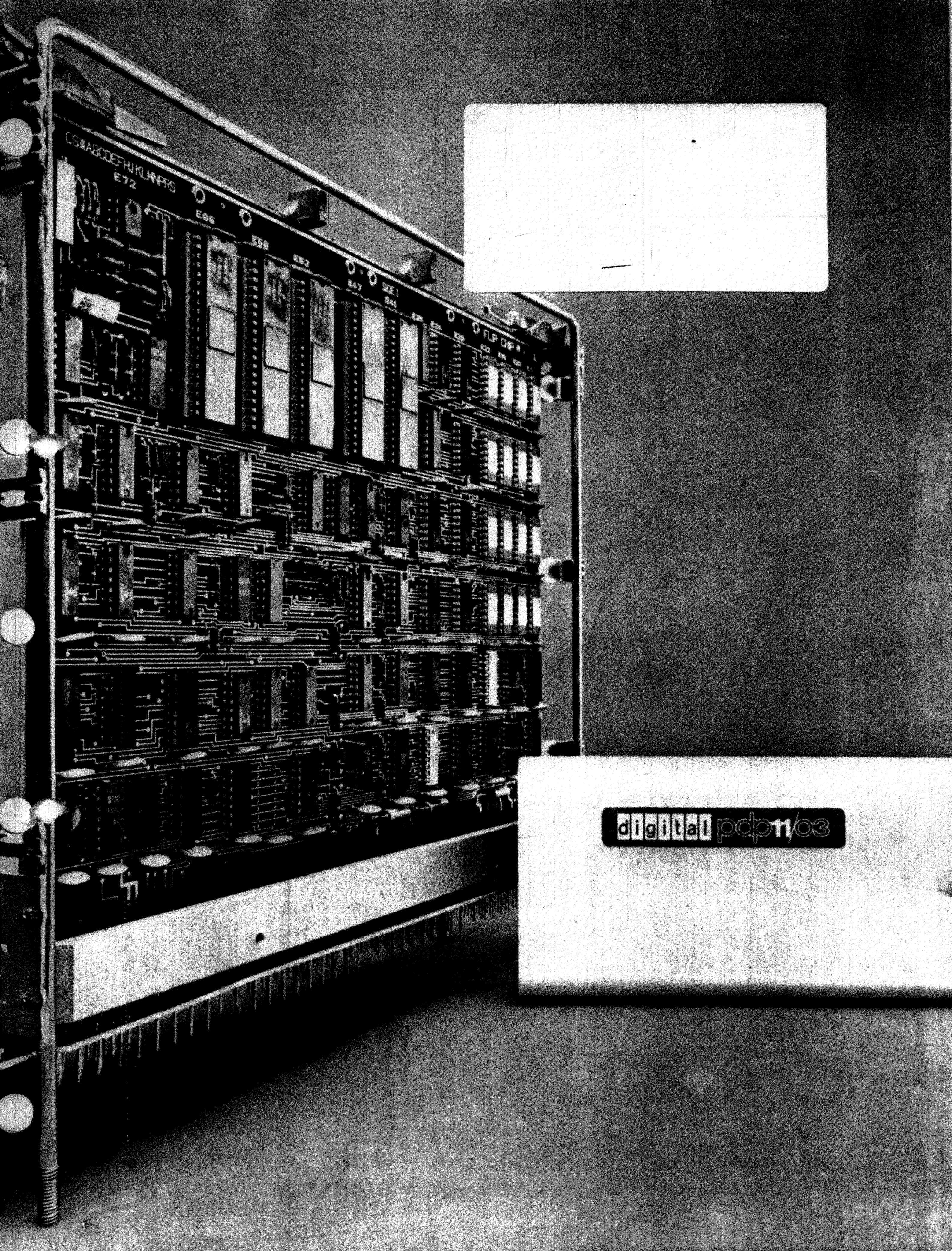

digital pdp11/03

EK-H780C-OP-001

# H780-C, -D, -H, -J, -K, -L power supply user's manual

digital equipment corporation • maynard, massachusetts

## CONTENTS



## ILLUSTRATIONS

## ILLUSTRATIONS (Cont)



## TABLES

# CHAPTER 1
# INTRODUCTION

## 1.1 GENERAL

The H780 power supply is designed to provide dc operating power for LSI-11 or PDP-11/03 systems.

Six H780 options are available:

H780-C - 100–127 Vac input, no console

H780-D - 200–254 Vac input, no console

H780-H - 100–127 Vac input, with master console

H780-J - 200–254 Vac input, with master console

H780-K - 100–127 Vac input, with slave console

H780-L - 200–254 Vac input, with slave console

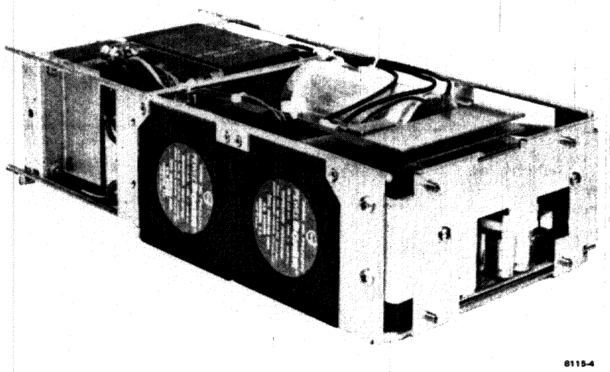
The H780 master console contains RUN and DC ON indicators for monitoring LSI-11 or PDP-11/03 states, as well as DC ON/DC OFF, LTC ON/OFF, and ENABLE/HALT switches for controlling the processor. The slave console contains only a DC ON indicator for monitoring the status of the slave power supply. The H780 power supply options are summarized in Table 1-1 and are shown in Figure 1-1. The power supply can be used as a stand-alone unit or it can be mounted to an H9270 backplane. Built-in cooling fans provide forced air cooling for the H780, and when mounted to an H9270 backplane, also provide cooling for the LSI-11 or PDP-11/03 modules mounted in the backplane. High frequency, low voltage, switching regulators, and a multiplexing scheme provide control of overcurrent, overvoltage, slow voltage buildup, low line voltage, and short-circuit protection. Proper power sequencing of the LSI-11 or PDP-11/03 power is also provided.

Table 1-1 H780 Power Supply Options

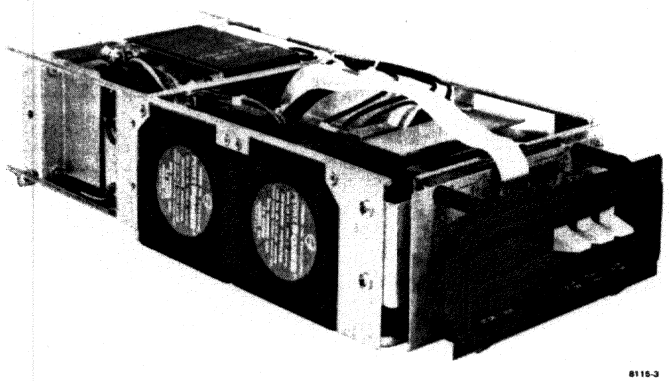
| Power Supply | Input Requirements | Console Supplied |
|---|---|---|
| H780-C | 100–127 Vac<br>50 ± 1 Hz or 60 ± 1 Hz | None |
| H780-D | 200–254 Vac<br>50 ± 1 Hz or 60 ± 1 Hz | None |
| H780-H | 100–127 Vac<br>50 ± 1 Hz or 60 ± 1 Hz | Master |
| H780-J | 200–254 Vac<br>50 ± 1 Hz or 60 + Hz | Master |
| H780-K | 100–127 Vac<br>50 ± 1 Hz or 60 ± 1 Hz | Slave |
| H780-L | 200–254 Vac<br>50 ± 1 Hz or 60 ± 1 Hz | Slave |

## 1.2 H780 BLOCK DIAGRAM DESCRIPTION

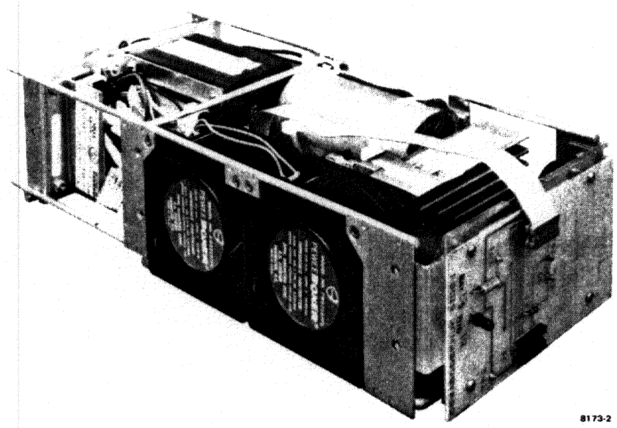
Figure 1-2 is a block diagram of the H780 power supply. AC line voltage is applied to the two cooling fans and to the power transformer. The transformer has dual primary windings to meet U.S. and European power requirements. A single secondary winding generates a stepped-down ac voltage which is rectified and filtered to produce 26 Vdc (nominal) unregulated. The unregulated 26 Vdc is applied to two three-terminal regulators which produce –15 V and +5 V for the H780 internal circuits. Unregulated 26 Vdc is also applied to +5 V and +12 V high frequency, high efficiency, switching regulators. The outputs of the +5 V and +12 V switching regulators supply operating power to the LSI-11 or PDP-11/03 system. Each switching regulator circuit is designed for good frequency stability, high noise rejection levels, and excellent load and line regulation. An L-C output filter and a fast-recovery diode is used in each switching regulator circuit. The +5 V switching regulator operates at a frequency from 7 kHz to 12 kHz, while the +12 V switching regulator operates from 8 kHz to 14 kHz. Both switching regulator circuits are protected from overvoltage, overcurrent, and short circuit outputs. In addition, failsafe short circuit startup is provided, along with protection against a short between the +5 V and +12 V outputs. Logic signal generation circuits within the H780 provide for proper power sequencing of an LSI-11 or PDP-11/03 system, as well as the generation of the line time clock (BEVNT L) and power supply status signals. H780-H and -J options are supplied with a console which contains RUN and DC ON indicators for monitoring the processor and power supply states, as well as DC ON/DC OFF, LTC ON/OFF, and ENABLE/HALT switches for controlling the system. The H780-K and -L options have a console which contains only a DC ON indicator.




H780-C and -D Power Supplies




H780-H and -J Power Supplies




H780-K and -L Power Supplies

Figure 1-1 H780 Power Supply Options

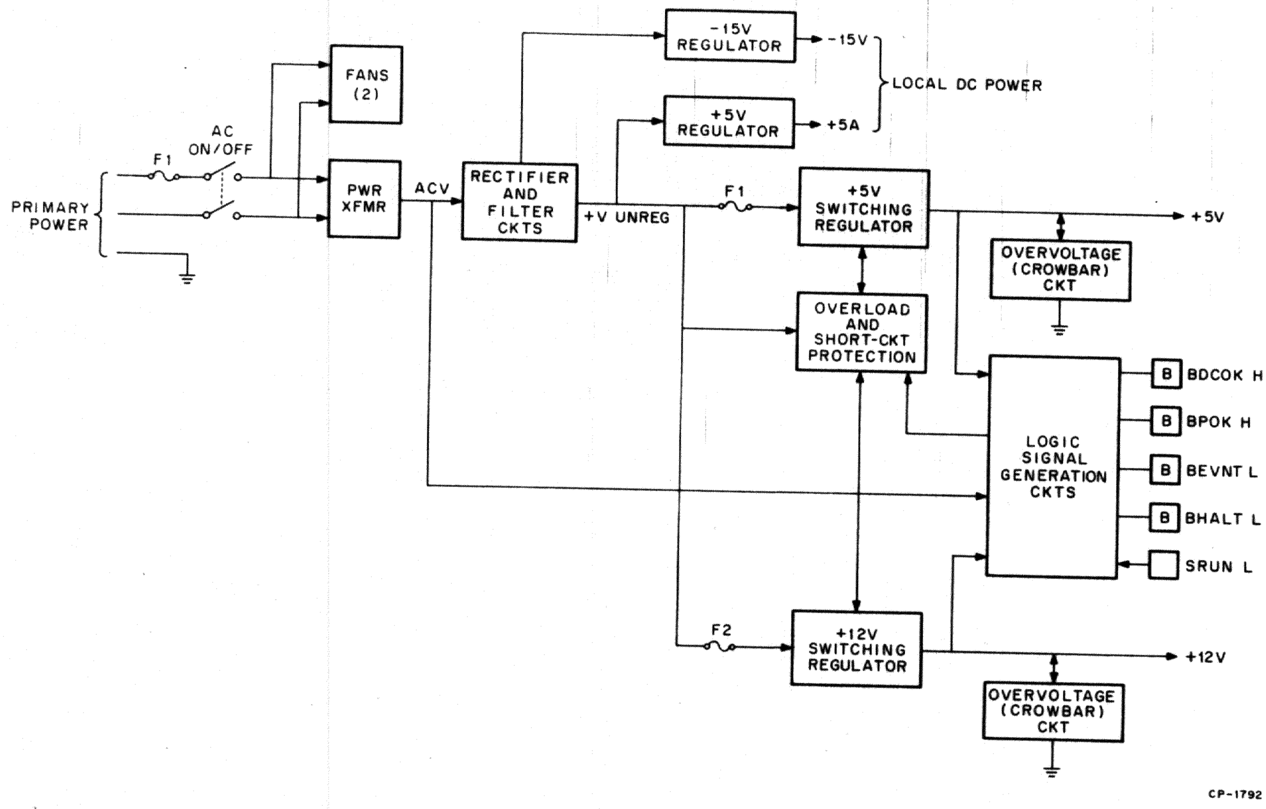



Figure 1-2 H780 Power Supply Block Diagram

## 1.3 SPECIFICATIONS

The following specifications and particulars are for informational purposes and are subject to change without notice.

**Electrical**

Input Voltage (Continuously – see Note 1)
- 100–127 Vac (H780-C, -H, -K)
- 200–254 Vac (H780-D, -J, -L)

Temporary Line Dips Allowed
- 100% of voltage, 20 ms max

AC Inrush Current
- 70 A @ 127 V, 60 Hz (8.33 ms)
- 25 A @ 254 V, 50 Hz (10 ms)

Input Power (fans included)
- 340 W @ full load max
- 290 W @ full load typical

EMI (Emission and Susceptibility)
- Per DEC Std 102.7 and VDE N-12 Limits

**Electrical (Cont)**

Input Protection
H780-C, -H, -K (100–127 Vac) fast blow 5 A fuse
H780-D, -J, -L (200–254 Vac) fast blow 2.5 A fuse

Hi-Pot
2 kV for 60 seconds from input to output, or input to chassis

Output Power (combinations not to exceed 110 W)
+5 V 1.5 A - 18 A
+12 V 0.25 A - 3.5 A

Maximum DC Current under Fault Conditions:
+5 V Bus = 28 A
+12 V Bus = 9.5 A

| | |
|---|---|
| +5 V Output | |
| Total Regulation | 5 V ±3% |
| Line Regulation | ±0.5% |
| Load Regulation | ±1.0% |
| Stability | 0.1%/1000 hours } (See Note 2) |
| Thermal Drift | 0.025%/° C } (See Note 2) |
| Ripple | 150 mv p-p (1% for f <3 kHz) |
| +5 V Output | |
| Dynamic Load Regulation | ±1.2%<br>di/dt = 0.5 A/μs<br>Δ1 = 5 A |
| Noise | 1% peak at f > 100 kHz (noise is superimposed on ripple) |
| Interaction due to +12 V | ±0.05% |
| +12 V Output | |
| Total Regulation | 12 V ±3% |
| Line Regulation | ±0.25% |
| Load Regulation | ±0.5% |
| Stability | 0.1%/1000 hours } (See Note 2) |
| Thermal Drift | 0.025%/° C above 25° C } (See Note 2) |
| Ripple | 350 mv p-p (1% for f < 3 kHz) |
| Dynamic Load Regulation | ±0.8%<br>di/dt = 0.5 A/μs<br>f < 500 Hz<br>Δ1 = 3 A |
| Noise | 1% peak f > 100 kHz (noise is superimposed on ripple) |
| Interaction due to +5 V | ± 0.2% |

**Electrical (Cont)**

Overvoltage Protection

| | |
|---|---|
| +5 V | 6.3 V nominal<br>min = 5.65 V<br>max = 6.8 V |
| +12 V | 15 V nominal<br>min = 13.6 V<br>max = 16.5 V |

Adjustments

| | |
|---|---|
| +5 V Output | 4.05 V – 6.8 V<br>guarantee range 4.55 – 5.65 V |
| +12 V Output | 10.6 V – 16.5 V<br>guarantee range 11.7 – 13.6 V |

Controls

| Rear Panel | Console (Master Only) |
|---|---|
| AC ON/OFF switch | DC ON/OFF switch<br>Halt/Enable Switch<br>LTC On/Off Switch |

Console Indicators

DC ON
Run } Master Only
Spare

Backplane Signals

BPOK H
BDCOK H
BEVNT L
BHALT L
SRUN L

**Mechanical**

Cooling

Two self-contained fans provide 30 CFM (0.7140 CMM; 200 LFPM) air flow.

Size

5-1/2 in. w × 3-1/3 in. h × 14-5/8 in. l
(13.97 cm w × 8.43 cm h × 37.15 cm l)

Weight

13 lbs (5.90 kg)

**Environmental**

Temperature

Ambient 5° C – 50° C (41° F – 122° F)
Storage –40° C – 70° C (–40° F – 158° F)

Humidity

90% maximum without condensation

**NOTES**

1. **Operation from ac lines below 100 V may cause the power supply to overheat because of decreased air flow from the cooling fans.**

2. **These parameters apply after five minutes of warmup and are measured with an averaging meter at the LSI-11 or PDP-11/03 backplane terminal block under system loading.**

## 1.4 RELATED LITERATURE

In addition to the H780 print set, the *Microcomputer Handbook* contains useful information for installing and operating the H780 power supply. Handbooks may be ordered from the nearest Digital Equipment Corporation Sales Office.

# CHAPTER 2
# INSTALLATION

## 2.1 GENERAL
Installation of an H780 power supply consists of inspecting the unit, connecting a suitable dc power cord, setting up the +5 V and +12 Vdc outputs, and connecting the power supply to the LSI-11 or PDP-11/03 system.

## 2.2 DIFFERENCES BETWEEN 115 VAC AND 230 VAC POWER SUPPLIES
The main differences between the 115 Vac H780 power supplies (H780-C, -H, and -K) and the 230 Vac H780 power supplies (H780-D, -J, and -L) are the ac input jumper configuration on the power supply terminal block (TB1), the fuse rating (115 Vac supplies are equipped with a 5 A fast-blow fuse; the 230 Vac supplies have a 2.5 A fast-blow), and the power line RFI filter which is used only on the 230 Vac supplies. Power supplies factory-wired for 115 Vac operation (H780-C, -H, and -K) can be rewired for 230 Vac operation by reconfiguring the jumpers on TB1. However, European users of 115 Vac supplies should not rewire the H780-C, -H or -K for 230 Vac operation as these supplies will not meet the EMI requirements of VDE N-12. On the other hand, the 230 Vac supplies (H780-D, -J, and -L) can be rewired for 115 Vac and used in European countries as well as the U.S. AC wiring configurations for the H780 power supplies are detailed in Paragraph 2.6.1.

## 2.3 SPACE REQUIREMENTS
The H780 power supply occupies a space 5-1/2 inches wide ± 3-1/3 inches high × 14-5/8 inches long (13.97 cm wide × 8.43 cm high × 37.15 cm long). Space should be available to the rear of the supply to gain access to AC ON/OFF toggle switch. H780-H, -J, -K and -L options should be installed to allow for unobstructed viewing and use of the power supply console. Users installing the H780 to an H9270 backplane must allow for power supply space toward the right of the backplane.

## 2.4 INPUT POWER REQUIREMENTS
The user's ac power source must be capable of providing 340 W (full load) of ac power at 50 ±1 Hz or 60 ±1 Hz. No ac power cord is supplied with the H780 options; it is the user's responsibility to provide the proper line cord and ac plug for his particular application. AC power connections to the H780 are detailed in Paragraph 2.6.1.

## 2.5 CABLE REQUIREMENTS
Three interface cables are supplied with the H780 options to connect the H780 console to the power supply and to connect the H780 to the LSI-11/PDP-11/03 backplane. These cables are listed below by type and part number.

| Cable | DEC Part No. |
|---|---|
| DC Output Cable | 7011584-0-0 |
| Power Supply Status Cable (logic cable) | 7011411-0K-0 |
| Power Supply Console Cable | 7008612-0M-0 |

In addition, if the user is controlling an H780 slave power supply (H780-K or -L) from an H780 master (H780-H or -J), the interface cable between the master and slave is the user's responsibility. This cable can be constructed from 12-conductor ribbon cable and two 16-pin, IC-type male connectors (3M part number 3416). The master/slave cable can be ordered from the nearest Digital Equipment Corporation Sales Office. Cable lengths and part numbers are listed in Table 2-1.

**Table 2-1 Master/Slave Interface Cables**

| Length | DEC Part No. |
|---|---|
| 4 in. | 7008612-0D |
| 6 in. | 7008612-0F |
| 9 in. | 7008612-0K |
| 11 in. | 7008612-0M |
| 14 in. | 7008612-1B |
| 18 in. | 7008612-1F |
| 49 in. | 7008612-4A |
| 2 ft. | 7008612-02 |
| 6 ft. | 7008612-6A |
| 10 ft. | 7008612-10 |

## 2.6 INSTALLATION PROCEDURE

After unpacking the H780 from the shipping container, inspect the unit and report any damage to the nearest Digital Equipment Corporation Sales Office. Inspect for the following:

1. Damage to the chassis or printed circuit boards.
2. Loose or broken components
3. Damage to the console on the H780-H, -J, -K, or -L
4. Free rotation of the blades on the cooling fans
5. Proper amperage fuse (2.5 A fast-blow for H780-D, -J, and -L; 5 A fast-blow for H780-C, -H, and -K)
6. Proper seating of the fuse
7. Proper seating of the console cable connectors (H780-H, -J, -K, and -L)
8. The presence of the plastic shield covering the terminal block at the rear of the H780.

### 2.6.1 Connecting AC Line Cord

The H780 power supplies are equipped with a terminal block (Figure 2-1) at the rear. Jumpers on this terminal block configure the supply for 115 Vac or 230 Vac operation (Paragraph 2.4), while two of the terminal block screws provide a means of connecting ac input power to the H780. A suitable length of No. 16 AWG, 3-conductor, stranded power cord is to be connected to the terminal block as shown in Figure 2-2 (for H780-C, -H, and -K supplies), or Figure 2-3 (for H780-D, -J, and -L supplies). The jumpers shown in Figures 2-2 and 2-3 are factory-installed. However, the jumper configuration can be altered by the user to change the ac input from 115 V to 230 V for the H780-C, -H, and -K, or from 230 V to 115 V for the H780-D, -J, and -L. European users are advised not to operate an H780-C, -H, or -K power supply on a 230 Vac line as these supplies are not equipped with an RFI line filter. When installing the ac line cord, remove the plastic shield covering the terminal block (Figure 2-1). Terminals should be crimped or soldered to the power cord wires. Connect the ac phase wires to the terminal block (Figure 2-2 or 2-3), and connect the ac ground wire to the H780 chassis using the Phillips head screw to the right of the terminal block (Figure 2-1). This screw also provides a ground for the RFI filter in the H780-D, -J, and -L supplies by means of a green/yellow wire. Make sure this wire is reconnected to ground when replacing the screw. Be sure to replace the plastic shield over the terminal block after completing the wiring. Route the power cord to the top of the H780 chassis and secure it to the chassis with a suitable strain relief, as shown in Figure 2-1. The upper-right screw at the rear of the H780 chassis can be used to anchor a cable clamp. The free end of the power cord should be terminated with a connector which is suitable for the user's requirements.

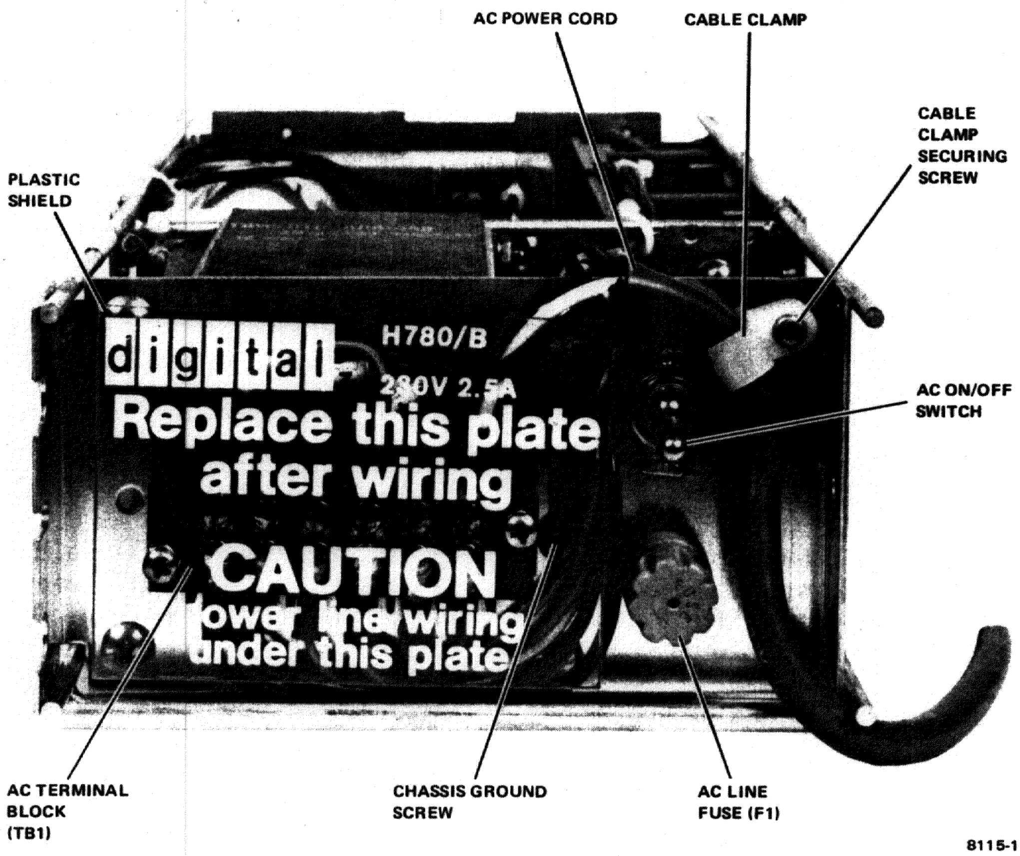



Figure 2-1 AC Terminal Block at Rear of H780

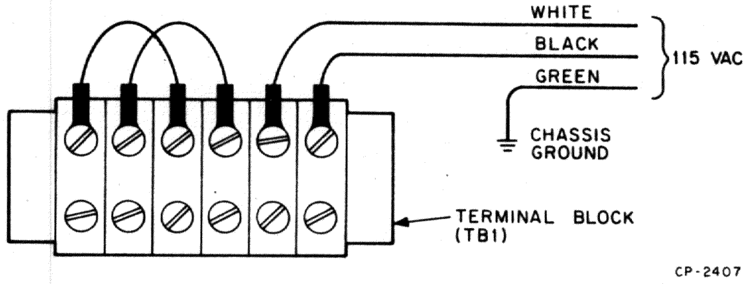



Figure 2-2 H780-C, -H, and -K (115 Vac) AC Terminal Block Wiring Configuration

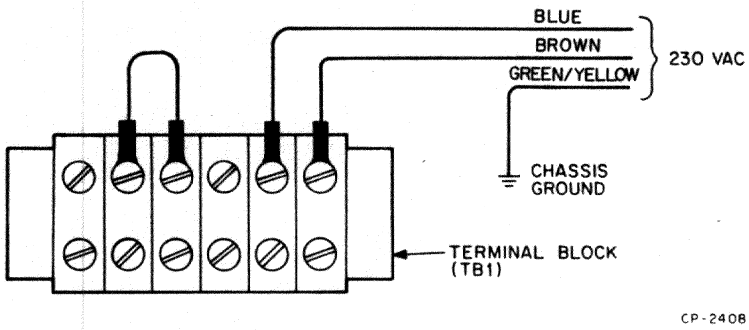



Figure 2-3 H780-D, -J, and -L (230 Vac) AC Terminal Block Wiring Configuration

### 2.6.2 H780-C and H780-D Stand-Alone Operation

If an H780-C or -D power supply is to be used as a stand-alone supply, a 510 1/4 W resistor must be installed between J2-2 and J2-9 on the power supply printed circuit board (Figure 2-4). The 510 resistor provides a pull-up level to an internal power supply gate, thus enabling the +5 V and +12 V outputs. This resistor is not required for the H780-K or -L slave supplies, nor is the resistor required for the H780-H and -J supplies. The resistor can be installed by bending its leads and inserting them into socket J2, or by soldering the resistor across pins 2 and 9 of a 16-pin DIP, IC-type male connector. Pinning for the J2 enable plug is shown in Figure 2-5.

### 2.6.3 Initial Power Turn-On

Before connecting the dc output of the H780 to an LSI-11 or PDP-11/03, verify the dc output voltages by performing the following procedure:

1. If the H780 is a slave supply (or an H780-C, -D), either cable J2 REMOTE of the slave H780 (or J2 on the power suply PC board of H780-C, -D) to the J2 REMOTE connector on the H780 master supply (refer to Paragraphs 2.5 and 2.6.6), or install a 510 1/4 W resister into the slave (Paragraph 2.6.2).

2. Connect the H780 to a suitable ac power source.

3. Set the H780 AC ON/OFF switch (Figure 2-1) to ON. The fans in the H780 should operate.

4. On H780-H and -J options, set the console DC ON/OFF switch (Figure 2-14) to ON. The DC ON indicator should light. (For master-slave operation, the DC ON/OFF switch and DC ON indicator are located on the user's master supply. The DC ON indicator on the slave should also light.)

5. Using a DVM, measure the +5 V and +12 Vdc outputs at J4 (Figures 2-9 and 2-10) on the H780 PC board (side 2). The +5 V output should not be greater than +5.15 V and the +12 V output should not exceed +12.36 V. Perform the adjustment procedure in Paragraph 2.8 if the outputs are out of tolerance.

6. Set the master console DC ON/OFF switch to the OFF position.

7. Set the AC ON/OFF switch to the OFF position.

8. Unplug the ac power cord and connect the H780 to the LSI-11 or PDP-11/03 system.

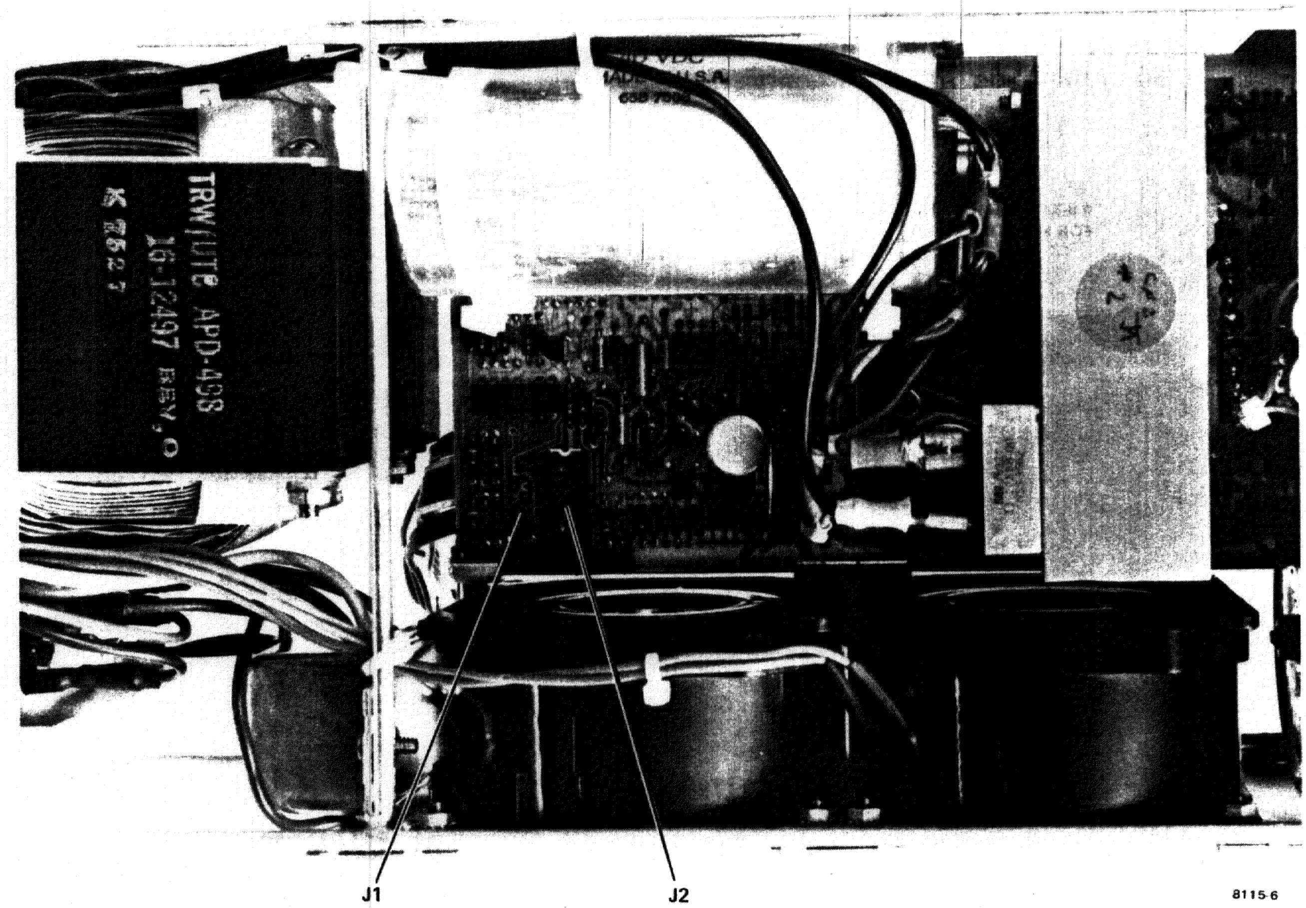



Figure 2-4 Locations of J1 and J2 on Power Supply Board

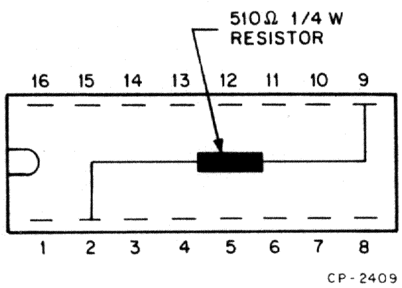



Figure 2-5 H780-C and -D Enable Plug

**2.6.4 Mounting an H780 to an H9270 Backplane**

The H780 power supply is designed to be mounted to the LSI-11/PDP-11/03 H9270 backplane. Four holes on the left side of the H780 are equipped with No. 8-32 threaded bosses (Figure 2-6). These holes mate with four holes in the right side of the H9270 backplane frame. Four No. 8-32 ×-1/2 inch screws are inserted through the H9270 backplane holes and are threaded into the H780 power supply. The H9270 backplane and the H780 power supply thus become one assembly (Figure 2-7). Figure 2-6 shows the location of the four mounting holes in the H780. The two screws securing the front chassis partition must be removed. These screws are to be replaced with longer screws (1/2 inch) when attaching the H780 to the H9270.

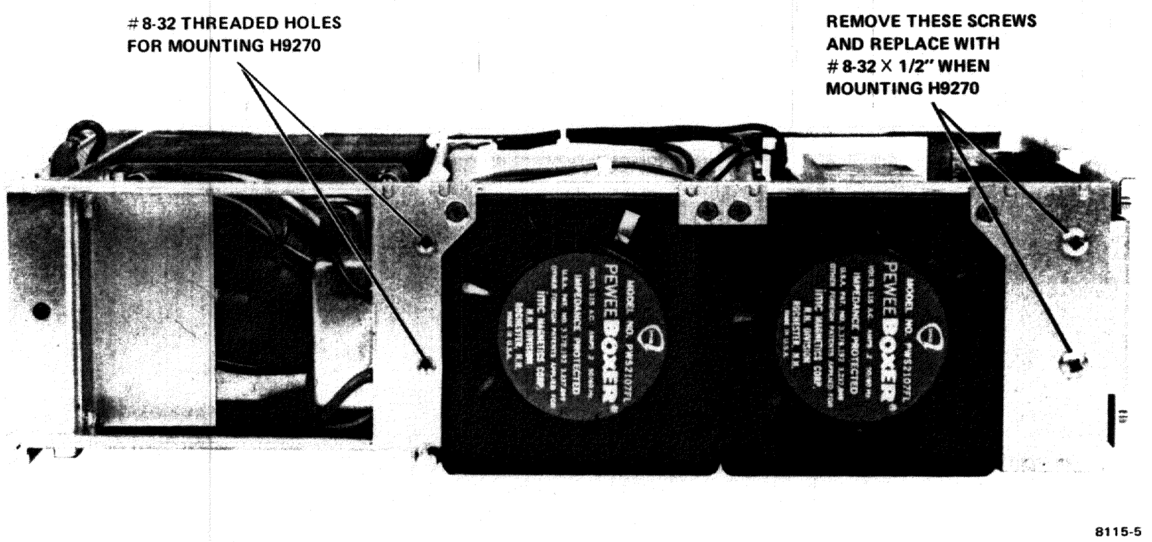



Figure 2-6 Left Side of H780 Showing H9270 Mounting Holes

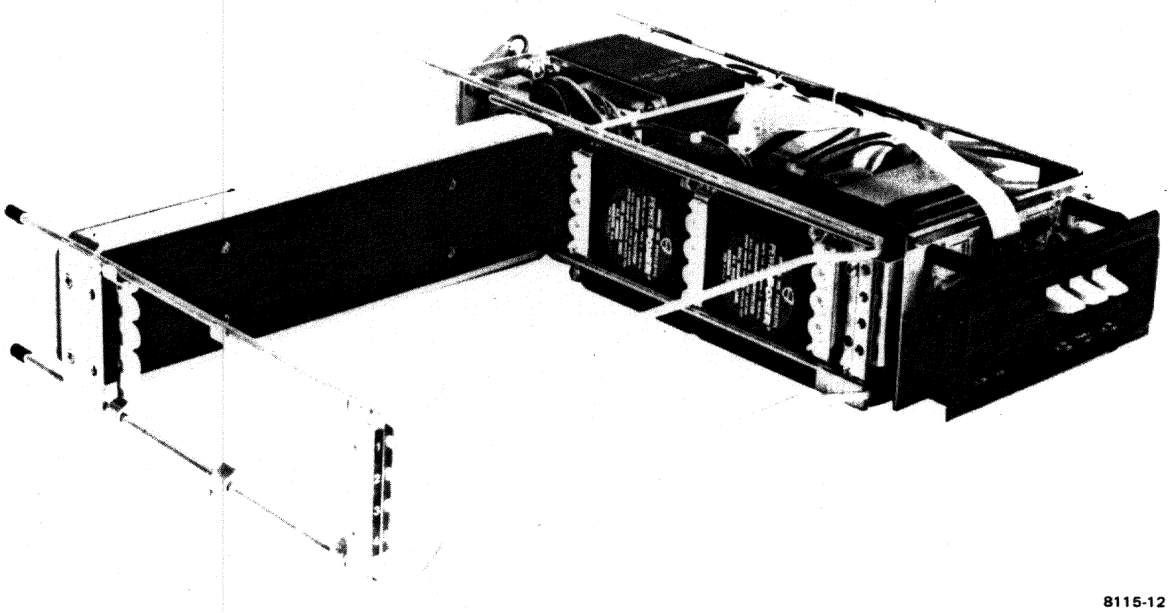



Figure 2-7 H780 Mounted to H9270 Backplane

### 2.6.5 Connecting an H780 to an H9270 Backplane

The H780 power supply is connected to the H9270 by means of two cables. These cables are supplied with the H780 (refer to Paragraph 2.5). One of these cables is a 10 inch logic signal cable (DEC part number 70-11411-0K-0) which connects from J1 on the power supply board (Figure 2-4) to connector pins on the H9270 printed circuit board (Figure 2-8). Either end of this cable can be connected to the power supply or the backplane. The other cable is a 12 inch dc output cable (DEC part number 70-11584-0-0). This cable is terminated at one end with a keyed, 12-pin connector which mates with J4 on side 2 of the H780 power supply board. Figure 2-9 shows the location of J4; Figure 2-10 shows J4 pinning. The remaining end of the dc output cable is terminated with a 6-lug connector strip which is connected to the H9270 backplane terminal block, as shown in Figure 2-8. When connecting the 6-lug connector strip to the H9270 backplane, make sure that the spade lug connectors are facing up. Figure 2-11 shows the dc output cable connected to J4 of the H780. The H780 logic signal and dc output cables are routed toward the rear of the power supply and exit from the supply chassis next to the H9270 backplane terminal block.

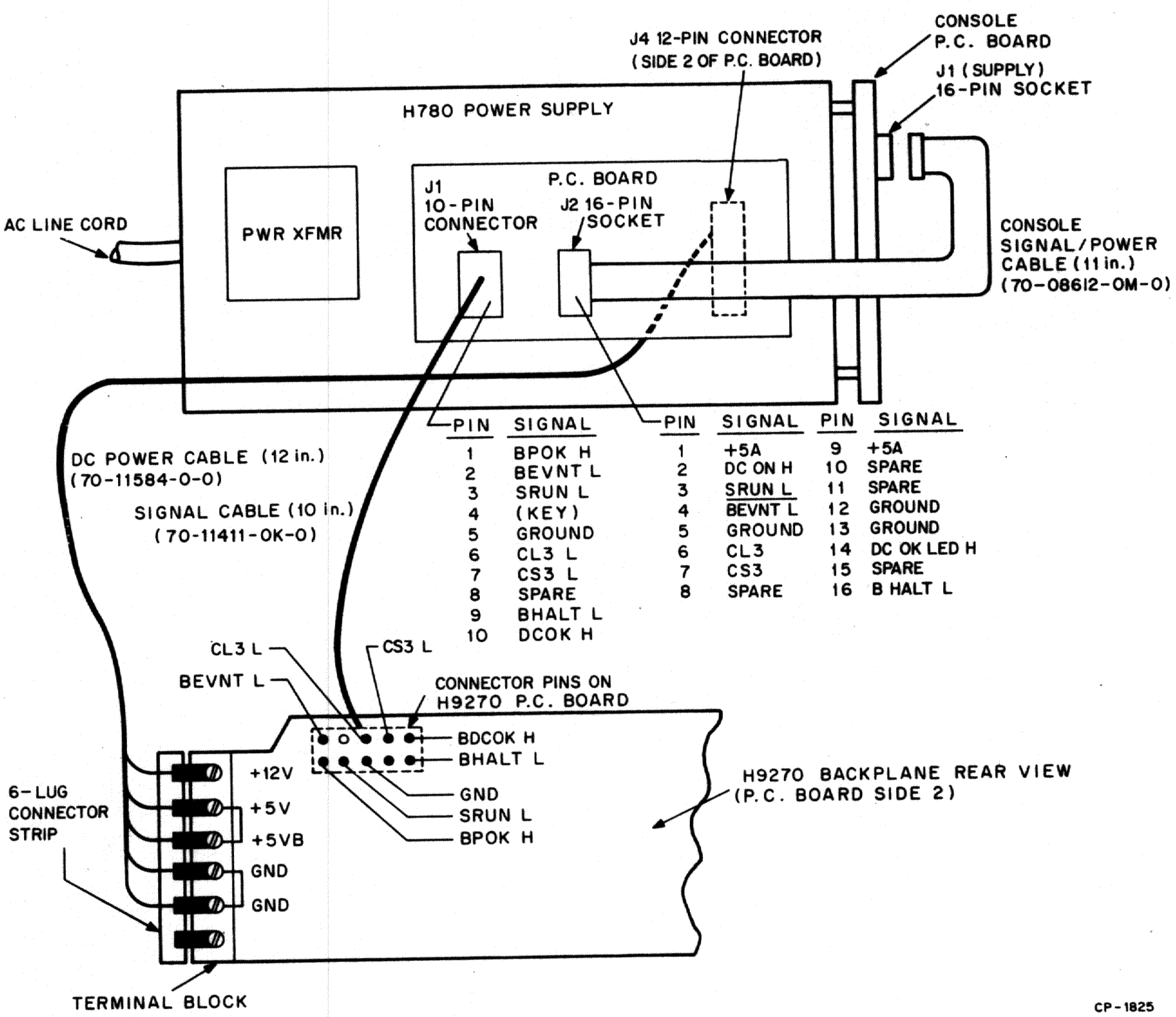



Figure 2-8 H780 to H9270 Backplane Connections

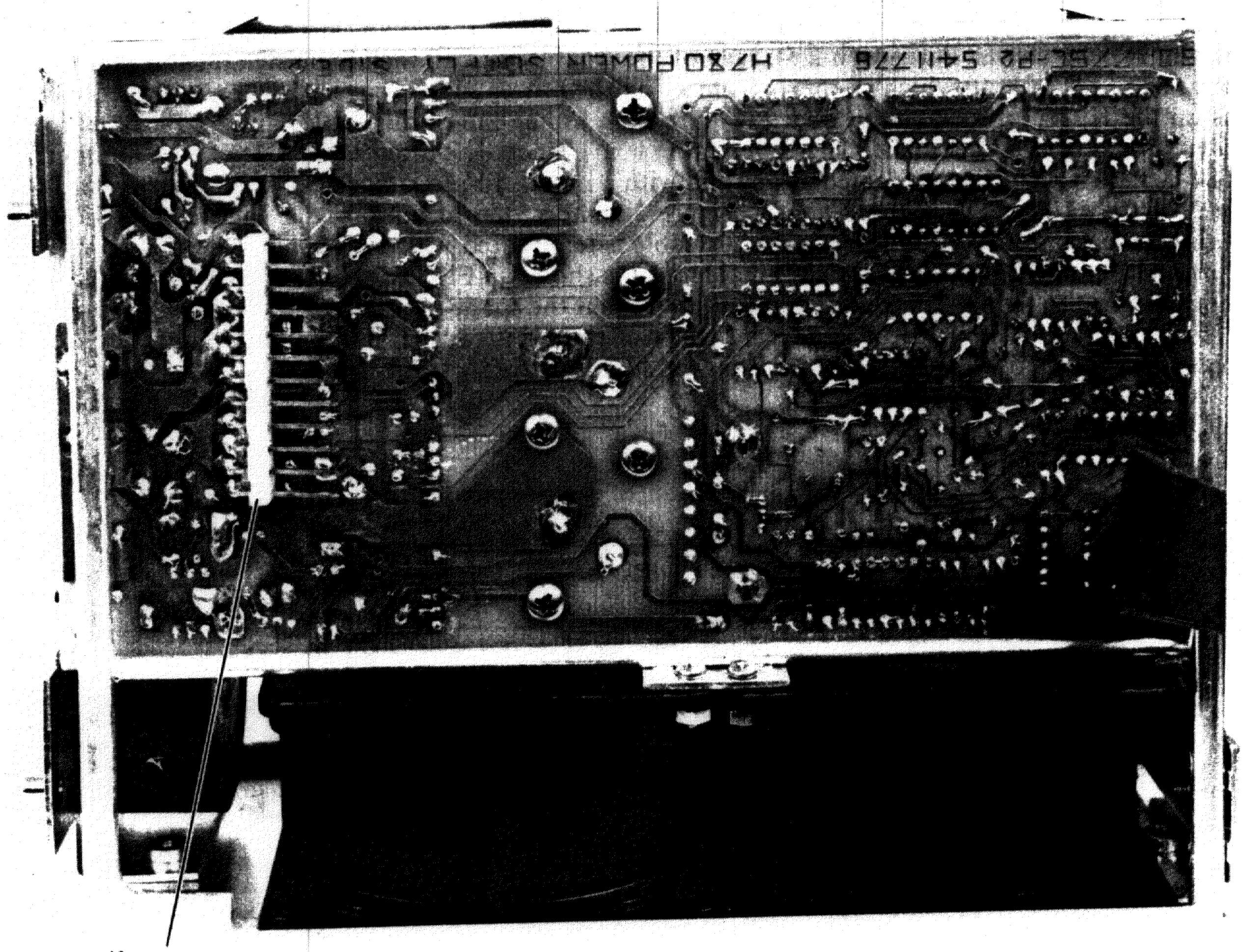



Figure 2-9 Location of H780 DC Output Connector (J4)

H780-H, -J, -K, and -L power supplies have a console that is attached to the H780 and connected to the supply by means of a console signal/power cable (DEC part number 70-08612-OM-0). This cable is factory-installed from J2 on the power supply board (Figure 2-4) to J1 on the console PC board (refer to Figures 2-8 and 2-12).

**2.6.6 H780 Master-Slave Connection**

An H780-H or -J power supply can be used as a master supply to control an H780-K or -L slave supply. This master-slave arrangement allows the user to power up/power down LSI-11 or PDP-11/03 expander backplane logic from the master supply console. The slave supply is connected to the master supply by means of the J2 (REMOTE) connector on the master supply console printed circuit board, and J2 (REMOTE) on the slave power supply console printed circuit board. The interconnecting cable is the user's responsibility. Two 16-pin, IC-type male connectors and a suitable length of 12-conductor cable (preferably ribbon type) can be used to construct the interconnecting cable (refer to Paragraph 2.5). Figure 2-12 shows the console printed circuit boards and the locations of the J1 (SUPPLY) and J2

(REMOTE) connectors. J1 is always connected to J2 of the power supply printed circuit board (Figure 2-8) by the console signal/power cable (DEC part number 70-08612-OM-0) which is factory-installed. Pinning for J2 (REMOTE) on the console printed circuit board is shown in Figure 2- 13. Pinning for J2 on the power supply printed circuit board is indicated in Figure 2-8.

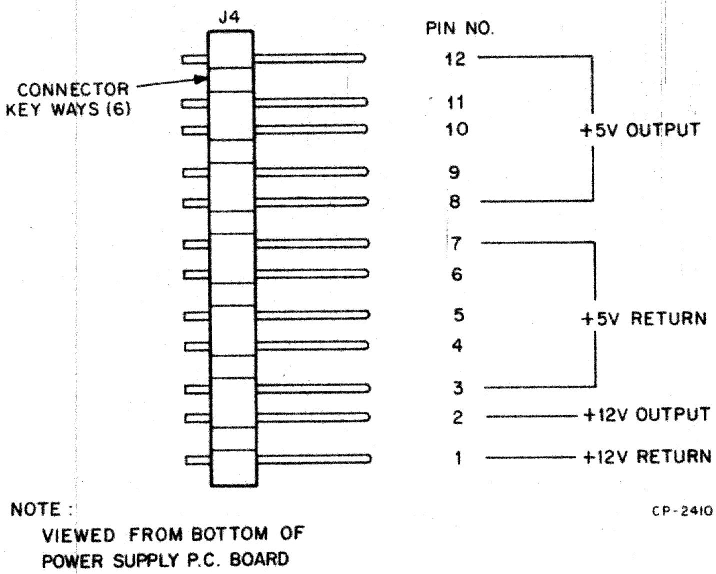



Figure 2-10 Pinning for H780 DC Output Connector (J4)

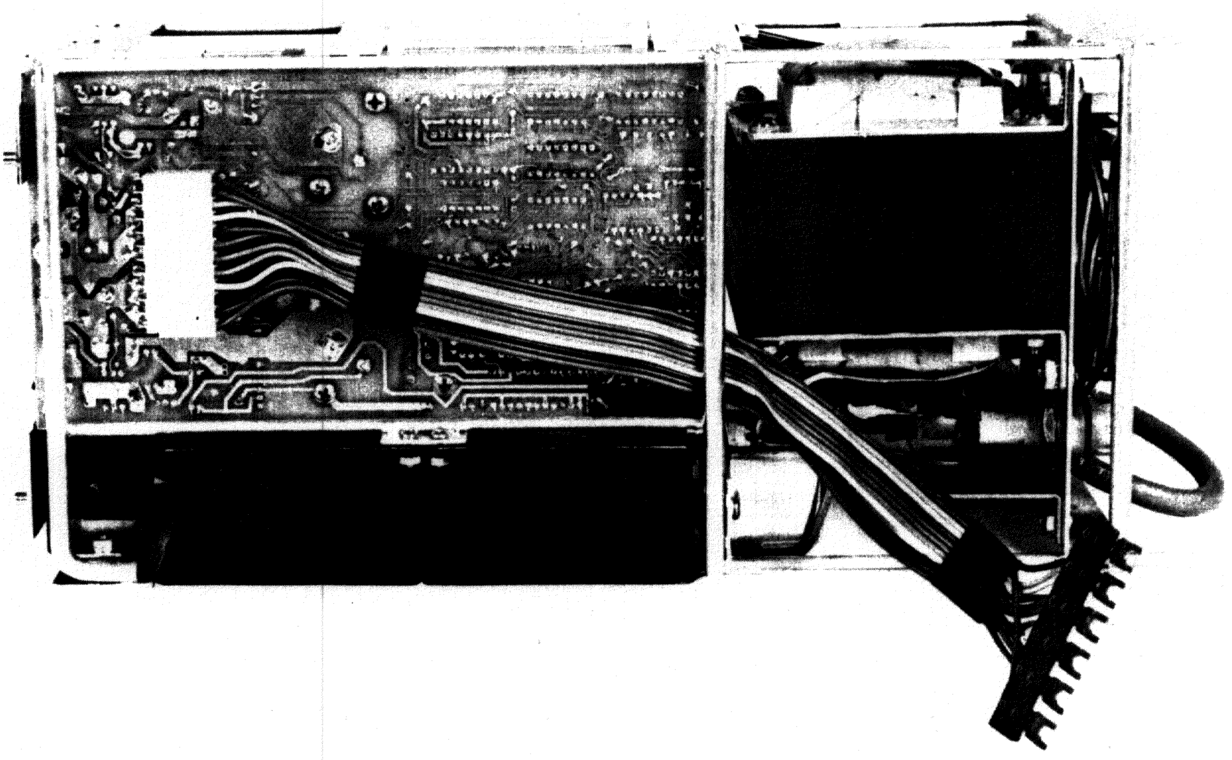
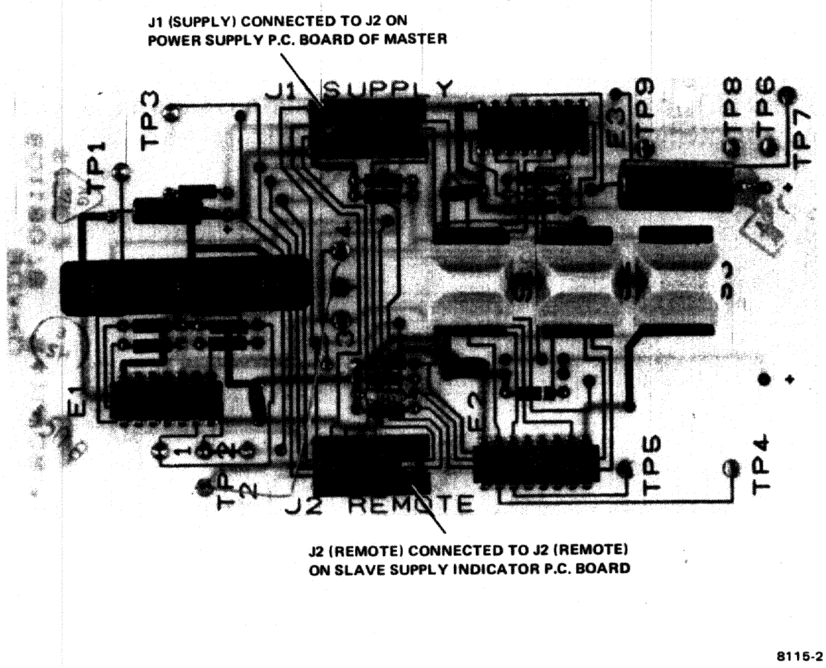
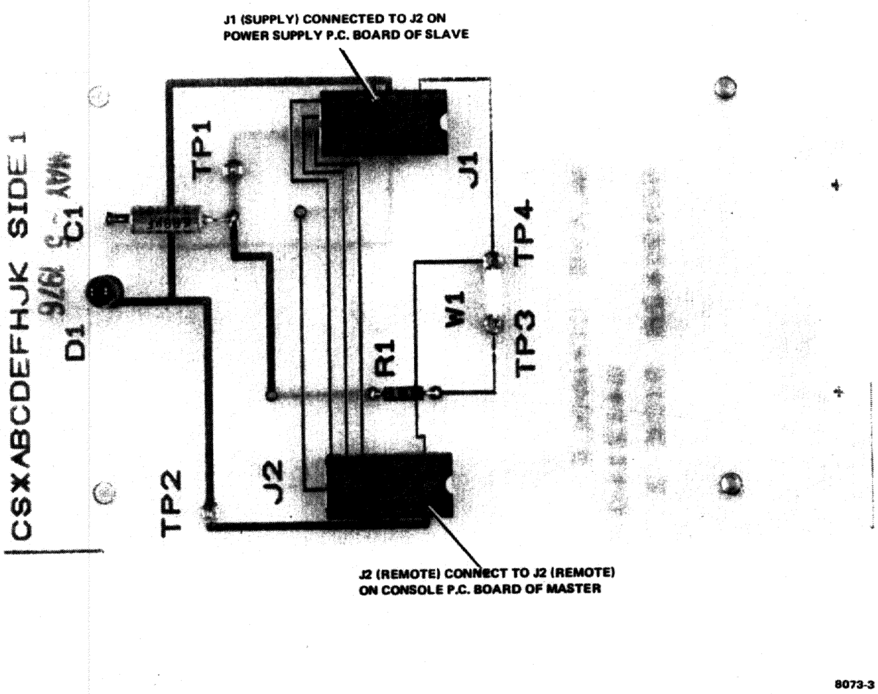



Figure 2-11 H780 DC Output Connector (J4) with Mating DC Output Cable (70-11584-0-0)

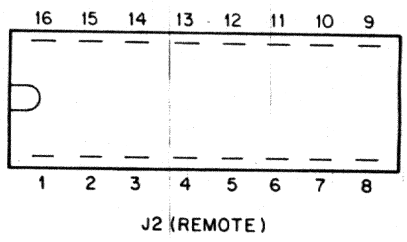



H780-H and -J (Master)




H780-K and -L (Slave)

Figure 2-12 H780 Master-Slave Connections




| PIN | SIGNAL | PIN | SIGNAL |
|---|---|---|---|
| 1 | NO CONNECTION | 9 | NO CONNECTION |
| 2 | DC ON H | 10 | SPARE 3 |
| 3 | NO CONNECTION | 11 | SPARE 4 |
| 4 | SPARE 2 | 12 | SPARE 5 |
| 5 | GROUND | 13 | GROUND |
| 6 | CL3 L | 14 | DC OK H |
| 7 | CS3 L | 15 | SPARE 6 |
| 8 | SPARE 1 | 16 | NO CONNECTION |

CP-2411

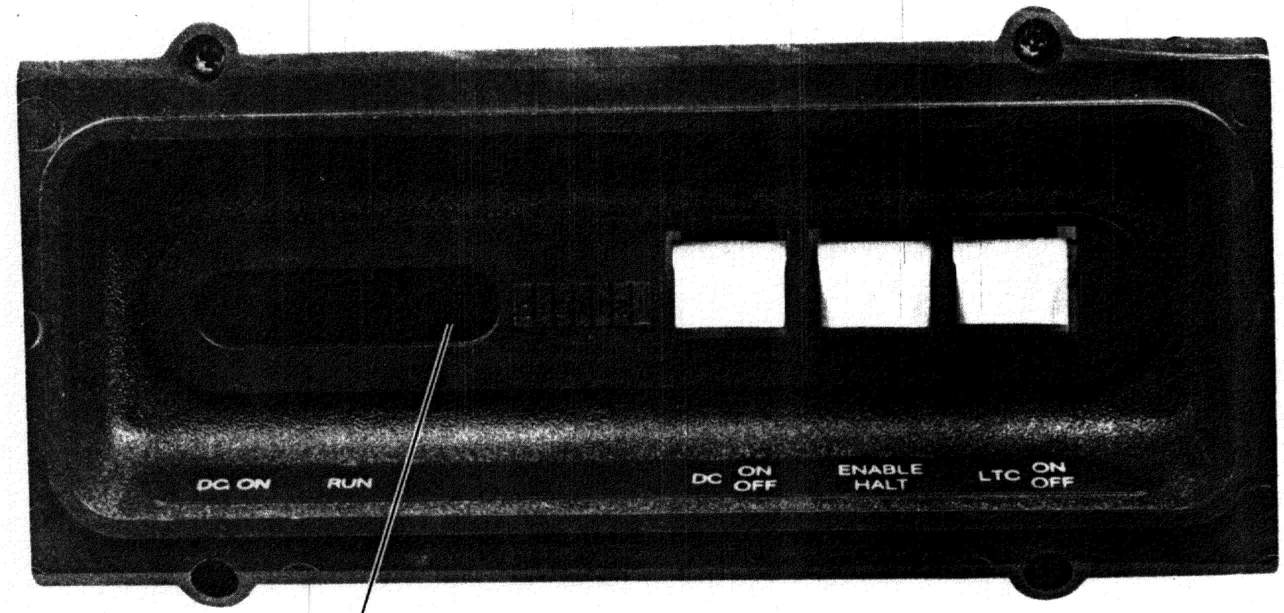
Figure 2-13 Pinning for J2 (REMOTE) on Console Printed Circuit Board

## 2.7 CONSOLE CONTROLS AND INDICATORS

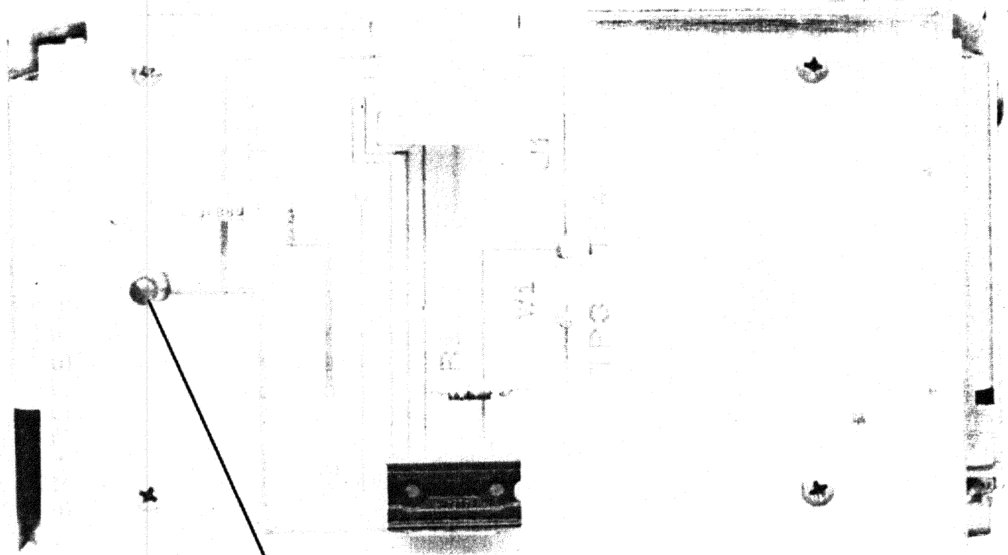
The H780-H or -J master console has three LED indicators and three, two-position, toggle switches. One of the LED indicators is a spare indicator. Circuitry to drive this indicator is included on the console printed circuit board for user application. The console on the H780-K and -L slave supplies has only one LED indicator – DC ON. Figure 2-14 shows the H780 console controls and indicators; they are described in Table 2-2. Additionally, the rear panel of the H780 contains an AC ON/OFF toggle switch and an ac line fuse (Figure 2-1).

## 2.8 +12 V AND +5 V ADJUSTMENT PROCEDURE

The H780 power supply is factory-adjusted to produce +12 V and +5 V outputs within the operating tolerance of an LSI-11 or PDP-11/03 system. The adjustment procedures presented allow the user to trim the dc outputs of the H780 to meet his particular needs. One adjustment is provided for the +12 V output, while two adjustments (one for the output voltage and one for the switching regulator frequency) are provided for the +5 V. Figure 2-15 shows the locations of the adjustments. A DVM, an oscilloscope, and a small screwdriver are required. Power supply loading is provided by the LSI-11 or PDP-11/03 system.




H780-H and -J Console




H780-K and -L Console

Figure 2-14   Console Controls and Indicators

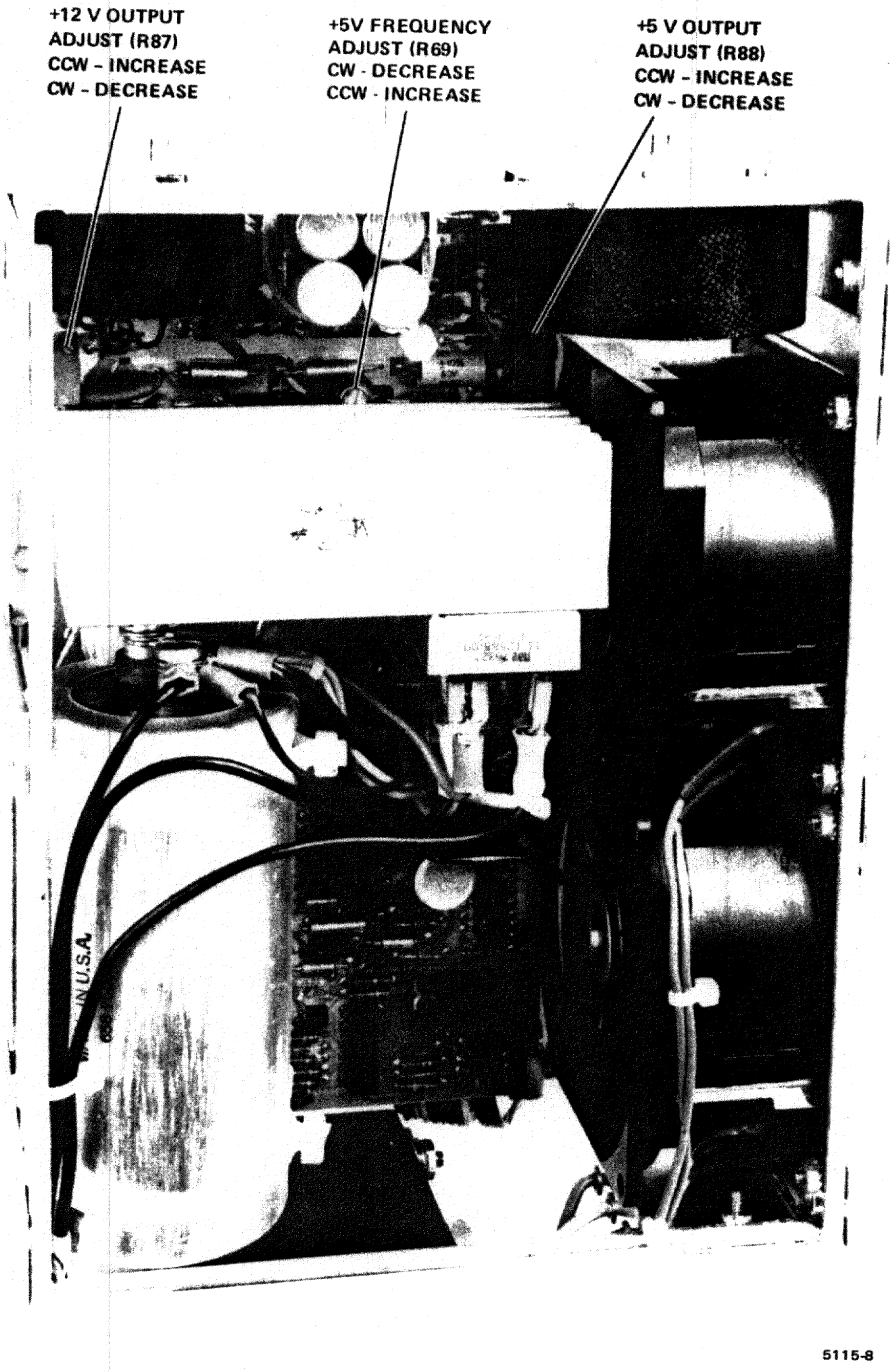



Figure 2-15 Locations of H780 Adjustments

Table 2-2 H780 Controls and Indicators

| Control/Indicator | Type | Function |
|---|---|---|
| DC ON | LED indicator | Illuminates when the DC ON/OFF toggle switch is set to ON and proper dc output voltages are being produced by the H780.<br><br>If either the +5 V or +12 V output from the H780 is faulty, the DC ON indicator will not illuminate. This is the only indicator on the H780-K and -L slave supplies. |
| RUN | LED indicator | Illuminates when the LSI-11 or PDP-11/03 processor is in the run state (see ENABLE/HALT). |
| SPARE | LED indicator | Not used by the H780 or processor. The H780 contains circuitry for driving this indicator for user applications. |
| DC ON/OFF | Two-position toggle switch | When set to ON, enables the dc outputs of the H780. The DC ON indicator will illuminate if the H780 dc output voltages are of proper values. If a slave supply is connected to a master, the slave DC ON indicator will light if the slave dc output voltages are of proper value.<br><br>When set to OFF, the dc outputs from the H780 are disabled and the DC ON indicator is extinguished. If a slave supply is connected to a master, the slave DC ON indicator will also extinguish. |
| ENABLE/HALT | Two-position toggle switch | When set to HALT, the B HALT L line from the H780 to the processor is not asserted and the processor is in the run mode (RUN indicator illuminated).<br><br>When set to ENABLE, the B HALT L line is asserted allowing the processor to execute console ODT microcode (RUN indicator extinguished). |

Table 2-2 H780 Controls and Indicators (Cont)

| Control/Indicator | Type | Function |
|---|---|---|
| LTC ON/OFF | Two-position toggle switch | When set to ON, enables the generation of the line time clock (LTC) by the H780.<br><br>When set to OFF, disables the H780 line time clock. |
| AC ON/OFF (rear panel) | Two-position toggle switch | When set to ON, applies ac power to the H780.<br><br>When set to OFF, removes ac power from the H780. |
| FUSE (rear panel) | 5 A or 2.5 A fast-blow | Protects H780 from excessive current. H780-C, -H, and -K use a 5 A fuse, H780-D, -J, and -L use a 2.5 A. |

### 2.8.1 +12 V Adjustment

Perform the following procedure when adjusting the +12 Vdc output:

1. Apply power to the LSI-11 or PDP-11/03 system and allow a five minute warmup period.

2. Using a DVM, measure the +12 V output at the LSI-11 or PDP-11/03 backplane terminal block (refer to Figure 2-8).

3. Using a small screwdriver, adjust R87 (Figure 2-15) until the DVM indicates +12.0 V (+11.64 V to +12.36 V acceptable range). Turning R87 CW decreases the +12 V output, while turning CCW increases the output.

NOTE

**If R87 is turned too far CCW, the +12 V output will crowbar and drop to approximately 0 V. This will occur between +13.0 V and +16.5 V. Do not allow the supply to crowbar as this may blow the internal fuse (F1) protecting the +12 V regulator.**

4. Using an oscilloscope, measure the ripple on the +12 V output at the backplane terminal block. The ripple should not be greater than 350 mV peak-to-peak.

### 2.8.2 +5 V Adjustment

Perform the following procedure when adjusting the +5 Vdc output:

1. Apply power to the LSI-11 or PDP-11/03 system and allow a five minute warmup period.

2. Using a DVM, measure the +5 V output at the LSI-11 or PDP-11/03 backplane terminal block (refer to Figure 2-8).

3. Using a small screwdriver, adjust R88 (Figure 2-15) until the DVM indicates +5.0 V (+4.85 V to +5.15 V acceptable range). Turning R88 CW decreases the +5 V output, while turning CCW increases the output.

NOTE

**If R88 is turned too far CCW, the +5 V output will crowbar and drop to approximately 0 V. This will occur between +5.6 V and +6.8 V. Do not allow the supply to crowbar as this may blow the internal fuse (F2) protecting the +5 V regulator.**

4. Using an oscilloscope, measure the amplitude and frequency of the ripple on the +5 V output at the backplane terminal block. The ripple should not be greater than 150 mV peak-to-peak with a period from 80–140 $\mu$s. If the ripple period is not within 80–140 $\mu$s, adjust R96 (Figure 2-15). Turning R96 CW decreases the ripple period, while turning CCW increases the period. After adjusting the ripple period, recheck the +5 V output (steps 2 and 3).

# CHAPTER 3
# BASIC OPERATION

## 3.1 GENERAL

This chapter contains a functional description of the H780 power supply. Major functions contained in the H780 were introduced in Paragraph 1.2 and illustrated in Figure 1-2. These functions include circuits which produce unregulated voltage and local power for the H780 internal circuits, +5 V and +12 V switching regulators, overload and short-circuit protection circuits, +5 V and +12 V crowbar (overvoltage protection) circuits, and logic signal generation circuits.

## 3.2 UNREGULATED VOLTAGE AND LOCAL POWER CIRCUITS

Unregulated voltage and local power circuits provide operating dc power for power supply logic and control circuits, and dc power for the +5 V and +12 V regulator circuits. These circuits are shown in Figure 3-1. AC power is supplied to the H780 via an ac input plug and cable. A toggle switch mounted on the rear of the H780 applies ac power to the power supply. Normally, this switch remains in the ON position, allowing ac power to be controlled by power distribution and control circuits in which the LSI-11 or PDP-11/03 system is installed. Primary circuit overload protection is provided by a fuse mounted on the rear of the H780.

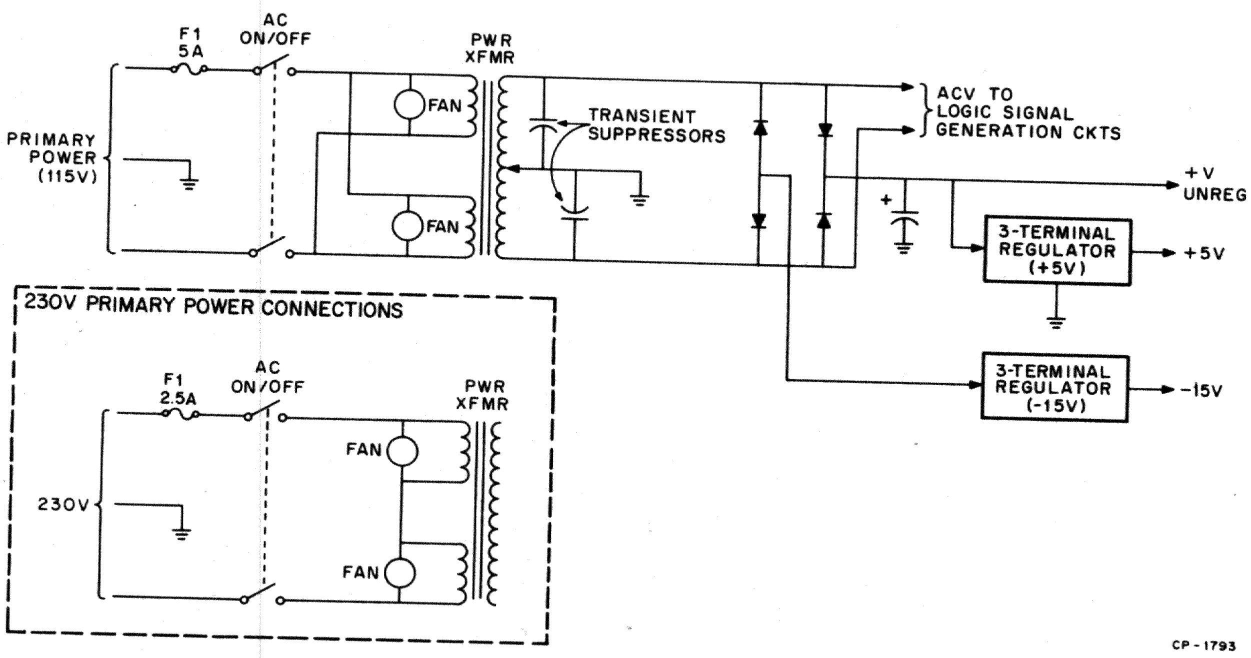



Figure 3-1 Unregulated Voltage and Local DC Power Circuits

Primary power circuits are factory-wired for 115 Vac (H780-C, -H, -K) or 230 Vac (H780-D, -J, -L) operation. Power transformer primary windings and the two fans operate directly from the switched ac power.

A single center-tapped secondary winding supplies power for regulator circuits and internal circuit operation. Conventional fullwave rectifiers and a –15 V, 3-terminal regulator IC provide regulated voltage for internal distribution. The rectifiers also provide +24 V (approx) for internal distribution and regulator operation. A 3-terminal regulator integrated circuit provides +5 V logic and control power for H780 circuits. The +5 V and +12 V regulators use the same +24 V unregulated voltage for regulation and distribution to the processor modules. AC voltage from one side of the transformer secondary is also routed to the line time clock (LTC) circuit, which generates a BEVNT L bus signal for a line time clock processor interrupt. When used with a 60 Hz line frequency, the interrupt occurs at 16.667 ms intervals; a 50 Hz line frequency will produce interrupts at 20 ms intervals.

## 3.3 +5 V AND +12 V SWITCHING REGULATOR CIRCUITS

Both +5 V and +12 V regulator circuits receive the +24 V unregulated input power. The +5 V and +12 V regulator circuits are identical except for component values. Hence, only the basic +5 V regulator is described in detail.

The basic regulator is a switching regulator which operates at approximately 10 kHz. The main controlling element is a 3-terminal regulator which operates at approximately the regulated output voltage level. Basic regulator circuits are shown in Figure 3-2. Note that the ground terminal of the 3-terminal regulator is connected to a circuit that allows adjustment of the terminal voltage over a –0.7 V – +1.5 V range. Hence, the 3-terminal regulator output in the +5 V regulator circuit can range from 4.3 V – 6.8 V (approx).

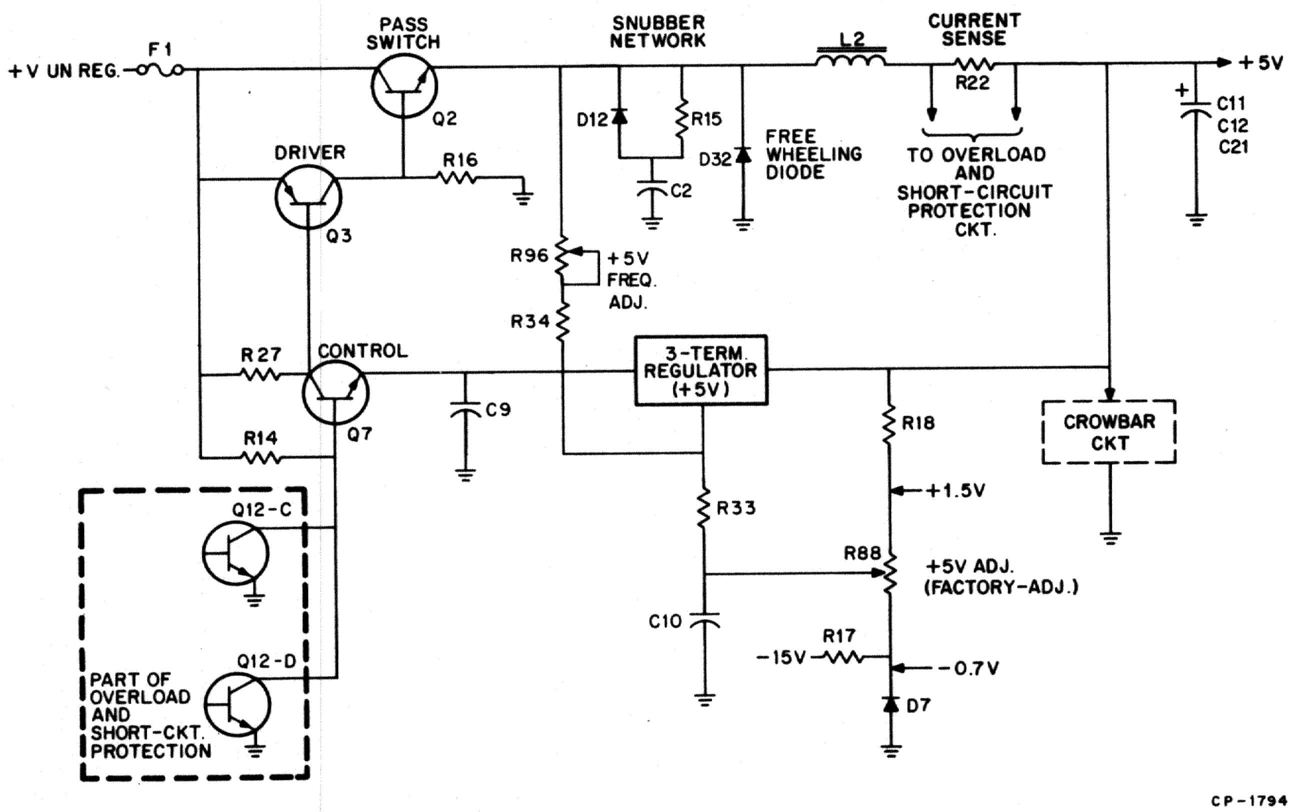



Figure 3-2 Basic Regulator Circuit

Normal switching regulator operation is accomplished when the control transistor is turned on. Forward-bias for the control transistor is supplied via R14. It is turned off only during fault conditions (overcurrent or shorted output voltage) or when the input ac line voltage is below specifications. Its emitter supplies unregulated voltage to the 3-terminal regulator. At less than 50 mA regulator output current (approx), the 3-terminal regulator supplies the output voltage. However, as load current through the 3-terminal regulator is increased beyond this value, the voltage drop across R27 forward-biases the driver transistor. The pass switch transistor then turns on and applies the unregulated +24 V to L2. The output capacitor then charges toward the +5 V value, current limited by the inductance of L2. When the output voltage rises to the 3-terminal regulator regulation voltage, the 3-terminal regulator turns off; current through R27 stops, and the driver transistor is not forward-biased. Hence, the driver and pass switch transistors cut off. The energy stored in L2 continues to charge the capacitor bank slightly beyond the designed output voltage via the free-wheeling diode and the current sense resistor. Once the inductor's stored energy is spent, the load discharges the output capacitor until the output voltage drops below the 3-terminal regulator's regulation voltage. At that point, current through R27 increases and turns on the driver and pass switch transistors, and the cycle repeats. Note that as the load is increased, the pass switch must remain on longer in order to charge the output capacitor to the regulated voltage value. This process repeats at a 7–12 kHz rate, producing the switching regulator operation.

Switching losses in the pass switch transistor are minimized by the snubber network. This network operates during the "off" switching transient (as the pass switch is biased-off) by controlling the rate of increasing collector to emitter voltage as collector current decreases.

The control transistor is turned off during a fault condition by overload and short-circuit protection circuits. When a fault condition is detected, the control transistor's base voltage drops to nearly 0 V, causing it to cut off. When cut off, operating voltage is removed from the 3-terminal regulator and R27 current is 0, disabling the switching regulator circuit.

## 3.4 OVERLOAD AND SHORT-CIRCUIT PROTECTION CIRCUITS

Each H780 dc output is overload and short-circuit protected. When in an overload condition, excessive power supply current is sensed, causing both switching regulators to go off and then cycle on and off at a low-frequency rate (approximately 7.5 Hz) until the overload is removed. Each time the power supply cycles on, the circuit checks for the overload condition. If the load current returns to normal, the 10 kHz switching regulator operation resumes.

Overcurrent sensing circuits for +5 V and +12 Vdc outputs are identical except for component values. A 5 V power supply overcurrent condition results in an increased voltage drop across the current sense resistor (Figure 3-3), forward-biasing the current sense transistor. (During normal operation, this transistor is not forward-biased.) Current sense transistor collector (Q8) voltage then drops from the normal +24 V (approx) to the +5 V regulator output value; this voltage, which is less than the +13.8 V reference applied to the current limit comparator's inverting input, is diode-coupled to the comparator's non-inverting input, causing the comparator's output to go low; the diode coupling provides an OR logic function for both +5 V and +12 V overcurrent fault conditions. The comparator's low output signal triggers the 50 μs one-shot, whose OVERCURRENT L pulse output triggers the 135 ms one-shot and sets the Current Limit flip-flop. The OVERCURRENT L pulse is also ORed with the POWER OFF L signal, turning on the +5 V and +12 V hold-off transistors. Both switching regulators are then disabled. The high 135 ms one-shot output pulse is ANDed with the Current Limit flip-flop output, turning on +5 V and +12 V extended hold-off transistors. Hold-off signals remain in this state and inhibit switching regulator operation for the 135 ms pulse duration. At the end of this time, the 135 ms one-shot resets, terminating the delayed hold-off signals, and triggers the 2 ms one-shot. Its active low output resets the Current Limit flip-flop and clears the 135 ms one-shot for 2 ms, allowing the regulator pass switch transistors to operate for 2 ms (minimum). At the end of this time, the 135 ms one-shot is again enabled (the clear input goes high) and a new overcurrent cycle is enabled. If the overload is removed, normal operation resumes; otherwise, the overload causes a new overload condition to occur and the cycle repeats, as described above.

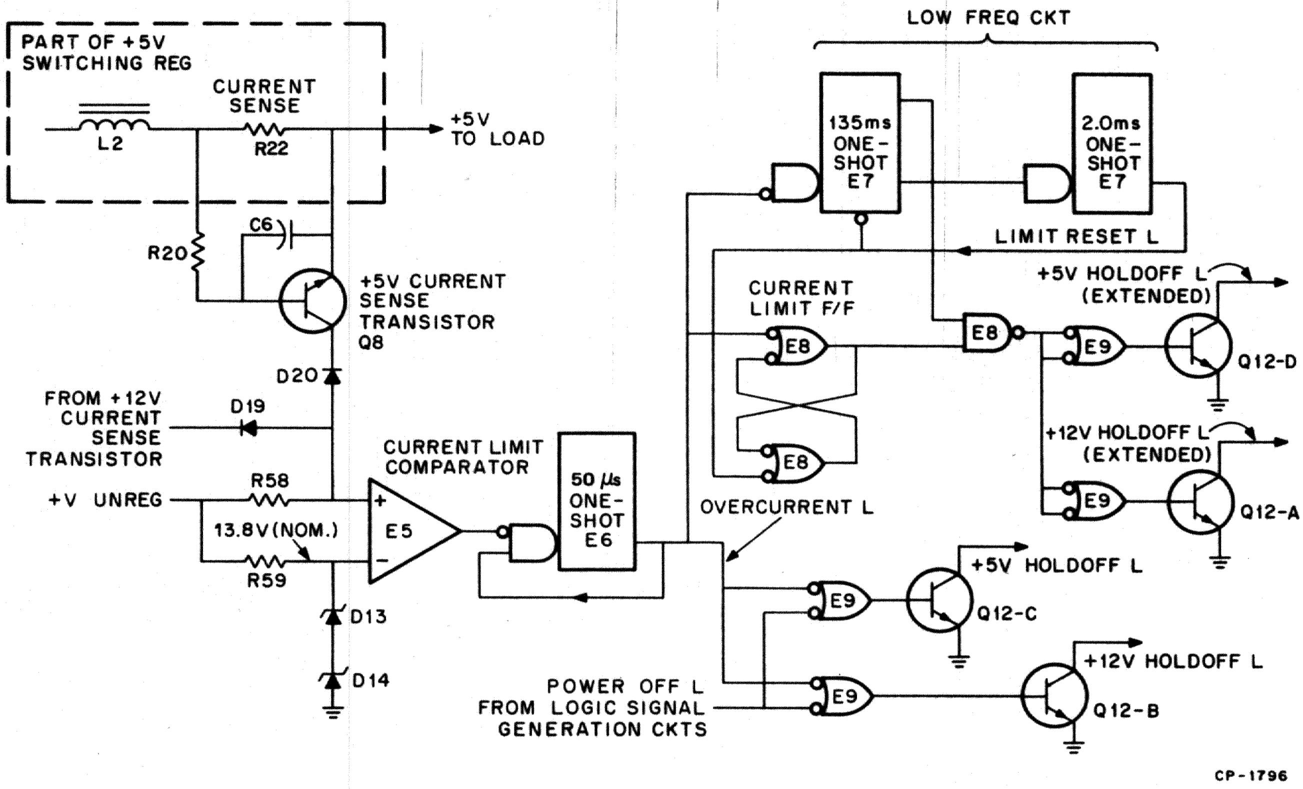



Figure 3-3 Overload and Short-Circuit Protection Circuits

Switching regulator operation is suspended when the operator places the DC ON/OFF switch in the OFF position. Logic signal generation circuits respond by immediately asserting BPOK H low to initiate a processor power-fail sequence. After a 5–10 ms "pseudo delay," POWER OFF L is asserted low. This low signal is wire-ORed with OVERCURRENT L, inhibiting the switching regulator operation, and dc power is removed from the backplane.

## 3.5 +5 V AND +12 V CROWBAR CIRCUITS

Crowbar circuits are connected across both +5 V and +12 V power supply outputs for overvoltage protection. An overvoltage condition could occur if +12 V and +5 V outputs shorted together, of if a driver or switch transistor becomes shorted. When shorted to a higher voltage source, the crowbar fires, shorting the supply voltage that is protected to ground (dc return). In this condition, the overload and short-circuit protection circuits respond by limiting the duty cycle of the switch transistor until the overvoltage source is removed. However, when the overvoltage is caused by a shorted driver or switch transistor, short-circuit protection is ineffective, and the excessive current caused by the crowbar circuit firing will blow the regulator's fuse (F1 for +5 V or F2 for +12 V).

The crowbar circuit for the +5 V output is shown in Figure 3-4. It comprises a 5.6 zener diode D9, diode D8, programmable unijunction transistor Q9 and silicon-controlled rectifier (Q15). Q15, R19, D8, and D9 supply the 6.1 Vdc (approx) crowbar reference (threshold) voltage to the gate of Q9 via R21. Q9 is normally off and its cathode supplies a 0 V gate input to Q15. An overvoltage is coupled into the circuit via C7, causing the gate voltage of Q9 to rise; this triggers Q9 and its cathode voltage rises to the output (overvoltage) potential. Q15 then fires and shorts (crowbars) the supply output. The circuit remains in this condition until the overvoltage is removed (Q15 current goes to zero) and either the power supply switch transistor is off, due to short-circuit protection, or the regulator's dc fuse opens.

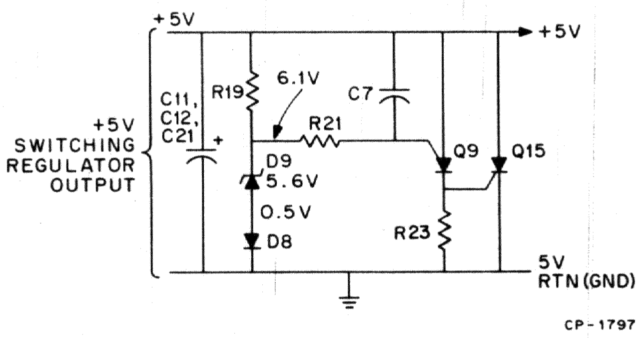



Figure 3-4 Crowbar Circuit

The +12 V crowbar circuit functions in a similar manner. However, the reference voltage for this power supply is approximately 13.5 V.

### 3.6 LOGIC SIGNAL GENERATION CIRCUITS

Logic signal generation circuits produce LSI-11 bus signals for power normal/power fail and line time clock interrupt functions and processor Run-Enable/Halt mode. The RUN indicator circuit monitors the SRUN L backplane (nonbused) signal and provides an active display when the processor is in the Run mode. BPOK H and BDCOK H indicate power status. When both are high, power to the LSI-11 bus is normal and no power fail condition is pending. However, if primary power goes abnormally low (or is removed) for more than 16.5 ms, BPOK H goes low and initiates a power-fail processor interrupt. If the power-fail condition continues for more than an additional 4 ms, a "pseudo delay" circuit causes BDCOK H to go low. The circuit also causes the overload and short-circuit protection circuit to inhibit +5 V and +12 V control transistors; normal output voltages are available for 50 μs (minimum) after BDCOK H goes low (depending on the loading of the dc output voltages). The DC ON/OFF switch simulates an AC ON/OFF operation by turning switching regulators on or off without turning system primary power off. A normal power-up/power-down sequence is produced by this circuit. The line time clock circuit produces a processor interrupt at the power line frequency (either 50 or 60 Hz). The circuit simply asserts the BEVNT L line at the line frequency.

DC voltage monitor circuits respond to both +5 V and +12 V power supply outputs. A +2.5 V reference at the voltage comparator's noninverting input is established by +5 A and a voltage divider comprised of R25 and R3, as shown in Figure 3-5. Voltages are sensed at the anodes of diodes D17 and D35.

The sensed voltage to the voltage comparator's inverting input is normally 5 V, causing the comparator's output to go low. The low signal forward-biases DC ON panel indicator driver transistor Q10, producing a DC ON indication, and reverse-biases the BDCOK H FET bus driver Q6. As a result, Q6 cuts off, and its source voltage rises to +5 V, producing the active BDCOK H signal.

When either (or both) power supply output is 0 V, the voltage at the voltage comparator's inverting input is less than the +2.5 V reference. Hence, the comparator's output goes high, turning off the DC ON indicator and allowing Q6 to conduct. Q6 asserts the BDCOK H signal low, indicating that a dc power-fail condition exists. When normal power is restored, as during the power-up sequence, C37 charges via R50. When the C37 voltage exceeds the +2.5 V reference, the comparator's output then goes low (normal).

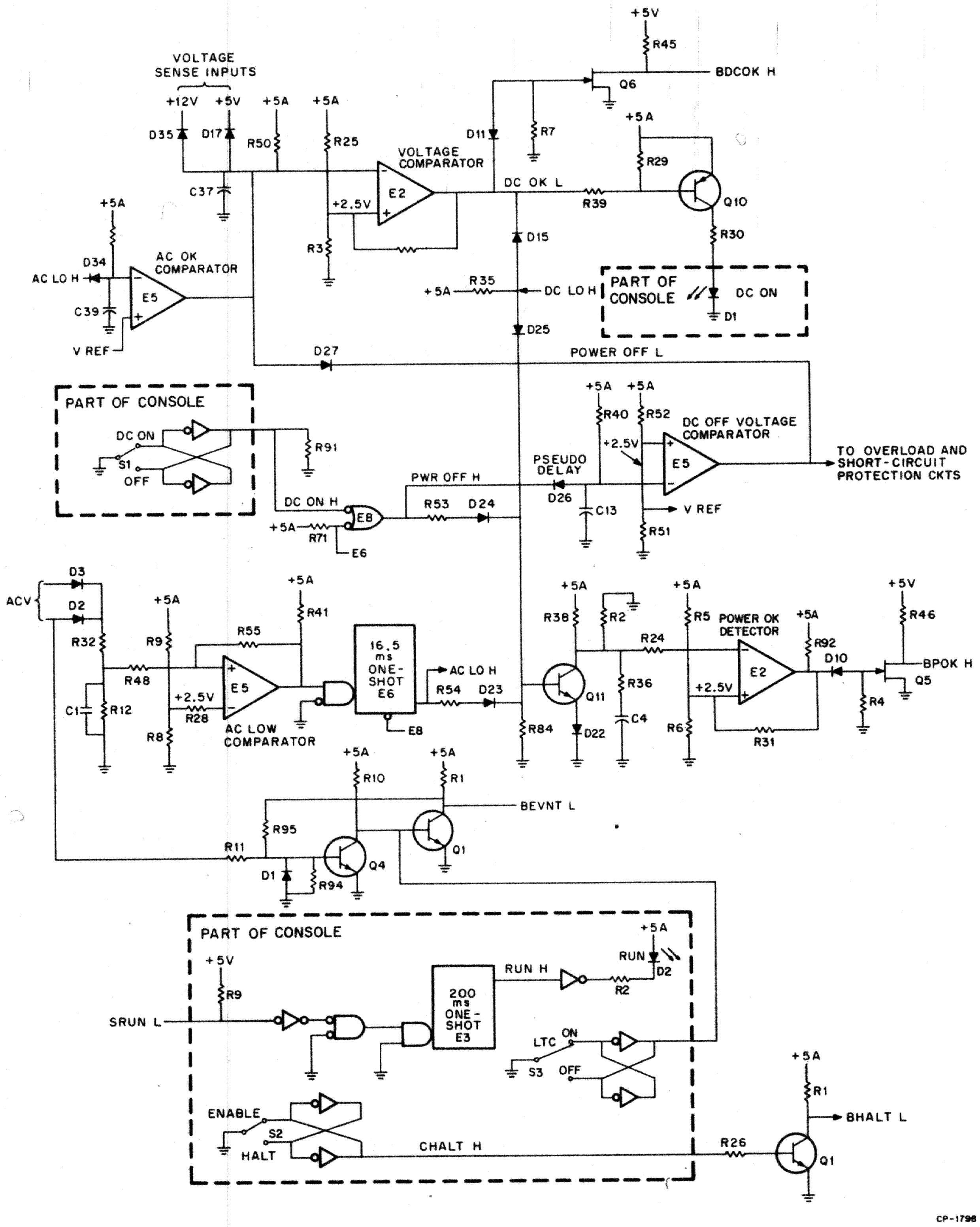



Figure 3-5 Logic Signal Generation Circuits

AC voltage monitor circuits include an ac low comparator, a 16.5 ms delay, and a BPOK H bus driver circuit, which is enabled only when BDCOK H is in the active (dc voltage normal) state. Rectifiers D2 and D3 produce positive-going dc voltage pulses at twice the ac line frequency. R32, R12, and C1 produce nominal +3.9 V (peak) normal line voltage pulses which are coupled to the noninverting input of the ac low comparator via R48. R8 and R9 produce a +2.5 V reference for the comparator's inverting input. The comparator's normal output is a series of pulses occurring at twice the ac power line frequency. Each positive-going leading edge retriggers the 16.5 ms one-shot, keeping it in the set state. The 16.5 ms one-shot output is diode-ORed with DCOK L via diodes D25 and D23 and PWR OFF H via D24. Normally, the three signals are low and Q11 remains cut off. In this condition, C4 charges to +3.125 V via R36 and R38. This signal is then applied to the power OK comparator's inverting input via R24. Since the noninverting input is referenced to +2.5 V by voltage divider R5 and R6, the comparator's output goes low, biasing off FET Q5. Q5's source voltage then rises toward +5 V via R46, producing the active BPOK H signal. Power-up/power-down sequence timing is shown in Figure 3-6.

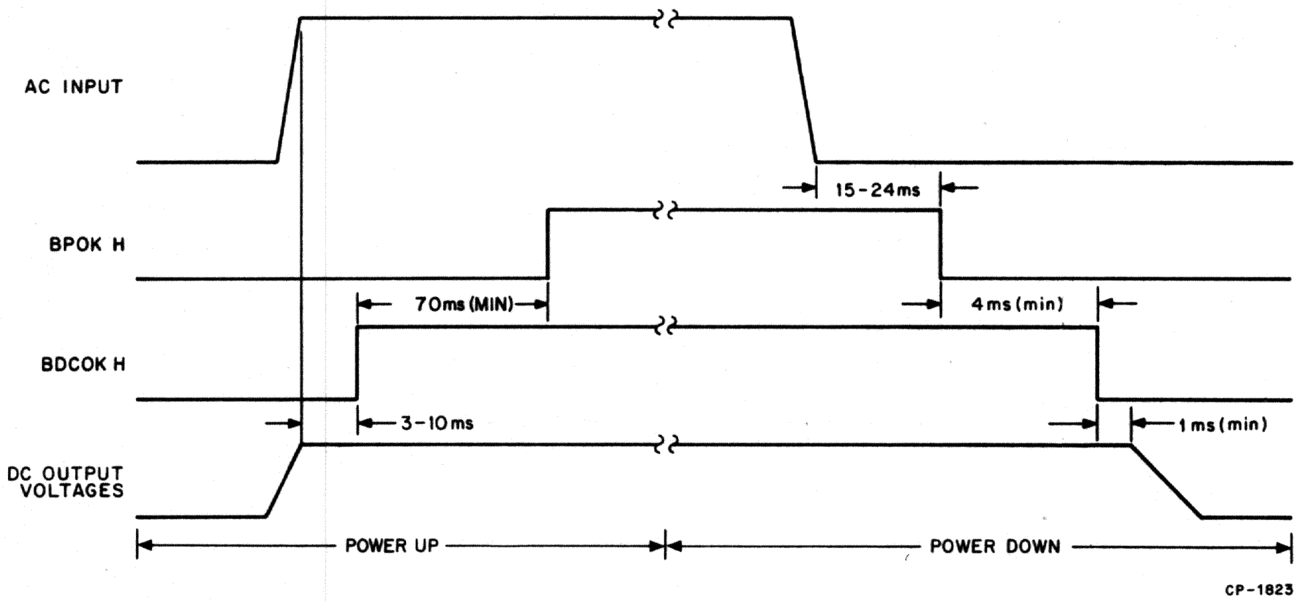



Figure 3-6 Power-Up/Power-Down Sequence

A power failure is first detected when the pulsating dc voltage at the ac low comparator's noninverting input is less than +2.5 V (peak). The comparator's output then remains low, allowing the 16.5 ms one-shot to go out of the retrigger mode. The one-shot resets 16.5 ms after the leading edge of the last valid ac voltage alternation; the 16.5 ms delay is equivalent to a full line cycle (two-alternate) failure. The high one-shot output is then coupled via D23 to the base of Q11, forward-biasing it. Q11 conducts and rapidly discharges C4; R36 limits peak discharge current.

The low voltage thus produced is less than the +2.5 V reference at the power OK comparator's input, and its output goes high. Q5 then conducts and asserts the BPOK H signal low (power fail). The AC LO H signal produced by the 16.5 ms one-shot is coupled via D34 to C39 on the inverting input of AC OK comparator E5. When C39's voltage rises above 2.5 V, the comparator's output goes low, turning off the DC ON indicator and negating BDCOK via the dc voltage monitor circuit, and turns off the regulator circuits by asserting POWER OFF L via D27.

When normal power is restored, the 16.5 ms one-shot returns to the retrigger (set) mode. AC LO H goes low and enables the dc voltage monitor and regulator circuits. The low AC LO H signal also removes forward bias from the base of Q11, cutting it off. Its collector voltage then rises as C4 charges at a relatively slow rate. R38 controls the charging rate of C4 and ensures that ac voltage and dc output voltages are normal for approximately 100 ms (70 ms minimum) before BPOK H goes high.

The DC ON/OFF switch simulates a power failure when it is placed in the OFF position. Cross-coupled inverters provide switch debounce protect on and a low (false) DC ON H signal is produced. This signal is inverted to produce a high PWR OFF H signal that is coupled via D26 to the "pseudo delay" circuit, causing a power fail sequence to occur, and to Q11 via R53 and D24, causing BPOK H to go low (power fail indication). After a 5–10 ms (approx) "pseudo delay," C13's voltage rises above the dc off voltage comparator's +2.5 V reference (noninverting) input. The comparator's output goes low, asserting POWER OFF L low and turning off the switching regulators. When the DC ON/OFF switch is returned to the ON position, PWR OFF H goes low, rapidly discharging C13. POWER OFF L then goes high and switching regulator operation resumes. Approximately 100 ms later, BPOK H goes high and normal processor operation is enabled. DC ON/OFF circuit timing is shown in Figure 3-7.

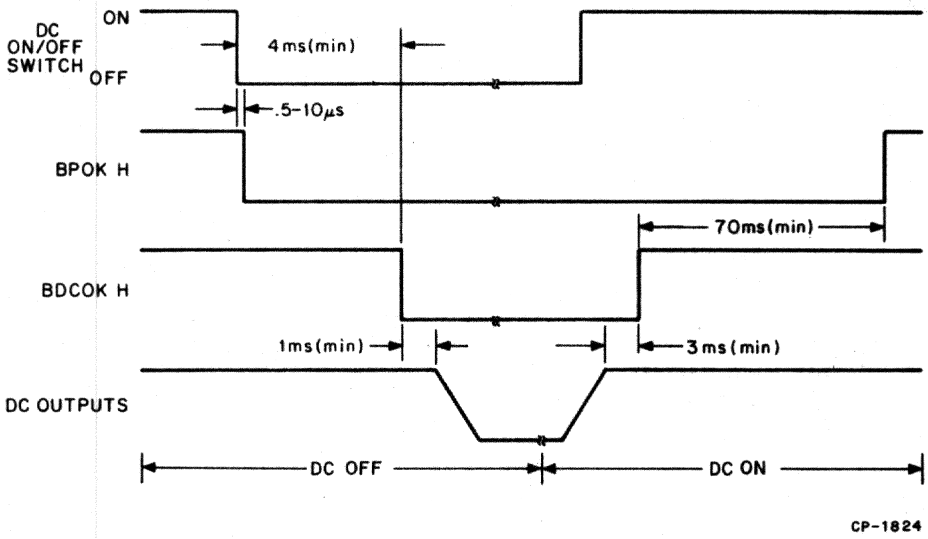



Figure 3-7 DC ON/OFF Circuit Timing

BEVNT L is the bused EVENT line which is normally used for line time clock interrupts. Q4 is cut off and Q1 is forward-biased during negative alternations of the ac line, producing low-active BEVNT L signals. D1 clips negative alternations and limits Q4's reverse-bias to emitter voltage. The LTC ON/OFF switch must be in the ON position for BEVNT L signal generation. When the LTC function is not desired, the LTC switch is set to the OFF position; CSPARE2 goes low. Q1 remains cut off, and BEVNT L remains passive (high).

The RUN indicator is illuminated whenever the processor is executing programs. SRUN L, a non-bused backplane signal, is a series of pulses which occur at 3–5 μs intervals whenever the processor is in the Run mode. The pulses trigger a 200 ms one-shot on each SRUN L pulse leading edge, keeping it in the retrigger mode. Its high RUN H output signal is then inverted, producing a low signal that turns on the RUN indicator. When the processor is in the Halt mode, SRUN L pulses cease and the 200 ms one-shot resets after the 200 ms delay. The RUN indicator turns off, indicating the Halt mode.

The HALT/ENABLE switch allows the operator to manually assert the BHALT L signal low, causing the processor to execute console ODT microcode. When in the ENABLE position, BHALT L is not asserted, and the Run mode is enabled. Cross-coupled inverters provide a switch debounce function.