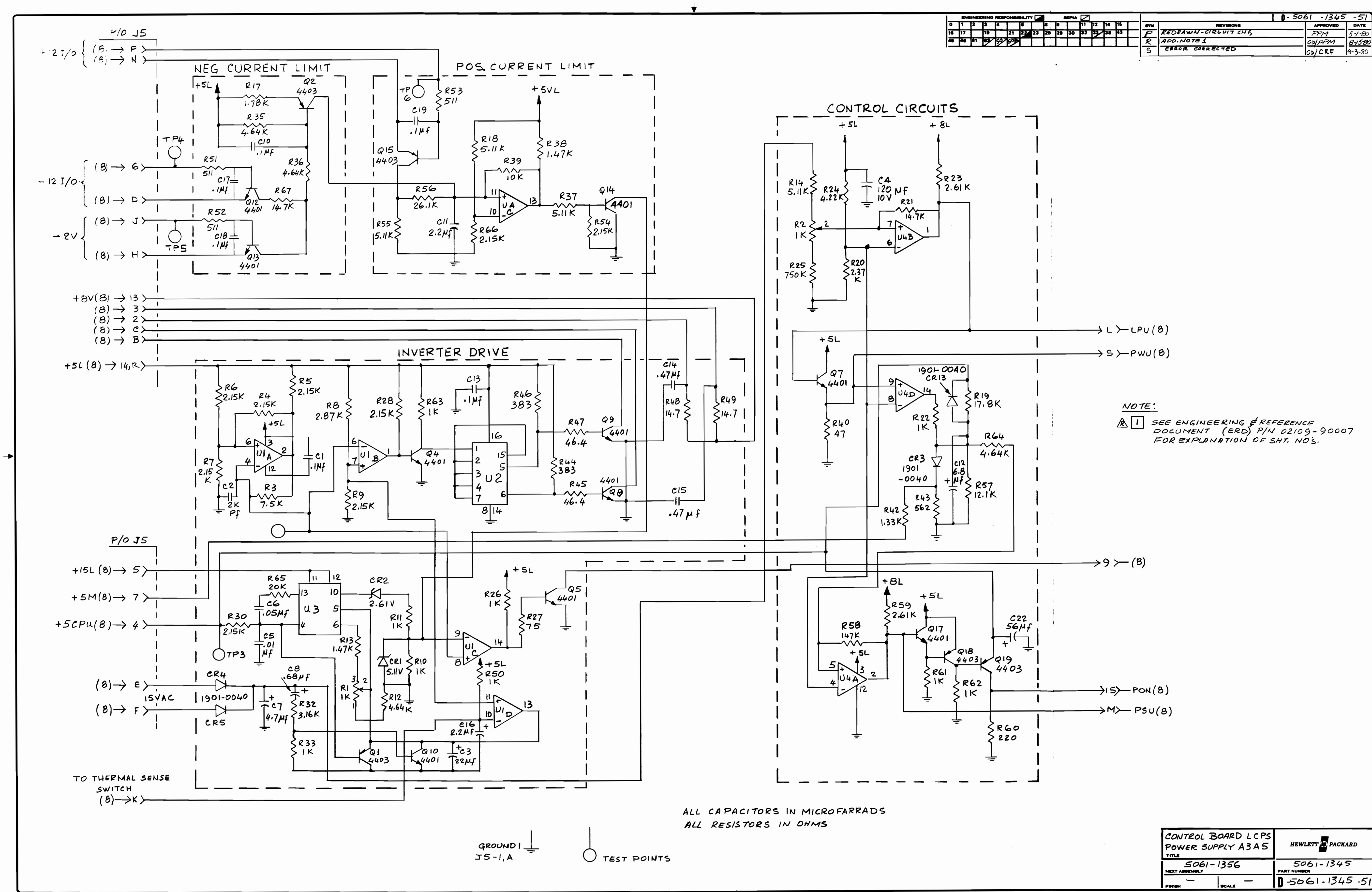
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
01	C14,15	CAP .47UF-20+80%		0160-0174		U	2
01	C6	CAP .047UF 20%		0160-0575		U	1
01	C5	CAP .01UF		0160-2055		U	1
00	C2	CAP 2000PF 5%		0160-2225		U	1
01	C1,10,	CAPACITOR-FIXED 13,17-19		0160-5054		U	6
01	C7	CAP 4.7UF 35WVDC		0180-0100		U	1
01	C11,16	CAP 2.2UF 10%		0180-0197		D	2
01	C3	CAP 22UF 10%		0180-0228		D	1
00	C8	CAP .68UF 10%		0180-0373		U	1
00	C22	CAP 56UF 6VDC		0180-0548		U	1
00	C12	CAP 6.8UF 20%		0180-1701		U	1
00	C4	CAP 120UF 10%		0180-2145		U	1
00	E1,2	STUD SOLDER TERM		0360-0294		U	2
00	R60	RES 220 5% .25		0683-2215		U	1
00	R40	RES 47 5% .25		0683-4705		U	1
01	R4-7,9	RES 2.15K 1%.125 ,28,30,54,66		0698-0084		U	9
		RES 2.61K 1%.125		0698-0085		U	2

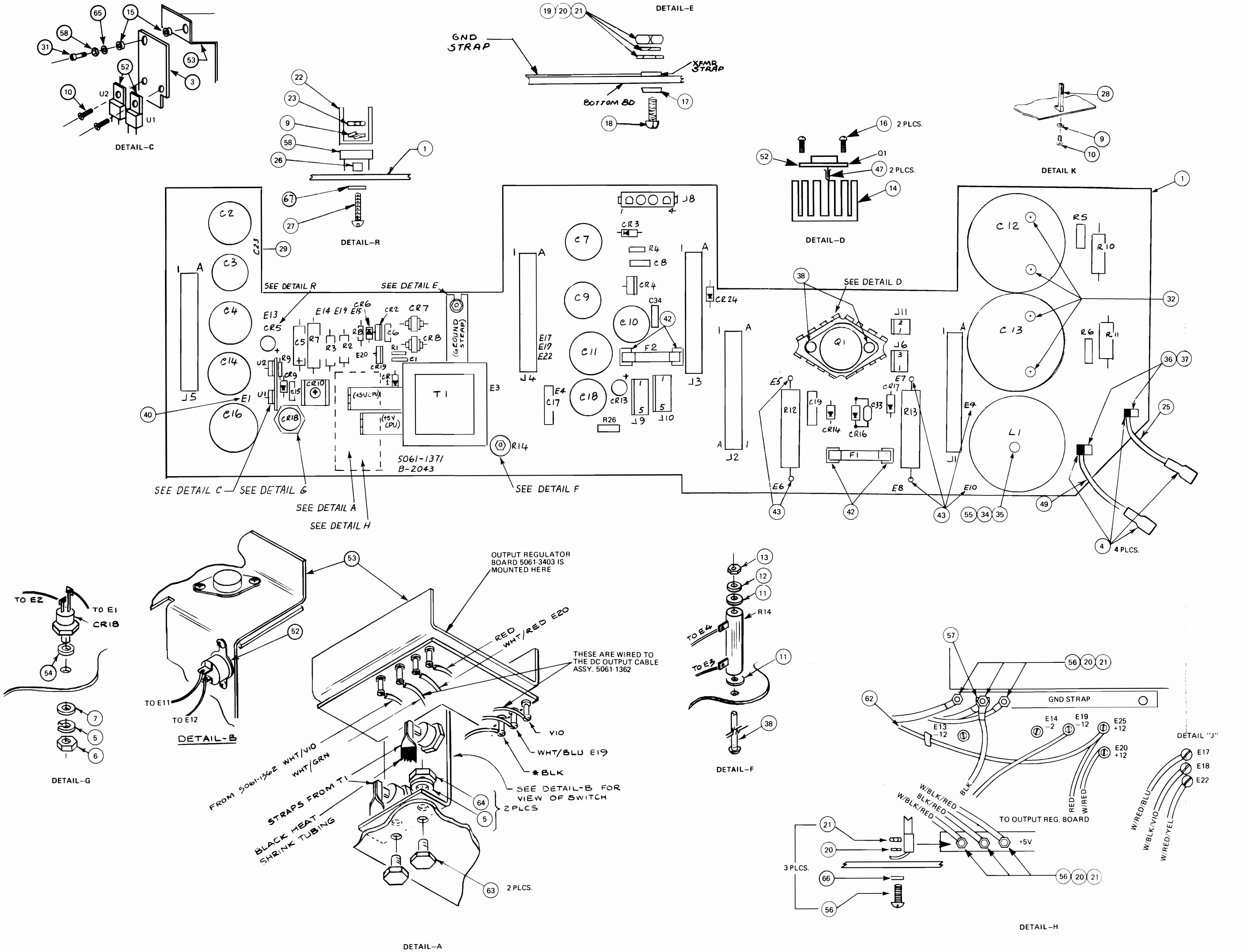
A5 Control Board Assembly Parts List (5061-1345) Sht. 2 of 3

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
01	R23,59			0698-0085			
01	R19	RES 17.8K 1%.125		0698-3136		U	1
01	R20	RES 2.37K 1%.125		0698-3150		U	1
00	R8	RES 2.87K 1%.125		0698-3151		U	1
01	R24	RES 4.22K 1%.125		0698-3154		U	1
01	R12,35,36,64	RES 4.64K 1%.125		0698-3155		D	4
01	R21,67	RES 14.7K 1%.125		0698-3156		D	2
00	R56	RES 26.1K 1%.125		0698-3159		D	1
01	R48,49	RES 14.7 1% .5W		0698-3388		U	2
01	R44,46	RES 383 1%.125		0698-3446		U	2
01	R58	RES 147K 1%.125		0698-3452		U	1
01	R45,47	RES 46.4 1%.125		0698-4037		U	2
01	R17	RES 1.78K 1%.125		0757-0278		U	1
00	R32	RES 3.16K 1%.125		0757-0279		U	1
01 03	R10,11,22,26 33,50,61,62,63	RES 1K 1%.125		0757-0280		D	9
00	R42	RES 1.33K 1%.125		0757-0317		U	1
00	R27	RES 75 1%.125		0757-0398		U	1
01	R51-53	RES 511 1%.125		0757-0416		D	3

A5 Control Board Assembly Parts List (5061-1345) Sht. 3 of 3

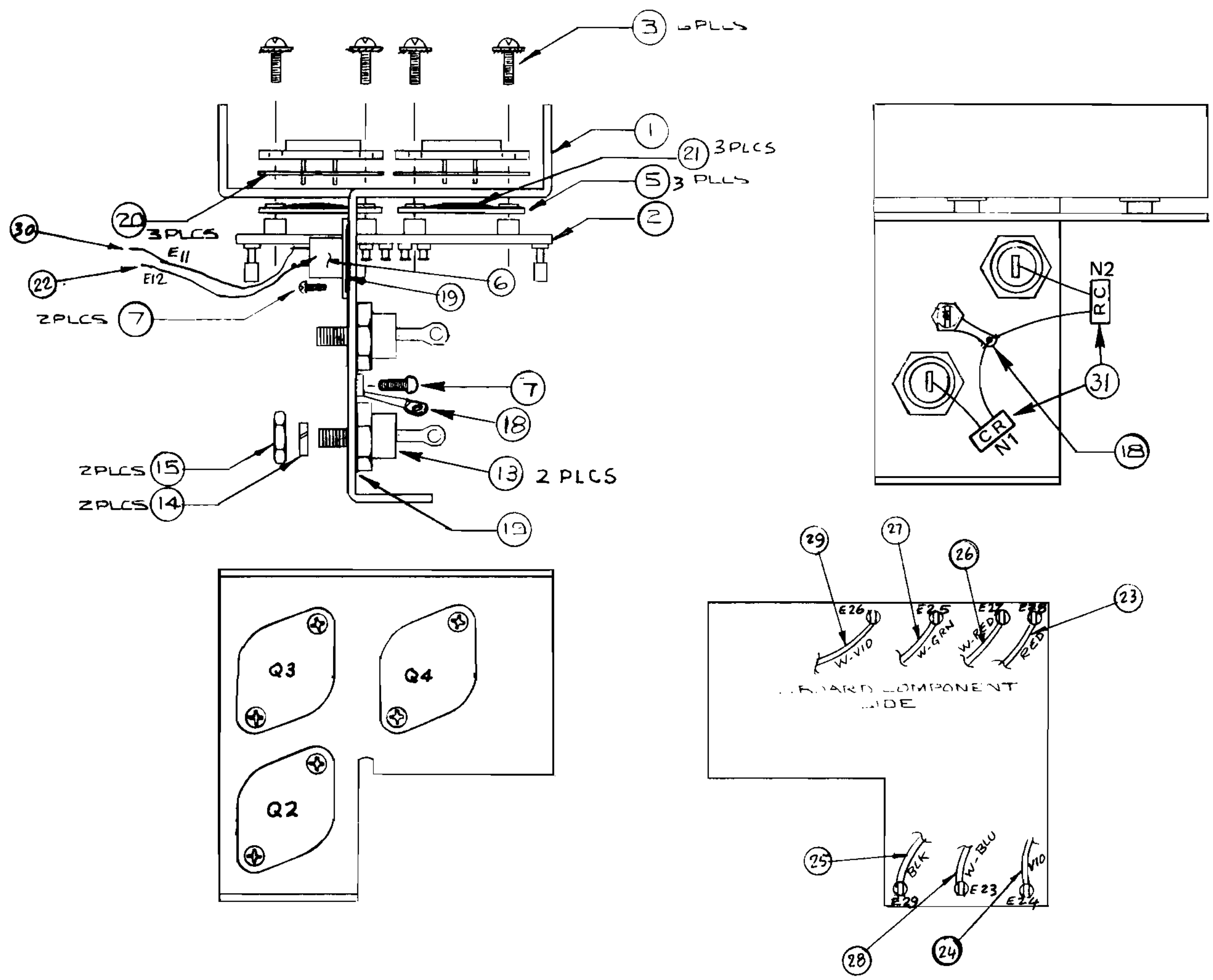
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
		RES 562 1%.125		0757-0417		D	1
00	R43						
		RES 750 1%.125		0757-0420		U	1
01	R25						
		RES 5.11K 1%.125		0757-0438		D	4
01	R14,18	,37,55					
		RES 7.5K 1%.125		0757-0440		U	1
00	R3						
		RES 10K 1%.125		0757-0442		D	1
00	R39						
		RES 12.1K 1%.125		0757-0444		D	1
01	R57						
		RES 20K 1%.125		0757-0449		D	1
01	R65						
		RES 1.47K 1%.125		0757-1094		D	2
01	R13,38						
		TBG #20 TFE NAT		0890-0212		U	0.09
		IC SN74S112N		1820-0629		U	1
00	U2						
		IC V REG		1826-0049		U	1
00	U3						
		IC QUAD COMPTR		1826-0138		U	2
00	U1,4						
		XSTR 2N4403 TO92		1853-0271		U	5
01	Q1,2,1	5,18,19					
		XSTR 2N4401 TO92		1854-0467		U	10
01	Q4,5,7	-10,12-14,17					
		DIODE SIL		1901-0040		D	4
01	CR3-5,	13					
		DIODE ZNR 5.11V		1902-0041		D	1
00	CR1						
		DIODE 2.61V		1902-0126		U	1
00	CR2						
		RES VAR 1K		2100-1986		U	2
00	R1,2						
		LABEL-USA		7120-6830		L	1


NEG CURRENT LIMIT
POS. CURRENT LIMIT
CONTROL CIRCUITS
INVERTER DRIVE
I/O J5
P/O J5
-12 I/O
-2V
+8V(8) → 13
+5L (8) → 14,R
+15L (8) → 5
+5M(8) → 7
+5CPU(8) → 4
15VAC
TO THERMAL SENSE SWITCH (8) → K
L — LPU(8)
S — PWU(8)
9 — (8)
15 — PON(8)
M — PSU(8)
NOTE:
1 SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHT. NO'S.
ALL CAPACITORS IN MICROFARRADS
ALL RESISTORS IN OHMS
GROUND 1 J5-1,A
TEST POINTS
REVISIONS
P REDRAWN-CIRCUIT CHG
R ADD NOTE 1
S ERROR CORRECTED
D-5061-1345-51
CONTROL BOARD LCPS
POWER SUPPLY A3A5
NEXT ASSEMBLY 5061-1356
PART NUMBER 5061-1345
HEWLETT PACKARD
D-5061-1345-51



ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L PART NO.
1	1	BOARD P.C.	5080-9798
2	4	PAD-FOAM	4208-0171
3	1	VOLTAGE REGULATOR HEATSINK	5001-2680
4	4	LUG CRP 16-14	0362-0561
5	3	LOCK WASHER SPLIT	2190-0032
6	3	NUT HEX	2950-0036
7	1	WASHER FIBER	3050-0665
8	1	SCREW 6-32x2.500	2360-0221
9	10	LOCKWASHER, SPLIT 4	2190-0003
10	14	SCREW 4-40x.250	2200-0139
11	2	EXTRUDED WASHER	3050-0006
12	1	WASHER FLAT	3050-0100
13	1	NUT HEX	2420-0001
14	1	HEAT SINK	1205-0312
15	2	FIBER WASHER W/LIP	3050-0004
16	2	SCREW	2360-0117
17	1	WASHER	3050-0239
18	1	SCREW 6-32x.625 LG	2360-0203
19	1	WASHER FLAT	3050-0227
20	7	WASHER SPLIT	2190-0851
21	7	NUT HEX 6.32	2420-0003
22	1	HEAT SINK	5001-2808
23	1	NUT HEX	2260-0001
24	2	EYELET	0361-1076
25	0.67'	WIRE 16 GA RED	8150-2185
26	1	SPACER NYLON	0380-0996
27	1	SCREW 4-40x.750	2200-0151
28	10	CARD HOLDERS	5040-0170
29	1	CAP 2.2 NF C23	0160-0128
30	0.33 FT	SLEEVING FLEX	0890-0064
31	1	SCREW 4-40 x .56	2200-0091
32	4	SCREW 10-32x.375	2680-0099
33	4	LOCK WASHER SPLIT #10	2190-0034
34	5	WASHER FLAT #10	3050-0236
35	1	NUT HEX #10	2740-0002
36	3	LUG FASTON	0360-1685
37	3	RIVET	0361-1032
38	2	SPACER	0380-0383
39	3	TERMINAL	0360-0090
40	1	TERMINAL	0360-1167
41	18	EYELETS	0361-0252
42	4	FUSE CLIP	2110-0269
43	16	TERMINAL	0360-1529
44	3-1/2"	WIRE BLUE 18 GA	8150-2893
45	2.500	WIRE YEL 18 GA	8150-0577
46	2"	WIRE GRN 22 GA	8150-1645
47	2	CONNECTOR, PIN TYPE	1251-2913
48	2	LUG-FASTON	0362-0480
49	0.61'	WIRE 16 GA BLACK	8150-2605
50	2	LUG CRP 22-18 GA RED	0362-0317
51	3	TY-WRAP	1400-0493
52	.01 TB	THERMAL COMPOUND	6040-0239
53	1	OUTPUT REG BD HEATSINK	5001-2691
54	1	SPACER	3050-0234
55	1	LK WASHER #10 INT	2190-0011
56	6	SCREW 6-32x375	2360-0197
57	1	LUG CRP 22-18 GA RED	0362-0321
58	1	HEX LOCK WASHER	2190-0108
59	.95'	WIRE 22 GA BLUE	8150-1546
60	1	GND STRAP	5001-2622
61	1	+5V STRAP	5001-2621
62	1	ASSY-WIRING	5061-1362
63	2	SCREW 1/4x20	2940-0103
64	2	NUT	2950-0004
65	1	FLAT WASHER	3050-0222
66	6	FIBER WASHER .144x.25	3050-0023
67	1	WASHER 1/4 FOR #4 SCREW	3050-0229

A6 Mother Board Assembly (5061-1371)



NOTE: THIS LAST SINK APPLICABLE
TO B REVISIONS OF 5061-1371
ONLY.

ITEM	QTY.	DESCRIPTION	PART NO.
1	1	HEAT SINK	5001-2691
2	1	PC ASSY	5061-3403
3	6	SCREW 6-32 x .500 WITH LOCK-WSH.	2360-0121
4		DELETED	
5	3	INSULATOR	0340-0503
6	1	THERMO SW.	3103-0085
7	3	SCREW 4-40 x .250	2200-0103
8		DELETED	
9		DELETED	
10		DELETED	
11		DELETED	
13	2	DIODE CR 11, 12	1901-0884
14	2	LOCKWASHER .250	2190-0032
15	2	NUT HEX	2950-0036
18	1	LUG SOLDER NO. 4	0360-0272
19	A/R	THERMO COMPOUND	6040-0239
20	3	INSULATOR	1200-0043
21	A/R	SUPER BONDER 430 ADHESIVE	0470-0526
22	5.5"	BLUE 22 AWG. WIRE	8150-1546
23	4.5"	RED 18 AWG. WIRE	8150-2891
24	4.5"	VIO 18 AWG. WIRE	8150-2894
25	3.5"	BLK 18 AWG. WIRE	8150-2890
26	4.5"	W-RED 18 AWG. WIRE	8150-2649
27	5.5"	W-GRN 18 AWG. WIRE	8150-2899
28	4.5"	W-BLUE 18 AWG. WIRE	8150-2900
29	5.5"	W-VIO 18 AWG. WIRE	8150-2650
30	5.5"	BLUE 22 AWG. WIRE	8150-1546
31	2	SNUBBER (N1, N2)	1810-0500

Heat Sink Assembly

A6 Mother Board Assembly Parts List (5061-1371) Sht. 1 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C34	CAP 0.1UF		0150-0121		U	1	
01	C17	CAP .01UF 20%		0150-0123		U	1	
01	C23	CAP. 2.2UF		0160-0128		U	1	
01	C53	CAP 50PF 5% 500V		0160-2023		U	1	
01	C1,6,8,15	CAP .01UF		0160-2055		U	4	
01	C19	CAP 4700PF 10%		0160-2627		U	1	
01	C12,13	CAP 1150UF		0180-0431		U	2	
00	C5	CAP 120UF 10%		0180-2145		U	1	
00	C2	CAP 9700UF 6.3V		0180-2652		U	1	
00	C18	CAP 750UF 40V		0180-2653		U	1	
00	C10	CAP 5200UF 6.3V		0180-2654		U	1	
00	C4,11,14	CAP 3300UF 25V		0180-2658		U	3	
00	C16	CAP 0.0165F 6.3V		0180-2659		U	1	
01	C3	C-F 2000UF 25V		0180-2660		U	1	
01	C7,9	C-F 900UF 25V AL		0180-2755		U	2	
		TRANS INSULATOR		0340-0503		U	3	
01	E2,11,12	STUD SOLDER		0360-0090		U	3	

A6 Mother Board Assembly Parts List (5061-1371) Sht. 2 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		TERM-SOLDER LUG		0360-0272		U	1	
00	E1	TERM DBL-TUR		0360-1167		U	1	
01	E5-10,13-15,17-20,22	TERM STUD FKD		0360-1529		U	16	
		LUG SOLDER #5		0360-1685		U	5	
		EYLT RLD FLG		0361-0252		U	20	
		EYLT .121DX.200		0361-1032		U	5	
		LUG CRP22-18FS6		0362-0317		U	2	
		LUG CRP22-18RT6		0362-0321		U	1	
		CONN-SGL CONT		0362-0561		U	4	
		STDF-RVT-ON		0380-0757		U	2	
		SPACER #4X.125		0380-0996		U	1	
		ADHESIVE BONDING		0470-0526		U	0.01	KT
01	R26	RES 2.61K 1% .5		0698-0024		U	1	
01	R1,4,8,9	RES 42.2 1%.125		0757-0316		U	4	
01	R10,11	RES 22K 5% 2W MO		0764-0045		U	2	
01	R12	RES 1K 5% 10W PW		0811-1586		U	1	
01	R3	RES .05 10% 3W		0811-1826		U	1	
00	R7	RES .125 OHM		0811-1846		U	1	
00	R13	RES .25 5% 10W		0811-3176		U	1	
00	R2	RES 0.18 OHM WW		0811-3293		U	1	
00	R14	RES 50 5% 20W PW		0819-0022		U	1	
		THERMISTOR		0837-0130 PART NO CONT		U	2	

A6 Mother Board Assembly Parts List (5061-1371) Sht. 3 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		PART NO CONT		0837-0130				
00	R5,6							
		SLEEVING FLEX.		0890-0064		U	0.33	FT
		TBG HS BLK .375D		0890-0291		U	0.17	FT
		INSL-XSTR T03 AL		1200-0043		U	3	
		HEAT SINK		1205-0312		U	1	
00	E29,30	CONN-SGL CONT		1251-0600		U	2	
00	J1-5	CONN PC2X15.156D		1251-2035		U	5	
		CONNECTOR; SGL		1251-2913		U	2	
00	J9,10	CONN MALE 5 POST		1251-3825		U	2	
00	J8	CONN UTIL 4PIN M		1251-3837		U	1	
00	J11	CONN POST 2POS M		1251-4245		U	1	
00	J6	CONN POST 3POS M		1251-4246		U	1	
		CA TIE 5.5L		1400-0493		U	1	
01	N1,N2	NETWORK-SNUBBER		1810-0500		U	2	
00	U1	IC RGLTR +5V		1826-0144		U	1	
00	U2	IC 7806C		1826-0146		U	1	
01	Q1	XSTR NPN T03 10A		1854-0869		U	1	
00	CR18	THYRISTOR 35AMPS		1884-0208		U	1	
01	CR2,4,19	THYRISTOR SCR		1884-0233		U	3	
01	CR11,12	SCHOTTKY RECT		1901-0884		U	2	
		DIODE HS 30 NS		1901-0893 PART NO CONT		U	1	

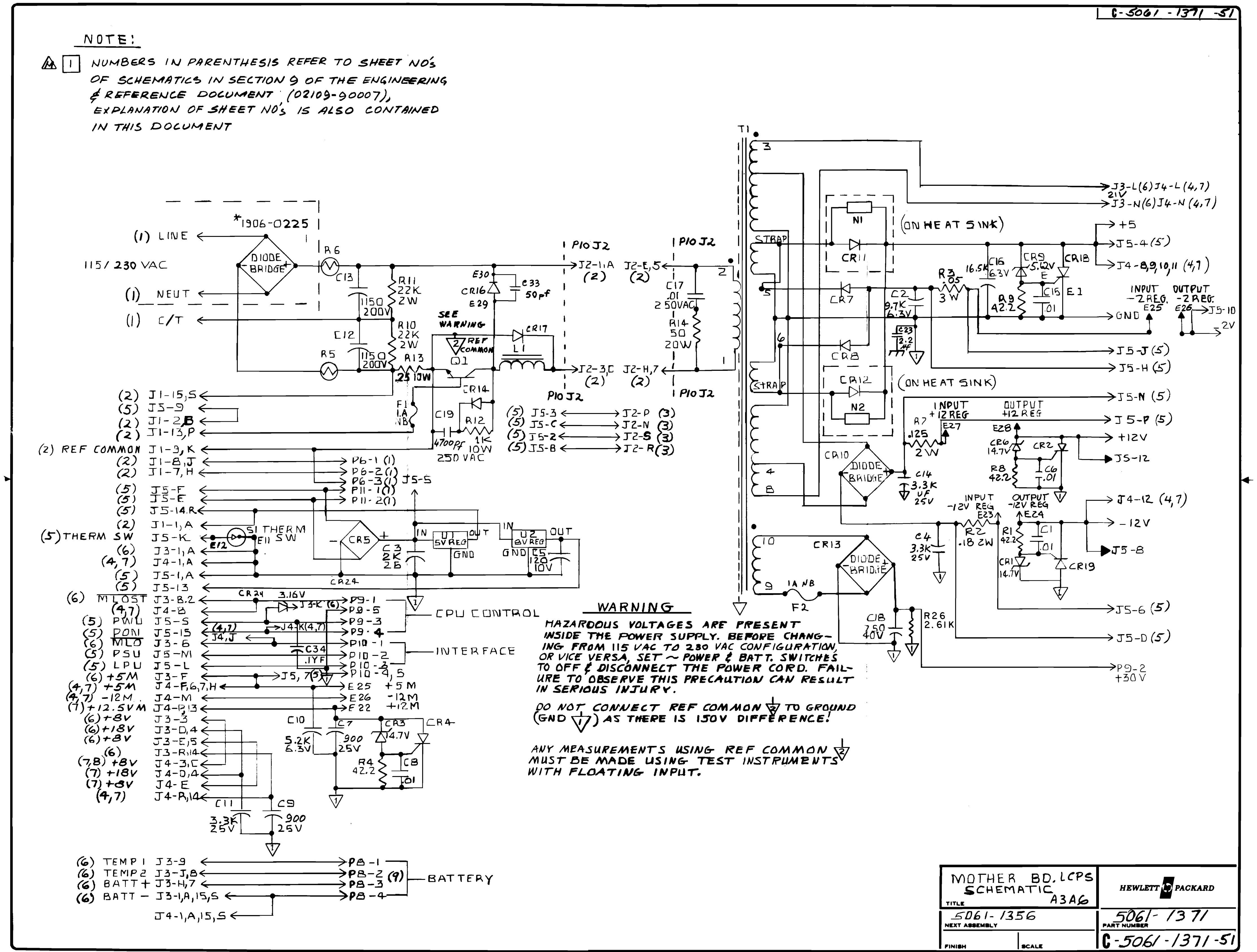
A6 Mother Board Assembly Parts List (5061-1371) Sht. 4 of 6

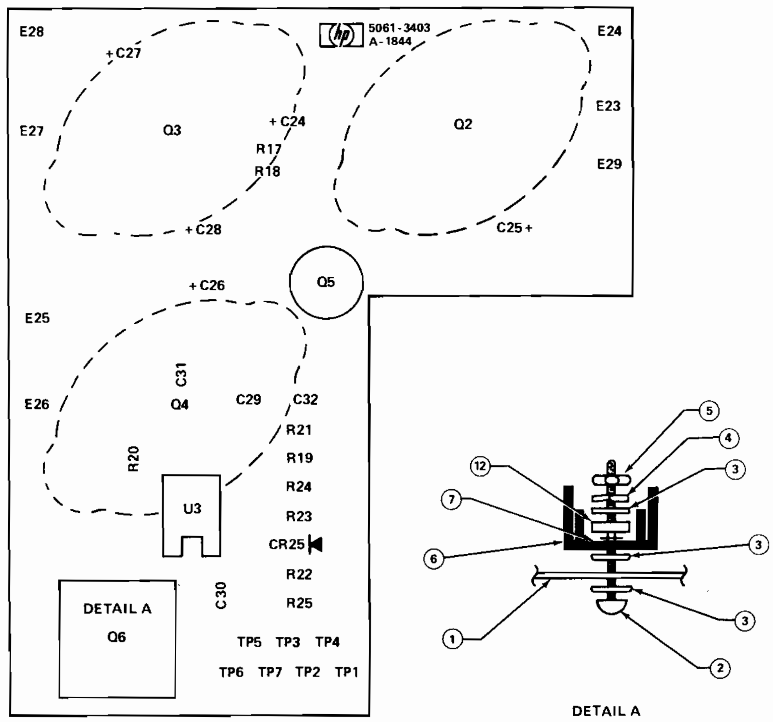
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		PART NO CONT		1901-0893				
01	CR16							
		DIODE IN4936		1901-1065		D	1	
01	CR14							
		DIODE		1901-1086		U	2	
00	CR7,8							
		RECTIFIER		1901-1087		D	1	
01	CR17							
		DIO-ZNR 14.7V 2%		1902-0078		U	3	
01	CR1,3,6							
		DIODE 3.16V		1902-3036		D	1	
00	CR24							
		DIO-ZNR 5.62V 2%		1902-3105		D	1	
01	CR4							
		DIODE-FW BRIDGE		1906-0051		U	2	
01	CR5,13							
		RECTIFIER		1906-0079		U	1	
00	CR10							
		FUSE 1A NB		2110-0001		U	2	
00	F1,2							
		FUSE CLIP .250D		2110-0269		U	4	
		LKWSHR 10 INT		2190-0011		U	1	
		LKWSHR 1/4 HEL		2190-0032		U	5	
		LKWSHR 10 HEL		2190-0034		U	4	
		LKWSHR 4 HEL		2190-0108		U	3	
		LKWSHR 6 HEL		2190-0851		U	7	
		SCREW		2200-0091		U	1	
		SCR 4-40X.25		2200-0103		U	14	
		SCR #4-40X.250L		2200-0139		U	12	
		SCR 4-40X.75		2200-0151		U	1	
		NUT 4-40 .250AF		2260-0001		U	1	
		SCR #6-32X.375L		2360-0117		U	2	
		SCR #6-32X.500L		2360-0121		U	6	

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		SCR #6-32X.375L		2360-0197		U	6	
		SCR #6-32X2.5L		2360-0221		U	1	
		NUT 6-32 W/LK		2420-0001		U	1	
		NUT 6-32 .312AF		2420-0002		U	1	
		NUT 6-32 .250AF		2420-0003		U	6	
		SCR 10-32X.375		2680-0099		U	4	
		NUT 10-32 .375AF		2740-0002		U	1	
		SCR 1/4-20X.500L		2940-0103		U	2	
		NUT 1/4-20		2950-0004		U	2	
		NUT 1/4-28		2950-0036		U	3	
		WASHER EXTRUDED		3050-0004		U	2	
		WSHR #10		3050-0006		U	2	
		WSHR #6		3050-0023		U	6	
		WSHR #6 BRS		3050-0100		U	1	
		WSHR #4 SS		3050-0222		U	1	
		WSHR #6 SS		3050-0227		U	1	
		WSHR #4 SS		3050-0229		U	1	
		WSHR .260ID BRS		3050-0234		U	1	
		WSHR #10 BRS		3050-0236		U	4	
		WSHR #8 FIBER		3050-0239		U	1	
		WASHER FLAT		3050-0665		U	1	
		SWITCH-THERMAL		3103-0085		U	1	
01	S1							
		FOAM-PLASTIC		4208-0171		U	4	
		WIRE 18 YEL		8150-0577		C	0.22	FT
		WIRE 22 GRN		8150-1545		C	0.17	FT
		WIRE 22 BLU		8150-1546		C	0.95	FT
		WIRE 16 RED		8150-2185		C	0.67	FT

A6 Mother Board Assembly Parts List (5061-1371) Sht. 6 of 6

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WIRE 16 BLACK		8150-2605		C	0.67	FT
		WIRE 18 WHT-RED		8150-2649		C	0.38	FT
		WIRE 18 WHT-VIO		8150-2650		C	0.46	FT
		WIRE 18 BLK		8150-2890		C	0.30	FT
		WIRE 18 RED		8150-2891		C	0.38	FT
		WIRE 18 BLU		8150-2893		C	0.29	FT
		WIRE 18 VIO		8150-2894		C	0.38	FT
		WIRE 18 WHT-GRN		8150-2899		C	0.46	FT
		WIRE 18 WHT-BLU		8150-2900		C	0.38	FT
		WIRE 30AWG WHT		8150-3426		C	0.33	FT
		CHOKE		9100-3947		U	1	
01	L1							
		XFMR-INVERTER		9100-4112		U	1	
01	T1							
		+5V STRAP		5001-2621		W	1	
		GROUND STRAP		5001-2622		W	1	
		VOLT REG HT SNK		5001-2680		W	1	
		OUTPT REG HT SNK		5001-2691		W	1	
		HEAT SINK		5001-2808		W	1	
		GUIDE-PC		5040-0170		W	10	
		ASSY-CBL DC OUT		5061-1362		1	1	
		ASSY-LCPS OUTREG		5061-3403		4	1	
		BOARD-ETCHED		5080-9798		W	1	


NOTE:
1 NUMBERS IN PARENTHESIS REFER TO SHEET NO'S OF SCHEMATICS IN SECTION 9 OF THE ENGINEERING & REFERENCE DOCUMENT (02109-90007), EXPLANATION OF SHEET NO'S IS ALSO CONTAINED IN THIS DOCUMENT
WARNING
HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY. BEFORE CHANGING FROM 115 VAC TO 230 VAC CONFIGURATION, OR VICE VERSA, SET ~ POWER & BATT. SWITCHES TO OFF & DISCONNECT THE POWER CORD. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY.
DO NOT CONNECT REF COMMON TO GROUND (GND) AS THERE IS 150V DIFFERENCE!
ANY MEASUREMENTS USING REF COMMON MUST BE MADE USING TEST INSTRUMENTS WITH FLOATING INPUT.
115/230 VAC
CPU CONTROL
INTERFACE
BATTERY
MOTHER BD. LCPS SCHEMATIC A3A6
5061-1356
5061-1371
C-5061-1371-51
HEWLETT PACKARD



DETAIL A

ITEM	OTY.	OESCRIPTION	PART NO.
1	1	BOARD ETCHED	5090-0582
2	1	SCREW 4–4OX.438	2200-0145
3	3	WASHED FLAT	3050-0229
4	1	WASHER SPLIT LOCK	2190-0108
5	1	NUT 4-40	2260-0001
6	1	HEAT SINK	1205-0219
7	-	THERMAL COMPOUND	6040-0239
12	1	TRANSISTOR Q6	1854-0683

A6A1 Output Regulator Board Assembly
5061-3403

A6A1 Output Regulator Board Assembly Parts List (5061-3403) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C29,32	CAP .1UF 20% 50V		0160-0576		D	2	
01	C30,31	CAP 1000PF 10%		0160-3456		U	2	
01	C25,27,28	CAP 100UF 20%		0180-0098		U	3	
01	C24,26	CAP 4.7UF 35WVDC		0180-0100		U	2	
		PAD-MTG TO5		0340-0164		U	1	
01	TP1-7	STUD SOLDER		0360-0090		U	7	
01	E23-29	TERM STUD FKD		0360-1529		U	7	
		STANDOFF-RIVT-ON		0380-1137		U	6	
01	R18	RES 2.37K 1%.125		0698-3150		D	1	
01	R17	RES 3.48K 1%.125		0698-3152		U	1	
01	R19	RES 215 1%.125		0698-3441		D	1	
01	R21	RES 316 1%.125		0698-3444		D	1	
01	R20,23,24	RES 1K 1%.125		0757-0280		D	3	
01	R22	RES 10K 1%.125		0757-0442		D	1	
01	R25	RES 100K 1%.125		0757-0465		D	1	
		HT DIS PL PWR		1205-0219		U	1	
		CONNECTOR; SGL		1251-2913		U	6	
01	Q3	VOLTAGE REGLTR		1813-0093		U	1	

A6A1 Output Regulator Board Assembly Parts List (5061-3403) Sht. 2 of 2

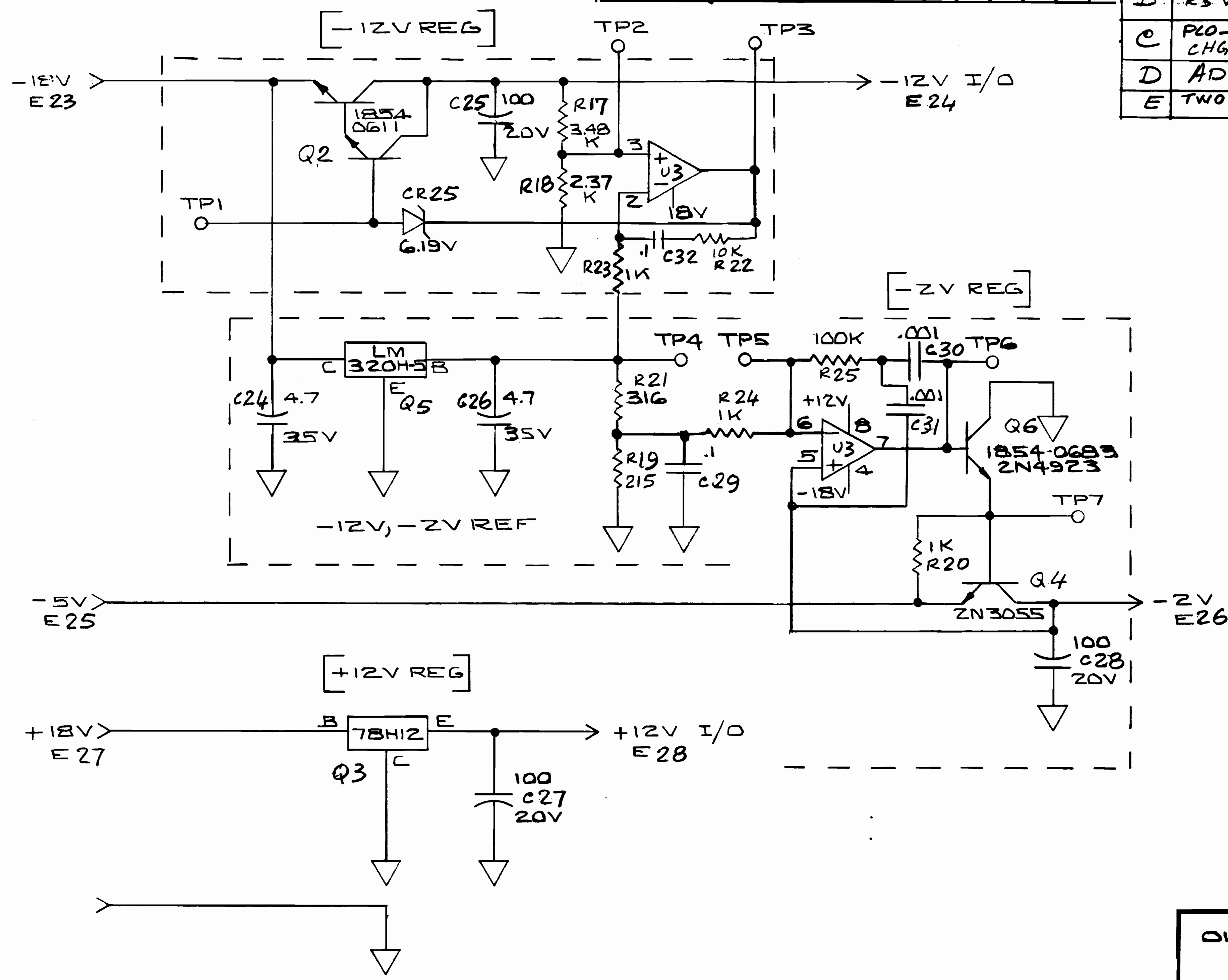
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	U3	IC MC1458 P1		1826-0139		U	1	
01	Q5	IC V REG -5V		1826-0220		U	1	
01	Q4	XSTR 2N3055 TO3		1854-0063		U	1	
01	Q2	XSTR 2N6055 TO3		1854-0611		U	1	
01	Q6	XSTR NPN SI		1854-0635		U	1	
01	CR25	DIODE 6.19V		1902-0049		U	1	
		LKWSHR 4 HEL		2190-0108		U	1	
		SCR 4-40X.438		2200-0145		U	1	
		NUT 4-40 .250AF		2260-0001		U	1	
		WSHR #4 SS		3050-0229		U	3	
		COMPOUND-THERMAL		6040-0239		U	0.01	TR

ENGINEERING RESPONSIBILITY ■ **SEPIA** ▢

0	1	2	3	4		6		8	9		11	12	14	15
16	17		19		21	22	23	25	29	30	32	33	38	43
45	46	61	63											

B-5061-3403-51

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		5/18/78
B	PCO-22-5159, ADD. MISSING REF. DESIGNATORS R3 WAS 196; R4 WAS 100	GD/	2-22-79
C	PCO-22-5704, ADD. SHT. 10 OF 10 CHG. DESIGNATORS NO'S.	GD/PPM	6/27/80
D	ADD. NOTE 1	GD/PPM	8-15-80
E	TWO R19'S IN ERROR, ONE CHG. TO R17	GD/PPM	12-10-80



NOTE:

△D 1 SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EXPLANATION OF SHEET NO'S.

OUTPUT REG. BD. LCPS TITLE	HEWLETT hp PACKARD
5061-1371 NEXT ASSEMBLY	5061-3403 PART NUMBER
FINISH / SCALE	B-5061-3403-51

SHEET OF

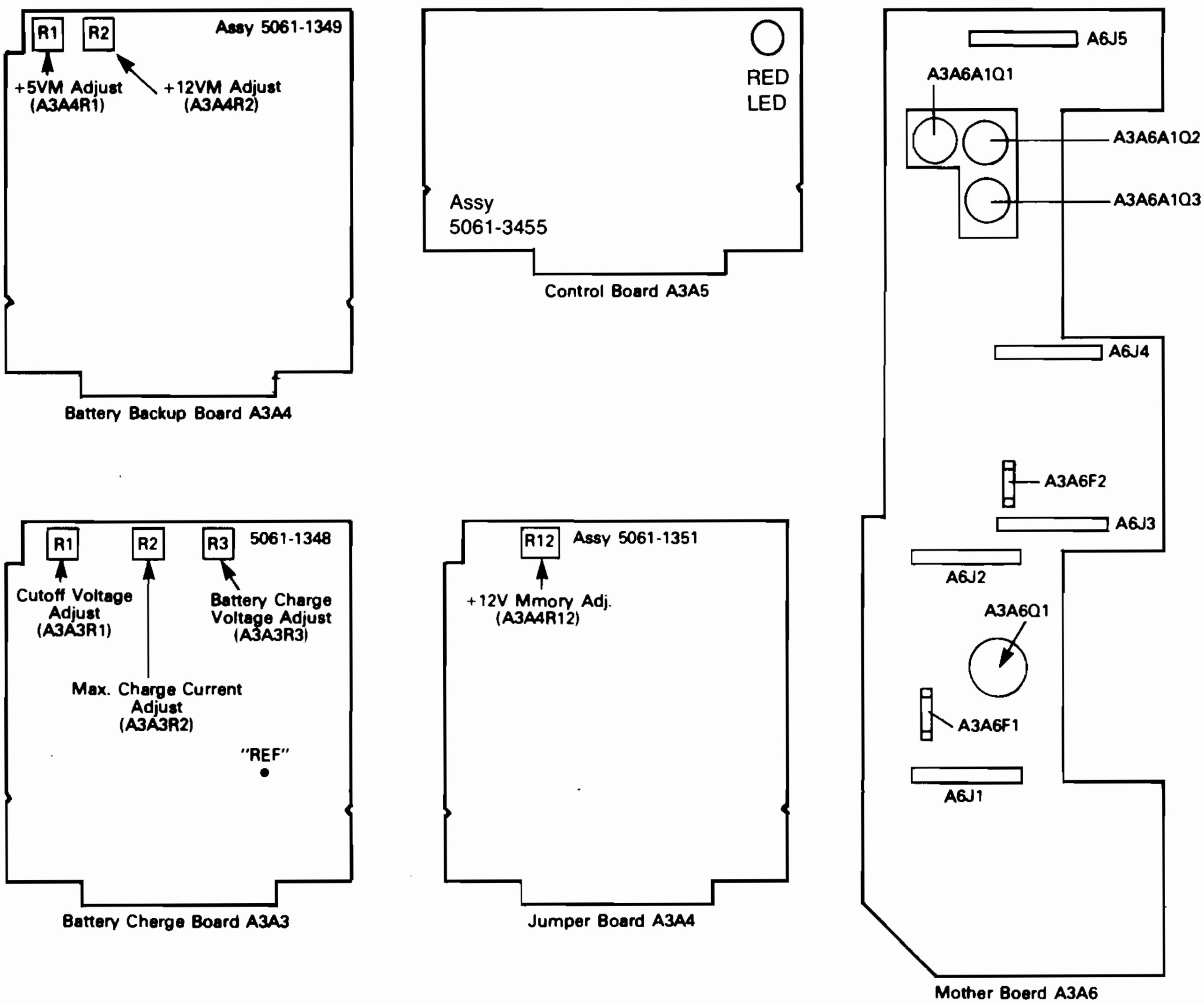
POWER SUPPLY
Part Number 5061-3476/5061-6615
FOR HP 1000 "B" MODEL
COMPUTERS AND EXTENDERS

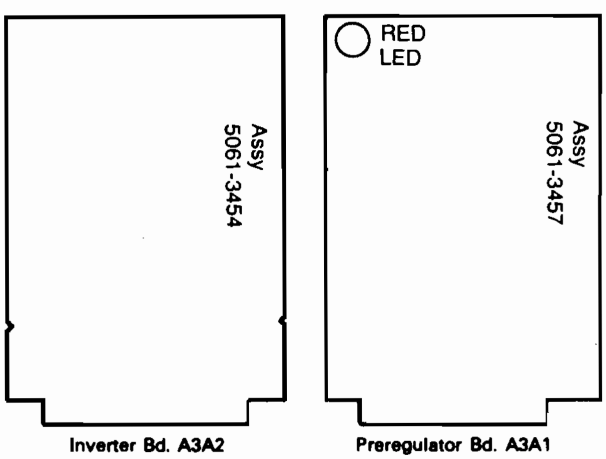
(2108B, 2109B, 2111F, 2112B, 2113B, 2117F, 12979B, AND 12990B)

THEORY OF OPERATION

Computer Serial Prefixes
5061-3476: 2108-2305
5061-6615: 2305 or later

CONTENTS
Subsections C through G
(Date Codes 2305 and above)





Description	New Part #	
Preregulator BD, A3A1	5061-3457	Power Supply A3. 5061-3476 5061-6615
Inverter Bd, A3A2	5061-3454	
Jumper Bd, A3A4	5061-1351	
Control Bd, A3A5	5061-3455	
Mother Bd, A3A6	5061-1371	
Output Regulator Bd, A3A6A1 (Mother Bd subassembly	5061-3403	
A3A6A1Q3 -2V I/O Transistor	1854-0063	
A3A6A1Q1-12V I/O Transistor	1854-0611	
A3A6A1Q2 +12V Regulator	1813-0093	
Battery Charge Bd, A3A3	5061-1348	Power Fail 12991B
Battery Backup Bd, A3A4	5061-1349	

Figure 1. Power Supply Replaceable Assemblies

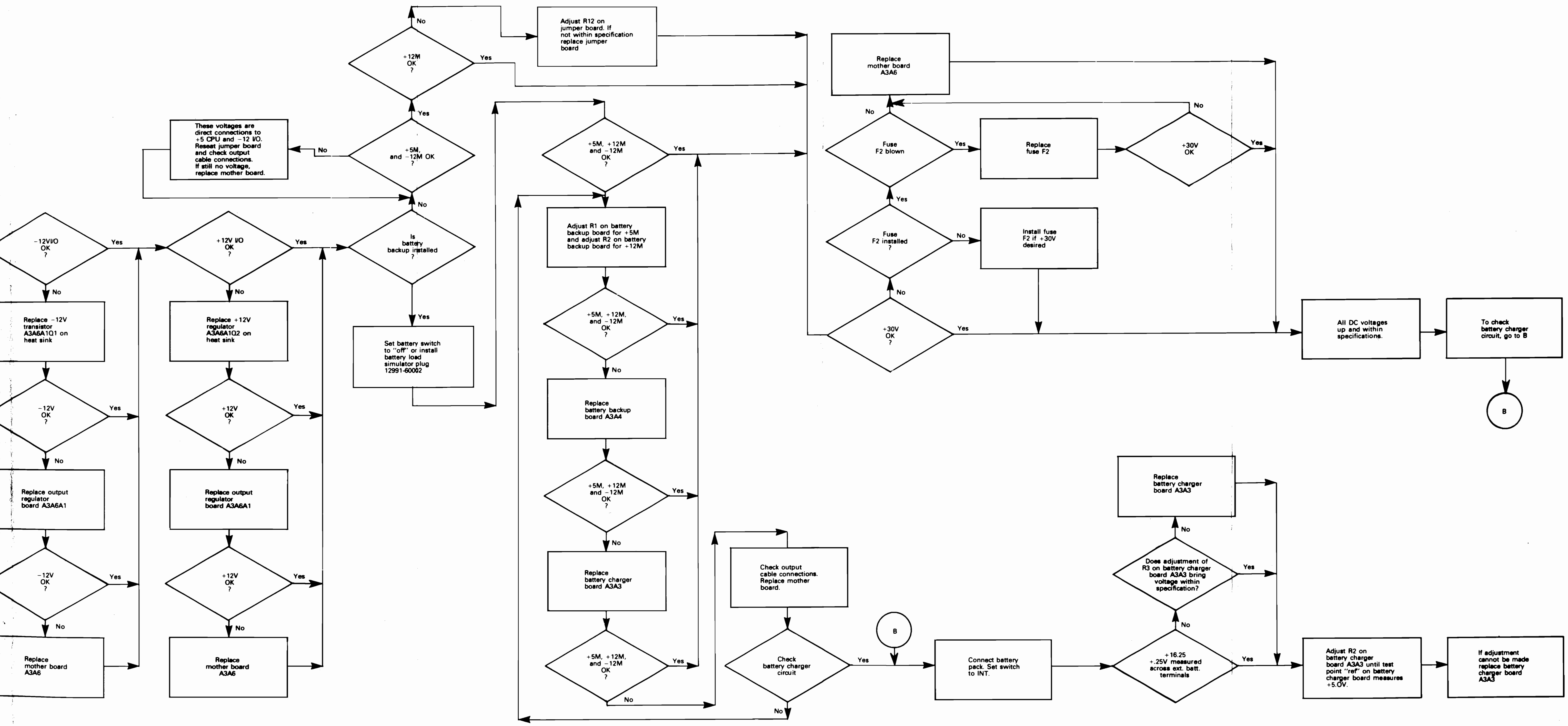
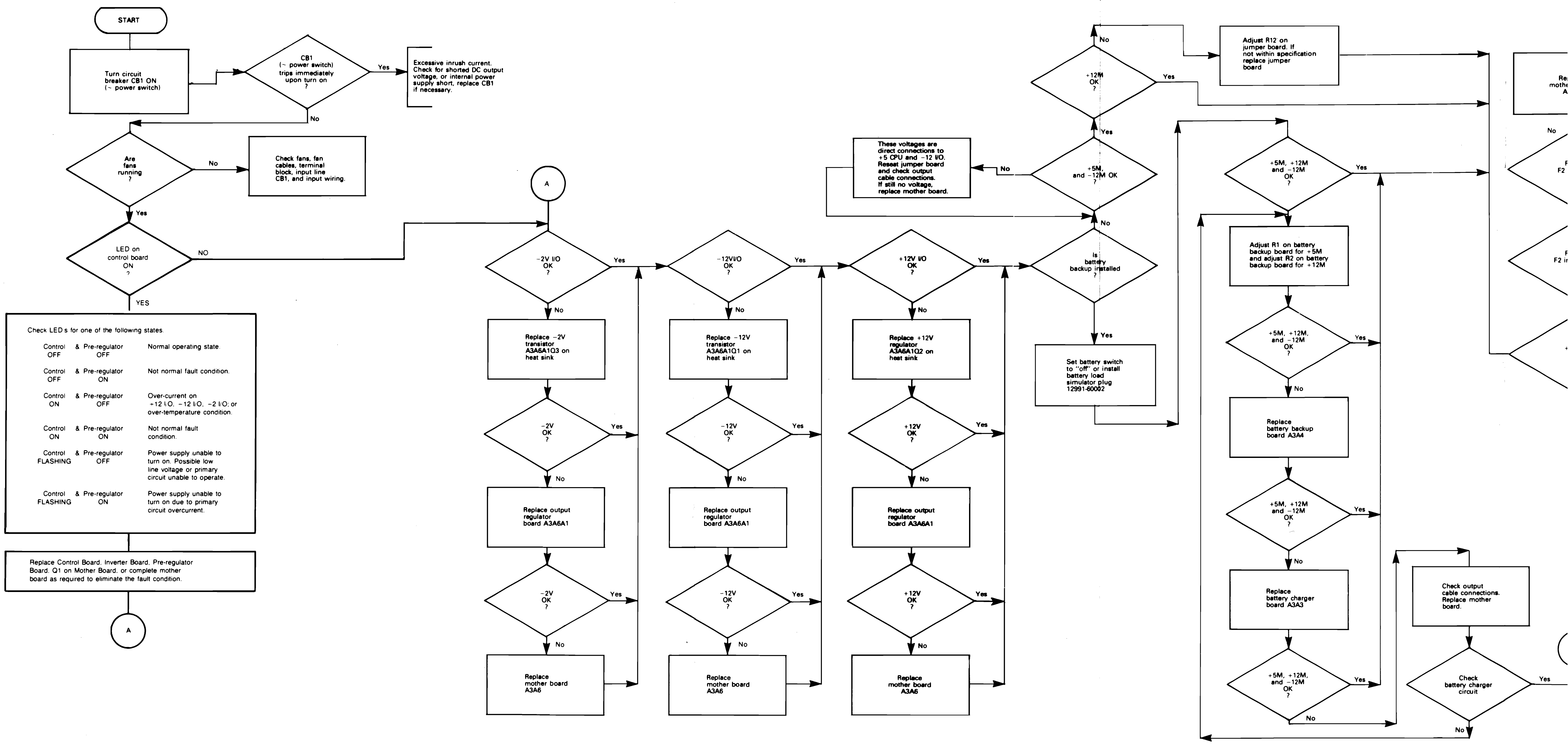


Figure 2. Power Supply Troubleshooting Flowchart



START
Turn circuit breaker CB1 ON (~ power switch)
CB1 (~ power switch) trips immediately upon turn on ?
Yes
Excessive inrush current. Check for shorted DC output voltage, or internal power supply short, replace CB1 if necessary.
No
Are fans running ?
No
Check fans, fan cables, terminal block, input line CB1, and input wiring.
Yes
LED on control board ON ?
NO
YES
Check LED s for one of the following states.
Control OFF & Pre-regulator OFF — Normal operating state.
Control OFF & Pre-regulator ON — Not normal fault condition.
Control ON & Pre-regulator OFF — Over-current on +12 I/O, −12 I/O, −2 I/O; or over-temperature condition.
Control ON & Pre-regulator ON — Not normal fault condition.
Control FLASHING & Pre-regulator OFF — Power supply unable to turn on. Possible low line voltage or primary circuit unable to operate.
Control FLASHING & Pre-regulator ON — Power supply unable to turn on due to primary circuit overcurrent.
Replace Control Board, Inverter Board, Pre-regulator Board, Q1 on Mother Board, or complete mother board as required to eliminate the fault condition.
A
A
−2V I/O OK ?
Yes
No
Replace −2V transistor A3A6A1Q3 on heat sink
−2V OK ?
Yes
No
Replace output regulator board A3A6A1
−2V OK ?
Yes
No
Replace mother board A3A6
−12V I/O OK ?
Yes
No
Replace −12V transistor A3A6A1Q1 on heat sink
−12V OK ?
Yes
No
Replace output regulator board A3A6A1
−12V OK ?
Yes
No
Replace mother board A3A6
+12V I/O OK ?
Yes
No
Replace +12V regulator A3A6A1Q2 on heat sink
+12V OK ?
Yes
No
Replace output regulator board A3A6A1
+12V OK ?
Yes
No
Replace mother board A3A6
Is battery backup installed ?
Yes
Set battery switch to "off" or install battery load simulator plug 12991-60002
No
+5M, and −12M OK ?
No
These voltages are direct connections to +5 CPU and −12 I/O. Reset jumper board and check output cable connections. If still no voltage, replace mother board.
Yes
+12M OK ?
No
Adjust R12 on jumper board. If not within specification replace jumper board
Yes
+5M, +12M and −12M OK ?
Yes
Adjust R1 on battery backup board for +5M and adjust R2 on battery backup board for +12M
+5M, +12M, and −12M OK ?
Yes
No
Replace battery backup board A3A4
+5M, +12M and −12M OK ?
Yes
No
Replace battery charger board A3A3
+5M, +12M, and −12M OK ?
Yes
No
Check output cable connections. Replace mother board.
Check battery charger circuit
Yes
No
No

Power Supply Complete Assembly (5061-3476) Sht. 1 of 2

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		INSULATOR		0340-0873		U	1	
		LUG SOLDER #6LKG		0360-0268		U	1	
		BLK BARR 5 TERM		0360-0624		U	1	
		MKR STRP 5X.375		0360-1309		U	1	
		TERM-BARR BLOCK		0360-1830		U	4	
		LUG CRP16-14.19F		0362-0144		U	1	
		LUG CRP26-24.19F		0362-0480		U	4	
		LUG CRP22-18.25F		0362-0482		U	1	
		GROM SNAP .375ID		0400-0056		U	1	
		NUT SHMET U 6-32		0590-0653		U	16	
		TERM-BARRBLK TAB		1251-3491		U	5	
		LKWSHR 6 HEL		2190-0851		U	24	
		SCR 4-40X.25		2200-0103		U	2	
		SCR #6-32X.312L		2360-0115		U	13	
		SCR #6-32X.250L		2360-0192		U	8	
		SCR #6-32X.250L		2360-0193		U	16	
		SCR #6-32X.500L		2360-0201		U	2	
		SCR #6-32X.750L		2360-0204		U	8	
		SCR #6-32X.750L		2360-0205		U	8	
		SCR 6-32X.375		2360-0359		U	8	
		WSHR #6 SS		3050-0227		U	18	
		WSHR #6 SS		3050-0228		U	2	
		SW SLIDE DPDT PC		3101-1338		U	1	
		CKT BRKR 2P 10A		3105-0116		U	1	
		FAN GRILLE		3160-0092		U	4	

Power Supply Complete Assembly (5061-3476) Sht. 2 of 2

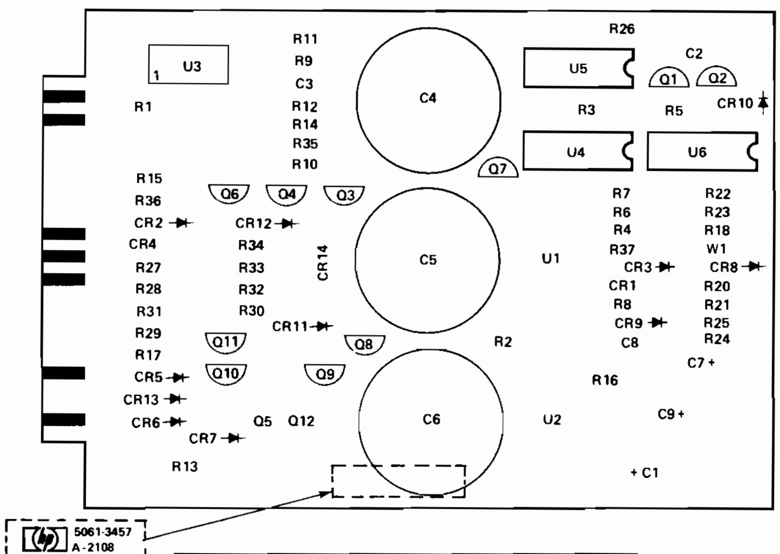
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		FAN-TBAX		3160-0341		U	2	
		FOAM-PLASTIC		4208-0172		U	2	
		FOAM-PLASTIC		4208-0205		C	1	
		LABEL SERIAL		7120-1002		U	1	
		LABEL-CAUTION		7120-3528		U	1	
		LABEL-INFO		7120-6073		U	1	
		LABEL-WARNING		7120-6317		U	1	
		WIRE 22 GRA		8150-1548		C	0.45	FT
		DECK-LCPS		5000-8088		W	1	
		LCPS-SIDE COVER		5000-8134		W	1	
		BRACKET		5001-2624		W	1	
		HOLD DWN BRACKET		5001-2625		W	1	
		COVER-PROT TB		5001-2628		W	1	
		COVER-PROT FP		5001-2630		W	1	
		COVER-FRONT,LCPS		5001-2660		W	1	
		COVER-TOP		5001-2661		W	1	
		ASSY-PS REAR PNL		5061-1350		4	1	
		ASSY-LCPS JUMPER		5061-1351		4	1	
		ASSY-CABLE FANS		5061-1359		1	1	
		ASSY-CABLE STAT		5061-1365		1	1	
		ASSY-LCPS MTHRBD		5061-1371		4	1	
		ASSY-LCPS INV II		5061-3454		4	1	
		ASSY-LCPS CTR II		5061-3455		4	1	
		ASSY-LCPS PREG 2		5061-3457		4	1	

Power Supply Complete Assembly (5061-6615) Sht. 1 of 2

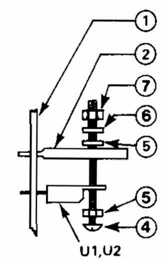
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		LUG SOLDER #6LKG		0360-0268		E	1	
		BARRIER BLOCK		0360-0624		E	1	
		MKR STRP 5X.375		0360-1309		E	1	
		TERM-BARR BLOCK		0360-1830		E	4	
		LUG CRP22-18.25F		0362-0482		E	1	
		GROM SNAP .375ID		0400-0056		E	1	
		TERM-BARRBLK TAB		1251-3491		E	5	
		LKWSHR 6 HEL		2190-0851		E	2	
		SCR #6-32X.312L		2360-0115		E	2	
		SCR #6-32X.375L		2360-0117		E	11	
		SCR #6-32X.250L		2360-0192		E	22	
		SCR #6-32X.500L		2360-0201		E	4	
		SCR #6-32X.875L		2360-0207		E	2	
		SCR 6-32X.375		2360-0359		E	2	
		WSHR #6 SS		3050-0228		E	2	
		FOAM-PLASTIC		4208-0205		C	1	
		FM-POLYU .375T		4208-0334		E	1	
		LCPS-SIDE COVER		5000-8134		E	1	
		BRACKET		5001-2624		E	1	
		COVER-PROT TB		5001-2628		E	1	
		COVER-TOP		5001-2661		C	1	
		PROTECTIVE COVER		5001-2696		E	1	
		SAFETY COVER		5040-6309		E	1	
		ASSY-R PNL LCPS		5061-1350		4	1	
		ASSY-LCPS JUMPER		5061-1351		4	1	

Power Supply Complete Assembly (5061-6615) Sht. 2 of 2

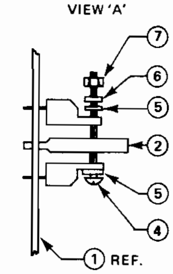
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		ASSY-CABLE FANS		5061-1359		E	1	
		ASSY-LCPS MTHRBD		5061-1371		4	1	
		ASSY-LCPS INV II		5061-3454		4	1	
		ASSY-LCPS CTR II		5061-3455		4	1	
		PCA-PREREGULATOR		5061-3457		4	1	
		LINE CONF JUMPER		5061-6618		E	1	
		LINE CONF JUMPER		5061-6619		E	1	
		ASSY-LCPS FRT PL		5061-6620		4	1	
		ASSY-LCPS DECK		5061-6621		4	1	
		ASSY-CBL FAN		02112-60018		E	2	



VIEW 'B'



VIEW 'A'



ITEM	QTY.	DESCRIPTION	PART NO.
1	1	BOARD ETCHED	5180-0113
2	3	HEAT SINK	1205-0349
3	7	NUT, HEX	2260-0009
4	1	SCREW 4-40x3/8	2200-0143
5	4	WASHER FLAT 4x40	3050-0229
6	1	WASHER SPLIT LOCK	2190-0108
7	1	NUT 4-40	2260-0001
8	2	SCREW 4-40	0624-0077

A1 Pre-regulator Board II Assembly
5061-3457

A1 Pre-regulator Board II Assembly Parts List (5061-3457) Sht. 1 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C1,9	C-F 150UF 15V TA		0180-0194		D	2	
01	C4-6	C-F 2600UF 20V		0180-2886		D	3	
		SCR TAP 4-40X.31		0624-0077		U	2	
01	R13	R F .82OHM 5% 2W		0811-1665		U	1	
		HEAT SINK		1205-0349		U	3	
01	U4	IC SN74LS00N		1820-1197		U	1	
01	U5	IC SN74LS38N		1820-1209		U	1	
01	U1	IC 7805		1826-0122		U	1	
01	U6	IC QUAD COMPTR		1826-0138		U	1	
01	U2	IC MC7908CT		1826-0344		U	1	
01	Q3,4,6,8	XSTR 2N4403 TO92		1853-0271		U	4	
01	Q5	XSTR PNP 2N6476		1853-0406		U	1	
01	Q1,2,7,9-11	XSTR 2N4401 TO92		1854-0467		U	6	
01	Q12	XSTR NPN 2N6474		1854-0727		U	1	
01	CR14	DIO-FW BRDG 100V		1906-0048		U	1	
01	CR10	LED-VISIBLE		1990-0627		U	1	
01	U3	OPTO-ISOLATOR		1990-0664		U	1	
		LKWSHR 4 HEL		2190-0108		U	1	

A1 Pre-regulator Board II Assembly Parts List (5061-3457) Sht. 2 of 4

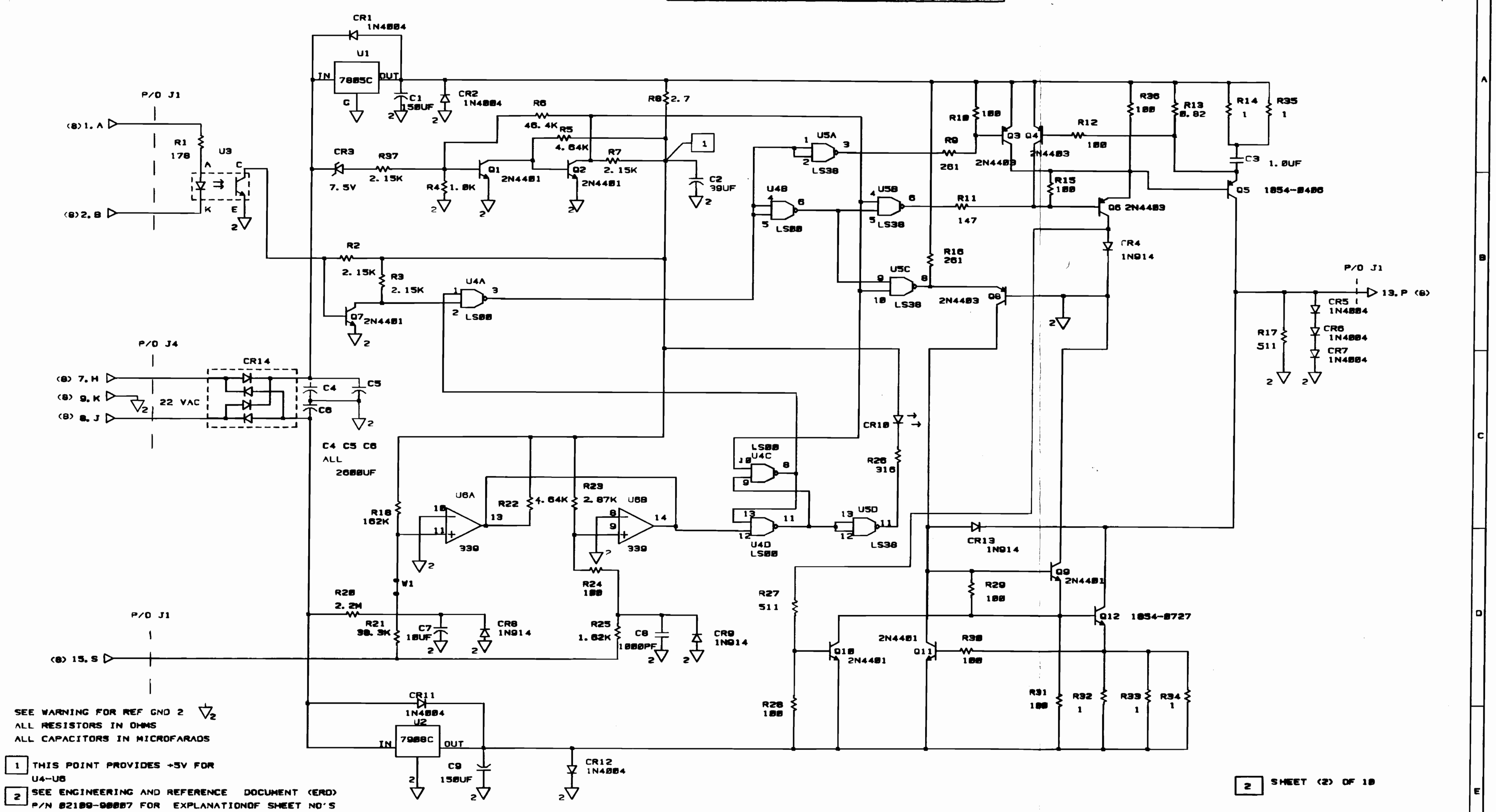
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		SCR 4-40X.312		2200-0166		U	2	
		NUT 4-40 .250AF		2260-0001		U	1	
		NUT 4-40 W/LK		2260-0009		U	1	
		WSHR #4 SS		3050-0229		U	4	
		LABEL-USA		7120-6830		L	1	
		BD-ETCHED		5180-0113		R	1	

A1 Pre-regulator Board II Assembly Parts List (5061-3457) Sht. 3 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C8	CAP 1000PF 5%		0160-4822		D	1	
01	C3	CAP 1.0UF +80-20		0160-4844		D	1	
01	C7	CAP 10UF 10%		0180-0374		D	1	
01	C2	CAP 39UF 10%		0180-0393		D	1	
01	R8	RES 2.7 5% .25		0683-0275		D	1	
01	R20	RES 2.2M 5% .25		0683-2255		D	1	
01	R2,3,7,37	RES 2.15K 1%.125		0698-0084		D	4	
01	R9,16	RES 261 1%.125		0698-3132		D	2	
01	R23	RES 2.87K 1%.125		0698-3151		D	1	
01	R5,22	RES 4.64K 1%.125		0698-3155		D	2	
01	R21	RES 38.3K 1%.125		0698-3161		D	1	
01	R6	RES 46.4K 1%.125		0698-3162		D	1	
01	R11	RES 147 1%.125		0698-3438		D	1	
01	R1	RES 178 1%.125		0698-3439		D	1	
01	R26	RES 316 1%.125		0698-3444		D	1	
01	R14,32-35	RES 1 5% .25W FC		0699-0208		D	5	
01	R4	RES 1K 1%.125		0757-0280		D	1	
01	R10,12,15,24,28-31,36	RES 100 1%.125		0757-0401		D	9	
		RES 511 1%.125		0757-0416 PART NU CONT		D	2	

A1 Pre-regulator Board II Assembly Parts List (5061-3457) Sht. 4 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R17,R27	PART NO CONT		0757-0416				
01	R25	RES 1.62K 1%.125		0757-0428		D	1	
01	R18	RES 162K 1%.125		0757-0470		D	1	
01	CR4,8,9,13	DIODE-SILICON		1901-0050		D	4	
01	CR1,2,5-7,11,12	DIO-PWR RECT		1901-0731		D	7	
01	CR3	DIODE		1902-0064		D	1	
01	W1	WIRE JUMPERS		8159-0005		D	1	



03			22			50	50A			39					

SYM	REVISIONS	APPROV.	DATE
A	AS ISSUED PER PC22-5839	PPM	3-29-[illegible]

SEE WARNING FOR REF GND 2
ALL RESISTORS IN OHMS
ALL CAPACITORS IN MICROFARADS

1 THIS POINT PROVIDES +5V FOR U4-U6

2 SEE ENGINEERING AND REFERENCE DOCUMENT (ERD) P/N 02100-00007 FOR EXPLANATIONOF SHEET NO'S

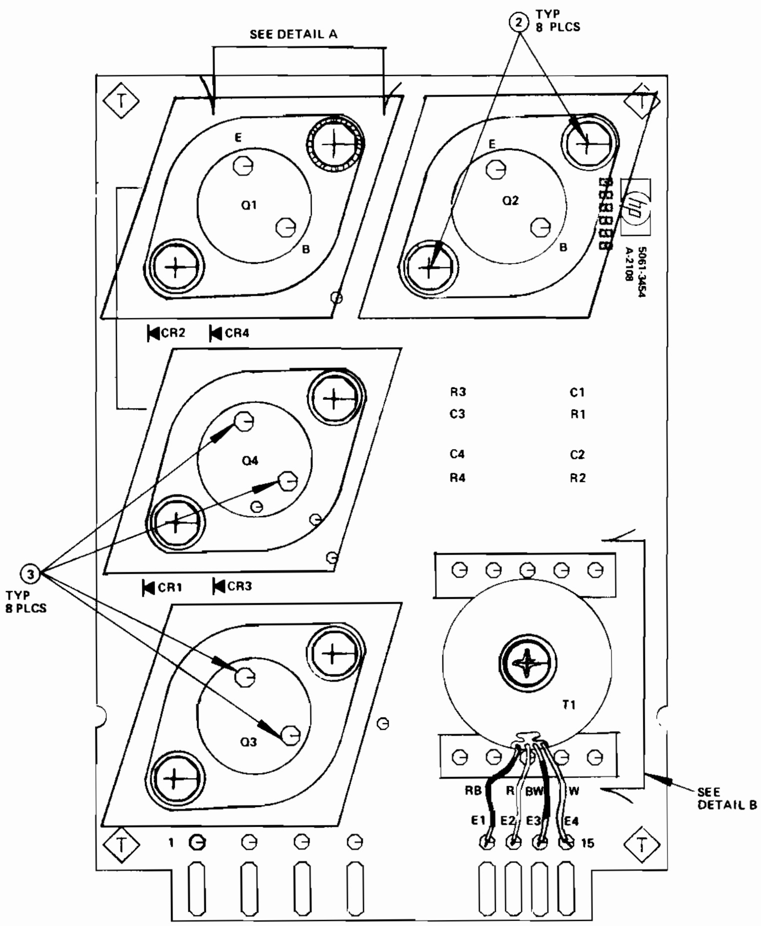
!! WARNING !!
HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY. BEFORE CHANGING FROM 110 VAC TO 220 VAC CONFIGURATION OR VICE VERSA SET POWER AND BATTERY SWITCHES TO OFF AND DISCONNECT THE POWER CORD. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY.

!! CAUTION !!
ANY MEASUREMENTS MADE USING REF. COMMON ∇_2 MUST BE MADE USING TEST INSTRUMENTS WITH A FLOATING INPUT

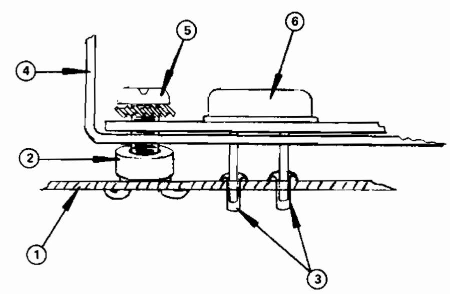
!! DO NOT CONNECT REF. COMMON ∇_2 TO GROUND ∇_1 AS THERE IS APPROX. 150 VOLTS DIFFERENCE !!

2 SHEET (2) OF 10

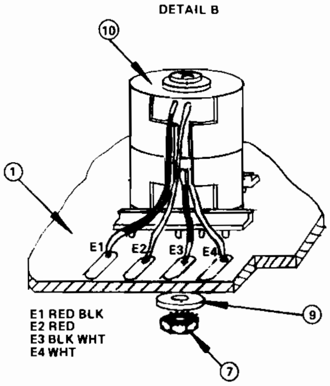
DRAWN P. MINER	PREREGULATOR II	HEWLETT/PACKARD	
ENGR. D. BELL	TITLE LCPS (A3A1)		
RELEASE P. MINER	NEXT ASSY. 5061-3476	PART# 5061-3457	
		5061 - 3457 - 51	SH 1 OF 1



DETAIL A



DETAIL B



ITEM	QTY.	DESCRIPTION	PART NO.
1	1	P.C. BOARD, ETCHED	5180-0111
2	8	SPCR TAP #6x.187	0380-0745
3	8	CONNECTOR, PIN	1251-2913
4	4	HEAT SINK TO-3	1205-0312
5	8	SCREW 6-32x.438 W/LK	2360-0119
6	4	XSTR TO3 Q1-Q4	1854-0869
7	1	NUT #6	2420-0001
9	1	FLAT WASHER	3050-0228
10	1	TRANSFORMER T1	9100-4142

A2 Inverter Board II Assembly
5061-3454

A2 Inverter Board II Assembly Parts List (5061-3454) Sht. 1 of 2

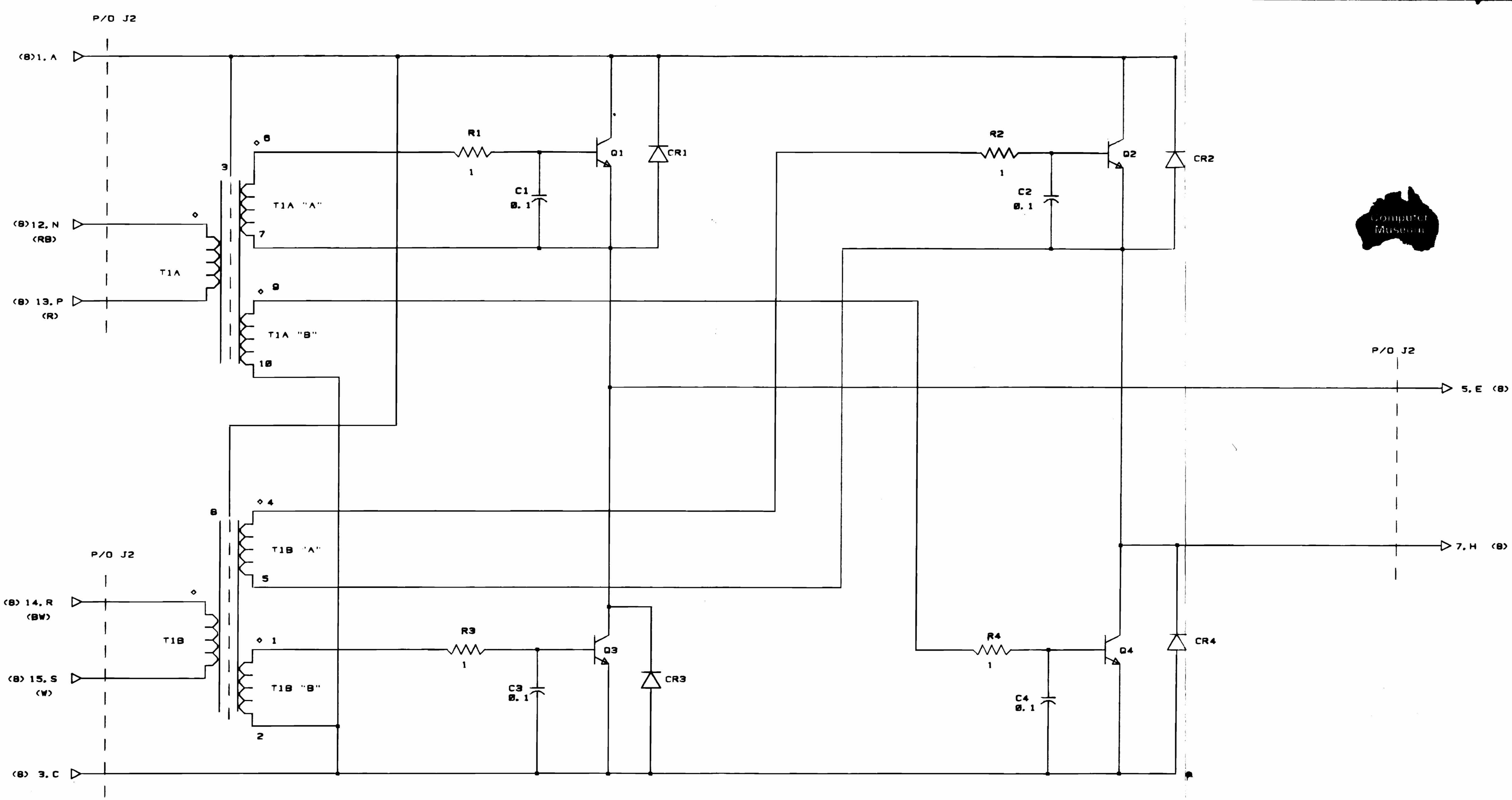
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		SPCR TAP #6X.187		0380-0745		U	8	
01	E1-8							
		HEAT SINK		1205-0312		U	4	
		CONNECTOR; SGL		1251-2913		U	8	
01	E9-16							
		XSTR NPN TO3 10A		1854-0869		U	4	
01	Q1-4							
		SCR #6-32X.437L		2360-0119		U	8	
		NUT 6-32 W/LK		2420-0001		U	1	
		WSHR #6 SS		3050-0228		U	1	
		LABEL-USA		7120-6830		L	1	
		X-FMR-INVERTER		9100-4142		U	1	
		BD-ETCHED		5180-0111		N	1	

A2 Inverter Board II Assembly Parts List (5061-3454) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP .1UF +80		0160-4841		D	4	
01	C1,2,3,4							
		RES 1 1% .75W PW		0811-0060		D	4	
01	R1,2,3,4							
		DIO-1N4937		1901-0831		D	4	
01	CR1-4							

B-5061-3454-51

SYM	REVISIONS	APPROV.	DATE
A	AS ISSUED PER PC22-5839	PDM	5-25-81
B	PCO-22-6728 NEXT ASSY. WAS 5061-3476		3/8/8

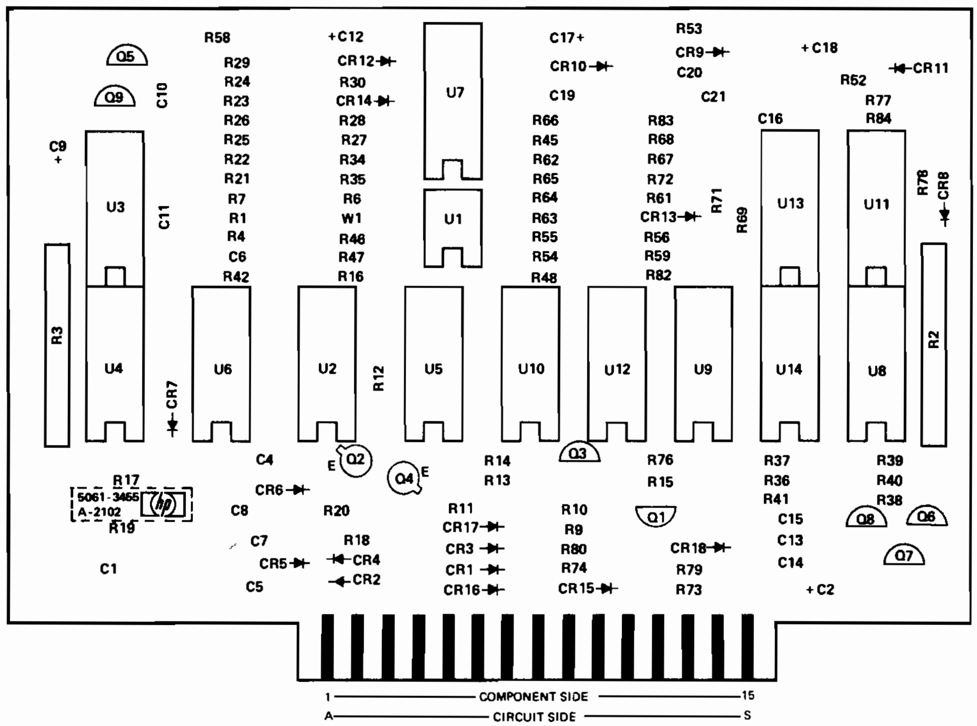


1 SHEET (3) OF 10

ALL RESISTORS IN OHMS
ALL CAPACITORS IN MICROFARADS

1 SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02100-90007 FOR EXPLANATION OF SHEET NO'S

INVERTER BD II TITLE LCPS (A3A2)	HEWLETT/PACKARD
NEXT ASSY. 5061-6615	PART# 5061-3454
	B- 5061 - 3454 -51
	7 SH 1 OF 1



ITEM	QTY.	DESCRIPTION	PART NO.
1	1	BOARD, ETCHED	5180-0112

A5 Control Board II Assembly
5061-3455

A5 Control Board II Assembly Parts List (5061-3455) Sht. 1 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP-FIX .01UF		0160-4832		E	5	
01	C6,10,	11,16,20						
		CAP .22UF +80-20		0160-4842		E	3	
01	C14,15							
05	C13							
		CAP 1.0UF +80-20		0160-4844		E	2	
01	C4,5							
		CAP 1000PF 10%		0160-4847		E	2	
01	C7,8							
		CAP .15UF 10%		0180-0218		E	1	
01	C12							
		CAP 1UF 10%		0180-0291		E	1	
01	C9							
		CAP-TA 3.30F		0180-2690		E	5	
01	C1,2,1	7,19,21						
		C-F 82UF 10V TA		0180-2925		E	1	
01	C18							
		INSUL-XSTR NYLON		0340-0190		E	2	
		RES 464 1%.125		0698-0082		E	1	
01	R4							
		RES 2.15K 1%.125		0698-0084		E	2	
01	R24,37							
		RES 2.37K 1%.125		0698-3150		E	1	
01	R23							
		RES 2.87K 1%.125		0698-3151		E	1	
01	R65							
		RES 3.83K 1%.125		0698-3153		E	3	
01	R1,74,	80						
		RES 4.64K 1%.125		0698-3155		E	1	
01	R59							
		RES 19.6K 1%.125		0698-3157		E	5	
01	R22,26	,29,36,41						

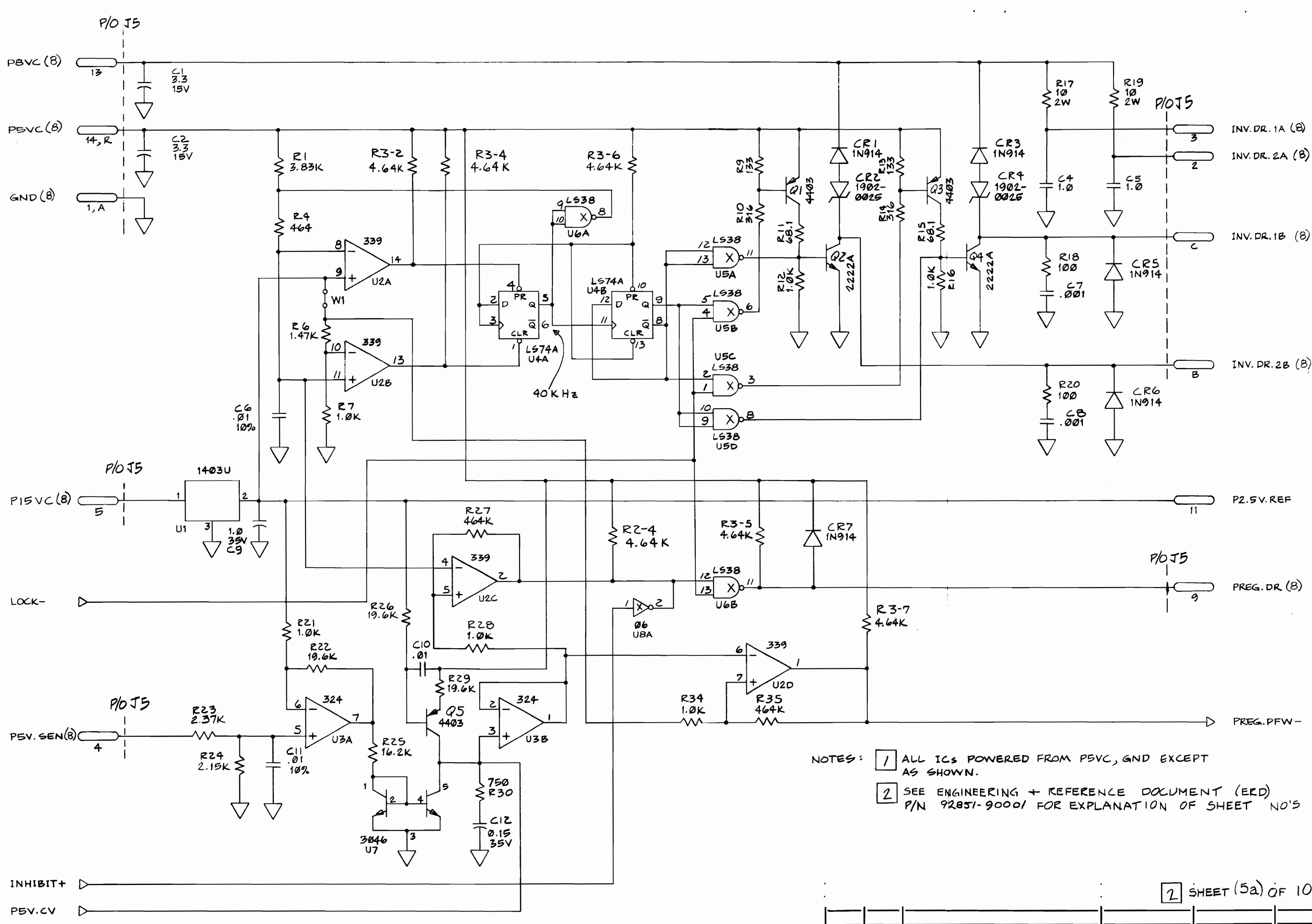
ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R62,53	RES 46.4K 1%.125		0698-3162		E	2	
01	R27,35,64,67	RES 464K 1%.125		0698-3260		E	4	
01	R9,13	RES 133 1%.125		0698-3437		E	2	
01	R63	RES 147 1%.125		0698-3438		E	1	
01	R76	RES 215 1%.125		0698-3441		E	1	
01	R10,14,52	RES 316 1%.125		0698-3444		E	3	
01	R73,79	RES 31.6 1%.125		0757-0180		E	2	
01	R42,58	RES 1.78K 1%.125		0757-0278		E	2	
01 03 05	R7,12,16,21,28,34,38 R39,40,48,55,61,77,82 R83	RES 1K 1%.125		0757-0280		E	15	
01	R11,15	RES 68.1 1%.125		0757-0397		E	2	
01	R18,20	RES 100 1%.125		0757-0401		E	2	
01	R30	RES 750 1%.125		0757-0420		E	1	
01	R56,66	RES 10K 1%.125		0757-0442		E	2	
01	R25	RES 16.2K 1%.125		0757-0447		E	1	
01	R68,69,71,72	RES 90.9K 1%.125		0757-0464		E	4	
01	R45,46,54,78,84	RES 100K 1%.125		0757-0465		E	5	
01	R6	RES 1.47K 1%.125		0757-1094		F	1	

A5 Control Board II Assembly Parts List (5061-3455) Sht. 3 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R17,19	RES 10 5% 2W PW		0811-1678		E	2	
01	W1	RES-FIXED 0 OHM		0811-3587		E	1	
01	R2,3	NTWK RES 9X4.7K		1810-0279		E	2	
01	U8	IC SN7406N		1820-0471		E	1	
01	U14	IC SN74S140N		1820-0697		E	1	
01	U4,9	IC SN74LS74N		1820-1112		E	2	
01	U12	IC SN74LS00N		1820-1197		E	1	
01	U11	IC SN74LS27N		1820-1206		E	1	
01	U5,6	IC SN74LS38N		1820-1209		E	2	
01	U7	TRANSISTOR ARRAY		1821-0001		E	1	
01	U2,10,13	IC LM339N		1826-0138		E	3	
01	U3	IC LM324N		1826-0161		E	1	
01	U1	IC 1403		1826-0544		E	1	
01	Q1,3,5	XSTR 2N4403 T092		1853-0271		E	3	
01	Q6	XSTR PNP 2N2907A		1853-0281		E	1	
01	Q7,8	XSTR NPN SI PL5		1854-0071		E	2	
01	Q9	XSTR 2N4401 T092		1854-0467		E	1	
01	Q2,4	XSTR 2N2222AT018		1854-0477		E	2	

A5 Control Board II Assembly Parts List (5061-3455) Sht. 4 of 4

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
		DIODE-SILICON		1901-0050		E	14	
01	CR1,3,	5-10,12,13,15-18						
		STABISTOR STB523		1901-0460		E	1	
01	CR14							
		DIODE 10V ZEN		1902-0025		E	2	
01	CR2,4							
		DIODE-LIGHT EMIT		1990-0486		E	1	
01	CR11							
		LABEL-USA		7120-6830		E	1	
		LABEL-DATE CODE		7121-2061		L	1	
		BD-ETCHED		5180-0112		E	1	
		3060 VACUUM FIX.		ET16742		X	0	



NOTES:
1. ALL ICs POWERED FROM P5VC, GND EXCEPT AS SHOWN.
2. SEE ENGINEERING + REFERENCE DOCUMENT (ERD) P/N 92851-90001 FOR EXPLANATION OF SHEET NO'S

2 SHEET (5a) OF 10

ENGINEERING RESPONSIBILITY	SEPIA

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PER PC22-5839	PPM	

ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

DO NOT SCALE THIS DRAWING

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

TOLERANCES .XX ± .02 .XXX ± .005

SEE CORP. STD. 608

DRAWN BY D. BELL DATE 3/17/80

ENGINEER D. BELL 3/17/80

RELEASE TO PROD. Peter Miner

SUPERSEDES DWG.

TITLE LCPS CONTROL BD II INV/PREREG DRIVE (A3A5)

NEXT ASSEMBLY 5061-3476

FINISH NONE SCALE NONE

HEWLETT PACKARD

PART NUMBER 5061-3455

C-5061 -3455 -51

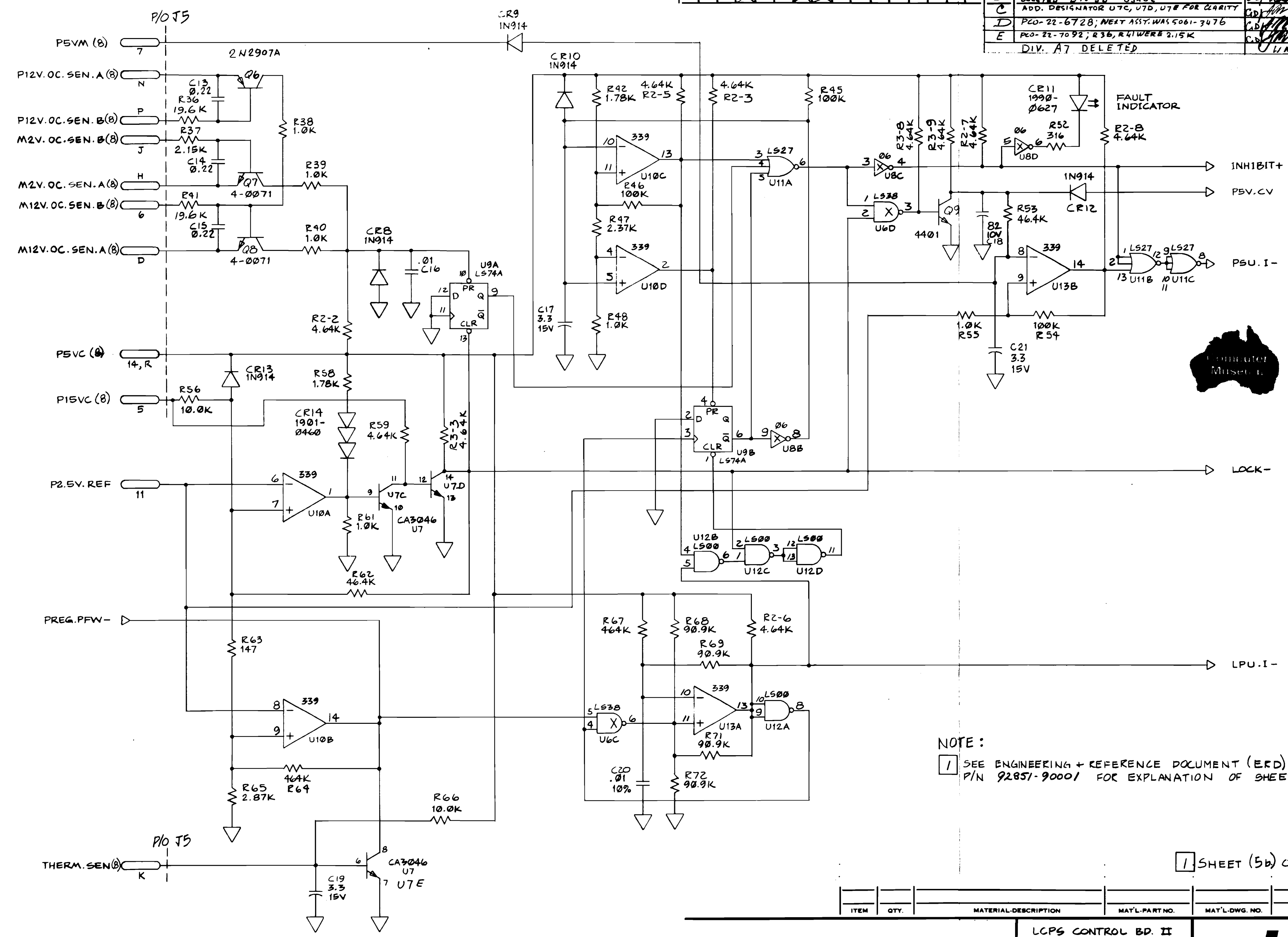
SHEET 1 OF 3

STOCK NO. 9280-0003 PRINTED ON DIEPO NO. 1030-10 CLEARPRINT FADEOUT

5061-3455-51 IXC - 27/ - 28

C-5061-3455-52

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PER PC22-5839	PPM	4/14/81
B	PCO-22-6409; C13, C14, C15 WERE 0.1 DELETED DIV. 6b USAGE		4/15/82
C	ADD. DESIGNATOR U7C, U7D, U7E FOR CLARITY		11/8/82
D	PCO-22-6728; NEXT ASSY. WAS 5061-3476		2/4/83
E	PCO-22-7092; R36, R41 WERE 2.15K		11/11/83
	DIV. A7 DELETED		8/7/84



NOTE:

1. SEE ENGINEERING + REFERENCE DOCUMENT (ERD) P/N 92851-90001 FOR EXPLANATION OF SHEET NO'S

1 SHEET (5b) OF 10

ALL RESISTORS IN OHMS
ALL CAPACITORS IN MICROFARADS

ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

TITLE: LCPS CONTROL BD. II CONTROL LOGIC (A3A5)

HEWLETT PACKARD

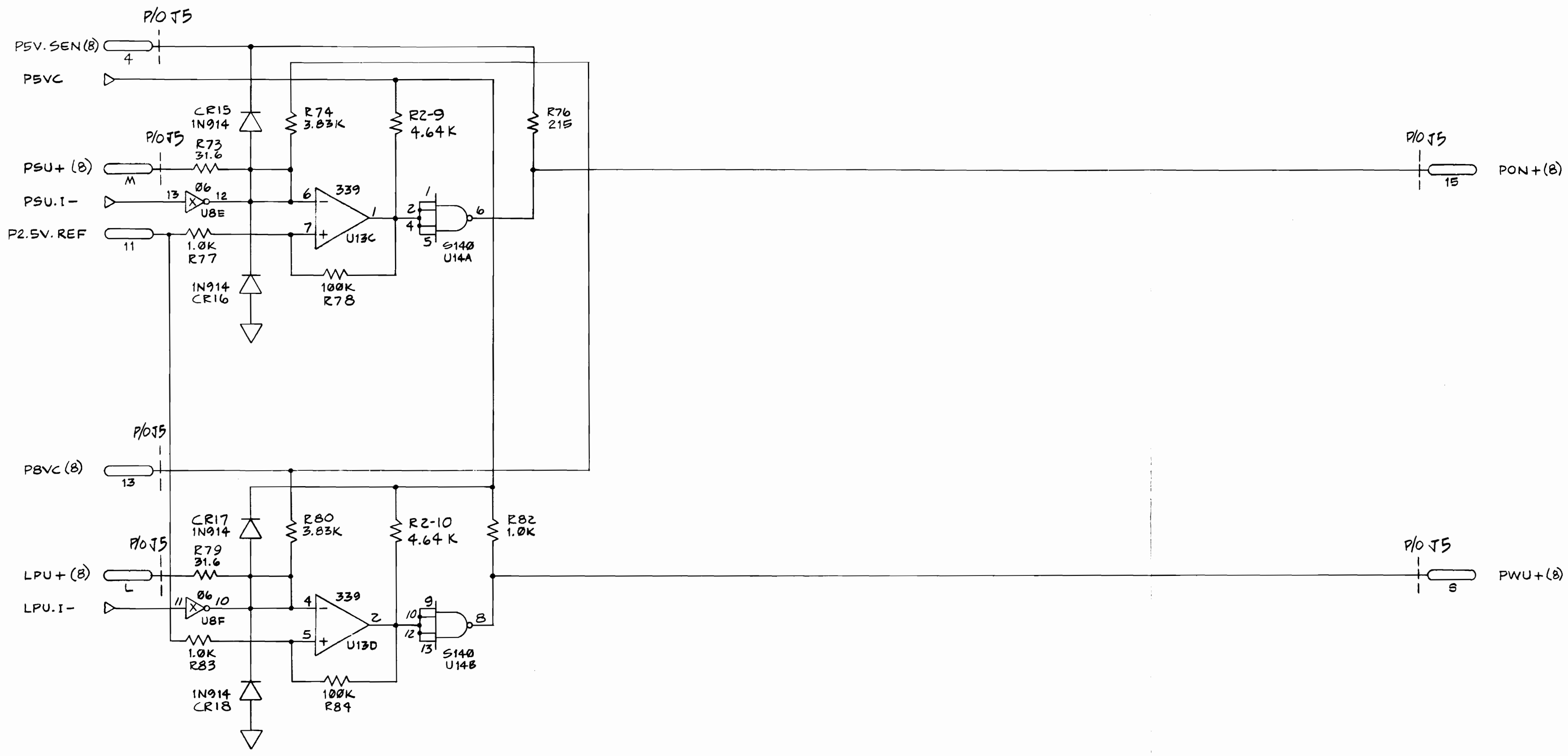
NEXT ASSEMBLY: 5061-6615

PART NUMBER: 5061-3455

FINISH: NONE SCALE: NONE

C-5061-3455-52

ENGINEERING RESPONSIBILITY	SEPIA	SYM	REVISIONS	APPROVED	DATE
		A	AS ISSUED PER PC22-5839	PPM	



NOTE:

[1] SEE ENGINEERING + REFERENCE DOCUMENT (ERD) P/N 92851-90001 FOR EXPLANATION OF SHEET NO'S

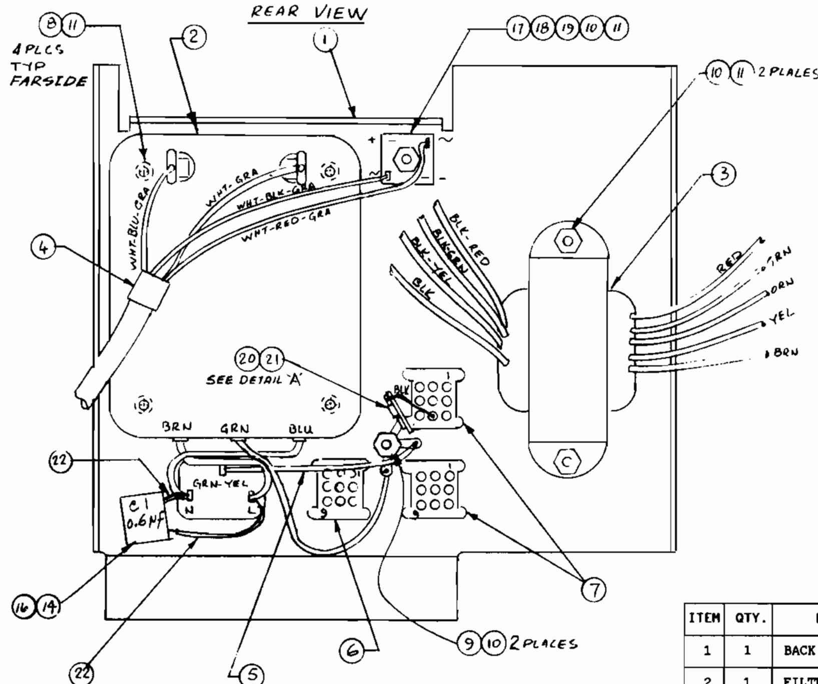
[1] SHEET (5C) OF 10

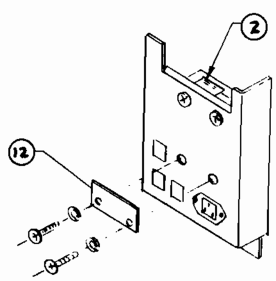
ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

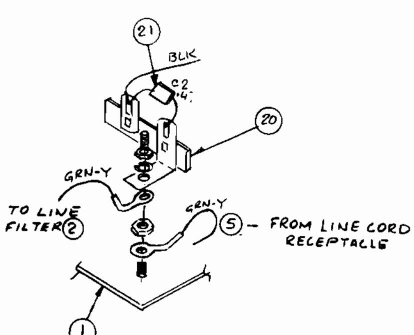
DO NOT SCALE THIS DRAWING	DRAWN BY D. BELL	DATE 4/2/80	LCPS CONTROL BD. II	HEWLETT PACKARD
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.	ENGINEER D. BELL	4/2/80	TITLE INTERFACE LOGIC (A3A5)	
TOLERANCES .XX ± .02 .XXX ± .005	RELEASE TO PROD. Peter Miner		NEXT ASSEMBLY 5061-3476	PART NUMBER 5061-3455
SEE CORP. STD. 608	SUPERSEDES DWG.		FINISH NONE / SCALE NONE	C - 5061 - 3455 -53

SHEET 3 OF 3

REAR VIEW







DETAIL "A"

ITEM	QTY.	DESCRIPTION	PART NUMBER
1	1	BACK PANEL	5001-2659
2	1	FILTER	9135-0097
3	1	TRANSFORMER	9100-4259
4	1	CABLE ASSY. AL PWR	5061-1358
5	0.29'	WIRE - 18 GRN - YEL	8150-2919
6	1	BATT. CABLE ASSY.	5061-1358
7	1	CABLE ASSY. CONTROL	5061-1360
8	4	SCREW 6-32 x .312 LG	2360-0195
9	2	LUG SOLDER	0360-0268
10	5	NUT HEX NO. 6	2420-0003
11	7	LOCKWASHER SPLIT #6	2190-0851
12	1	INFO TAG	5001-1632
13	1	LABEL WARNING	7120-4626
14	1	CAP 0.6 MF	0160-4413
15		DELETED	
16	1	CAP PLASTIC	1401-0197
17	1	DIODE BRIDGE	1906-0225
18	A/B	THERMNAL COMPD	6040-0239
19	1	SCREW 6.32 x .625	2360-0202
20	1	TIE POINT	0360-0014
21	1	CAP .47 MF	0160-0174
22	.750	SLEEVING-FLEX	0890-0064

Rear Panel Assembly

Power Supply Rear Panel Parts List (5061-1350)

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP OPTION	LOC	QUANTITY PER	UM
01	C2	CAP .47UF +80		0160-0174		E	1	
01	C1	CAPACITOR-FIXED		0160-4413		E	1	
		TIE POINT		0360-0014		E	1	
		LUG SOLDER #6LKG		0360-0268		F	2	
		SLEEVING FLEX.		0890-0064		F	0.125	FT
		CAP-PLASTIC		1401-0197		E	1	
		DIODE BRDG 15A		1906-0225		F	1	
		LKWSHR 6 HEL		2190-0851		E	7	
		SCR #6-32X.312L		2360-0195		F	4	
		SCR #6-32X.625L		2360-0202		E	1	
		NUT 6-32 .250AF		2420-0003		E	6	
		PTCTR-REAR PANEL		4040-1742		E	0.0001	
		COMPOUND-THERMAL		6040-0239		E	0.01	TB
		LABEL-WARNING		7120-4626		F	1	
		LABEL-USA		7120-6830		E	1	
		WIRE 18 GRN-YEL		8150-2919		O	0.29	FT
		XFMR-PWR		9100-4259		E	1	
		FILTER-LINE		9135-0097		E	1	
		INFO TAG		5001-2632		F	1	
		PANEL-REAR,LCPS		5001-2659		E	1	
		ASSY-CABLE BATT		5061-1357		E	1	
		ASSY-CABLE AC		5061-1358		E	1	
		ASSY-CBL CONTROL		5061-1360		E	1	

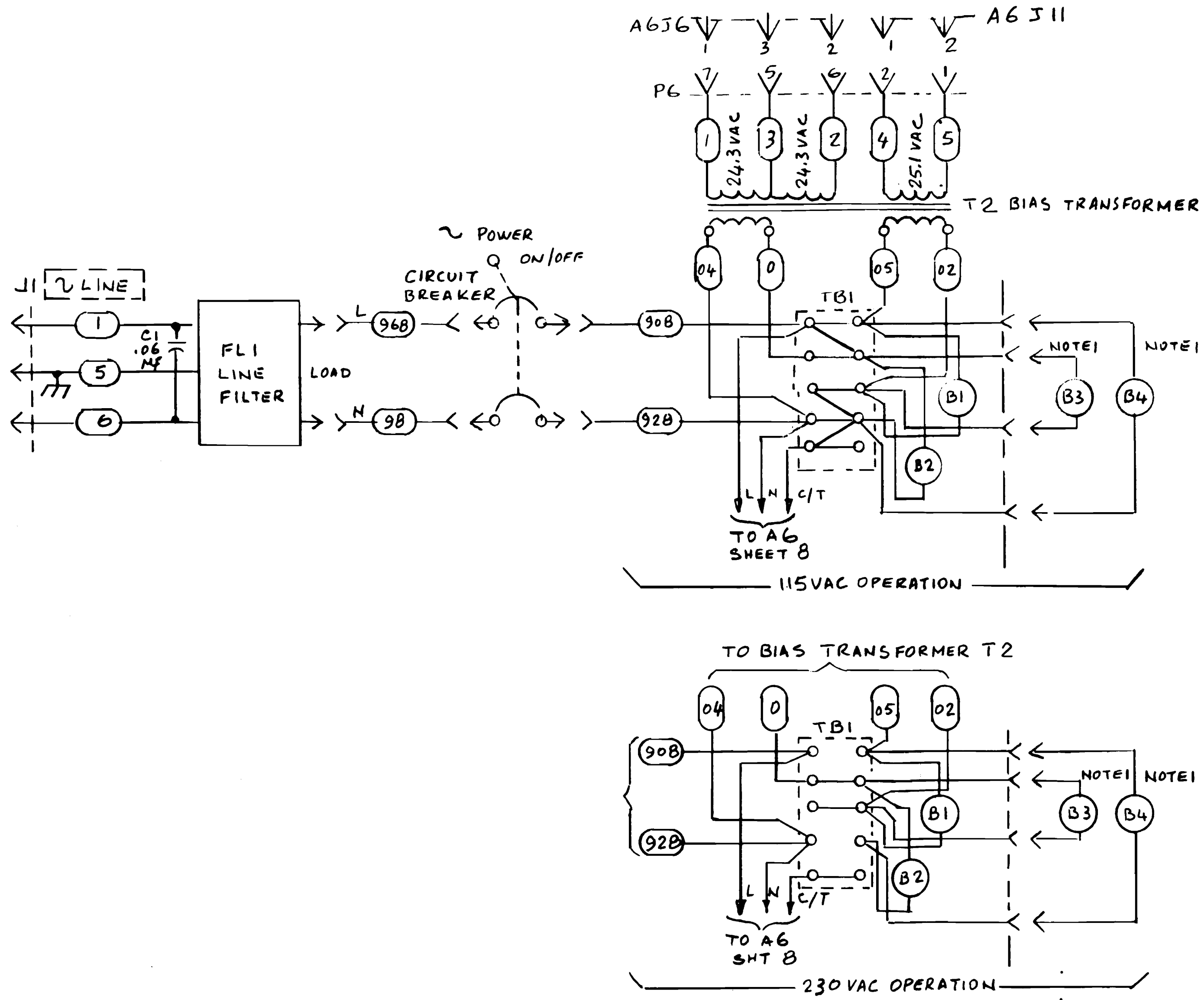
REF. DWGS: D-1 ASSY LCPS
B D-6 LCPS CABLE WIRING
A-5 ASSY. PROCEDURE

ENGINEERING RESPONSIBILITY / SEPIA

0	1	2	3	4		6		8	9		11	12	14	15
16	17		19		21	22	23	25	29	30	32	33	38	43
45	46	61	63									A7		

B-5061-6615-51

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PER PCO-22-6728	JW	2/8/83
B	DELETED REF. DWGS: B2, B3 AND ADD. D-6 PER PCO-22-7052; DELETED A-4 PER PCO. 22-7041	CD/RG	2/9/84



WARNING.
HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY! BEFORE CHANGING FROM 115VAC TO 230VAC CONFIGURATION, OR VICE VERSA, SET ~ POWER AND BATTERY SWITCHES TO OFF AND DISCONNECT THE POWER CORD! FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY.

NOTES:

1. FANS B3 & B4 ARE REQUIRED ONLY FOR THE HP 2113B, HP2112B, 2111F, 2117F
2. ENCLOSED WIRE COLOR CODE. CODE USED IS THE SAME AS THE RESISTOR COLOR CODE. FIRST NO. IDENTIFIES THE BASE COLOR, SECOND NO. IDENTIFIES THE WIDE STRIP AND THE THIRD NO. IDENTIFIES THE NARROW STRIP e.g 947 DENOTES WHITE BASE, YELLOW WIDE STRIPE, AND VIOLET NARROW STRIPE.

3 SEE ENGINEERING & REF. DOCUMENT (ERD) P/N 92851-90001 FOR EXPLANATION OF SHEET NOS.

3 SHEET 1 OF 10

DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

L.C.P.S.
LINE (MAINS) POWER DISTRIBUTION SCHEMATIC
TITLE

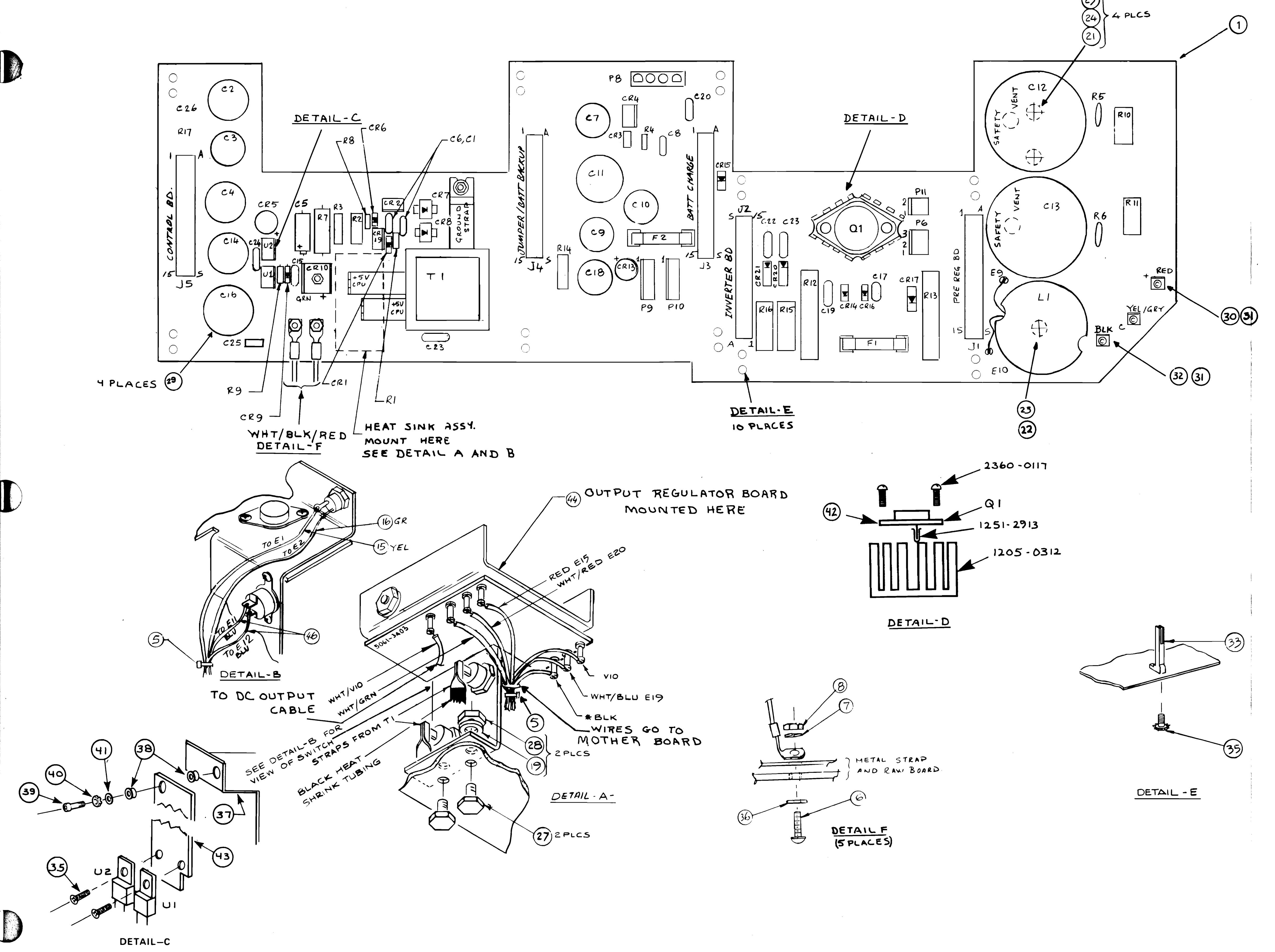
HEWLETT PACKARD

NEXT ASSEMBLY

5061-6615
PART NUMBER

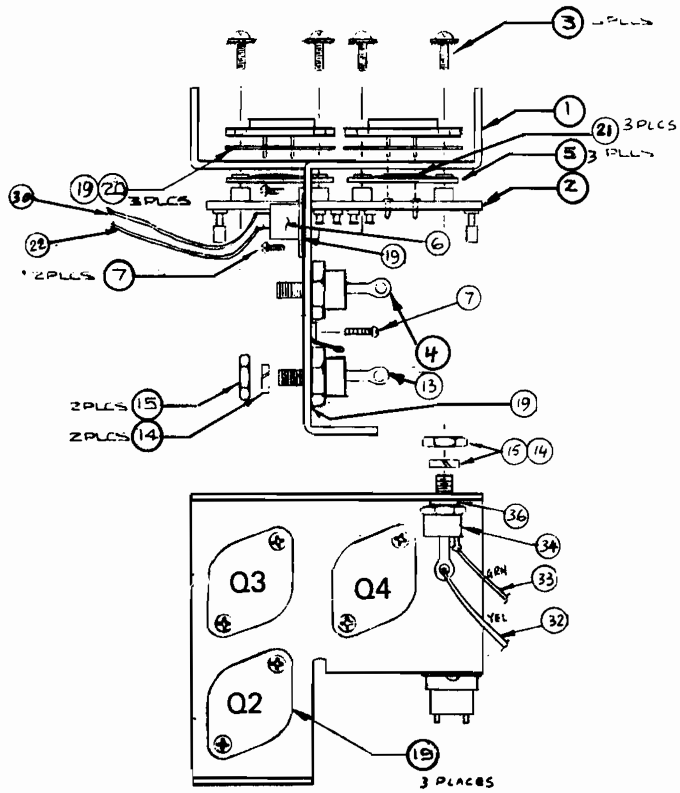
FINISH — SCALE —

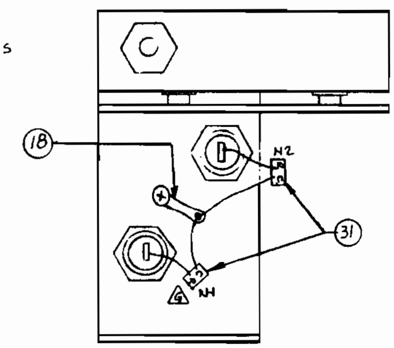
B-5061-6615-51

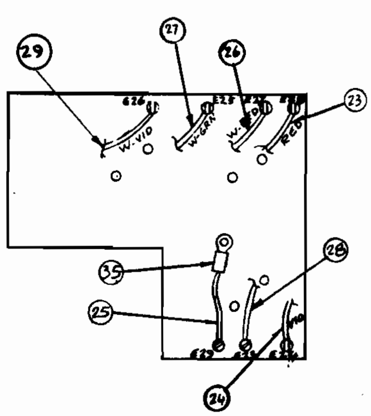


ITEM	QTY.	DESCRIPTION	PART NUMBER
1	1	MOTHER BOARD P.S.	5061-6622
2		DELETED	
3		DELETED	
4		DELETED	
5	5	TY-WRAP	1400-0493
6	4	SCREW 6-32 x .375	2360-0197
7	4	WASHER, SPLITLOCK	2190-0851
8	4	NUT, HEX 6-32	2420-0003
9		DELETED	
10		DELETED	
11		DELETED	
12		DELETED	
13		DELETED	
14		DELETED	
15	5"	WIRE, YEL 18AWG	8150-0577
16	6"	WIRE, GRN 22AWG	8150-1545
17		DELETED	
18		DELETED	
19	2	WASHER, SPLITLOCK	2190-0032
20		DELETED	
21	4	WASHER, FLAT #10	3050-0236
22	1	WASHER, INT. LOCK	2190-0011
23	1	NUT, HEX #10	2740-0002
24	4	WASHER, SPLITLOCK #10	2190-0034
25	4	WASHER, 10-32 x .375	2680-0099
26	1	LUG, CRIMP 22-18AWG RED (NOT SHOWN)	0362-0321 REF. ONLY
27	2	SCREW 1/4-20	2940-0103
28	2	NUT 1/4-20	2950-0004
29	4	FOAM PLASTIC	4208-0171
30	8"	WIRE 16AWG RED	8150-2185
31	4	LUG, CRIMP 16-14	1251-5053
32	8"	WIRE BLACK 16AWG	8150-2605
33	10	GUIDE PC	5040-0170
34		DELETED	
35	12	SCREW 4-40 WITH STAR WSH.	2200-0103
36	6	FIBER WASHER .144 x .250	3050-0023
37	1	OUTPUT REG. BD HEAT SINK	5001-2691
38	2	FIBER WASHER W/LIP	3050-0004
39	1	SCREW NYLON #4 x .500	0570-0031
40	1	HEX LOCK WASHER	2190-0108
41	1	FLAT WASHER	3050-0222
42	A/R	THERMAL COMPOUND	6040-0239
43	1	VOLTAGE REG. HEAT SINK	5001-2680
44	1	HEAT SINK ASSY. LCPS MOTHER	5061-6625

A6 Mother Board Assembly (5061-1371)







ITEM	QTY.	DESCRIPTION	
1	1	HEAT SINK	5001-2691
2	1		5061-3403
3	6	SCREW 6-32 x 500 W/LOCK-WSH.	2360-0121
5	3	INSULATOR	0340-0503
6	1	THERMO SW.	3103-0085
7	3	SCREW 4-40 X .250	2200-0103
18	1	LUG SOLDER NO. 4	0360-0272
19	A/R	THERMO COMPOUND	6040-0272
20	3	INSULATOR	1200-0043
21	A/R	SUPER BONDER 430 ADHESIVE	0470-0526
22	5.5"	BLUE 22AWG WIRE	
23	4.5"	RED 18AWG WIRE	
24	4.5"	VIO 18AWG WIRE	
25	3.5"	BLK 18AWG WIRE	
26	5.0"	W-RED 18AWG WIRE	
27	5.5"	W-GRN 18 AWG WIRE	
28	4.5"	W-BLUE 18 AWG WIRE	
29	5.5"	10 18AWG WIRE	
30	5.5"	BLUE 22AWG WIRE	
31	2	SNUBBER (N1,N2)	1810-0500
32	1	WIRE YEL 18AWG	
33	1	WIRE GRN 22AWG	
34	1	SCR CR18	1884-0303
35	1	LUG CRIMP	0362-0321
36	1	WASHER FLAT .25ID.	3050-0234

A6 Mother Board Assembly Parts List (5061-1371*) Sht. 1 of 3

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C12,13	CAP 1150UF		0180-0431		E	2	
00	C2	CAP 9700UF 6.3V		0180-2652		E	1	
00	C18	CAP 750UF 40V		0180-2653		E	1	
00	C10	CAP 5200UF 6.3V		0180-2654		E	1	
01	C4,11,14	CAP 3300UF 25V		0180-2658		E	3	
00	C16	CAP 0.0165F 6.3V		0180-2659		E	1	
01	C3	C-F 2000UF 25V		0180-2660		E	1	
01	C7,9	C-F 900UF 25V AL		0180-2755		E	2	
01	E2,11,12	STUD SOLDER		0360-0090		E	3	
00	E1	TERM DBL-TUR		0360-1167		E	1	
01	E3-10,13-15,17-20,22	TERM STUD FKD		0360-1529		E	14	
		LUG SOLDER #5		0360-1685		E	3	
		EYLT .121DX.200		0361-1032		E	3	
		STDF-RVT-ON		0380-0757		E	2	
		SCR NYLON #4X.5		0570-0031		E	1	
		RES 1K 5% 10W PW		0811-1586		E	1	
00	R13	RES .25 5% 10W		0811-3176		E	1	
		TBG #20 TFE NAT		0890-0212		E	0.04	FT
		HEAT SINK		1205-0312		E	1	

*Date Code 2305 and Later.

A6 Mother Board Assembly Parts List (5061-1371*) Sht. 2 of 3

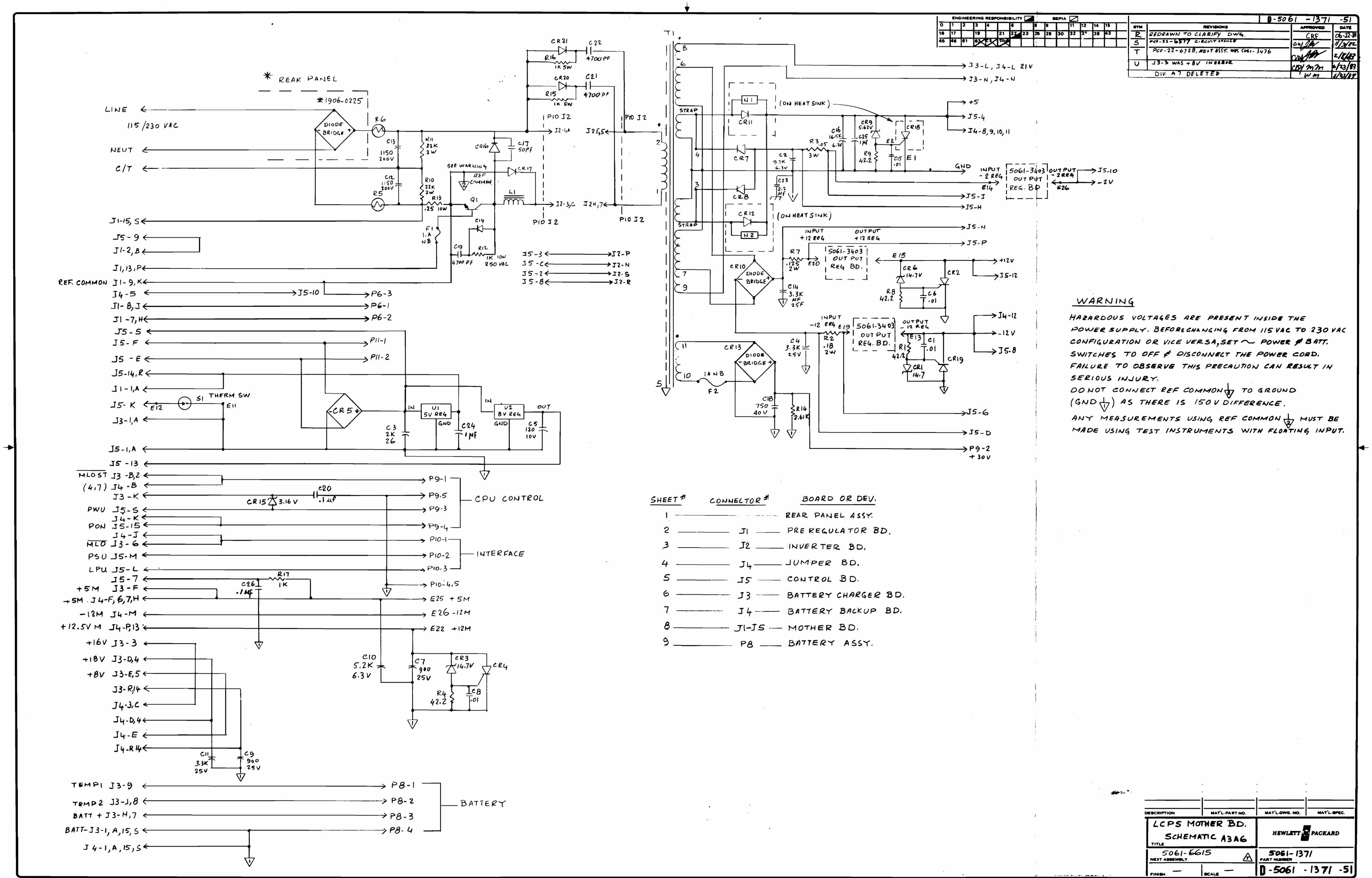
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CONN-SGL CONT		1251-5053		E	4	
		CA TIE 5.5L		1400-0493		E	1	
00	U1	IC RGLTR +5V		1826-0144		E	1	
00	U2	IC 7808C		1826-0146		E	1	
01	Q1	XSTR NPN T03 10A		1854-0869		E	1	
00	F1,2	FUSE 1A NB		2110-0001		E	2	
		LKWSHR 10 INT		2190-0011		E	1	
		LKWSHR 1/4 HEL		2190-0032		E	2	
		LKWSHR 10 HEL		2190-0034		E	4	
		LKWSHR 4 HEL		2190-0108		E	1	
		SCR 4-40X.25		2200-0103		E	12	
		SCR #6-32X.500L		2360-0121		E	2	
		SCR 10-32X.375		2680-0099		E	4	
		NUT 10-32 .375AF		2740-0002		E	1	
		SCR 1/4-20X.500L		2940-0103		E	2	
		NUT 1/4-20		2950-0004		E	2	
		WASHER EXTRUDED		3050-0004		E	2	
		WSHR #4 SS		3050-0222		E	1	
		WSHR #10 BRS		3050-0236		E	4	
		FOAM-PLASTIC		4208-0171		C	4	
		LABEL-DATE CODE		7121-2061		L	1	
		WIRE 18 YEL		8150-0577		O	0.46	FT
		WIRE 22 GRN		8150-1545		O	0.50	FT
		WIRE 22 BLU		8150-1546		O	0.92	FT
		WIRE 16 RED		8150-2185		O	0.67	FT
		WIRE 16 BLACK		8150-2605		O	0.67	FT

*Date Code 2305 and later.

A6 Mother Board Assembly Parts List (5061-1371*) Sht. 3 of 3

ITEM NO	REFERENCE DESIGNATOR FIRST SIX	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WIRE 18 WHT-RED		8150-2649		O	0.42	FT
		WIRE 18 RED		8150-2891		O	0.44	FT
		WIRE 18 VIO		8150-2894		O	0.38	FT
		WIRE 18 WHT-GRN		8150-2899		O	0.46	FT
		WIRE 18 WHT-BLU		8150-2900		O	0.38	FT
		CHOKE		9100-3947		E	1	
01	L1							
01	T1			9100-4112				
		VOLT REG HT SNK		5001-2680		E	1	
		GUIDE-PC		5040-0170		E	10	
		ASSY-CBL HI CRNT		5061-6613		E	1	
		ASSY-CBL LO CRNT		5061-6614		E	1	
		ASSY-MOTHERBOARD		5061-6622		4	1	
		ASSY-HEAT SINK		5061-6625		4	1	
		VAR. AC SUP.		ET 6739		X	0	
01	TEST	FIXTURE						
		POWER SUP LOAD		ET 7616		X	0	
01	TEST	FIXTURE						
		STA SIG TESTER		ET10329		X	0	
01	TEST	FIXTURE						
		LCPS M/B HOLDER		ET13416		X	0	
01	TEST	FIXTURE						
01	TEST	FIXTURE		ET13458				

*Date Code 2305 and later.



WARNING

HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE POWER SUPPLY. BEFORE CHANGING FROM 115 VAC TO 230 VAC CONFIGURATION OR VICE VERSA, SET ~ POWER & BATT. SWITCHES TO OFF & DISCONNECT THE POWER CORD. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN SERIOUS INJURY.

DO NOT CONNECT REF COMMON TO GROUND (GND) AS THERE IS 150 V DIFFERENCE.

ANY MEASUREMENTS USING REF COMMON MUST BE MADE USING TEST INSTRUMENTS WITH FLOATING INPUT.

SHEET #	CONNECTOR #	BOARD OR DEV.
1		REAR PANEL ASSY.
2	J1	PRE REGULATOR BD.
3	J2	INVERTER BD.
4	J4	JUMPER BD.
5	J5	CONTROL BD.
6	J3	BATTERY CHARGER BD.
7	J4	BATTERY BACKUP BD.
8	J1-J5	MOTHER BD.
9	P8	BATTERY ASSY.

Table of Contents

"B" POWER SUPPLY (5061-6615) THEORY OF OPERATION	APPENDIX A

The "B" Power Supply regulates dc voltages to the M-, E- and F-Series HP 1000 computers. This appendix describes in detail the operation of the 5061-6615 version of the supply which is a redesign of the 5061-3476 supply. The redesign reroutes the high current +5V, +5M, and ground lines from the Molex connector through a terminal strip designed for high current. It uses the same board assemblies except the Mother Board must be date coded C-2305 or later, and the Control Board must be date coded A-2305 or later. The earlier 5061-1356 version of the "B" supply is covered in subsection IXB).

The material is organized into sections according to the primary function of each separate PC board of the supply.

A.1 Overview

The "B" Power Supply is a combination of both switching and linear supplies. +5V CPU, +5VM and -12VM are supplied by switching regulators (-12VM is available only when the "B" Power Supply is equipped with either a 12944B or a 12991B power fail recovery system); -2V I/O, +12V I/O and -12V I/O are supplied by linear regulators.

Figure A-1 is a functional block diagram of the main power and the feedback components of the supply. In the figure the dashed lines divide it into its four main boards: mother board, inverter board, pre-regulator board and control board.

Abbreviations used are as follows: MB for mother board and pre-reg for pre-regulator.

The 325 Vdc bus is developed from the ac line by a diode bridge configured as either a voltage doubler for 115 Vac operation or a normal bridge rectifier for 230 Vac operation. The 325 Vdc bus is stepped down by the MB board pre-reg circuit to 150 Vdc and applied to the inverter board.

The MB pre-reg functions in a similar manner to a switching regulator with Q1 being the switching transistor, L1 the energy storage inductor and CR16 the catch diode. CR17 serves as a protection diode.

The 150 Vdc bus is chopped by the inverter and applied to the primary of the inverter transformer T1. The square wave is stepped down to 10 volts peak-to-peak (Vpp) by T1 and then rectified to 5 Vdc by CR11 and CR12.

The 5V CPU output is sampled at the sense input on the control board and applied to an error amplifier where it is compared to a 5V reference voltage. The error output is a dc level applied to the Pulse Width Modulator (PWM). The PWM second input is a triangle wave and when compared with the error level, the PWM output provides a regulating drive to the pre-reg board. An opto-isolator on the pre-reg board isolates the low voltage control board from the high voltage pre-reg circuits. The error amplifier on the control board will adjust the duty cycle of the pre-reg to just the right value to maintain the 5V CPU output at 5 volts.

A.2 Block Diagram

A complete block diagram is shown in Figure A-2. As shown at the upper left hand corner of the diagram, the ac line comes through the line filter and circuit breaker, and is then fed into both the diode bridge and the bias transformer. The bias transformer is located on the rear panel. It supplies power to all of the "B" Power Supply control circuits, drive circuits and logic.

Two power sense circuits, one on the control board, one on the pre-reg board, monitor the on/off state of the voltages supplied to those boards. No drive can be applied to either the pre-reg transistor on the mother board or the inverter until the pre-reg and control boards are operating. This ensures that the supply always "powers-up" in a controlled manner.

A control board power sensor circuit provides a "lock" signal for power up protection. (This signal is different from the lock/operate switch on the front panel that overrides a signal to the CPU.) The pre-reg board power sensor only cuts off drive to the pre-reg transistor.

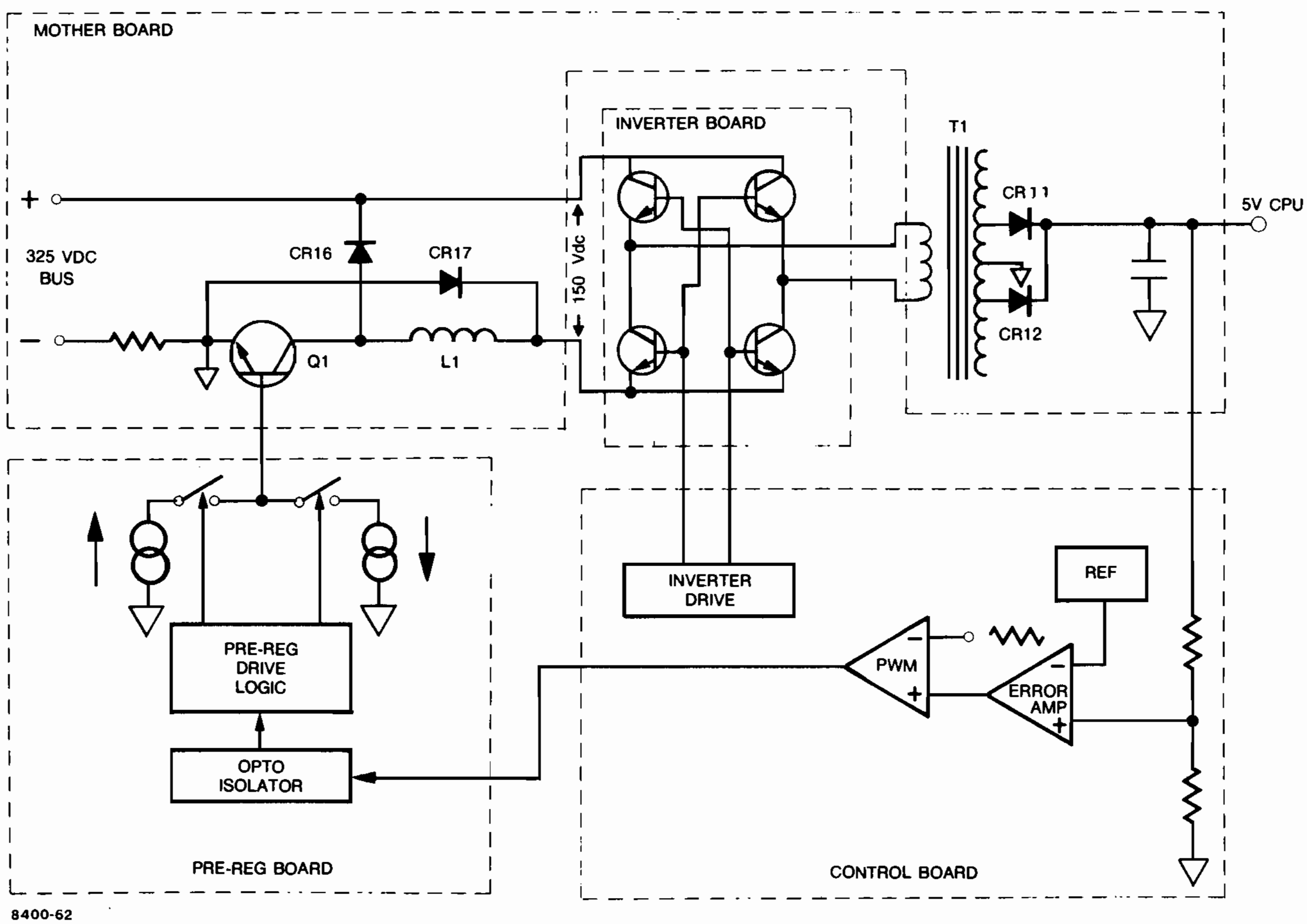


Figure A-1. Functional Block Diagram

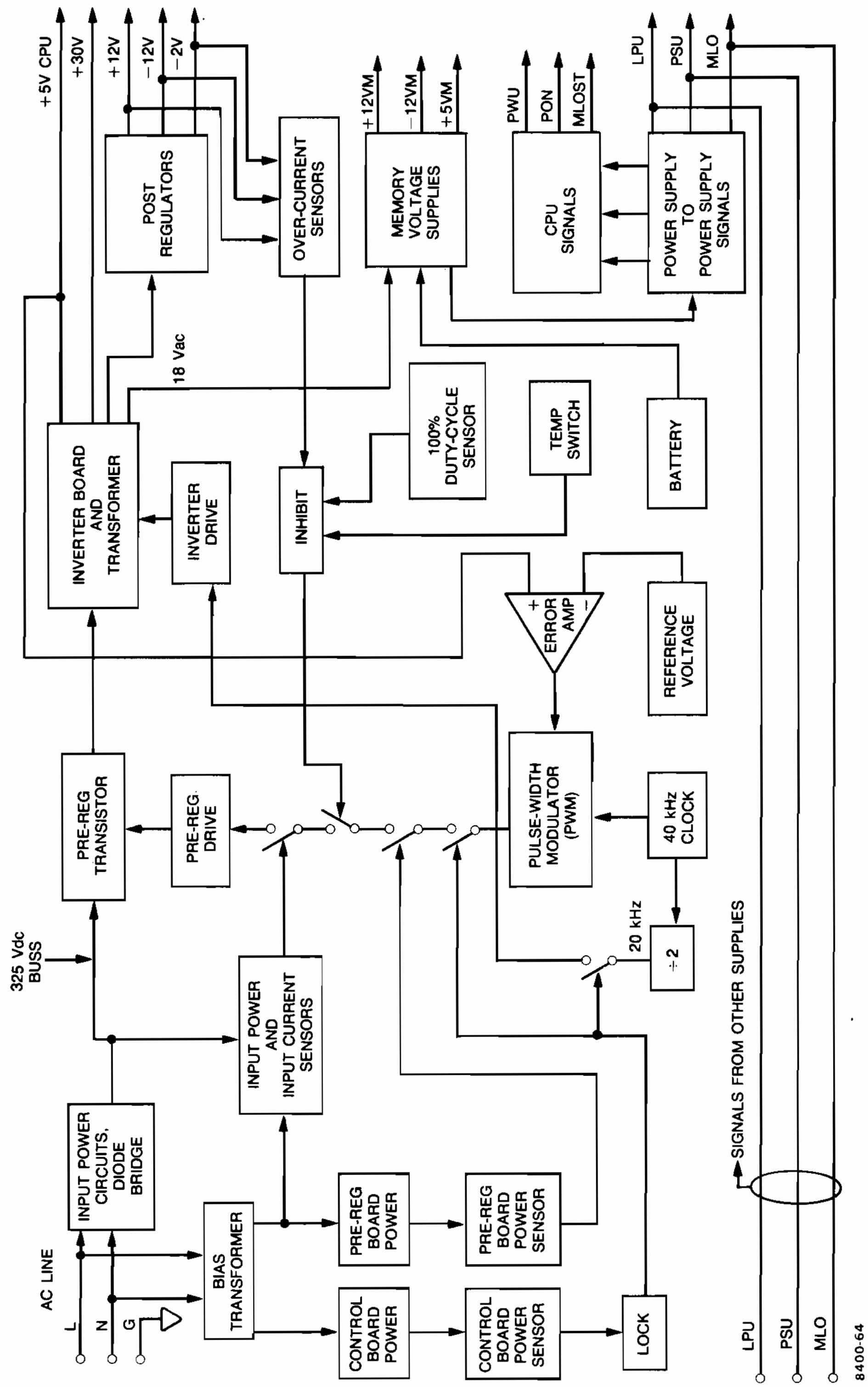


Figure A-2. Power Supply Block Diagram

There are four circuits altogether that can cut off drive to the pre-reg transistor. The two power sense circuits (described above), the inhibit circuit, and the input power and current sensors.

The inhibit circuit monitors the current of the -2V CPU, the +12V I/O and -12V I/O outputs, the duty cycle of the pre-reg circuit and the temperature of the post regulator heat sinks. If an over-current, over temperature or excessive duty cycle condition is sensed, the inhibit circuit will cut off drive to the pre-reg transistor. The input current and power sensors monitor both line voltage and pre-reg transistor current.

The bottom left-hand area of the block diagram shows three signals (LPU, PSU, AND MLO) coming from either another "B" Power Supply, a memory, an I/O extender, another computer, or an FPP supply in an F-Series computer. These signals are ORed together so that either source can pull the signals down to ground potential. The "power-supply to power-supply signals" also drive an identical set of signals that connect directly to the CPU. The signals have the following meaning in their active states:

Signal	Active State	Meaning
PWU	HIGH	line power up
PON	HIGH	supply outputs up
MLOST	LOW	memory voltages down
LPU	HIGH	line power up
PSU	HIGH	supply outputs up
MLO	LOW	memory voltages down

Figures A-3 and A-4 show the memory voltage portion of the block diagram. Figure A-3 shows the supply configured with a power-fail recovery system (PFRS). The memory voltages are developed from either 18 Vac supplied by the supply's inverter transformer or from 14 Vdc supplied by a battery. Figure A-4 shows the supply without a PFRS. +5VM and -12VM are connected directly to +5V CPU and -12V I/O by the jumper board; +12VM is supplied by a linear regulator on the jumper board that runs from the same 18 Vac source as the PFRS.

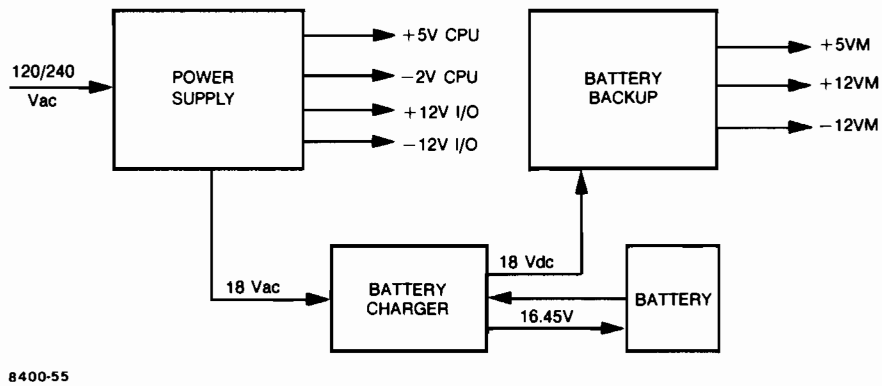


Figure A-3. Power Supply With PFRS

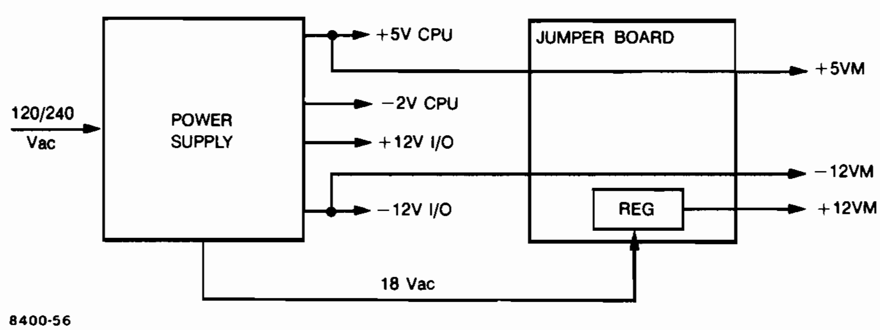


Figure A-4. Power Supply Without PFRS

A.3 Mother Board (5061-1371)

The mother board (MB) is the main PC board of the "B" Power Supply. The MB holds the pre-reg transistor, the inverter transformer, the post regulators and all of the plug-in boards.

Refer to the MB schematic (D-5061-1371-51) on page IXC-45, for the following discussion. The diode bridge is the first main power component on the MB. The line voltage (either 88V-132V or 166V-264V) is configured with jumpers on power distribution barrier block TB1 shown on schematic B-5061-6615-51 (page XIC-35). The diode bridge is used as a voltage doubler when the supply is configured for 115V operation (nominal).

A.3.1 Input Power

For 230V operation, it is used as a normal bridge rectifier to supply the same 325 volts dc (approx.) The voltage across C12 and C13 will vary with line voltage, in either configuration.

R5 and R6 are thermistors that help to limit the turn-on surge currents into C12 and C13. The thermistors have a cold resistance of about 2.5 ohms, and a hot resistance of about 0.25 ohms. When hot the voltage drop is 0.75 volts at 3 amp which limits the urge current to about 65 amperes.

A.3.2 Pre-regulator Transistor

The circuit to the right of the diode bridge is the pre-reg transistor Q1 circuit that drives the inverter board, inverter transformer and its various loads.

The pre-reg Q1 circuit operates like a switching regulator. When Q1 is on, current flows through the load, through L1 and out to ground. When Q1 is off, the polarity of L1 instantly reverses and CR16 is biased on. Load current continues to be supplied through CR16 by the energy stored in L1 until Q1 turns on again. The duty cycle of the pre-reg is set by the control board to the value that will maintain the output of the supply at exactly 5 volts.

CR14, R12 and C19 form a snubber network that absorbs the energy of L1 while Q1 is turning off.

A.3.3 Inverter Transformer

The output voltage of the pre-reg circuit (about 150 Vdc) is chopped by the inverter circuit on the board that plugs into J2 of the MB. The resulting square wave is applied to the primary of the inverter transformer T1. T1 has several secondary windings as follows:

a. Winding 3-4. Steps down the square wave to 10 Vpp. CR11 and CR12 rectify the 10 Vpp waveform to provide a +5 Vdc output. CR7 and CR8 also rectify the 10 Vpp square wave but are oppositely connected with respect to CR11 and CR12 and thus provide -5 Vdc output. The -5 volts is stepped down to -2 volts by the post-regulator board.

b. Winding 6-7. Using diode bridge CR10, it provides plus and minus 18 volts dc to the post-regulator board. This board steps the voltages down to plus and minus 12 volts dc.

c. Winding 8-9. Provides power to the charger, battery backup and jumper boards to develop the memory voltages and maintain battery charge.

d. Winding 10-11. In conjunction with diode bridge CR13, provides 30 Vdc to the various I/O cards that need it.

R2, R3 and R7 are current sense resistors for the +12V I/O, -12V I/O and -2V CPU outputs. The voltage across these resistors is monitored by the control board, which can shut the supply off if excess current is drawn.

C2, C3, C4, C9, C10, C11, C14, C16 and C18 are filter capacitors for the various low voltage dc outputs and internal supplies (control board power).

Each output is protected from overvoltage by a crowbar circuit in which an SCR is used as the shorting device. The SCRs are CR2, CR4, CR18 and CR19. To describe their operation, the 5V CPU output is used as an example. If the output voltage rises above 5.62 volts, CR9 will begin to conduct, allowing current to flow through R9. If the current rises high enough to to cause a 0.55 volt drop across R9, the gate of CR18 will be slightly forward biased. When the gate threshold current is reached (very small), CR18 conducts heavily and acts as a short circuit on the output, and causes the supply to shut down by it's overcurrent sense.

A.4 Inverter Board (5061-3454)

The inverter board plugs into J2 of the MB. The inverter circuit chops the dc output voltage of the pre-reg circuit into square wave, so that it can be fed into, and stepped down by, the inverter transformer T1. The circuit performs a switching function as would a double-pole/double-throw switch that was cross connected for polarity reversal. That is, in one half-cycle the plus/minus inputs connect to one set of transformer terminals and reverse in the next half-cycle.

The switch is driven at 20 kHz so that the dc polarity of the dc voltage on the primary of T1 is reversed every 25 microseconds. The result is the equivalent of applying a square wave having a peak-to-peak voltage of twice the dc output voltage of the pre-reg.

A.4.1 Inverter Drive

Figure A-5 shows the drive circuit of one pair of inverter transistors. Components to the left of the inverter-drive transformer (T1A) are located on the control board, the remaining components are located on the inverter board. When supply power is switched on, C4A5 charges rapidly to 8 volts through R17A5. Consider what happens when Q4A5 switches on. Current begins to flow into the lower end of the primary of T1A from C4A5, out of the upper end and through Q4A5 to ground.

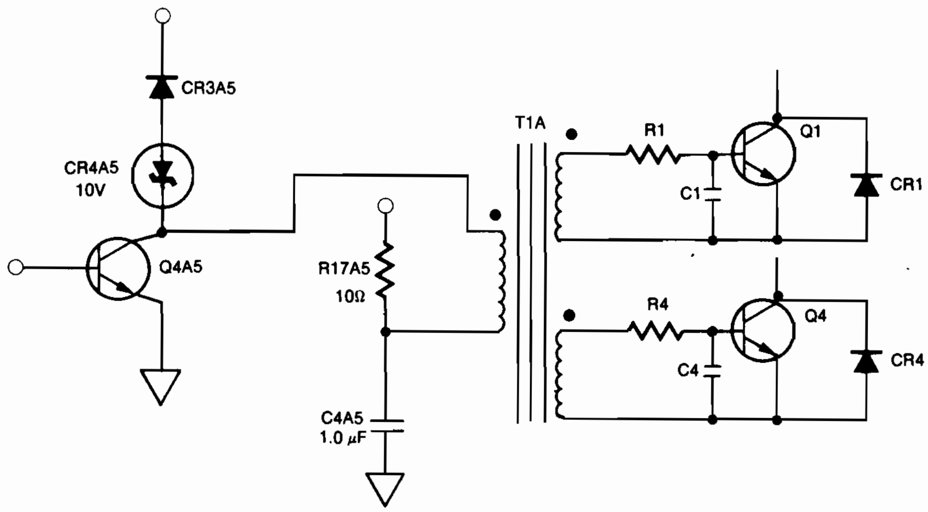


Figure A-5. Inverter Drive Circuit

The inverter transformer is marked with polarity dots to show current flow direction; e.g., current flowing out of the dot side of the primary causes current to flow into the dot side of all secondaries. In this case, when Q4A4 switches on the current flows out of the dot side of the primary, currents flow into the dot sides of the secondaries and turn off Q1 and Q4.

As current flows into the dot sides of the secondaries, C1, C4 and the base-emitter regions of Q1 and Q4 become fully discharged. Once the charge in these areas has been bled off, Q1 and Q4 become reverse biased and no more current can flow into the secondaries of T1A. At this point, the current in the primary of T1A reaches steady state and is set by R17A5. Energy is stored in the core of T1A due to the inductance of the primary and the current through it. when Q4A5 turns off, the energy stored in the core is transferred to the secondaries and causes a large current to flow into the bases of Q1 and Q4, turning them on and driving them into saturation. As Q4A5 turns off, a large voltage spike is generated across the primary of T1A. When the voltage spike reaches about 19 volts, CR3A5 and CR4A5 turn on and bleed some of the energy stored in the core of T1A into the 8 volt supply bus. This bleeding off of energy reduces the current flowing into the bases of Q1 and Q4 and helps to "reset" the core for the next cycle.

A.5 Pre-regulator Board (5061-3457)

The pre-reg board circuit provides the control drive to the pre-reg transistor Q1 on the MB and is part of the same circuit. It also provides over-current and input power sensing for the entire supply, and provides isolation between the control board and pre-reg circuits.

Figure A-6 is a functional block diagram of the pre-reg board. Power is supplied to the board from a separate winding on the bias transformer. This is required because the ground of the pre-reg board must be connected to the ground of the pre-reg circuit, which is about 150 volts below the ground of the control board.

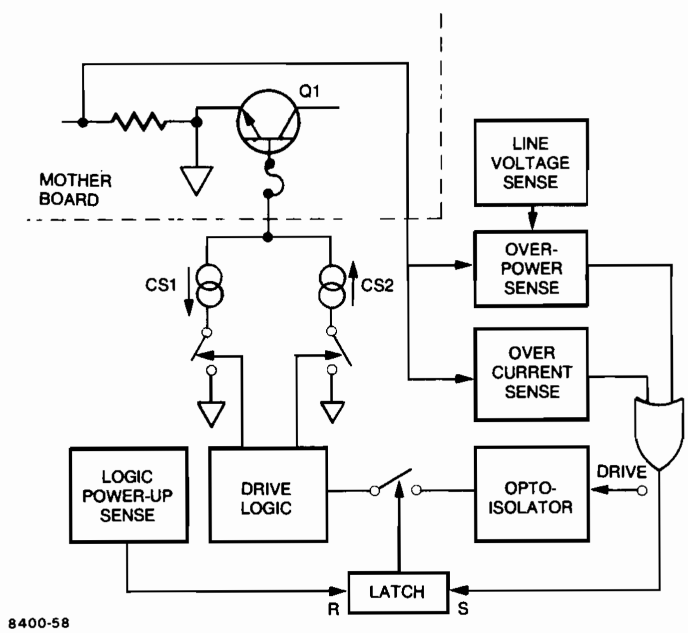


Figure A-6. Pre-regulator Board Block Diagram

A.5.1 Pre-reg Drive Signal

The drive signal coming from the control board is isolated by an opto-isolator. The drive signal is processed by switching logic, providing plus/minus current sources to the base of Q1 so that Q1 is alternately switched on and off. The drive signals to the current sources can be interrupted by the pre-reg board power sense circuit, which ensures that the over current and input power sensors are functioning before Q1 on the MB can be switched on.

Referring to the pre-reg board schematic (B-5061-3457-51), when the drive signal coming from the control board to the opto-isolator (U3) is high, Q7 is turned off. When the drive is low, Q7 turns on due to pull-up R2. R3, the collector load for Q7, is coupled to U4A, the first switch in the pre-reg drive path shown in Figure A-6.

If pin 1 of U4 is low, the pre-reg drive signal gate is off. The signal at pin 1 of U4 comes from the over-current and input power protection circuits (described later) and is high for normal operation; i.e, output state at pin 9 is the always the opposite state of pin 2. U4A thus inverts the signal and passes the pre-reg drive signal on to inverters U4B and U5A. The main drive signal is passed through U4B to gates U5B and U5C, which form the switches controlled by the pre-reg board over power sensor. Pins U4-4 and -10 are connected to the pre-reg board power sensor and are high for normal operation.

A.5.2 Q1 Current Sources

Figure A-6 shows Q1 on the MB being driven by two current sources (drive logic), CS1 and CS2. CS1 is formed by Q4, Q5 and Q6; CS2 is formed by Q9, Q11 and Q12. Consider what happens when the output of U4B is high. The outputs of both U5B and U5C are low; a low on the output of U5B provides base drive to Q6 through R11 and a low on the output of U5C pulls down the emitter of Q8, turning it off. When Q6 is on, base drive is supplied to Q5, turning it on as well.

Just before Q5 turns on, C3 is held discharged by R13, R14 and R35 and appears as a short circuit so that R13, R14 and R35 are effectively in parallel. The emitter resistance seen by Q5 as it turns on is about 0.31 ohms. Note that when Q6 is on, current can flow through R27 and turn on Q10, thus clamping Q12 off. When Q5 turns on, current very quickly builds up in R13, R14 and R35 to about 1.5 amperes, at which point Q4 begins to turn on and pull away base drive from Q6. As C3 approaches full charge (about 2.5 microseconds later), there will be no more current flow in R14 and R35 and the current in Q5 will decrease until the voltage across R13 is barely enough to keep Q4 on (about 0.66 volts). Once C3 is fully charged, Q4, Q5 and Q6 form a current source that drives the base of Q1 on the MB at about 0.8 amperes.

Returning to inverter U4B, when pin 6 goes low, the outputs of both U5B and U5C go high. The output of U5B going high takes away base drive from Q6, turning it and Q10 off. At the same time, U5A turns on Q3 which clamps Q5 off. The output of U5C going high allows Q8 to turn on, which supplies base drive to Q9. Q9 supplies base drive to Q12, which pulls current out of the base of Q1 on the MB, turning it off.

Q9, Q11 and Q12 form a current source that tends to pull current out of the base of Q1 on the MB at a constant 2 amperes. In operation, Q12 emitter resistors R32, R33 and R34 (with a combined parallel resistance of 0.33 ohms) provide the base voltage to Q11. The current will rise until the voltage drop reaches the turn-on voltage of Q11 (about 0.66 volts). The required current for this is about 2.0 amperes and at that current, Q11 begins to pull base drive away from Q9, which in turn decreases the base drive to Q12. Not long after Q12 turns on, all stored charge in the base of Q1 on the MB will be pulled out, stopping current flow.

At this point, Q11 will turn off, allowing Q9 to supply full base drive to Q12, forcing it into saturation. When Q12 is saturated, the base of Q1 on MB will be pulled down to -8 volts and be held in a cutoff state.

A.5.3 Pre-reg Summary

In summary, when the pre-reg drive signal coming from the control board is high, a positive current source is turned on, driving on Q1 of the MB. When the pre-reg drive signal goes low, The positive current source turns-off and a negative current source (current sink) turns-on, pulling all the stored charge out of the base of Q1, turning it off. After all the charge has been removed from the base of Q1, the current sink saturates, clamping it off. The base current waveform of pre-reg transistor Q1 of the MB is shown in Figure A-7.

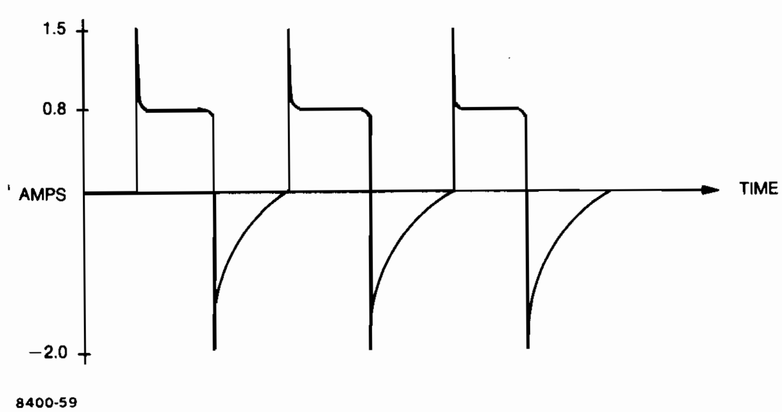


Figure A-7. Transistor Q1 Base Current Waveform

A.5.4 Pre-reg Power and Power Sense

Power to the pre-reg board is 22 Vac, supplied by bias transformer (rear panel) and rectified by CR14 and filtered by C4, C5 and C6. C4 and C5 are in parallel to provide extra filtering to the +5 volt bus, as it must supply voltage to the "on-board" logic as well as the positive current source. U1 and U2 are standard three terminal regulators, U1 supplying +5 volts, U2 supplying -8 volts.

When power is turned-on to the supply, it is very important that no drive signals be applied to the pre-reg circuit until the over-current and input power protection circuits are functioning. The pre-reg board has a logic power sense circuit that prevents the positive current source from turning on, thus preventing Q1 of the MB from turning on until power is up and all circuits are functioning.

A.5.4.1 Pre-reg Drive Control

The power sense for the pre-reg drive control is formed by CR3, Q1, Q2 and their associated resistors. When the supply is turned on, the voltage at the input of U1 begins to rise. Before the output of U1 begins to supply 5 volts, pins 4 and 10 of U5 and pin 10 of U4 are pulled down to ground by R4 and R6. When the input of U1 gets up to about 7 volts, it's output begins to supply 5 volts to the "on-board" circuitry. C2 charges smoothly to 5 volts and provides power to U4, U5 and U6 (see note 1 on the pre-reg schematic). The same point provides base drive to Q2 through R5; Q2 saturates, pulling pins 4 and 10 of U5 and pin 10 of U4 hard to ground. When the input of U1 gets up to about 8 volts, CR3 turns on and supplies base drive to Q1, which saturates and pulls down the base of Q2. Q2 turns off and R7 now pulls pins 4 and 10 of U5 and pin 10 of U4 up to 5 volts. U5B and U5C are now able to pass pre-reg drive along to the current sources.

A.5.4.2 Pre-reg Input Power and Over-current Control

U6A and U6B form the input power and over-current sensors, respectively. U6A and U6B sample the voltage across R13of the MB through R21 and R25. The voltage across R13 is a measure of the pre-reg current; the larger the pre-reg current, the more negative (with respect to ground 2) the voltage presented to R21 and R25 becomes. R28 ties the noninverting input of U6A to the negative raw dc input of the pre-reg board. The larger the input line voltage, the more negative R28 pulls the noninverting input of U6A.

Both U6A and U6B are comparators, with their inverting inputs referenced to ground. As soon as the noninverting input of either U6A or U6B goes slightly below ground (a few millivolts is enough), the OR tied outputs of both go low and set the latch formed by U4C and U4D. When the latch is set, the output of U4C is low and the output of U4D is high. With a low on pin 1 of U4A, the pre-reg drive signal is prevented from going on to U4B and U5A, and the supply will not run. A high on the output of U4D is inverted by U5D and LED CR10 is driven on. The latch will remain set until power to the supply is switched off and then back on again, which causes a reset via pin 10 of U4C.

A.6 Control Board (5061-3455)

The control board contains many different circuit functions and is connected to most of the other boards in the power supply. The following is a list of the different functions and circuits of the control board

1. Error amplifier
2. Pulse-width modulator (PWM)
3. 100% duty cycle sense
4. Pre-reg drive
5. Inverter drive
6. Lock circuit
7. Secondary over-current sensors
8. Over-temperature cutout
9. CPU signals
10. Power supply control signals

For this discussion of the control board, refer to sheet 1 of the control board schematic, C-5061-3455-51. Power is supplied to the control board from two regulator ICs on the MB. Two voltages are used on the control board, +5 and +8 volts and are filtered for noise by C1 and C2. The 5-volt supply powers all comparators, amplifiers and gates; the 8-volt supply is used to drive the inverter board.

A.6.1 Error Amplifier

The error amplifier for the main regulation loop is formed by U3, U7 and Q5. U3A is connected as a differential amplifier. The inverting input of the differential amplifier is connected to the 2.5 volt reference; the noninverting input is connected to the 5V CPU output. The output of the differential amplifier drives a current "mirror" (equal and opposite) formed by two transistors of U7. A current flowing into the collector of the left transistor will cause a certain voltage to develop across its base-emitter junction. The two transistors must have the same Vbe because they have their bases and emitters tied together. The transistors of U7 are contained on the same substrate, so they will have very nearly identical base-emitter characteristics and will thus have identical collector currents as long as their Vbe voltages are equal. The range of the current mirror is approximately zero to 200 microamperes, depending on the voltage at the output of the U3A.

The emitter of Q5 is tied to +5 volts by R29 and its base is tied to +2.5 volts by R26. With the base and emitter referenced to regulated supplies, Q5 has a constant base current and thus a constant collector current (approximately 100 microamperes). The collectors of Q5 and the right-hand transistor of U7 are connected together along with the input of a voltage follower U3B and an R-C network R30- C12. The same node is also connected to the slow start circuit (P5V.CV line) which is an open circuit for all but start-up conditions. The current mirror of U7 and the current source of Q5 are connected together by their collectors; Q5 tries to inject current in to, and U7 to pull current out of, their common node.

When U7 is not pulling any current, there is a net current flow out of the node, which charges C12 through R30; when U7 is pulling 200 microamperes, there is a net current flow in to the node, which discharges C12. the voltage at the node thus rises and falls due to the charge and discharge of C12.

The voltage across C12 and R30 is buffered by U3B and applied to the PWM U2C. The pre-reg drive signal at the output of the PWM can be pulled down to ground by U8A and thus disabled, when the inhibit signal is high. U6B can also prevent the pre-reg drive signal from reaching the pre-reg board. If the lock circuit has a low output, U6B will allow the signal to pass through. CR7 prevents the output of U6B from being forced more positive than +5.7 volts.

A.6.2 Pulse Width Modulator

A sawtooth waveform generator that is used in the PWM is formed by U2A, U2B, U4A, U6A, C6 and some associated resistors. When power to the control board comes up, C6 is initially discharged and pins 8 and 11 of U2 are at ground potential. A 2.5 volt reference is connected to pin 9 and a 1.0 volt reference is provided on pin 10 by voltage divider R6-R7.

In operation, with C6 discharged, the output of U2A is high and the output of U2B is low. With the output of U2B low, U4A is held cleared and its "Q" output is low. U6A inverts the low on "Q" and its output is pulled up by R1. C6 charges through the series combination of R1 and R4. when the voltage across C6 reaches 1 volt, the output of U2B goes high and removes the clear signal from U4A (keep in mind that the small circle on the preset and clear inputs means they are active in the low state).

When the voltage across C6 reaches 2.5 volts, the output of U2A goes low and presets U4A, which causes the "Q" output to go high. The high on "Q" is inverted by U6A, which pulls the junction of R1 and R4 down to ground and discharges C6. When the voltage across C6 gets below 1 volt, the output of U2B goes low and U4B is cleared, causing "Q" to go low. The low on "Q" is inverted by U6A and allows C6 to begin charging again. The cycle repeats itself, with U4A being alternately cleared and preset at a 40 kHz rate. U4B divides the 40 kHz signal by two to provide 20 kHz drive signals to the inverter board. The exponential sawtooth waveform across C6 is used by the PWM to be described later. Figure A-8 shows the voltage waveforms of C6, U4A and U4B.

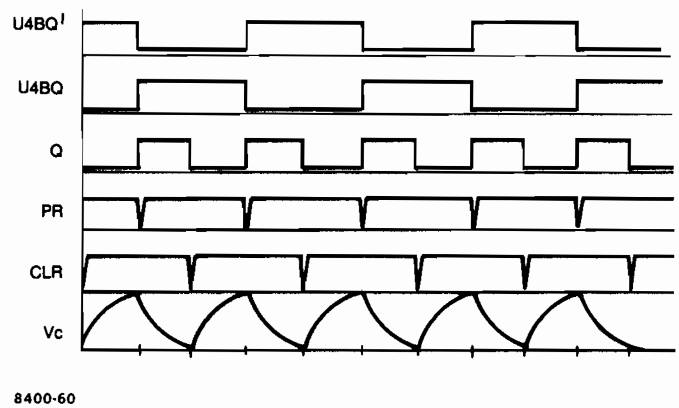


Figure A-8. Triangle Waveform Generator Timing

A.6.3 Inverter Drive

The "Q" and "Q'" outputs of U4B provide 180 degree out-of- phase drive signals for the inverter drivers Q2 and Q4. Referring to U4B, when "Q" is high and "Q'" is low, and assuming that the lock signal on pins 1 and 4 of U5 are high, then the output of U5A will be high and the output of U5B will be low. A low at the output of U5B will turn on Q1, which will provide base drive to Q2 through R11. Q1 acts as an active pull-up for the base of Q2. When "Q" goes low, the output of U5B will go high, turning off Q1. A low on "Q" will also cause the output of U5A to go low, which will turnoff Q2. U5B acts as an active pull-down for the base of Q2, helping it to turn off. U5C and U5D perform the same function for Q3 and Q4, but 180 degrees out of phase. The inverter drive circuit is further described in the inverter board section.

A.6.4 100-Percent Duty Cycle Sensor

U2D forms a 100% duty cycle sensor. One input is referenced to the peak value of the triangle waveform (2.5 volts) that is supplied to the PWM. The other input is connected to the error amplifier output buffer. If the voltage at the error amplifier buffer were to rise above 2.5 volts, the output of the PWM would have reached 100% duty cycle, which is an indication that there is trouble in the supply somewhere (normal duty cycle is in the range of approximately 30-70%). When the voltage at the inverting input of U6B gets slightly above 2.5 volts, the output will go low and pull down the pre-reg power-fail warning line (PREG.PFW-), which will cause the supply to shut down 700 microseconds later.

A.6.5 Lock Circuit

The lock circuit is shown on sheet two of the control board schematic (C-5061-3455-52). It consists of U10A, CR13 and CR14. The voltage on pin 5 of J5 (P15VC) is the raw dc input to the 5- and 8-volt regulators on the MB. As soon as P15VC rises to about 1.5 volts, R59 will drive the base of U7 connected to pin 12 into saturation, which will pull down on the lock signal and hold it low.

When P15VC rises to about 4 volts, the 2.5 volt reference IC on the control board (U1) will come on. As P15VC reaches about 7 volts, the 5-volt regulator on the MB will begin to supply power to the ICs on the control board. The voltage on P15VC is divided down by the divider network R56-R63-R65. At P15VC=7 volts, the voltage on the noninverting input of U10A will be about 1.6 volts; with 2.5 volts on the inverting input, the output will be driven low, which will clamp the base of U7C off.

At a line voltage of about 70 Vac, P15VC will reach 10.8 volts, which, when divided down by R56, R63 and R65, will put 2.5 volts at the noninverting input of U10A. When the line voltage increases just a fraction more, the output of U10A will go positive, allowing R58 and CR14 to drive U7C on. CR14 is a stabistor diode and is identical to three diodes in series. CR14 does not allow U7C to turn on unless there is at least 2.8 volts coming in to the control board from P5VC. U10A begins to function at 2 volts, so CR14 will not allow U7C to turn on until U10A is operational. When U7C turns on, it pulls down the base of U7D, which allows R3-3 to pull the lock signal high. As all this has been happening, the output of U10B has remained low due to the 2.5 volts on its inverting input. When the line voltage gets up to about 74 volts, the output of U10B will go high, allowing PREG.PFW to come up.

A.6.6 Over-temperature Cutout

The thermal sense switch connected to pin-K of J5 is closed for normal operation. When the temperature of the post regulator heat sink gets above about 212 degrees F, the thermal switch opens, allowing R66 to drive U7E on. when U7E is on, PREG.PFW is pulled down and the supply acts as though a power failure has occurred.

A.6.7 Power-up Sequence

The timing between the signals that the supply sends to the computer is controlled by the LPU (Line Power Up) circuit. The LPU circuit is formed by U6C, U13A and U12A. Suppose a power failure occurs where the line voltage drops rapidly. The normal state of the LPU circuit is low. So, for normal operation, the output of U13A is low and the output of U12A is high. PREG.PFW is also high for normal operation, so the output of U6C will be low.

The voltage across C20 will be about 0.8 volts due to the voltage divider R67-R69 (the right end of R69 is pulled down to ground by the low output of U13A). The low on the output of U6C will pull down the noninverting input of U13A and thus the LPU.I output will be stable in the low state. When the line drops below about 74 volts, the output of U10B will go low. A low on one input of U6C will cause its output to go high, which will allow the noninverting input of U13A to come immediately up to 1.7 volts (set by the voltage divider formed by R68 and the parallel combination of R71 and R72). U13A now has a larger voltage on its noninverting input than on its inverting input, so its output will go high, allowing R2-6 to pull LPU.I high.

As soon as the output of U13A goes high, three things happen. First, the output of U12A goes low, which ensures that the output of U6C will not be affected by further changes in PREG.PFW. Second, C20 begins to charge through the series combination of R2-6 and R69 in parallel with R67. Note that R2-6 is small compared to R69 and R71, so the right end of R69 and the top of R71 are pulled almost exactly to 5 volts when the output of U13A is high. Also note that R67 is large compared to R69, so their parallel combination is roughly equal to R69, which sets the charge current through of U13A changes.

With R2-6 pulling the output of U13A high, R71 is roughly in parallel with R68, and the voltage on the noninverting input of U13A rises to about 3.3 volts. C20 continues to charge until it reaches 3.3 volts, at which point the output of U13A goes low and the output of U12A goes high, clocking the flip- flop U9A (positive edge triggering). The time required for C20 to charge from 0.8 to 3.3 volts is about 700 microseconds.

As soon as U9B is clocked, the low on "D" will be placed on "Q," and "Q'" will go high. Referring back to U6C, if PREG.PFW has gone high before the output of U12A goes high, the output of U6C will go low at the same time U9B is clocked. A low on the output of U6C will pull down the noninverting input of U13A, which will cause LPU.I to go low immediately, signaling the CPU that line power is back up.

The normal power-up sequence of the control board is quite complicated and begins with the LOCK and PREG.PFW signals coming up. Before LOCK comes up, pin 2 of U12C is low, which means it's output is high. The high is inverted by U12D, which holds U9B in a cleared state. When U9B is cleared, "Q'" is high. The high on "Q'" is inverted by U8B, which holds C17 discharged. The voltage divider string of R42, R47 and R48 puts about 3.27 volts on pin-11 of U10 and about 0.97 volts on pin 4 of U10, so when C17 is held discharged, the output of U10C is high and the output of U10D is low.

The low on the output of U10D holds U9B in the preset state, which means U9B is both preset and cleared, causing both "Q" and "Q'" to be high. The high output on U10C places a high on pin 4 of U12B. At this point, both LOCK and PREG.PFW are both still low. With PREG.PFW low, LPU.I will be oscillating on and off at about 660 Hz. Note also that the high outputs of U10C and U9B-Q' cause the output of U11A to go low, driving LED CR11 on and activating INHIBIT. When LOCK comes up, pin 2 of U12C goes high. The next time LPU.I goes low, the output of U12B goes high. Both inputs of U12C are now high, so it's output goes low, which is inverted by U12D, taking away the clear signal from U9B.

With preset still activated and the clear signal gone, "Q'" goes low, which is inverted by U8B, allowing C17 to begin charging. However, as soon as LPU.I goes high again, U9B will be cleared and "Q'" will go high, causing U8B to pull down C17 before it ever gets very far.

When PREG.PFW comes up, LPU.I will come down and stay down, causing the output of U12B to go high, which results in the clear signal at U9B going high. Again, "Q'" will go low, which lets C17 to begin charging. Notice also that when "Q'" goes low, pin 5 of U11A goes low also. When the voltage across C17 gets up to 0.97 volts, the output of U10D goes high, which takes away the preset from U9B. C17 continues to charge and when it gets above 3.27 volts, the output of U10C goes low, which now allows the output of U11A to go high, turning off LED CR11.

A high on the output of 11A, along with the high on LOCK, will allow the output of U6D to go low, turning off Q9. With Q9 off, C18 begins to charge through R3-9. As C18 charges, the voltage at the noninverting input of U3B to rise slowly (C-5061-3455-51). C18, R3-9, CR12 and Q9 form a slow-start circuit. The slow charge of C18 allows the duty cycle of the PWM to increase smoothly until normal operation is reached. When the voltage across C18 gets up to 5 volts, CR12 will be reverse biased and the slow start circuit will have no more effect on the PWM.

When +5VM comes up, C21 will begin to charge through R21. When the voltage across C21 gets above 2.5 volts, the output of U13B will go low. Since INHIBIT is also low, PSU.I will go low.

When a pre-reg over current comes along, the pre-reg board will no longer drive Q1 on the MB. The 5V CPU output will start falling and the control board will try to compensate by increasing the duty cycle of the pre-reg drive. When the duty cycle gets to 100%, PREG.PFW will go low, which will start a power fail routine. When INHIBIT goes low, Q9 will turn on and pull down the noninverting input of U3B, which will decrease the duty cycle to 0%. A low on INHIBIT will also turn on LED CR11. With the duty cycle at 0%, PREG.PFW will come back up and the supply will go through a normal slow start routine and the CR11 will go off. Because the pre-reg board is latched off, however, the duty cycle increases to 100% and the whole process will repeat itself, causing flashing CR11 to periodically flash.

A.6.8 Computer Signals

The PON and PWU circuits are located on the third sheet of the control board schematic, C-5061-3455-53. Starting with the PON circuit, PSU+ is the OR-tied signal from another power supply. If PSU+ is low, the output of U13C will be high due to the 2.5 volt reference voltage on it's non-inverting input. The high will be inverted by U14A, and PON will be low. Once PSU+ is high, the supply is free to raise or lower PON according to its own state. When PSU.I- goes low, it means that the supply is up and running. The low is inverted by U8E and a high is placed on the inverting input of U13C. The output of U13C goes low, which is inverted by U14A, driving PON high.

PSU+ terminals connected. Note that CR15 A and B have their cathodes connected to P5V.SEN, which is just the +5V CPU output of each supply. When a power supply is running, if it supplies only 1 ampere at 5 volts, that represents a load resistance of 5 ohms. A load represents a low resistance to a power supply whether the supply is running or not. The +5V CPU output sees a low resistance to ground when the supply is not running. If supply B is off, then the cathode of CR15-B is essentially connected to ground.

When supply A powers up and tries to raise PON, pull-up resistor R74-A will not be able to pull the inverting input of U13C-A up because of R73 A and B in series connected to ground through CR15-B. When supply B comes up, CR15-B will be reverse biased and both PON-A and PON-B can come up. The circuit for PWU works exactly the same way, except that CR17 is connected to P5VC (5 volt control board power) instead of P5V.SEN. The output of U14A pulls up to P5V.SEN so that there is no way that PON can come up unless +5V CPU is up.

A.6.9 Secondary Over-current Sensors

Q6, Q7 and Q8 are the over current sensors for the +12V I/O, -2V CPU and -12V I/O, respectively. Figure A-9 shows the connections between the current sensors, the sense resistors on the MB, and the post regulator board. When the voltage across R3 gets above 0.56 volts, Q8 will turn on, which pulls the preset of U9A down toward -12 volts. CR8 prevents the preset input from being pulled more than 0.7 volts below ground. C16 and R40 prevent U9A from responding to over-currents shorter than about 10 microseconds. The circuit for the -2V CPU output works exactly the same way. The +12V I/O circuit is a little different though. When Q6 turns on, it supplies base drive to Q8 through R38. Q8 turns on, acting just like a -12V I/O over current. R36, R37, R41 and C13-15 provide RC delays of about 500 microseconds to slow down the response of the current sensors.

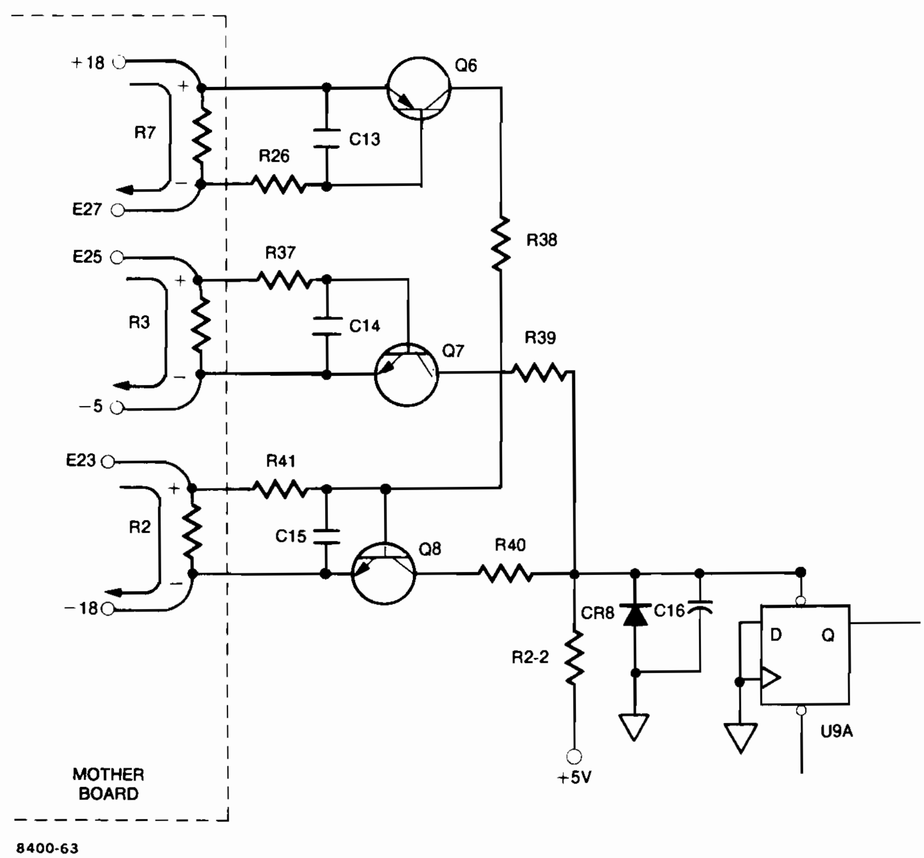


Figure A-9. Secondary Over-current Sensors

A.7 Output Regulator Board (5061-3403)

The output regulator board is mounted on Heat Sink Assembly 5061-6625. It consists of three linear regulators that provide +12, -12 and -2 volt outputs. Refer to the output regulator schematic B-5061-3403-51 on page IXB-93. Unregulated dc voltages of +18, -18 and -5 volts are supplied to this board from the MB.

The +12V is provided by Q3 which is a three-terminal (input, output and ground) voltage regulator. It is rated to supply up to 5 amperes of load current. C27 helps improve the stability of Q3. Q5 is also a three-terminal regulator, providing a -5 volt reference for the -2 and -12 volt regulators.

Q2, CR25 and U3A form a simple linear regulator. In operation, suppose that when power is applied to the circuit, Q2 is off. When Q2 is off, there will be no output voltage at its collector and the voltage at the noninverting input of U3A. There is, however, -5 volts at the inverting input of U3A, supplied by Q5 through R23. The inputs of U3A draw almost no current, so there will be little voltage drop across R23. With the noninverting input at ground (if Q2 is off, R18 pulls the noninverting input to ground) and the inverting input at -5 volts, the output of U3A will swing positive. As the output of U3A goes positive, CR25 begins to turn-on in its reverse direction and supply base drive to Q2.

CR25 is used as a level shifter. The emitter of Q2 is tied to -18 volts, so the base of Q2 must be driven at a voltage of about two diode drops more than that (-16.6 volts). U3A would have trouble driving to such a large negative voltage, so CR25 is used to shift the voltage up. The output of U3A need only drive to -10.4 volts to turn on Q2 with CR25 in the circuit. U3A continues to drive Q2 until it's collector voltage rises to -12 volts, at which point the voltage divider R17-R18 will present -5 volts to it's noninverting input. If the collector voltage of Q2 goes below -12 volts, the voltage on the noninverting input of U3A would go below -5 volts, leaving a net positive voltage on the inverting input, which would cause the output of U3A to go negative and turn off Q2. U3A will thus drive Q2 so that the output is just exactly -12 volts. R22 and C32 form a frequency compensation network to help improve stability.

U3B, Q4 and Q6 form another linear regulator that supplies -2 volts. Voltage divider R19-R21 provide a -2 volt reference to the inverting input of U3B from the -5 volt output of Q5. Again, the inputs of U3B draw very little current, so there is little voltage drop across R24. Again, suppose both Q4 and Q6 are off when power is applied. There will be no voltage at the collector of Q4 and the noninverting input of U3B.

A net negative voltage on the inverting input will cause the output to go positive, driving Q6 on. When Q6 turns on, it supplies base drive to Q4. When Q4 turns on, the voltage on its collector begins to swing toward -5 volts. When the voltage gets just slightly negative of -2 volts, the net voltage on the inverting input of U3B is positive, which causes its output to swing negative, turning off Q4. U3 will always supply just the right amount of drive to Q6 and Q4 to maintain the collector of Q4 at -2 volts. Below is a table showing the approximate test point voltages for normal operation:

Test Point	Voltage Range
1	about -16.6 V (depends on -18 value)
2	-4.85 to -5.15 V
3	about -10.4 V (depends on -18 value)
4	-4.85 to -5.15 V
5	-1.94 to -2.06 V
6	about -3.6 V (depends on -5 value)
7	about -4.3 V (depends on -5 value)

Note: The ground lead of meter should be connected directly to ground on the post regulator board.

A.8 Charger Board (5060-1348)

The charger board has several different functions. First, and most obvious, is to charge the batteries in the Power Fail Recovery System (PFRS). Second, is a circuit that senses battery voltage and cuts off operation of the battery backup board when the battery voltage gets below a set level. Last is a timing signal circuit that signals the CPU and other power supplies that +5 VM is either up or down.

Referring to the battery charge board schematic (C-5061-1348-51), approximately 18 to 22 volts ac is supplied to the battery charger board through J3 pins L and N. The ac is rectified by CR6 and CR7 and filtered by C9 on the MB. The filtered dc is fed into the emitter of Q1 and to the battery backup board through J3 pins R and 14. Q1, U1 and Q8 form a simple linear voltage regulator. CR2 and R2 form a fairly stable, adjustable reference source to the noninverting input of U1.

The output voltage of the regulator is fed-back to the inverting input of U1 by a network that is capable of sensing battery temperature. Connected between J3 pin 9 and J3 pins J and 8 is an 815 ohm resistor which is mounted on the battery. The resistor is a high stability wire wound type whose resistance changes very little with temperature.

The output voltage at the collector of Q1 is set by R2 and R3. If the output voltage tries to drop, U1 will drive Q8 a little harder, which will in turn pull more base current from Q1, causing the output voltage to rise. If the output voltage tries to rise, U1 will decrease the drive to Q8, which will in turn decrease the drive to Q1, lowering the output voltage. The circuit works exactly the same as all the linear regulators discussed previously. C1, C8, C9 and R30 provide frequency compensation to improve stability.

Q2, Q3 and R21 form a current limiting circuit. If the voltage drop across R21 gets above about 0.6 volts, Q3 begins to turn on and supply base drive to Q2 through R13. As Q2 turns on, it begins to pull the output of U1 down toward ground, which decreases the drive to Q8, which in turn decreases the drive to Q1, lowering the output voltage and decreasing the output current. C6 and R12 provide frequency compensation for the current limit circuit.

The battery charge circuit is known as a "float" charger. The charge voltage is set to 16.45 volts at the cathode of CR5 using R2 and R3, which works out to 2.35 volts per cell for the seven cell battery packs used in the 12944B and 12991B. The current limit circuit limits the battery charge current to about 2 amperes for a fully discharged battery. CR5 prevents the battery from discharging back through the charge circuit when power is turned off.

U2A acts as a battery voltage monitor. The battery voltage, sampled by R1, R5 and R8 is compared by U2A to a reference voltage formed across CR3. R1 is set so that when the battery voltage drops below 12.5 volts, the output of U2A goes high, shutting off Q5 and Q7.

Q7 controls two voltages used by the battery backup board, +16 and +8 volts. The +8 volts is developed by Q6, a three-terminal regulator. When Q7 is off, neither +16 or +8 volts is supplied to the battery backup board, which causes it to shut off (fully described in the battery backup board section). C2 provides noise filtering to the sampling network of R1 and R8, CR3 does the same for CR3. Battery current is supplied to the battery backup board through CR4 during power failures. For line operation, CR4 is reverse biased and no current flows through it. See the battery backup section for a further explanation.

U2B senses when +5 VM is up and supplies appropriate signals to the CPU and other power supplies. When +5VM comes up, C7 begins to charge through R23. R24 and CR9 provide a 2.37 volt reference to the inverting input of U2B. When the voltage across C7 gets above 2.37 volts, the output of U2B goes high, which allows R25 to pull MLO' high and drives Q10 hard into saturation. When Q10 is in saturation, MLOST' is pulled up toward +5VM.

A.9 Battery Backup Board (5061-1349)

The battery backup board supplies +5VM, +12VM and -12VM to computer memory in "B" Power Supply's equipped with PFRS. The battery backup board (BBB) consists of one switching regulator that supplies both +5VM and -12VM and a linear regulator that supplies +12VM. The BBB can take power from either the raw battery charge voltage on the charger board or directly from the battery itself.

Figure A-10 shows how the charger board and the BBB are connected. During line operation, the dc voltage at the cathodes of CR6 and CR7 is about 20 volts, so the voltage at the anode of CR10 is about 20 volts and the voltage at the cathode of CR10 and CR4 is about 19.3 volts (both may vary with line voltage and load). The battery charge voltage at the anode of CR4 is 16.45 volts, so CR4 is reverse biased and no current can flow from the battery to the BBB. When line power is cut off, the voltage at the cathodes of CR6 and CR7 and the anodes of CR5 and CR10 goes to zero. C11 begins to discharge from 20 volts as the regulators on the BBB continue to draw current. As soon as the voltage on C11 gets down to about 14 volts, CR4 turns on and allows current to flow from the battery to the BBB. CR5 and CR10 remain reverse biased until line power comes back up and the battery begins to charge again.

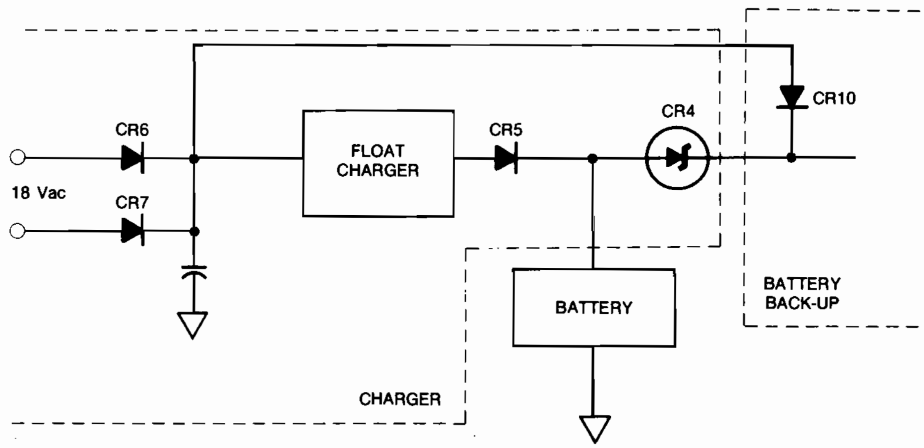


Figure A-10. Battery Backup Board to Charger Connection

Referring to the BBB schematic (C-5061-6609-51), the top two thirds of the sheet is associated with the +5VM switching regulator. Q5 is the main switching transistor, with Q6, Q7 and Q8 in it's base drive circuit. T1 acts as both an inductor and a flyback transformer. The series connected windings between pins 1 and 4 act as an inductor for energy storage while the winding between pins 7 and 8 acts as the secondary of a flyback transformer. U1 is voltage regulator IC that acts as an error amplifier and a current limiter. U3A is connected as a sawtooth wave oscillator and U3B is connected as a PWM.

In operation, suppose that when power is applied, C10 is completely discharged and there is no voltage at the inverting input of U3A. The output of U3A will be high because of the voltage applied to the noninverting input by R27. U3 is an open collector type comparator, so when the output is high, the series combination of R30 and R31 is in parallel with R27, which results in about 4.57 volts at the noninverting input of U3A. C10 begins to charge through R29 and R31 and when it gets just above 4.57 volts, the output of U3A goes low.

Two things happen when the output goes low. First, C10 begins to discharge through R29. Second, R30 becomes effectively in parallel with R17, which lowers the voltage at the noninverting input to about 2.67 volts. C10 will continue to discharge until it goes just below 2.67 volts, at which point the output will go high, starting the cycle over again. The voltage at the inverting input of the PWM (U3B) will be a sawtooth waveform which oscillates between 2.67 and 4.57 volts at 20kHz. The frequency of oscillation is determined by C10, R29, R30 and R31. C9 provides filtering to the supply voltage of U3.

The noninverting input of the PWM is driven by the error amplifier (U2) through level shifting diode CR6. The PWM controls the base drive circuit of Q5. Q6 and Q7 form a simple current regulator between the base of Q5 and the center-tap of T1. When Q8 is turned on by a high on the output of the PWM, Q7 turns on, causing current to flow out of the base of Q5 (turning it on), through R25 and Q7, and into the center-tap of T1. When the base current of Q5 gets up to about 600 milliamperes, the voltage drop across R25 begins to turn on Q6, which starts to clamp off the base-emitter junction of Q7. Q6 and Q7 work together to maintain a constant 600 milliamperes base current in Q5. While Q5 is on, current flows through T1, storing energy in a magnetic field, charging A6-C10, and supplying current to the load.

CR7, R21, C7 and R22 form a turn-off network for Q5. When Q5 is on, there is almost no voltage from collector to emitter of Q5, so C7 is held discharged by R21 and R22. Note also that when Q7 is on, the top end of L1 is positive and current flows downward through it. When the output of the PWM goes low, Q8 turns off, which cuts off base drive to Q7. The current that has built up in L1 now forces it's way into the base of Q7, turning Q7 off rapidly. When Q7 turns off, base drive to Q5 is cut off. As soon as Q5 turns off, CR8 turns on to allow current to continue flowing in T1. The instant CR8 turns on, it's cathode, along with the collector of Q5 and the top end of R22 go to one diode drop above ground. When the top end of R22 is pulled near ground, base current is pulled from Q4 through C7. Q4 saturates and clamps off the base-emitter junction of Q5, helping it to turn off. When Q5 turns on again, C7 discharges rapidly through R22 and CR7. During the off period of Q5, load current is supplied by T1 and A6-C10.

The output voltage is sensed by pin 4 of U2 and compared with an adjustable reference voltage at pin 5. Any difference between the voltages at pins 4 and 5 will cause the error amplifier to drive the PWM to correct the difference. C3, C4, C6 and R18 are frequency compensation components.

R1 sets the output voltage with C5 providing noise filtering. CR4 acts as a simple slow-start circuit by preventing the reference at the wiper of R1 from rising faster than the output voltage. This ensures that the duty cycle of the regulator increases slowly in a controlled manner. R20 senses the output current and turns on the transistor connected between pins 2 and 3 of U2 at about 8 amperes. When the transistor turns on, it pulls drive away from the PWM circuitry and causes the output voltage to drop. C12 provides on-board output filtering for +5VM. CR9, CR11 and R26 form a crowbar circuit. R28 provides a minimum load to the output of the regulator.

The -12VM is developed by a flyback winding on T1. The output rectified and filtered by CR5 and C8 and is not regulated. The -12VM output voltage will vary depending on both -12VM current and +5VM current.

The +12VM regulator circuit diagram is located in the lower third of the BBB schematic. +12VM uses a linear regulator that provides good efficiency due to a relatively small voltage drop across the output transistor Q3. U1A is the error amplifier and compares a reference voltage set by R2 to the output voltage divided by R7 and R8. U1A drives Q2, the output driver, through level shifter CR2. Q2 pulls base current from Q3 through R6. The output current is sensed by R3, R5 and U1B.

If the output current gets above about 2.5 amperes, the output of U1B will go high, causing CR12 to conduct, thus pulling drive from Q2. Once CR12 begins conducting, power to the supply must be turned off before the +12VM regulator will come up again. R12 limits the gate current in CR12. CR11 and R11 provide noise filtering for CR12. R34 and C1 slow down the response time of the over-current circuit so that CR12 will not fire unless the over-current is longer than about 0.1 sec. C2 and R13 are for frequency compensation. Output filtering and crowbar voltage protection for the +12VM circuit are provided on the MB.

A.10 Jumper Board (5061-1351)

The jumper board is used in power supplies that are not equipped with a PFRS. Figures A-3 and A-4 show the different configurations with and without a PFRS. Referring to the jumper board schematic (B-5061-1351-51), U2 is a LM723 voltage regulator and is exactly the same internally as U2 on the battery backup Board. 18 to 22 volts ac from the inverter transformer is rectified by CR4 and CR5, and filtered by A6C9 on the MB.

The reference source at pin 6 of U2 is connected directly to the noninverting input of the error amplifier. The inverting input is connected to the wiper of R12, which provides adjustable output voltage feedback. Pin 11 pulls base drive from Q1. Overcurrent sensor R10 is connected between pins 2 and 3 and causes the current limit transistor to pull drive away from Q1 when the output current gets above about 2.25 amperes. Crowbar over-voltage protection and output filtering are provided on the MB.

U2 and Q3 develop the MLO' and MLOST' signals. When +5VCPU comes up (jumpered to +5VM), C1 begins to charge through R6. When the voltage on C1 gets above the 2.37 volt reference on the inverting input of U1, the output of U1 goes high. A high on the output of U1 allows R4 to drive Q3 on and pull MLO' high. When Q3 is on, MLOST' is pulled high. CR7 keeps C1 from charging unless PON is high. -12V I/O is jumpered to -12VM (Rev. G and earlier schematics show +12V CPU being jumpered to -12VM, an error).

A.11 Battery Pack

There are two versions of the battery pack. The 12944-60001 contains one seven cell, 14 volt battery; the 12991-60001 contains two seven cell, 14 volt batteries in parallel. Refer to Appendicies D and E for the 12944B and 12991B, respectively. Referring to the battery schematic, a three position switch, S1, selects either batteries off, internal batteries, or external batteries. In the external position, a car battery or a 14 volt dc power supply may be connected to run the battery backup for long periods of time.

The battery status assembly 5061-1352 (Appendix D), is used to test for a fully charged battery. When S1 is pushed (S1 on the 5061-1352 assembly), a 3-ohm load is placed across the battery, and power is applied to the status board. The 3-ohm load draws about 4.6 amperes from a fully charged battery. If the battery voltage under load is above 14.0 volts, CR1 begins to conduct, turning Q1 on and lighting LED CR2. R1 limits the current in CR1, R2 limits base current in Q1, and R3 limits the LED current. Even a fully charged battery will discharge rapidly under a 4.6 amp load. In fact, in only a few seconds, the voltage may drop below 14 volts, causing the LED to go out. As long as the LED will stay lit for about three seconds, the battery is good. It is normal for the three-ohm resistor to get quite warm when S1 is pushed. If a battery is installed backwards, CR1 will conduct heavily and cause fuse F1 to blow. Each individual battery has an 815 ohm temperature sensing resistor; in the 12991, only one is connected. Refer to the battery charger board section for a description of the temperature-sense circuit.

12944B Battery Box Assembly Parts List (12944-60001) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
		BARRIER BLOCK		0360-0643		U	1
		TERM-SOLDER LUG		0360-1158		U	1
		TERMINAL STRIP		0360-1607		U	1
		RES 3 1% 50W		0811-2966		U	1
		SLEEVING FLEX.		0890-0064		U	0.15
		BATTERY ASSY		0950-1596		U	1
		WASHER NEOPRENE		1400-0090		U	1
		DIODE		1901-1086		U	1
		FUSE 6A NB		2110-0056		U	1
		CAP-FUSEHOLDER		2110-0465		U	1
		FUSEHOLDER-BODY		2110-0470		U	1
		LKWSHR 1/2 INT		2190-0068		U	1
		LKWSHR 4 HEL		2190-0108		U	4
		LKWSHR 6 HEL		2190-0851		U	2
		SCR 4-40X.25		2200-0103		U	2
		SCR #4-40X.375L		2200-0143		U	2
		NUT		2260-0002		U	2
		SCR #6-32X.250L		2360-0113		U	10
		SCR #6-32X.625L		2360-0203		U	2
		NUT 6-32 .250AF		2420-0003		U	2
		NUT 1/2-28		2950-0054		U	1
		SW SLIDE DP3T PC		3101-2151		U	1
		FOAM-PLASTIC		4208-0173		U	1
		WIRE 18 BLK		8150-2890		C	0.63
		WIRE 18 RED		8150-2891		C	0.25
		WIRE 18 AWG BARE		8151-0011		U	0.19

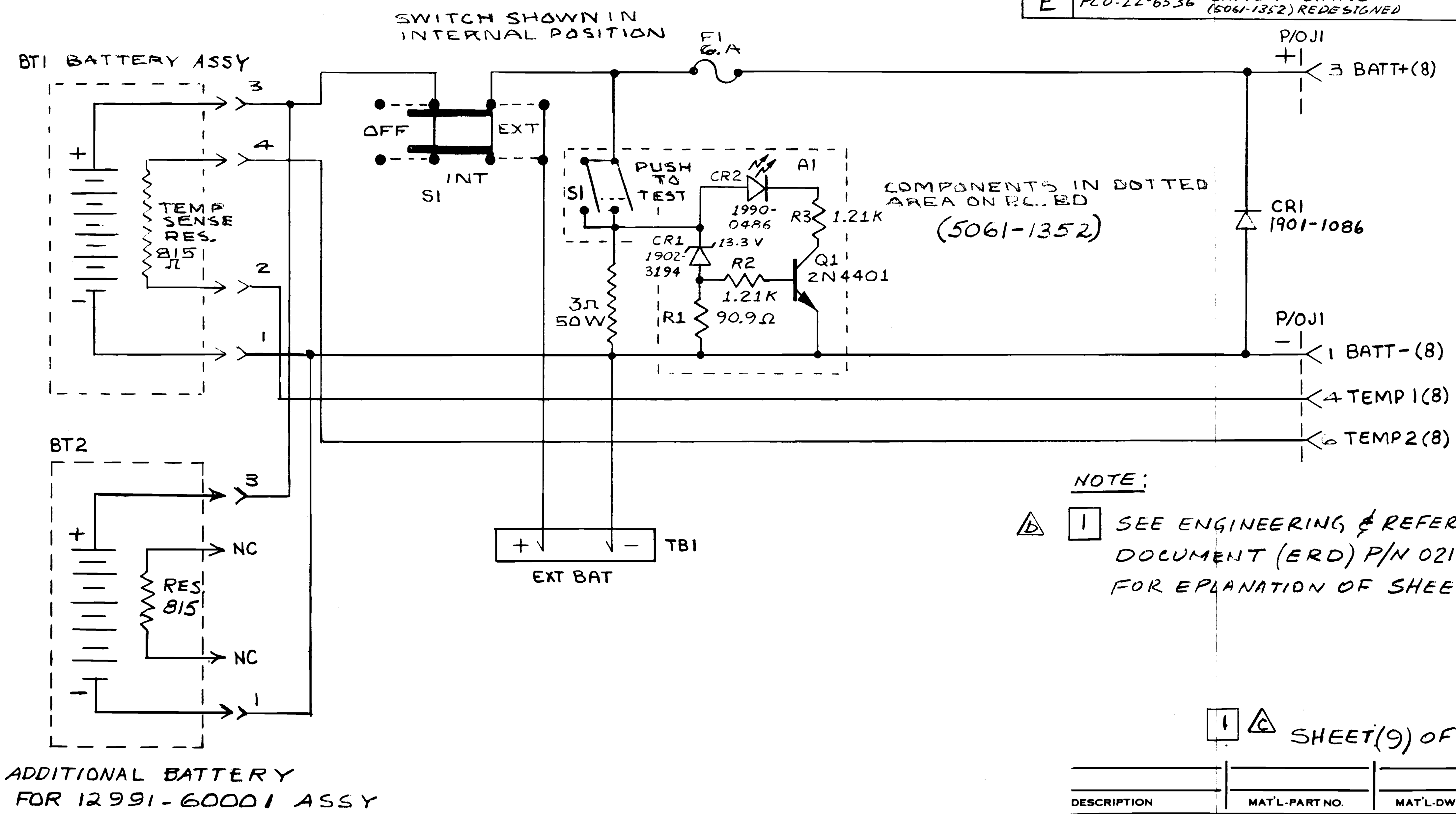
12944B Battery Box Assembly Parts List (12944-60001) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER
		PAD-FOAM		9220-2070		C	1
		BOX-BATTERY		5000-8095		W	1
		COVER-BATTERY		5000-8096		W	1
		HOLD DWN BATTERY		5000-8097		W	1
		ASSY-LCPS STATUS		5061-1352		4	1
		ASSY-BAT. CBL		12944-60005		1	1

12944B Battery Box Subassembly Parts List (5061-1352)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	DIV.33							
03	DIV.63							
		TERM-SOLDER LUG		0360-0272		E	2	
		TERM-BARR BLOCK		0360-1824		E	2	
		EYLT .121DX.200		0361-1032		E	3	
		RES 1.21K 1%.125		0757-0274		E	2	
00	R2,3							
		RES 90.9 1%.125		0757-0400		E	1	
00	R1							
		XSTR 2N4401 TO92		1854-0467		E	1	
00	Q1							
		DIO-ZNR 13.3V 2%		1902-3194		E	1	
00	CR1							
		DIODE-LIGHT EMIT		1990-0486		E	1	
00	CR2							
		SW SLIDE MOM		3101-2153		E	1	
00	S1							
		LABEL-USA		7120-6830		E	1	
		LABEL-DATE CODE		7121-2061		L	1	
		PCB-BATT.STATUS		5081-2303		E	1	

	B-12944-90004-51		
SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		10/29/76
B	PCO-22-4230- BATTERY ASSY. WAS 12944-60004		8/24/77
C	PCO-22-5704, ADD. SHT. 9 OF 10	PPM	6/27/80
D	ADD, NOTE 1	PPM	8-15-80
E	PCO-22-6536 BATTERY STATUS ASSY (5061-1352) REDESIGNED		6-1-82



NOTE:

1. SEE ENGINEERING & REFERENCE DOCUMENT (ERD) P/N 02109-90007 FOR EPLANATION OF SHEET NO'S.

1 SHEET (9) OF 10

DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

TITLE BATTERY/STATUS SCHEMATIC (PFRS) LCPS

HEWLETT PACKARD

NEXT ASSEMBLY 12944B / 12491B / 13303J

PART NUMBER 5061-1352, 12944-60001, 12991-60001

FINISH

SCALE

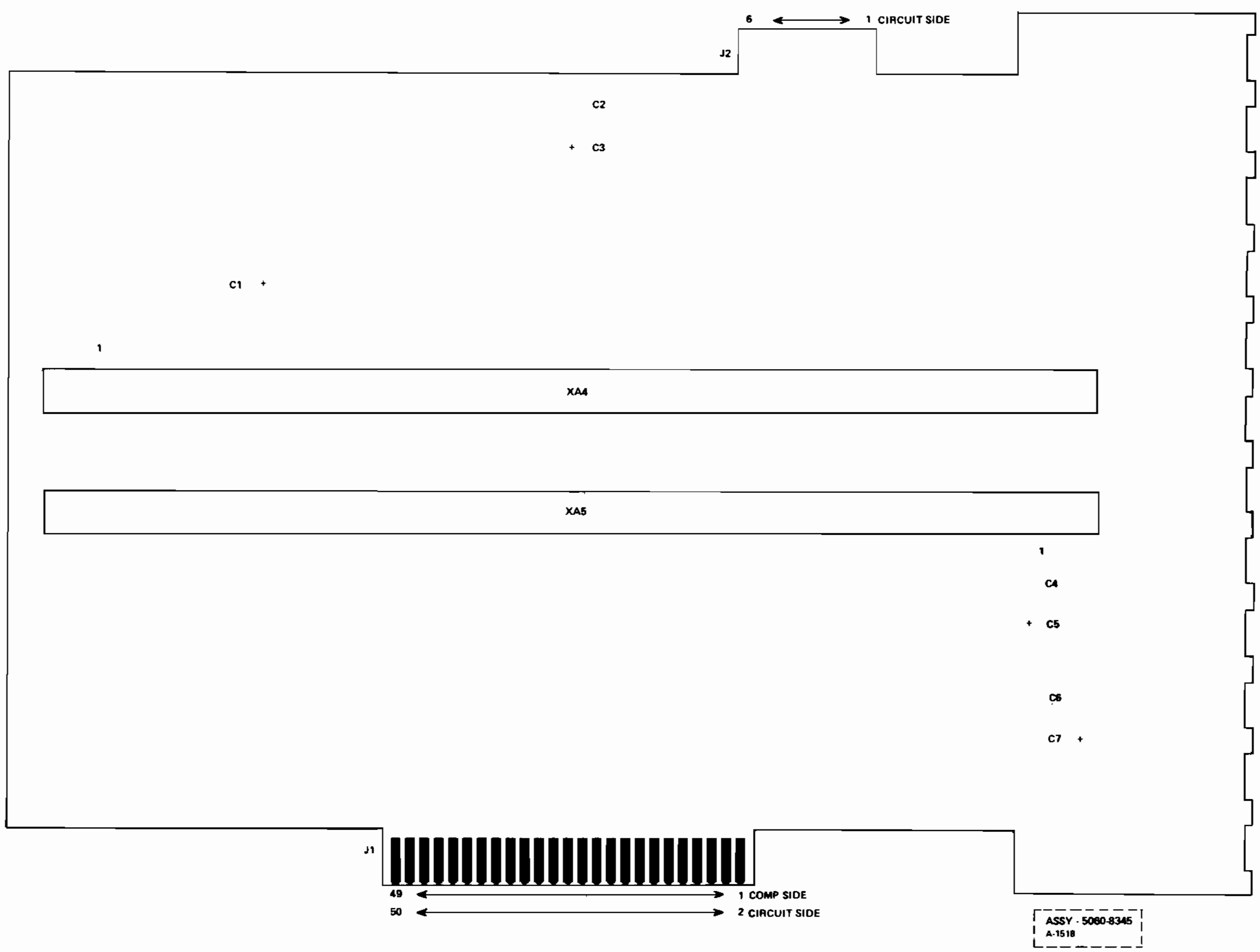
B-12944-90004-51

12991B Battery Box Assembly Parts List (12991-60001) Sht. 1 of 2)

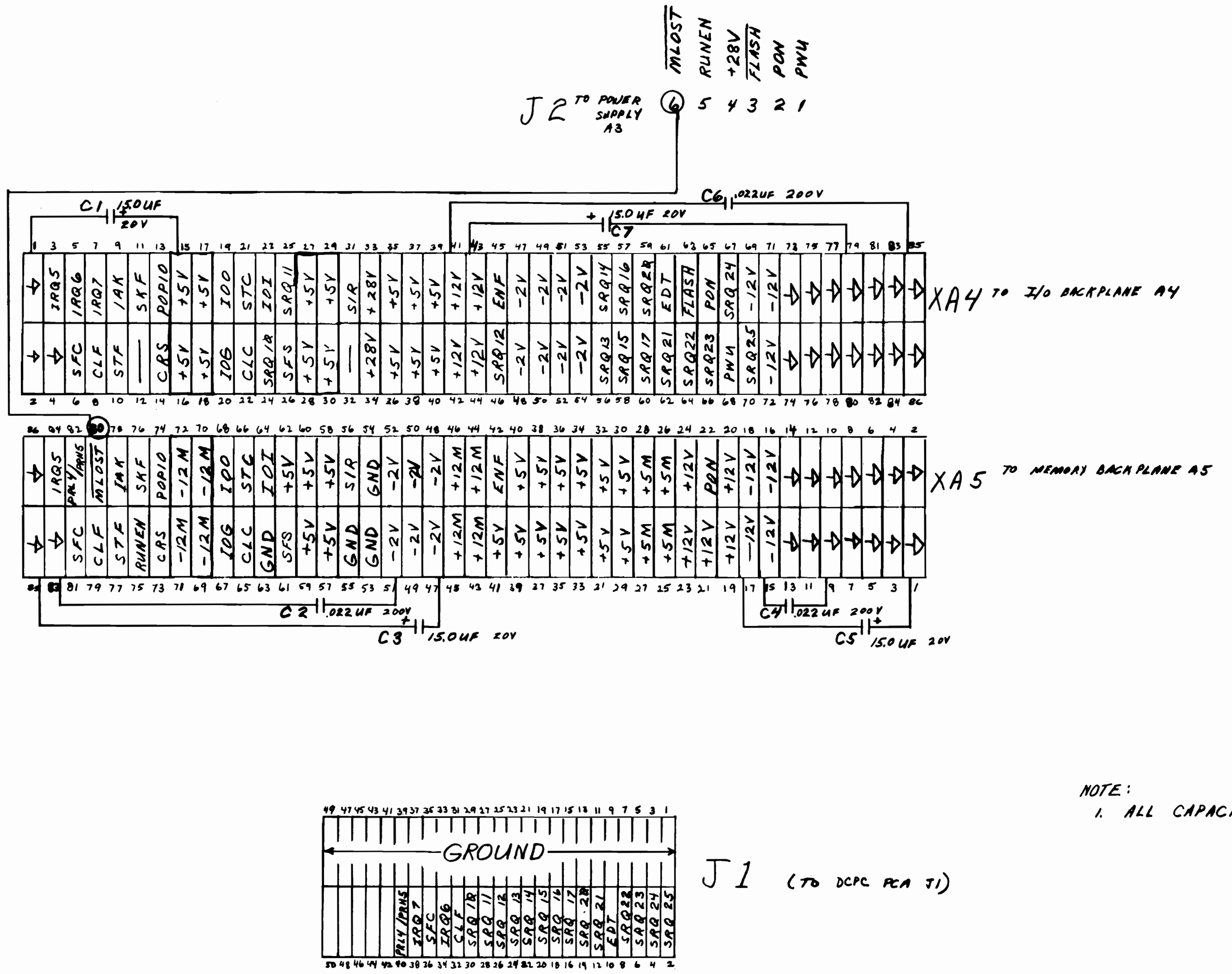
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		BARRIER BLOCK		0360-0643		U	1	
		TERM-SOLDER LUG		0360-1158		U	1	
		TERMINAL STRIP		0360-1607		U	1	
		RES 3 1% 50W		0811-2966		U	1	
		SLEEVING FLEX.		0890-0064		U	0.15	FT
		BATTERY ASSY		0950-1596		U	2	
		CONN UTIL 4PIN		1251-4623		U	1	
		CONTACT-CONN		1251-4747		U	2	
		WASHER NEOPRENE		1400-0090		U	1	
		DIODE		1901-1086		U	1	
		FUSE 6A NB		2110-0056		U	1	
		CAP-FUSEHOLDER		2110-0465		U	1	
		FUSEHOLDER-BODY		2110-0470		U	1	
		LKWSHR 1/2 INT		2190-0068		U	1	
		LKWSHR 4 HEL		2190-0108		U	4	
		LKWSHR 6 HEL		2190-0851		U	2	
		SCR 4-40X.25		2200-0103		U	2	
		SCR #4-40X.375L		2200-0143		U	2	
		NUT		2260-0002		U	2	
		SCR #6-32X.250L		2360-0113		U	10	
		SCR #6-32X.625L		2360-0203		U	2	
		NUT 6-32 .250AF		2420-0003		U	2	
		NUT 1/2-28		2950-0054		U	1	
		SW SLIDE DP3T PC		3101-2151		U	1	
		FOAM-PLASTIC		4208-0173		U	1	
		WIRE 18 WHT-RED		8150-2649		C	0.50	FT

12991B Battery Box Assembly Parts List (12991-60001) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WIRE 18 BLK		8150-2890		C	1.13	FT
		WIRE 18 RED		8150-2891		C	0.25	FT
		WIRE 18 AWG BARE		8151-0011		U	0.19	FT
		PAD-FOAM		9220-2070		C	2	
		ASSY-LCPS STATUS		5061-1352		4	1	
		ASSY-BAT. CBL		12944-60005		1	1	
		HOLD DWN BATTERY		12991-00001		W	1	
		COVER-DOUBLE		12991-00002		W	1	
		BOX-BATTERY		12991-00003		W	1	



2105A/08A/09A/12A/13A Crossover Board Assembly
5060-8345



NOTE:
1. ALL CAPACITORS ARE ±10%

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED SERIES 1353		
B	22-2147, REM R1, SERIES 1415		

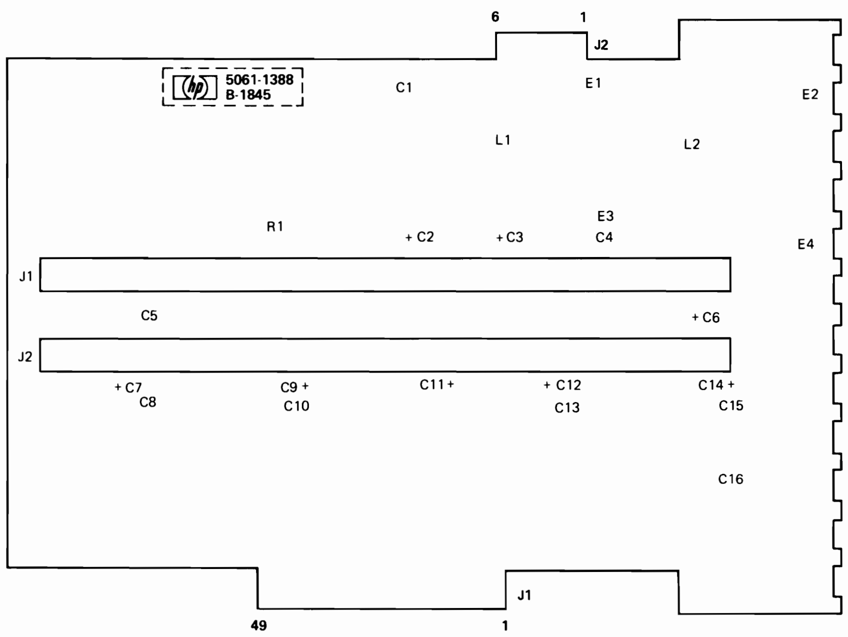
CROSS-OVER PCA

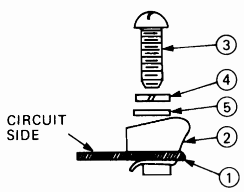
TITLE SCHEMATIC

HEWLETT PACKARD

PART NUMBER D-5060-8345-51

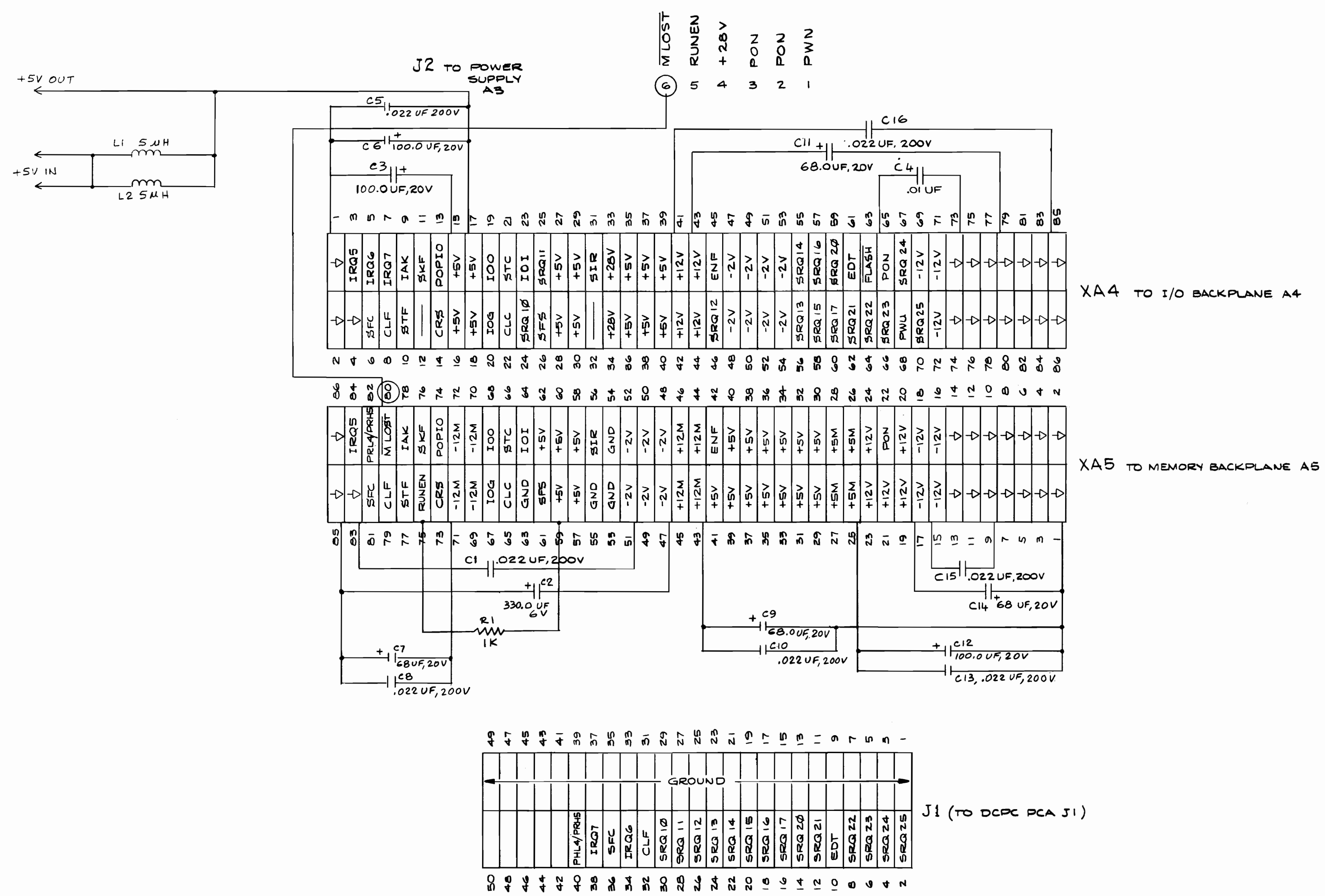
SHEET 1 OF 1





ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.
1	1	BOARD ETCHED	5090-1601
2	12	CLIP	0360-0589
3	12	SCREW, 6-32 x .437 LG.	2360-0199
4	12	WASHER SPLIT LOCK	2190-0851
5	12	WASHER FLAT	3050-0228
6	3"	WIRE MAGNET 20 AWG	8180-2220
7	4	E1-E4	0360-1529
8	2	L1, L2	9100-2957

2108B/09B/11F/12B/13B/17F Crossover Board Assembly
5061-1388



NOTE:
1. ALL CAPACITORS ARE ±10%

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED		5-18-77
B	PCO-22-4577-ADD. R1 (1K) DATE CODE 15 1732	GD	9-5-77
C	PCO-22-4832, CIRCUIT CHG. DATE CODE IS 1837	LD	9-15-78
D	PCO-22-5159, C2 WAS 150 MF 20V - DATE CODE IS 1845	GD	2-27-79

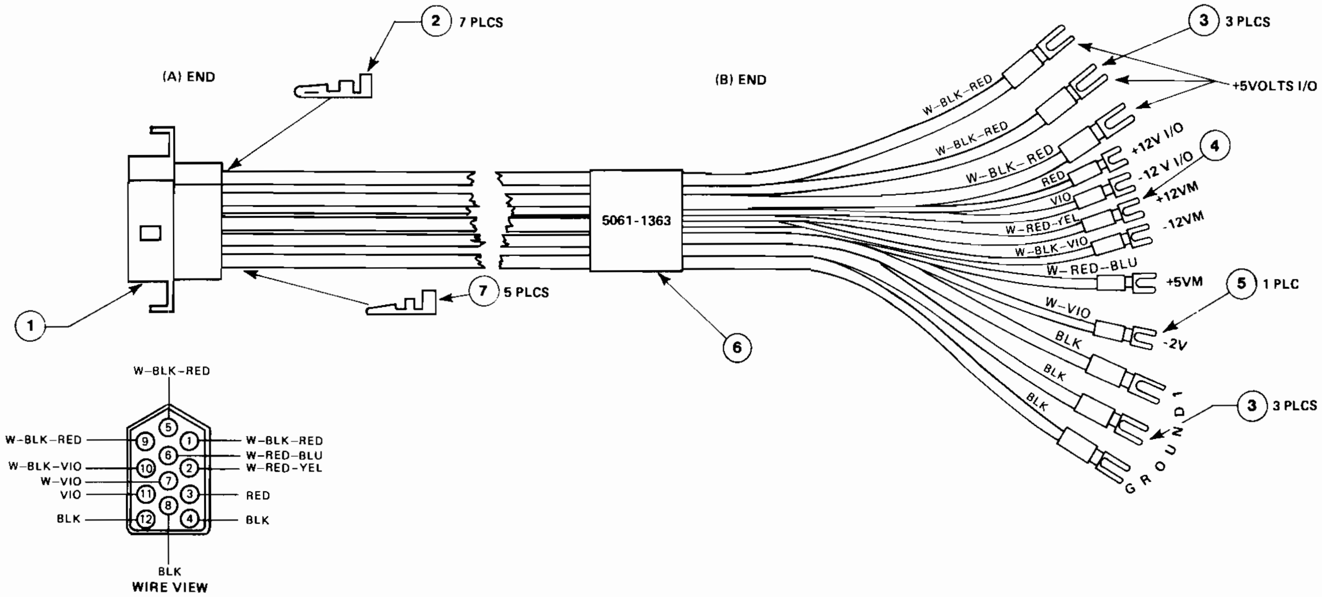
D-5061-1388-51

CROSS-OVER PCA SCHEMATIC

HEWLETT PACKARD

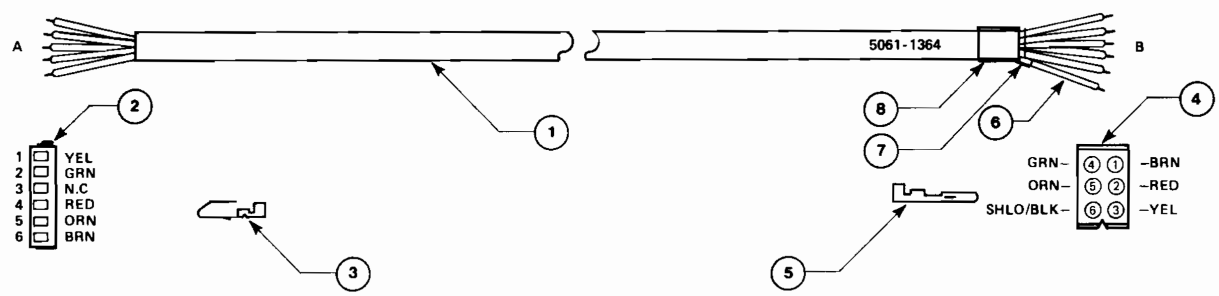
PART NUMBER D-5061-1388-51

SHEET 1 OF 1



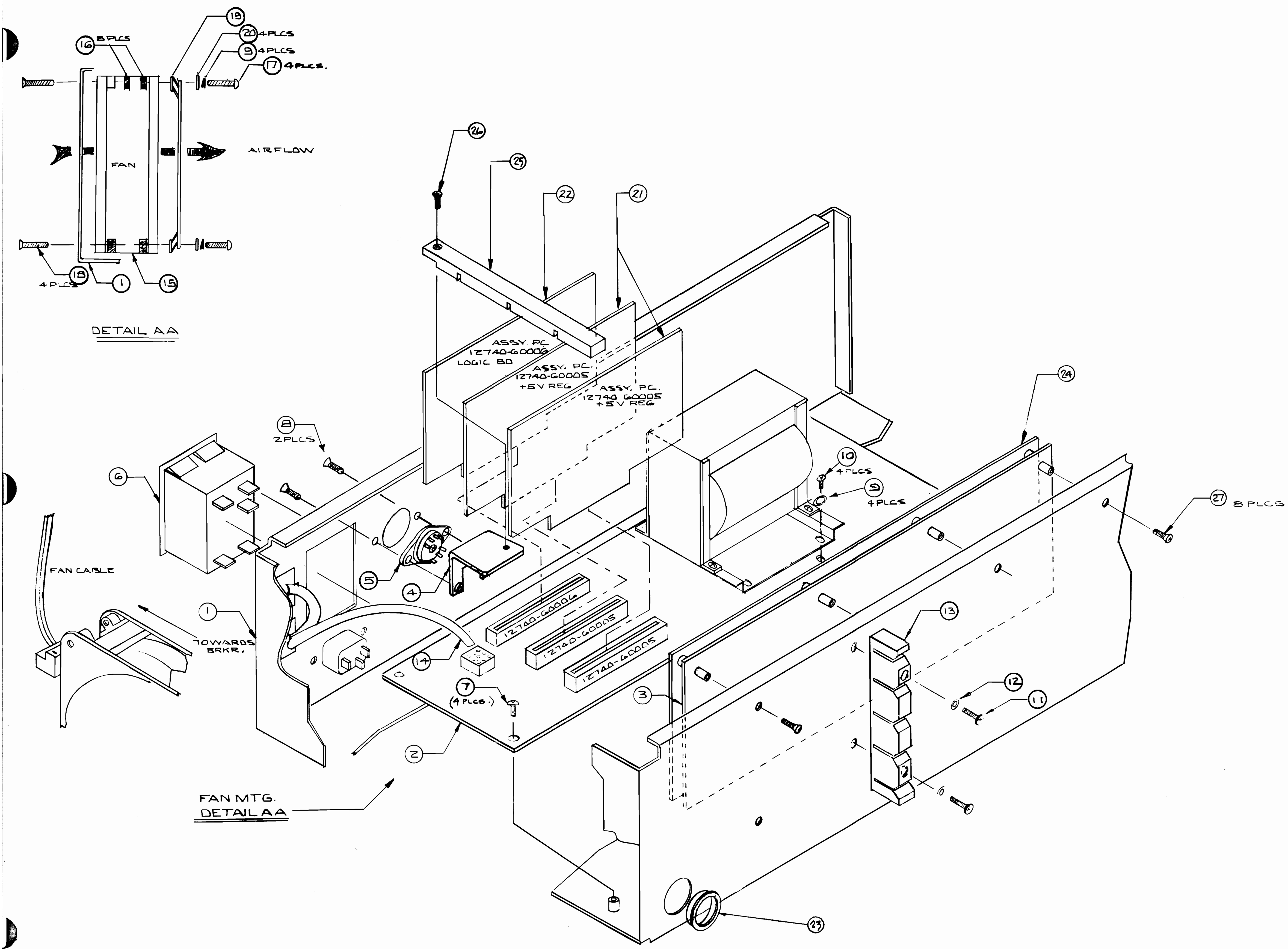
ITEM	QTY.	DESCRIPTION	PART NO.
1	1	HOUSING	1251-4638
2	7	CONTACT MALE	1251-4592
3	6	LUG CRIMP (YEL)	0362-0305
4	5	LUG CRIMP (RED)	0362-0317
5	1	LUG CRIMP (BLU)	0362-0318
6	0.15 FT	SHRINK TUBING	0890-0301
7	5	CONTACT MALE	1251-4537

"B" Model Crossover Cable Assembly
5061-1363



ITEM	QTY.	DESCRIPTION	PART NO.
1	25.00	CABLE 5 COND & SHLD	8120-1856
2	1	HOUSING MOLEX	1251-2546
3	5	CONTACT MALE	1251-2754
4	1	HOUSING MOLEX	1251-2507
5	6	CONTACT MALE	1251-2599
6	2.00	BLK 22 GA WIRE	8150-1540
7	.500	SHRINK TUBING	0890-0311
8	1.500	SHRINK TUBING	0890-0201

"B" Model Crossover Status Cable Assembly
5061-1364



ITEM	QTY.	DESCRIPTION	PART NO.
1	1	BOX PWR SPLY	12740-00004
2	1	ASSY M. BD	12740-60003
3	1	ASSY BACK PLANE	12740-60004
4	1	COVER SWITCH	12740-00012
5	1	SWITCH	3100-3450
6	1	BREAKER	3105-0147
7	4	6-32 SCREW	2360-0113
8	2	4-40 X .375 SCREW	2200-0167
9	8	LOCKWASHER SPLIT	2190-0006
10	4	6-32 X .437 SCREW	2360-0199
11	2	6-32 X .750 SCREW	2360-0125
12	2	WASHER FLAT	3050-0228
13	1	GUIDE PC	13037-20003
14	1	ASSY CABLE	12740-60010
15	1	FAN	3160-0341
16	8	NUT TINNERMAN	0590-0653
17	4	SCREW	2360-0205
18	4	SCREW 6-32 X .625 FHD	2360-0202
19	1	GRILLE WIRE	3160-0092
20	4	WASHER FLAT	3050-0227
21	2	ASSY PC +5V REG	12740-60005
22	1	ASSY PC LOGIC	12740-60006
23	1	GROMMET	0400-0085
24	1	SHIELD-BACKPLANE	12740-00019
25	1	BOARD RETAINER	12740-20003
26	1	SCREW ~ FH 6-32 X .500	2360-0200
27	8	SCREW 6-32 X .875 FH	2360-0206

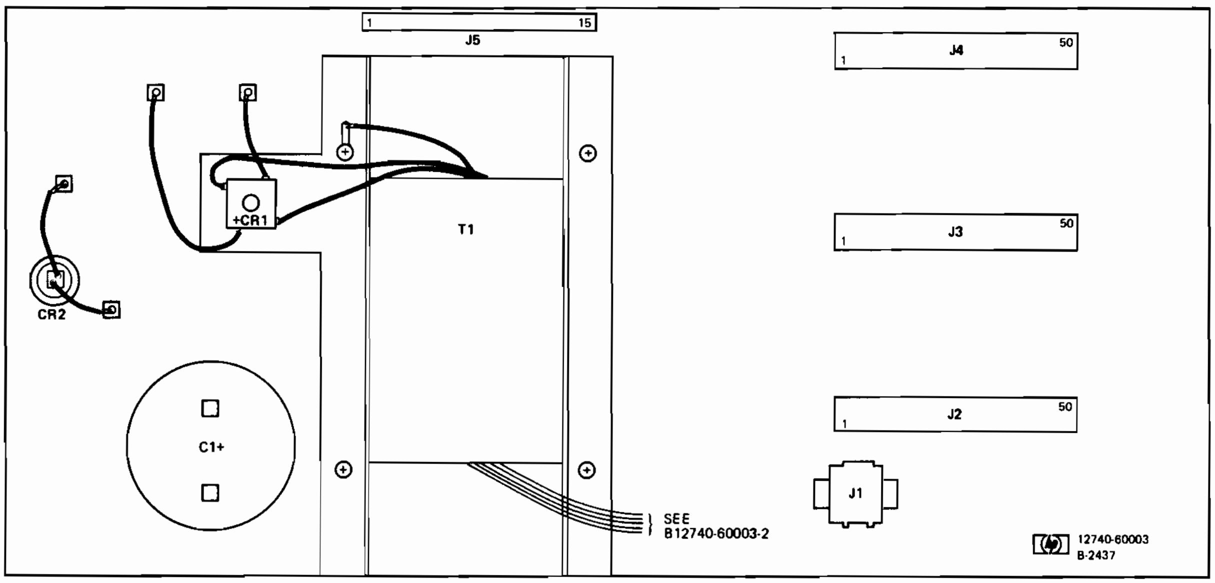
FPP Power Supply Assembly (12740-60007)

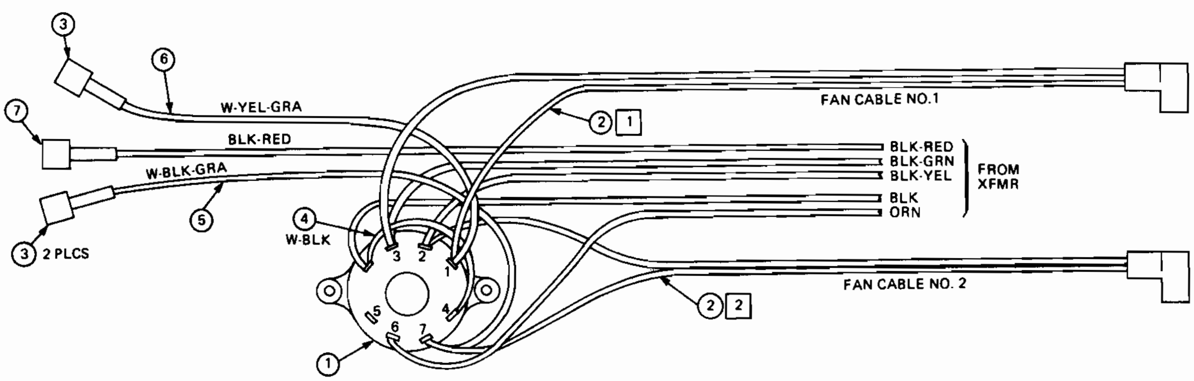
FPP Power Supply Assembly Parts List (12740-60007) Sht. 1 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		CAP .22UF 10%		0160-4259		U	1	
		LUG SOLDER #6LKG		0360-0268		U	1	
		CONN-SGL CONT		0362-0561		U	2	
		GROM SNAP .875ID		0400-0085		U	1	
		NUT SHMET U 6-32		0590-0653		U	8	
		SLEEVING FLEX.		0890-0064		U	0.09	FT
		TBG HS BLK .375D		0890-0291		U	0.17	FT
		TBG HS BLK .750D		0890-0301		U	0.09	FT
		LKWSHR 6 HEL		2190-0006		U	6	
		SCR #4-40X.375L		2200-0167		U	2	
		SCR #6-32X.250L		2360-0113		U	8	
		SCR 6-32X.75		2360-0125		U	2	
		SCR #6-32X.437L		2360-0199		U	4	
		SCR #6-32X.500L		2360-0200		U	1	
		SCR #6-32X.625L		2360-0202		U	4	
		SCR #6-32X.750L		2360-0205		U	4	
		SCR #6-32X.875L		2360-0206		U	8	
		NUT 6-32 .250AF		2420-0003		U	1	
		WSHR #6 SS		3050-0227		U	4	
		WSHR #6 SS		3050-0228		U	2	
		CIRCUIT BREAKER		3105-0147		U	1	
		FAN GRILLE		3160-0092		U	1	
		FAN-TBAX		3160-0341		U	1	
		LABEL INFO		7120-3738		U	1	
		LABEL-WARNING		7120-4567		U	1	
		WIRE 22 BLK		8150-1540		C	0.25	FT

FPP Power Supply Assembly Parts List (12740-60007) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WIRE 18 W-BN-GRA		8150-2651		C	0.30	FT
		WIRE 18 W-O-GRA		8150-2916		C	0.30	FT
		WIRE 18 GRN-YEL		8150-2919		C	0.21	FT
		BOX-P.S.		12740-00004		W	1	
		COVER-SWITCH		12740-00012		W	1	
		TAG-INFO 100/220		12740-00013		W	1	
		TAG-INFO 120/240		12740-00014		W	1	
		SHIELD		12740-00019		W	1	
		BRACE		12740-20003		W	1	
		ASSY-FPP MOTHER		12740-60003		4	1	
		ASSY-FPP BK PLN		12740-60004		4	1	
		ASSY- +5V REG		12740-60005		4	2	
		ASSY-LOGIC		12740-60006		4	1	
		ASSY-CBL CTPL		12740-60010		1	1	
		GUIDE PC BD REAR		13037-20003		W	1	





WIRING VIEW

NOTES:

1. FAN CABLE NO.1 CUT TO 10"LG STRIP WIRE ENDS ,250
2. FAN CABLE NO.2 CUT TO 19" LG STRIP WIRE ENDS ,250

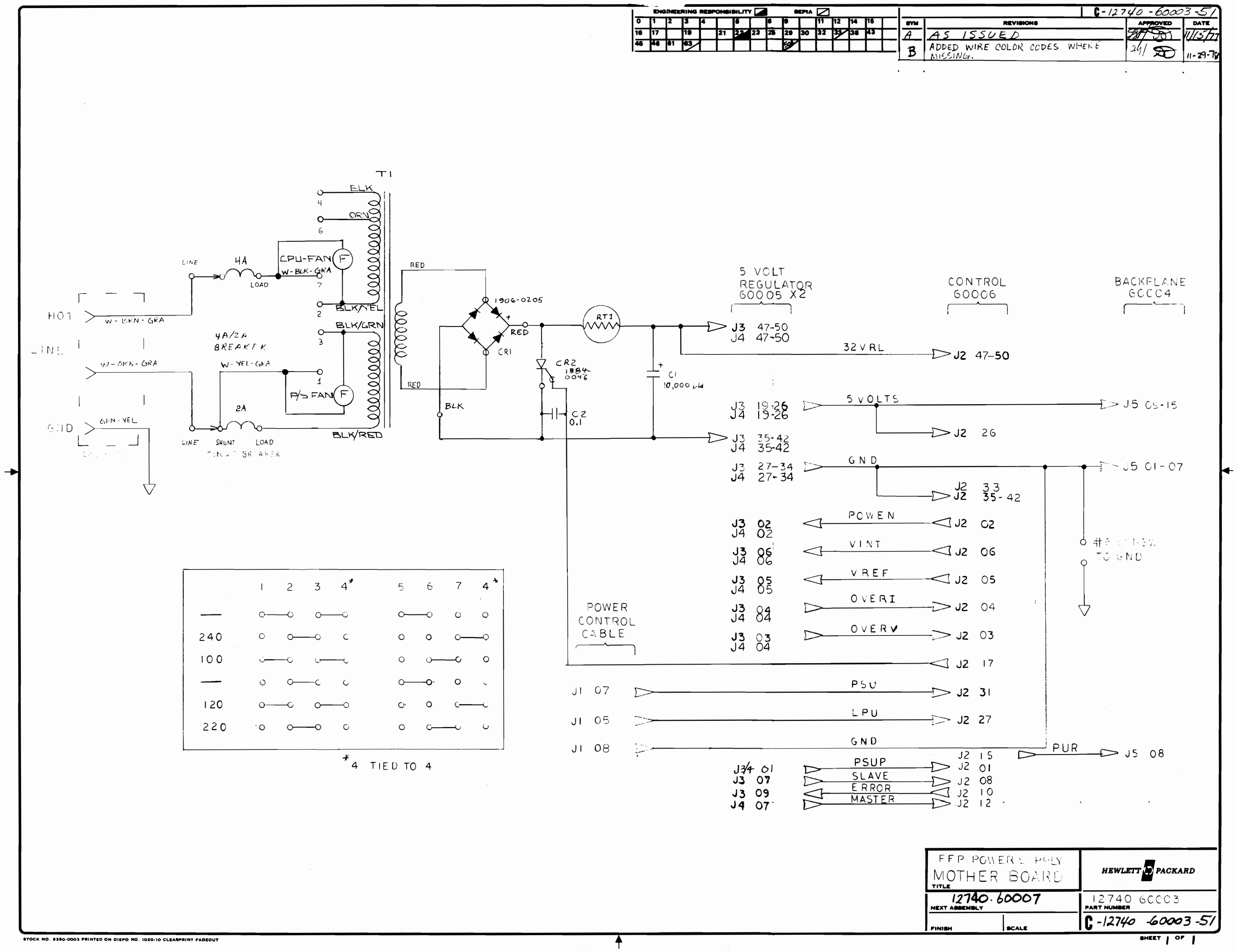
7	1	LUG CRIMP FASTOM	0362-0467
6	0.50'	WHT-YEL-GRA 18GA	8150-0581
5	0.63'	WHT-BLK-GRA-18GA	8150-2920
4	0.25	WHT BLK 18GA	8150-2895
3	2	LUG CRIMP FASTON	0362-0561
2	2	FAN CABLE	8120-1478
1	1	SWITCH	3100-314

FPP Power Supply Mother Board Assembly
12740-60003

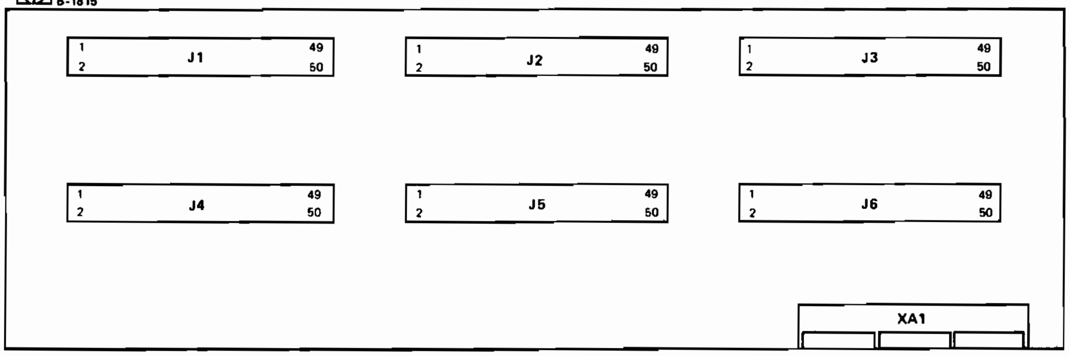
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C1	CAPACITOR-FIXED		0180-2830		E	1	
		LUG SOLDER #6LKG		0360-0268		E	1	
		LUG CRP22-18.25F		0362-0467		E	1	
		CONN-SGL CONTACT		0362-0539		E	2	
		CONN-SGL CONT		1251-5053		F	4	
01	J5	CONN-15 POS		1251-5093		F	1	
01	CR2	RECTIFIER		1884-0046		E	1	
01	CR1	DIO-FW BRDG 200V		1906-0205		F	1	
		LKWSHR 1/4 INT		2190-0027		E	1	
		LKWSHR 10 HEL		2190-0034		E	2	
		SCR 4-40X.25		2200-0103		E	6	
		SCR #6-32X.500L		2360-0201		F	1	
		SCR 6-32X.375		2360-0359		F	6	
		SCR 10-32X.375		2680-0099		E	2	
		NUT 1/4-28		2950-0036		E	1	
		WSHR #10 SS		3050-0226		F	2	
		WSHR #6 SS		3050-0228		E	7	
		WSHR .260ID BRS		3050-0234		E	2	
01	S1	SW RTRY 6POS AC		3100-3450		E	1	
		COMPOUND-THERMAL		6040-0239		E	0.01	TB
		CDSET FAN UL		8120-1478		E	2	
01	FT	WIRE 18 W-Y-GRA		8150-0581		O	0.50	FT
		WIRE 22 Y		8150-1544		O	0.17	FT

FPP Power Supply Mother Board Assembly Parts List (12740-60003) Sht. 2 of 2

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		WIRE 16 RED		8150-2185		[illegible]	0.42	FT
		WIRE 16 BLACK		8150-2605		[illegible]	0.49	FT
		WIRE 18 WHT-BLK		8150-2895		[illegible]	0.25	FT
		WIRE 18 W-BK-GRA		8150-2920		[illegible]	0.63	FT
01	T1	TRANSFORMER-PWR		9100-4070		E	1	
		GUIDE-PC		5040-0170		E	6	
		PLATE-XFMR		12740-00009		F	1	
		PCA-MOTHERBOARD		12740-60027		4	1	


AS ISSUED
ADDED WIRE COLOR CODES WHERE MISSING.
C-12740-60003-51
HOT
LINE
GND
CPU-FAN
P/S FAN
4A/2A BREAKER
T1
RT1
CR1
CR2
C1 10,000 μf
C2 0.1
5 VOLT REGULATOR 60005 X2
CONTROL 60006
BACKPLANE 6CCC4
32VRL
5 VOLTS
GND
POWEN
VINT
VREF
OVERI
OVERV
PSU
LPU
PSUP
SLAVE
ERROR
MASTER
PUR
POWER CONTROL CABLE
240
100
120
220
*4 TIED TO 4
FFP POWER SUPPLY MOTHER BOARD
12740-60007
12740 6CCC3
C-12740-60003-51
HEWLETT PACKARD

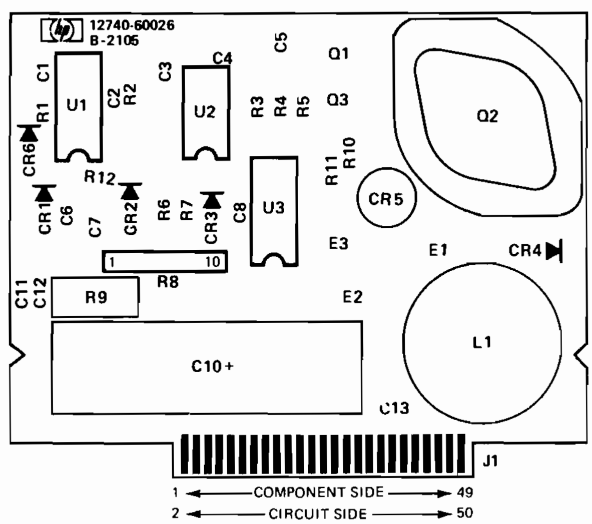
12740-60004
B-1815



(LOGIC LOCATED ON CIRCUIT SIDE)

ITEM	QTY.	DESCRIPTION	PART NO.
4	8	STANDOFF	0380-0076
3	6	PC CONNECTOR 50 PIN	1251-4573
2	1	MOLEX CONN. 15 PIN	1251-5578
1	1	PC BOARD ETCHED	12740-80004

F-Series FPP Backplane Assembly 12740-60004



FPP Power Supply 5V Regulator Assembly - 12740-60026

Note: Replaces 12740-600005.

12740A FPP Power Supply 5V Regular Assembly Parts List (Sht 1 of 3) (12740-60026)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C4	CAP 1.0UF 20%		0160-0127		E	1	
01	C2	CAP .0022UF 10%		0160-0154		E	1	
01	C8	CAP .47UF +80		0160-0174		E	1	
01	C9	CAP .1UF 20% 50V		0160-0576		E	1	
01	C1,3,5,7	CAP .01UF 20%		0160-3879		E	4	
01	C11	CAP 470PF 5%		0160-4808		E	1	
01	C12,13	CAP 1000PF 10%		0160-4847		E	2	
01	C6	CAP 15UF 10%		0180-1746		E	1	
01	C10	CAPACITOR-FIXED		0180-2829		E	1	
		PAD-MTG TO5		0340-0164		E	1	
01	E1,2,3	TERM-SLDR STUD		0360-1819		E	3	
		SPCR TAP #6X.125		0380-0305		E	2	
		STDF-RND .250-IN		0380-1145		E	1	
01	R7	RES 2.15K 1%.125		0698-0084		E	1	
01	R3	RES 464K 1%.125		0698-3260		E	1	
01	R4,5	RES 215 1%.125		0698-3441		E	2	
01	R11	RES 196K 1%.125		0698-3453		E	1	
01	R1	RES 21.5K 1%.125		0757-0199		E	1	

12740A FPP Power Supply 5V Regular Assembly Parts List (Sht 2 of 3)
(12740-60026)

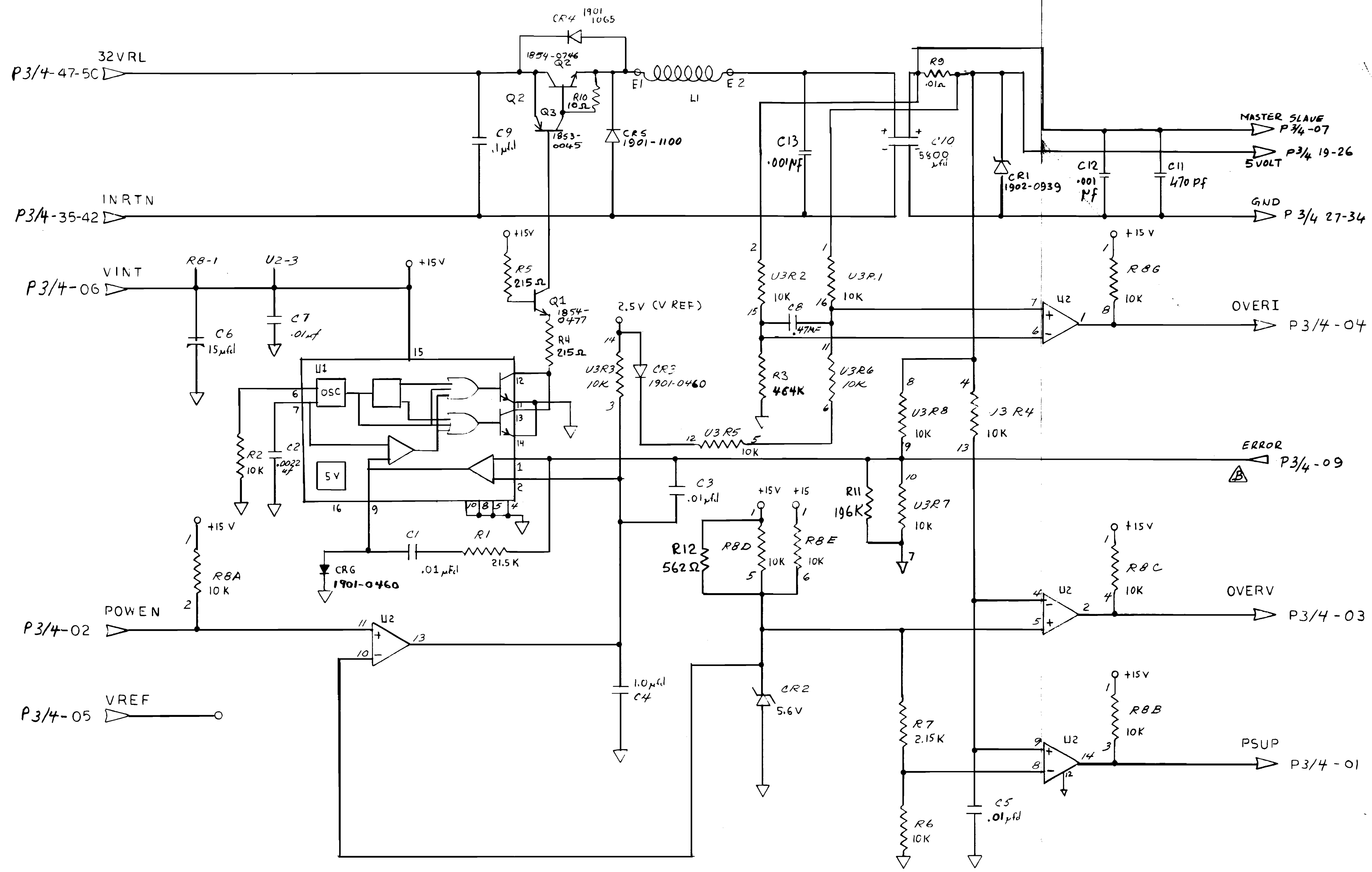
ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R10	RES 10 1%.125		0757-0346		E	1	
01	R12	RES 562 1%.125		0757-0417		E	1	
01	R2,6	RES 10K 1%.125		0757-0442		F	2	
01	R9	RESISTOR-FIXED		0811-3511		E	1	
		HT DIS TO-3		1205-0289		F	1	
01	R8	NTWK RES 9X10K		1810-0280		E	1	
01	U3	RESISTOR-ARRAY		1810-0316		E	1	
01	U2	IC LM339N		1826-0138		E	1	
01	U1	IC SG3524		1826-0428		E	1	
01	Q3	TRANSISTOR		1853-0045		E	1	
01	Q1	XSTR 2N2222ATO18		1854-0477		E	1	
01	Q2	PWR TRANSISTOR		1854-0746		E	1	
01	CR3,6	STABISTOR STB523		1901-0460		F	2	
01	CR4	DIODE 1N4936		1901-1065		E	1	
01	CR5	DIO-SCHOTTKY		1901-1100		E	1	
01	CR1	DIODE 1N5908		1902-0939		F	1	
01	CR2	DIO-ZNR 5.62V 2%		1902-3105		E	1	
		LKWSHR 10 HEL		2190-0034		E	1	

12740A FPP Power Supply 5V Regular Assembly Parts List (Sht 3 of 3)
(12740-60026)

ITEM NO	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
		LKWSHR 6 HEL		2190-0851		E	1	
		SCR 6-32X.375		2360-0359		E	2	
		NUT 6-32 .312AF		2420-0002		E	1	
		WSHR #6 SS		3050-0228		E	2	
		COMPOUND-THERMAL		6040-0239		E	0.01	TB
		LABEL-DATE CODE		7121-2061		L	1	
		WIRE 18 BLU		8150-2893		O	0.15	FT
		CHOKE		9140-0307		E	1	
01	L1							
		PCB-+5 FPP REG		12740-80026		E	1	

SYM	REVISIONS	APPROVED	DATE
A	AS ISSUED PER PC-22-6720		2/27/81
B	PCO-22-7138, CHG. DIRECTION OF ARROW FOR P3/4-09		1-25-82

C-12740-60026-S1

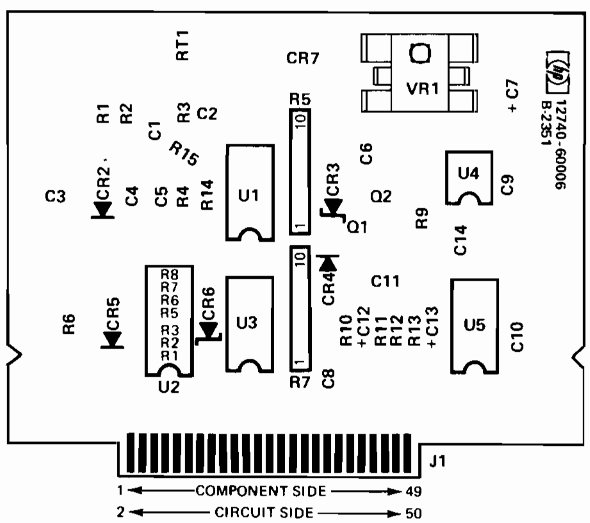


ITEM	QTY.	MATERIAL-DESCRIPTION	MAT'L-PART NO.	MAT'L-DWG. NO.	MAT'L-SPEC.

FPP POWER SUPPLY
.5VOLT REGULATOR

HEWLETT PACKARD

NEXT ASSEMBLY: 12740-60007
PART NUMBER: 12740-60026
FINISH
SCALE
C-12740-60026-S1



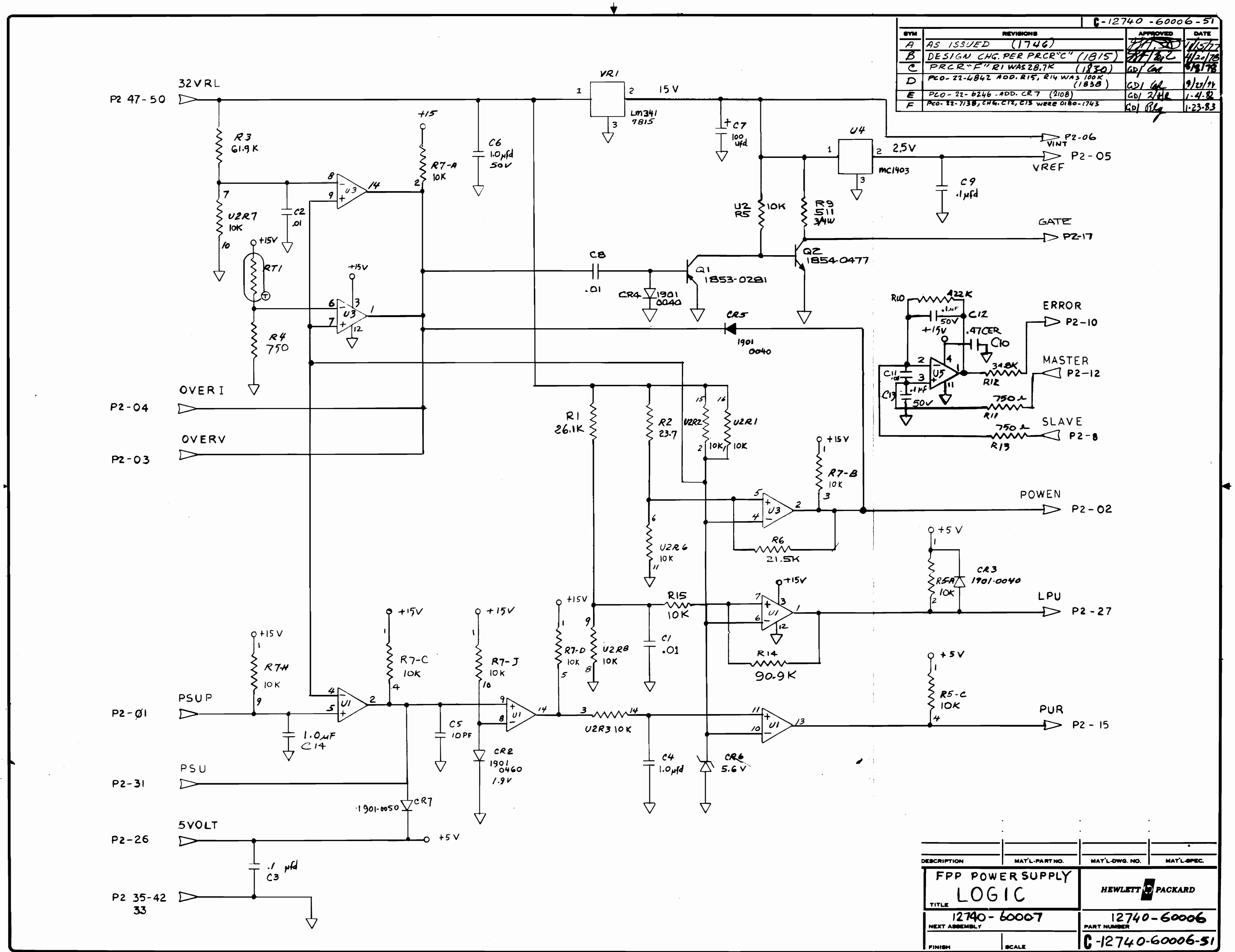
FPP Power Supply Logic Board - 12740 - 60006

12740A FPP Power Supply Logic Board Assembly Parts List (Sht 1 of 2) (12740-60006)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	C4,14	CAP 1.0UF 20%		0160-0127		E	2	
01	C10	CAP .47UF +80		0160-0174		E	1	
01	C3,9	CAP .1UF 20% 50V		0160-0576		E	2	
01	C6	CAPACITOR-CERAMI		0160-3490		E	1	
01	C5	CF CE 10P 100V		0160-3567		E	1	
00	C1,2,8,11	CAP .01UF 20%		0160-3879		E	4	
01	C12,13	CAP .1UF 10%		0160-4835		E	2	
00	C7	CAP 100UF-10+75%		0180-0061		E	1	
		STUD SOLDER TERM		0360-0474		E	2	
		EYELET		0361-1076		E	1	
01	R2	RES 23.7K 1%.125		0698-3158		E	1	
01	R1	RES 26.1K 1%.125		0698-3159		E	1	
01	R10	RES 422K 1%.125		0698-3460		E	1	
01	R12	RES 34.8K 1%.125		0757-0123		E	1	
00	R6	RES 21.5K 1%.125		0757-0199		E	1	
01	R4,11,13	RES 750 1%.125		0757-0420		E	3	
01	R15	RES 10K 1%.125		0757-0442		E	1	
00	R3	RES 61.9K 1%.125		0757-0460		E	1	

12740A FPP Power Supply Logic Board Assembly Parts List (Sht 2 of 2)
(12740-60006)

ITEM NO.	REFERENCE DESIGNATOR (FIRST SIX)	PART DESCRIPTION	PARENT OPTION	PART NUMBER	COMP. OPTION	LOC	QUANTITY PER	UM
01	R14	RES 90.9K 1%.125		0757-0464		E	1	
01	R9	RES 511 1% .50		0757-0814		E	1	
01	RT1	THERMISTOR DISC		0837-0040		E	1	
		HT DIS PL PWR		1205-0219		E	1	
01	R5,7	NTWK RES 9X10K		1810-0280		E	2	
00	U2	RESISTOR-ARRAY		1810-0316		E	1	
01	U5	IC LM324N		1826-0161		E	1	
00	U1,3	I.C. MC 3302		1826-0174		E	2	
01	VR1	IC 7815 V RGLTR		1826-0396		E	1	
01	U4	IC 1403		1826-0544		E	1	
00	Q1	XSTR PNP 2N2907A		1853-0281		E	1	
01	Q2	XSTR 2N2222AT018		1854-0477		E	1	
00	CR3,4,5	DIODE SIL		1901-0040		E	3	
00	CR7	DIODE-SILICON		1901-0050		E	1	
00	CR2	STABISTOR STB523		1901-0460		E	1	
00	CR6	DIO-ZNR 5.62V 2%		1902-3105		E	1	
		SCR #4-40X.375L		2200-0143		E	1	
		NUT 4-40 W/LK		2260-0009		E	1	
		COMPOUND-THERMAL		6040-0239		E	0.01	TB


C-12740-60006-51
SYM
REVISIONS
APPROVED
DATE
A AS ISSUED (1746)
B DESIGN CHG. PER PRCR "C" (1815)
C PRCR "F" R1 WAS 28.7K (1830)
D PCO-22-4842 ADD. R15, R14 WAS 100K (1838)
E PCO-22-6246 ADD. CR7 (2108)
F PCO-22-7138, CHG. C11, C12, C13 WERE 0180-1743
32VRL
P2 47-50
VR1
LM341 7815
15V
C7 100 ufd
U4
MC1403
2.5V
P2-06
VINT
VREF
P2-05
C9 .1 ufd
GATE
P2-17
R3 61.9K
C6 1.0 ufd 50V
R7-A 10K
U3
U2R7 10K
C2 .01
RT1
R4 750
U2 R5 10K
R9 511 3/4W
Q2 1854-0477
C8 .01
Q1 1853-0281
CR4 1901 0040
CR5 1901 0040
R10 422K
C12 .1 uF 50V
.47CER
C10
U5
C11
C13
R12 34.8K
R11 750
R13 750
ERROR
P2-10
MASTER
P2-12
SLAVE
P2-8
OVER I
P2-04
OVERV
P2-03
R1 26.1K
R2 23.7
U2R2 10K
U2R1 10K
R7-B 10K
POWEN
P2-02
U2R6 10K
R6 21.5K
+5V
CR3 1901-0040
R5A 10K
R15 10K
LPU
P2-27
C1 .01
R14 90.9K
R7-D 10K
U2R8 10K
R7-H 10K
R7-C 10K
R7-J 10K
R5-C 10K
PSUP
P2-01
U1
C14 1.0 uF
C5 10PF
CR2 1901 0460 1.9V
U2R3 10K
C4 1.0 ufd
CR6 5.6V
PUR
P2-15
PSU
P2-31
1901-0050
CR7
5VOLT
P2-26
C3 .1 ufd
P2 35-42 33
DESCRIPTION
MAT'L-PART NO.
MAT'L-DWG. NO.
MAT'L-SPEC.
FPP POWER SUPPLY
LOGIC
TITLE
HEWLETT PACKARD
12740-60007
NEXT ASSEMBLY
12740-60006
PART NUMBER
C-12740-60006-51
FINISH
SCALE