

## SECTION 8 – POWER SUPPLIES

The PDP-8/E computer uses a DEC H724 or H724A (the latter for 230 Vac lines) Power Supply that provides three regulated dc voltages, one non-regulated dc voltage, and one center-tapped ac winding that delivers 28 Vac. The PDP-8/F and the PDP-8/M use a DEC H740 Power Supply that provides three regulated dc voltages and 28 Vac, center-tapped.

Each type of power supply features dc-voltage monitoring, protection against overvoltage and thermal overload, and fusing of all dc power supplies. The PDP-8/E power supply is detailed in Paragraph 3.47; the PDP-8/F and PDP-8/M supply is described in Paragraph 3.48.

### 3.47 PDP-8/E POWER SUPPLY

#### 3.47.1 Primary Network

The primary network of power transformer T1 is shown in Figure 3-122. The input ac voltage is controlled by relay K1. When the key switch on the front panel is turned to the POWER position, and the interlocks are connected, the relay closes, applying the input ac to the power transformer.

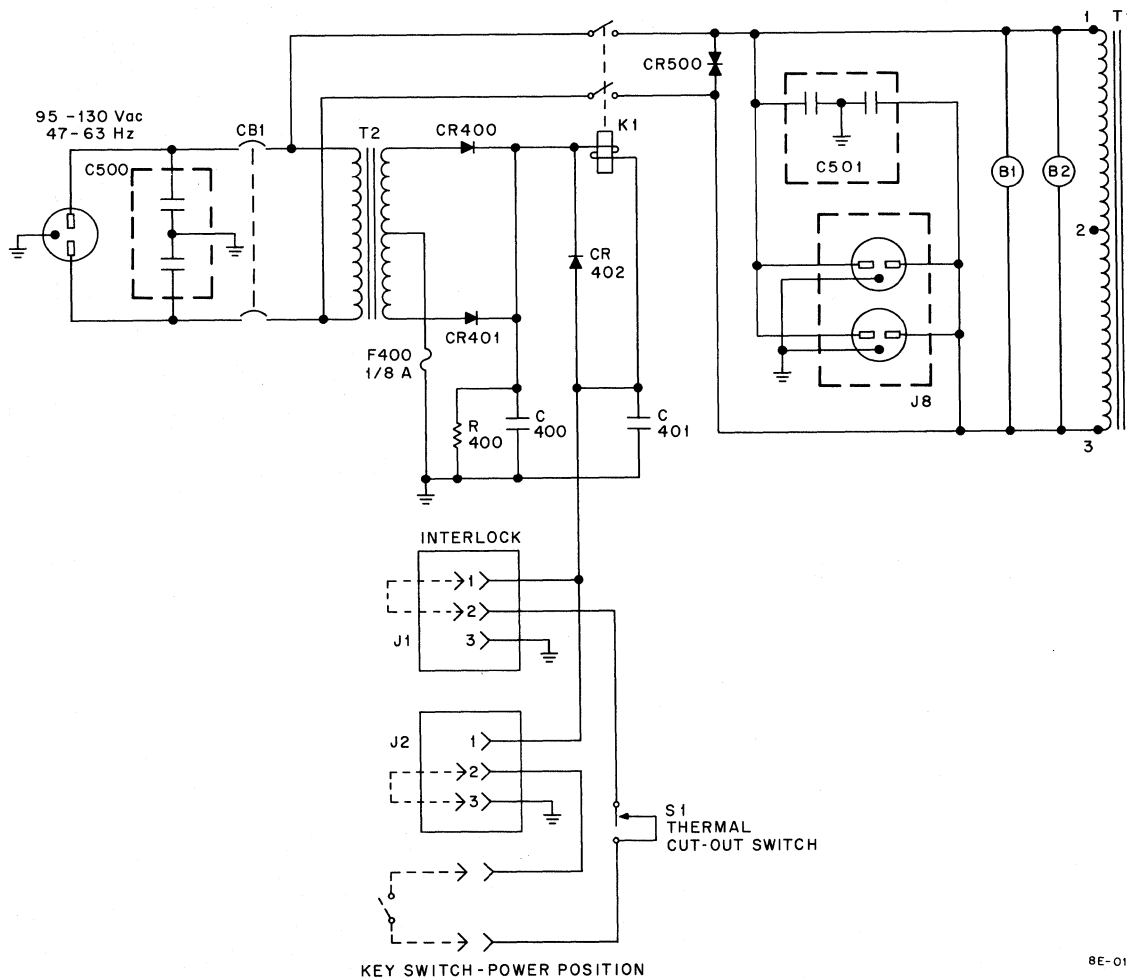


Figure 3-122 H729 Power Supply Primary Network

Switch S1 monitors the ambient temperature and opens when the temperature reaches 90°C, ±5°C. Relay K1 is, in turn, opened and removes the input ac. S1 must be reset by hand if it has been tripped.

### 3.47.2 +8 Vdc Power Supply

Figure 3-123 shows the +8 Vdc power supply. The +8V is obtained from a full-wave, center-tapped rectifier providing 2A, rated load. Because the +8 Vdc is used only as the supply for front panel indicators, filtering and regulation are unnecessary.

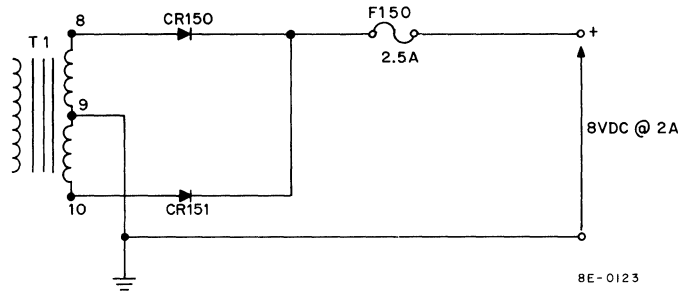


Figure 3-123 +8 Vdc Power Supply

### 3.47.3 +15 Vdc Power Supply

The +15 Vdc power supply is shown in Figure 3-124. The rectified dc voltage is filtered and applied to the series pass transistor, Q100, which provides +15V at its emitter. Load changes at the emitter are transferred by the R6/R7 voltage divider to the regulating difference amplifier, Q2/Q3. This amplifier, which becomes unbalanced when the base of Q3 changes from 0V, provides an error signal for emitter-follower Q1. The error signal is passed on to Q100, which then acts to correct the condition that produced the error. For example, an increase in the load on the output terminals requires that more current be supplied by Q100; therefore, the +15V output tends to decrease. The voltage divider produces a more negative level at the base of Q3. Q3 provides a positive error signal that is passed on to the base of Q100. The increase in forward-bias causes Q100 to oppose the tendency of the emitter voltage to decrease. The operating point of Q100 has been shifted; thus, the demand for more current is met, even though the collector-emitter voltage remains constant.

The +15 Vdc supply is also regulated against static and dynamic line voltage variation. Changes in the rectified dc voltage cause the collector-emitter voltage of Q100 to change in the same direction. The +15V output also changes, but in such small proportion that it essentially remains constant over the allowable ac input range.

Note that this power supply has no adjustment. The -15 Vdc regulated supply voltage works with the +15V output to develop error voltages at the R6/R7 voltage divider. In addition, the -15 Vdc voltage controls the total emitter current of the difference amplifier. Thus, static changes in the -15 Vdc output can be passed on to the +15 Vdc regulator. An adjustment potentiometer is included in the -15 Vdc supply; consequently, both supplies can be adjusted at the same time, the +15V output tracking the -15V output.

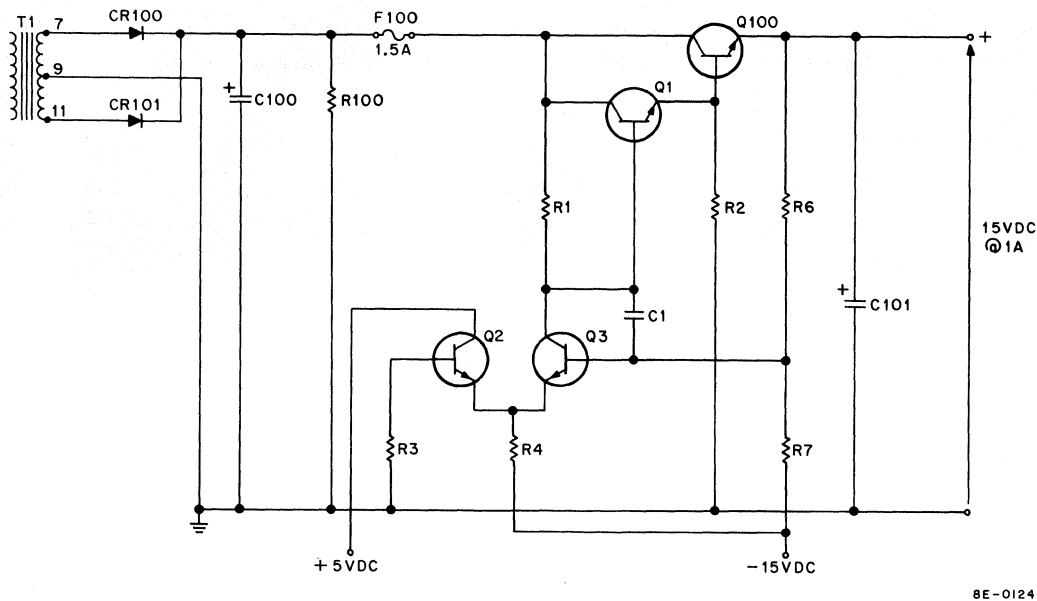


Figure 3-124 +15 Vdc Power Supply

### 3.47.4 -15 Vdc Power Supply

The -15 Vdc power supply is shown in Figure 3-125. This power supply is regulated in a manner similar to that described in the last paragraph. However, the procedure is carried out more precisely. The regulating amplifier is a precision voltage regulator IC, VR1. This IC contains a temperature-compensated reference amplifier, an error amplifier, and a series power-pass transistor. Pin 4 is the output of the reference amplifier. The reference voltage for the error amplifier is taken from the wiper arm of potentiometer R5, the -15 Vdc adjustment. This reference is compared with a sample of the -15 Vdc output, which is applied to the error amplifier at pin 2. The error signal is amplified and transferred, via pin 6, to Q300, which provides a change in base drive for Q301-304. Thus, static and dynamic load and line changes are regulated as in the +15 Vdc regulator.

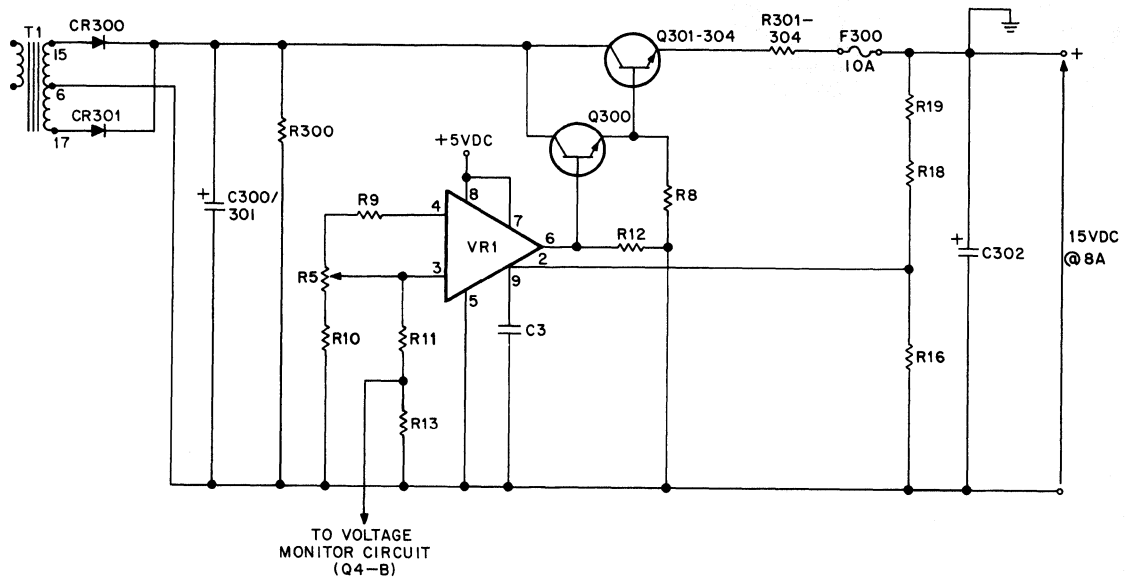
Note that the series pass transistor consists of four transistors, Q301 through Q304, in parallel. Each transistor has a 0.25Ω, 3W resistor connected to its emitter lead. The 0.25Ω resistors encourage equal division of the regulated load current through the pass transistors. In the event of an overload that is not sufficiently large to burn out F300, there is less likelihood of damage to a pass transistor. In addition, the parallel arrangement reduces the possibility of a pass transistor burning out before F300 if the output terminals are shorted.

### 3.47.5 +5 Vdc Power Supply

The +5 Vdc power supply is shown in Figure 3-126. Again, precise regulation is possible through the use of a voltage regulator IC, VR5. The reference voltage is taken from potentiometer R21, the +5V adjustment, and compared to the +5V output. The error signal controls the parallel pass transistors.

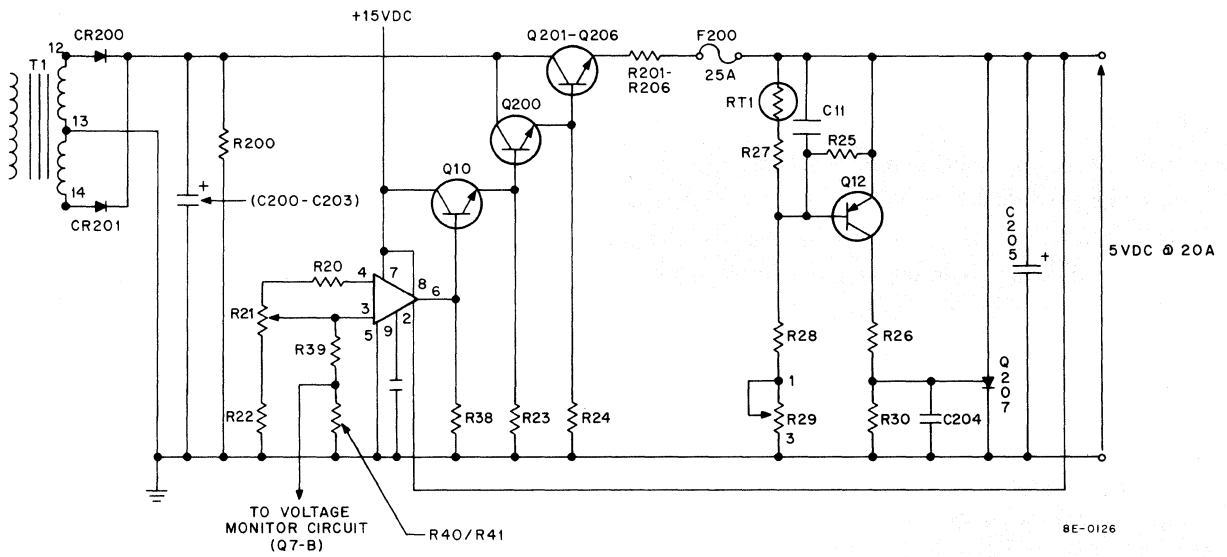
### 3.47.6 dc Voltage Monitor Circuit

The dc voltage monitor circuit is shown in Figure 3-127. This circuit negates the POWER OK H signal whenever a regulated dc voltage is less than an established absolute value. Such a condition occurs when the power is turned on or off, or when a failure occurs within the power supply. These absolute values are 4.3V for +5 Vdc voltage, 12V for +15 Vdc voltage, and 13.5V for the -15 Vdc voltage.



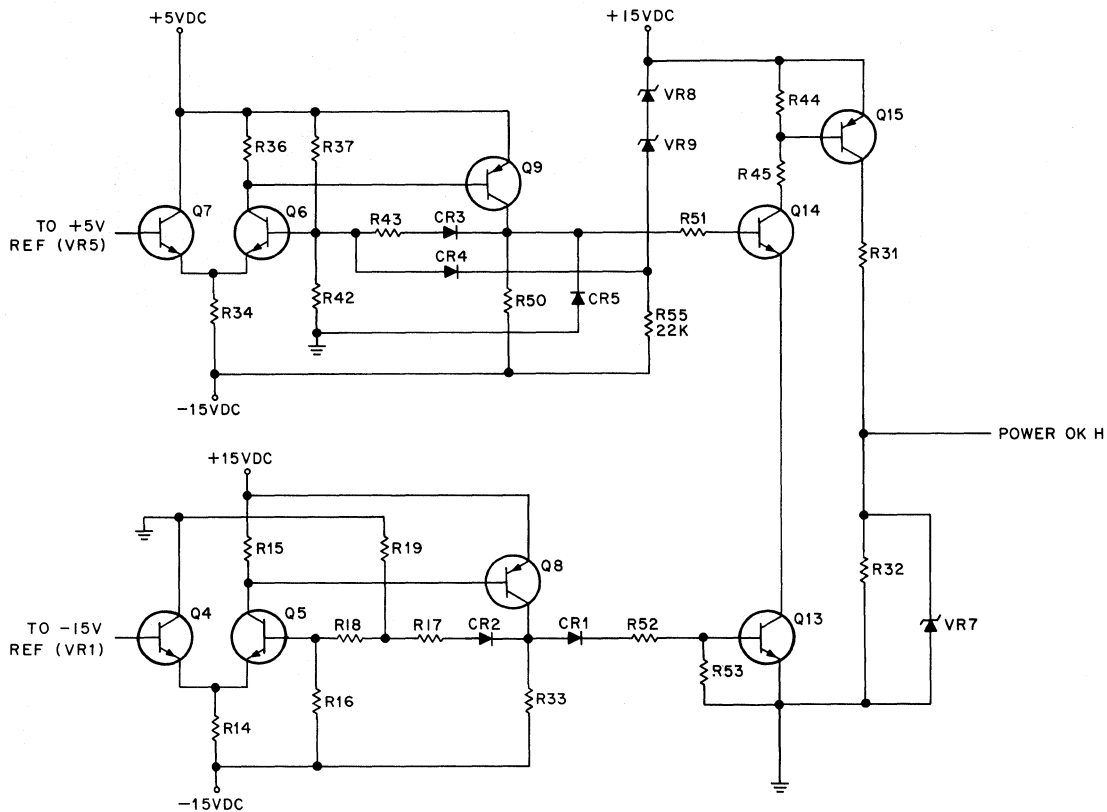
8E-0125

Figure 3-125 - 15 Vdc Power Supply



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Figure 3-126 +5 Vdc Power Supply



8E-0127

Figure 3-127 dc Voltage Monitor

If all three regulated voltages are above the limit, Q13, Q14, and Q15 are switched on. Zener diode VR7 maintains the POWER OK line at approximately 4.3V. If the -15 Vdc voltage goes more positive than -13.5V, Q13 is switched off, leaving the emitter of Q14 floating. Q15 turns off and the POWER OK line goes to ground. If the +15 Vdc voltage goes more negative than +12V, or if the +5 Vdc voltage goes more negative than +4.3V, Q14 is switched off, accomplishing the same result as before.

The circuits that control the switching of Q13 and Q14 are nearly identical. The circuit that includes Q6, Q7, and Q9 monitors both +5 Vdc and +15 Vdc. The Q6/Q7 difference amplifier is balanced when +5 Vdc is satisfactory. If +5 Vdc goes negative, Q6 is turned off, removing the emitter-base voltage of Q9, which turns off. The cathode of CR3 goes to ground, causing Q14 to turn off. If, instead of +5 Vdc, +15 Vdc goes more negative than its limit, CR4 is allowed to conduct. This action causes Q6 to turn off and, in turn, Q9 and Q14.

The circuit that includes Q4, Q5, and Q8 monitors the -15 Vdc voltage and works almost identically to the upper circuit. In this case, Q5 is turned off when -15 Vdc goes more positive. This action removes the base current from Q8. This removes base current from Q13, which then turns off.

### 3.47.7 Overvoltage Protection

The +5V power supply is provided with overvoltage protection, in the form of an SCR trigger circuit (Figure 3-126). If the +5V output rises to 6.5V, Q12 provides a triggering voltage for the gate of the SCR, Q207. The SCR conducts, and the resulting short circuit on the output terminals causes fuse F200 to burn out.

- 3 Program should run without error.
- 4 Halt program and delay strobe 10 ns (1 position clockwise), then restart.
- 5 If program still runs without error, proceed to the next position. When errors occur, stop and memorize this strobe position.
- 6 Repeat the same procedure advancing the strobe (counterclockwise) until errors occur, then stop and memorize this position.
- 7 A reliable system has to have a minimum of three working consecutive positions.
- 8 Finally set strobe to the middle working position. If there is an even number of working positions, favor the most delayed (clockwise) of the two center positions.
- 9 In checkout, "Checkerboard" should always run in the middle position and, for at least 15 minutes, in the positions to the left and right of middle with no errors.
- 10 Acceptance is to be run only in the final strobe position.
- 11 Setting strobe for extended memories, load basic memory checkerboard (MAINDEC-8E-D1AA-D) into extended fields and proceed to set strobe position according to Steps 1 through 10.

#### 4.8 H724 POWER SUPPLY TROUBLESHOOTING PROCEDURES

The H724 Power Supply provides power for CPU logic, the memory, bus loads, and the lamps on the Programmer's Console. If the power supply is established to be the source of the problem through symptom analysis with the aid of the system troubleshooting chart (Figure 4-1), voltage checks should be performed. Voltages and tolerances are given in Table 4-7. A component troubleshooting aid, Table 4-8, and parts location, Figure 4-7, are included as aids to isolating and correcting the malfunction.

The following paragraphs describe some of the power supply features and characteristics that can aid in isolating the malfunction.

**Table 4-7**  
**H724 Power Supply Parameters**

Output Voltage	Wire Color	Minimum Voltage	Maximum Voltage	Tolerance	Current Rating	Maximum Ripple
+5V	Red	4.85V	5.15V	± 3%	20A	50 mV p-p
- 15V	Blue	- 14.25V	- 15.75V	± 5%	8A	50 mV p-p
+15V	Orange	13.5V	16.5V	± 10%	1A	75 mV p-p
+8V	Yellow	6V	10V	± 26%	2A	
dc Volts OK	Grey	3.75V	5V			
Overtoltage Protection			6.5V			
14 Vac				± 26%	0.2A	
AC INTLK					0.12A	

**Table 4-8**  
**Component Troubleshooting Aid for H724 Power Supply**

Output Volts	Wire Color	Jack & Pin	Fuse (amps)	Module	Transistors	Adjustment	Use
+5 Vdc	Red	J3-3 J4-3	25	A2	Q200 Q201-6	R21	CPU Logic
-15 Vdc	Blue	J3-4 J4-4 J6-3	10	A1	Q300 Q301 Q304	R5	Memory
+15 Vdc	Orange	J3-5 J4-5	1	A1	Q100	R5	Bus Loads
+8 Vdc	Yellow	J6-4	25				Lights
14 Vac	-	J5-1 J5-3	.5				Options
Overtoltage Protect	-			A2			Power Surge
dc Volts OK (3.75)	Grey	J3-6 J4-6		A2		R29 (Factory Adjustable Only)	Power Loss

Static ohmmeter reading of thermistor is approximately 23Ω.

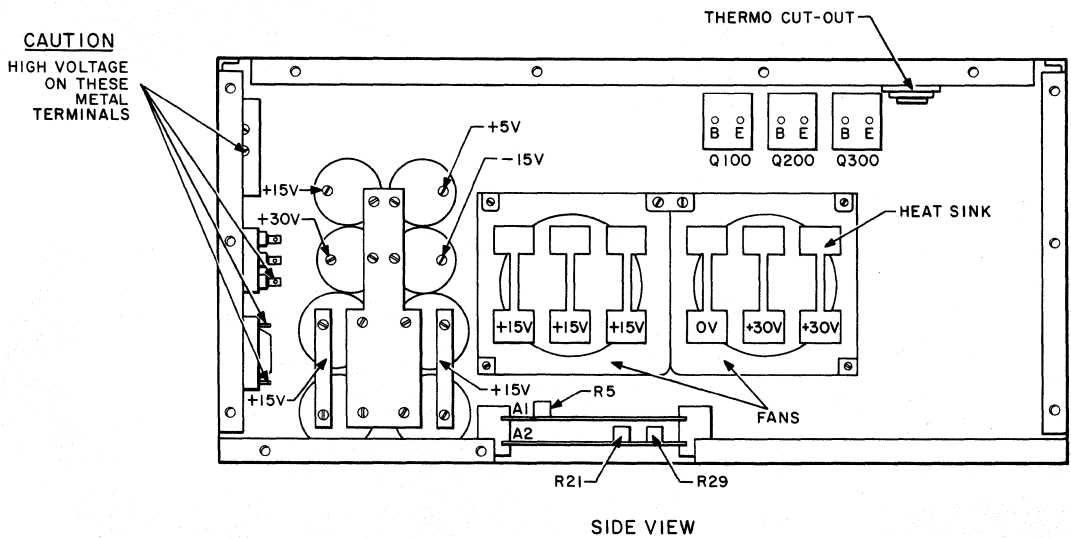


Figure 4-7 H724 Power Supply

#### 4.8.1 Overcurrent Protection

The power supply should not be loaded by more than 175 percent of the rated output current (Table 4-7).

#### 4.8.2 Hold-Up Time

The regulated output voltages under maximum load conditions should remain stable for a minimum of 2 ms after loss of line voltage.

#### 4.8.3 Thermal Protection

A thermal switch is in series with the interlock circuit. This switch is located in the forward top section of the power supply (Figure 4-6). It will disconnect primary power at  $90^{\circ}\text{C} \pm 5^{\circ}$ . The thermal switch must be reset manually if it is tripped.

#### 4.8.4 Contact Protection

Contact protection is provided to limit the primary power at the input to the convenience outlet to twice the nominal peak voltage. In addition, protection is provided against a rate of change in the voltage exceeding 10V/second as the solenoid or circuit breaker is opened.

#### 4.8.5 Input Switching

The primary power is switched by a 24 Vdc relay, controlled by an interlock circuit. Grounding pin A on the interlock panel will operate the solenoid and apply power to the computer. The solenoid will break both sides of the line.

#### 4.8.6 Power ON-OFF Switch Adjustment

The Power ON-OFF switch is cam-adjusted according to Table 4-9.

Table 4-9  
Power ON-OFF Switch Adjustment

Power Switch Position	Three Cam-Operated Switches Switch Position	
	Back 2 Switches	Front Switch
OFF	ON	OFF
ON	ON	ON
Panel Lock	OFF	ON

#### 4.8.7 Parallel Operation

Two or more power supplies must not be wired in parallel to extend the current driving capability.