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PDP-11/60  
cabinet and power  
supply manual

digital

**PDP-11/60  
cabinet and power  
supply manual**

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# CHAPTER 1 INTRODUCTION

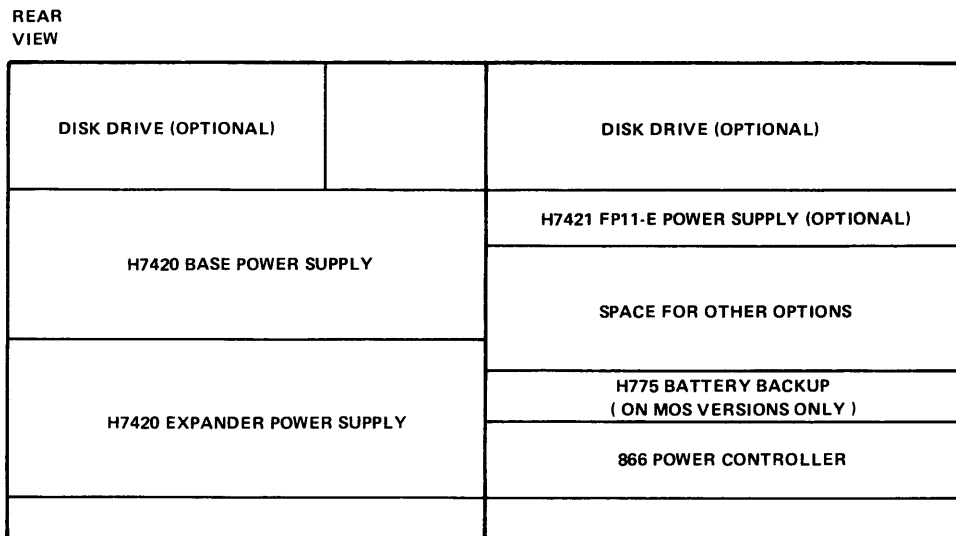
## 1.1 GENERAL

This chapter includes a typical PDP-11/60 power system block diagram; description of the power controller and supplies and their locations within the cabinets; power control, supply, and regulator specifications; dc connections (ac to dc, primary ac, remote, etc.); and distribution descriptions. Various system configurations are also discussed with regard to differences in cabinets, power requirements, and memory structure.

## 1.2 OVERALL SYSTEM DESCRIPTION

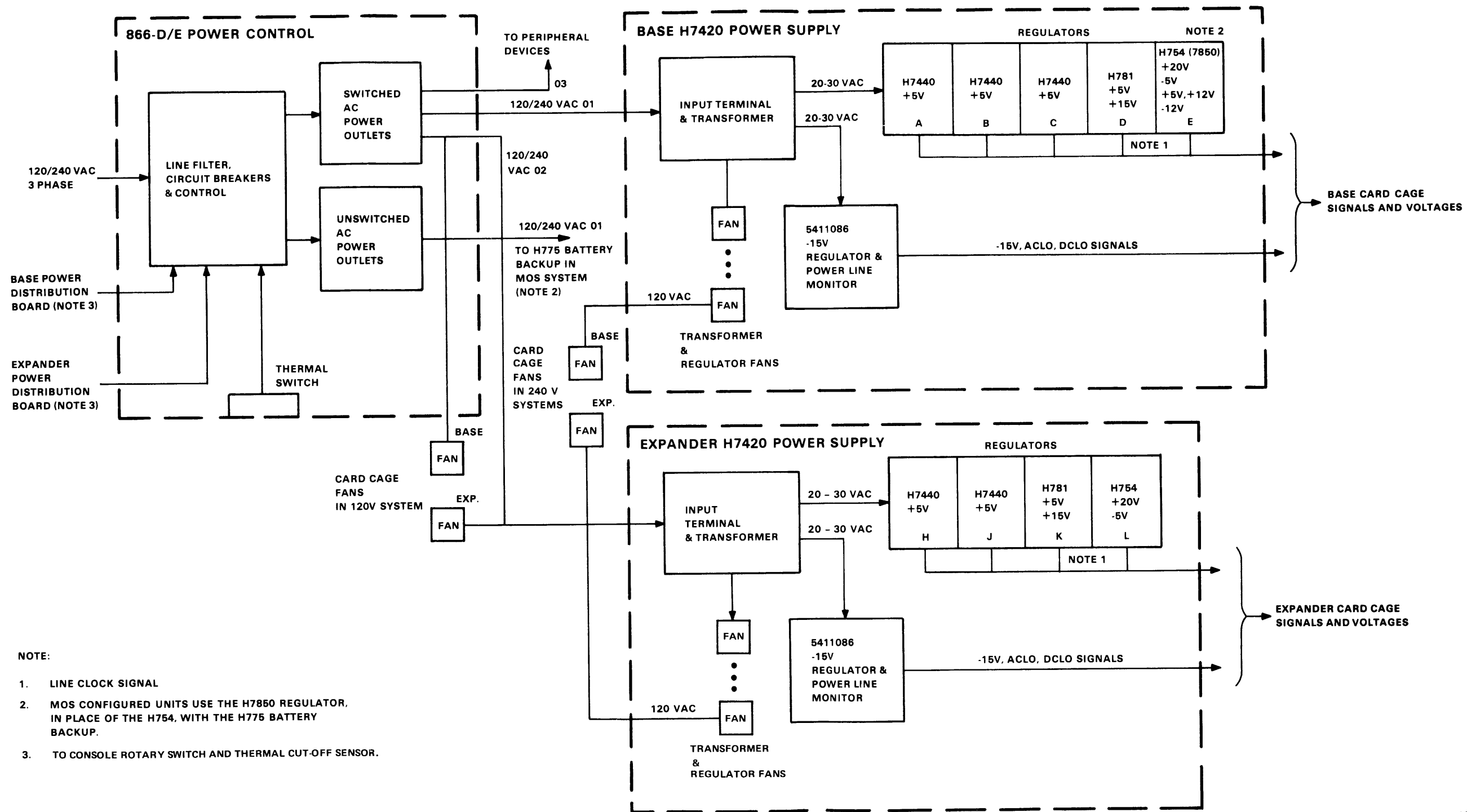
### 1.2.1 PDP-11/60 Corporate Cabinet (Electrical)

Figure 1-1 shows the physical location of the PDP-11/60 (double-width low-boy) power system. The power system consists of one 866-D/E power controller and one or two H7420-A/B power supplies. Figure 1-2 is a block diagram of the power system for a typical PDP-11/60. The 866 power controller is used to control and distribute ac voltage to the power supplies, fans, and other electrical devices that require ac inputs within the system. The basic PDP-11/60 (X, Y, S, and T) systems utilize the H7420 power supplies to provide a variety of dc voltages. Table 1-1 indicates the regulators within these power supplies and their voltage distribution.



MA-0675

Figure 1-1 PDP-11/60 Power System  
Physical Location



MA-0669

Figure 1-2 PDP-11/60 Power System Block Diagram

**Table 1-1 Power Supply Voltage Regulators**

Type	Name	Qty	Location*	Application
H7440	+5 V Reg	5	A	+5 V to processor module slots 1 and 2.
			B	+5 V to processor module slots 3, 4, and 5.
			C	+5 V to SUs 4, 5, and 6 in base card cage.
			H	+5 V to SUs 3 and 4 in expander card cage.
			J	+5 V to SUs 1 and 2 in expander card cage.
H781	+5 V, +15 V Reg	2	D	+5 V to processor module slots 6, 7, 12-14, and console power; +15 V to processor module slots 12-14 and SUs 4, 5, and 6 in base card cage; line clock signal to processor module slots 12-14 and SUs 4, 5, and 6 in base card cage.
			K	+5 V to SUs 5 and 6 in expander card cage; +15 V and line clock signal to all SUs in expander card cage.
H754†	+20 V, -5 V Reg	2	E	+20 V and -5 V to SUs 4, 5, and 6 in base card cage.
			L	+20 V and -5 V to all SUs in expander card cage.
H7850†	+5 V, +12 V, -12 V Reg	1	E	+5 V, +12 V, -12 V to SUs 4, 5, and 6 in base card cage.
54-11086	-15 V Reg	2	Base H7420	-15 V to processor module slots 12-14 and SUs 4, 5, and 6 in base card cage; DC LO and AC LO sensing for base H7420.
			Expdr. H7420	-15 V to all SUs in expander card cage; DC LO and AC LO sensing for expander H7420.

\*Location within the H7420s.

†MOS-configured units use the H7850 regulator in place of the H754, with the H775 battery backup.

The PDP-11/60 system cabinet's 866 power controller is connected to the building mains (120/208 V, 3-phase wye) which must be capable of supplying 24 A (866-D) or 12 A (866-E) per pole. Two types of outlets are provided on the 866: switched and unswitched. The switched group of outlets, which can be controlled either locally or remotely, consist of phase 1, 2, and 3 outlets. The unswitched outlets, however, are controlled solely by the 866 front panel circuit breakers (the main circuit breaker, CB1, and phase 1 circuit breaker, CB2). The 866 switched outlets are controlled remotely by a rotary switch on the processor console and a thermal switch which is mounted flush on the side of the 866 box. These switched outlets are deenergized if the thermoswitch detects an overtemperature or the console rotary switch is turned to the STD BY position.

The H7420 power supplies, designated the base (upper) H7420 and the expander (lower) H7420, are connected to phase 1 and phase 2 switched outlets, respectively (Figure 2-2). The base power supply distributes its power and signal outputs to the CPU (base) card cage via the base power distribution board, P/N 54-12478; the expander supply distributes its power and signal outputs to the expander card cage via the expander power distribution board, P/N 54-11833.

The base H7420 power supply contains five regulators while the expander H7420 power supply contains four regulators. There is a slight difference in the regulators used, depending on which type of memory system (core or MOS) is included with the PDP-11/60 system. These regulators provide a variety of dc voltages as well as line clock signals to the base card cage and expander card cage backplanes. Their applications are listed in Table 1-1.

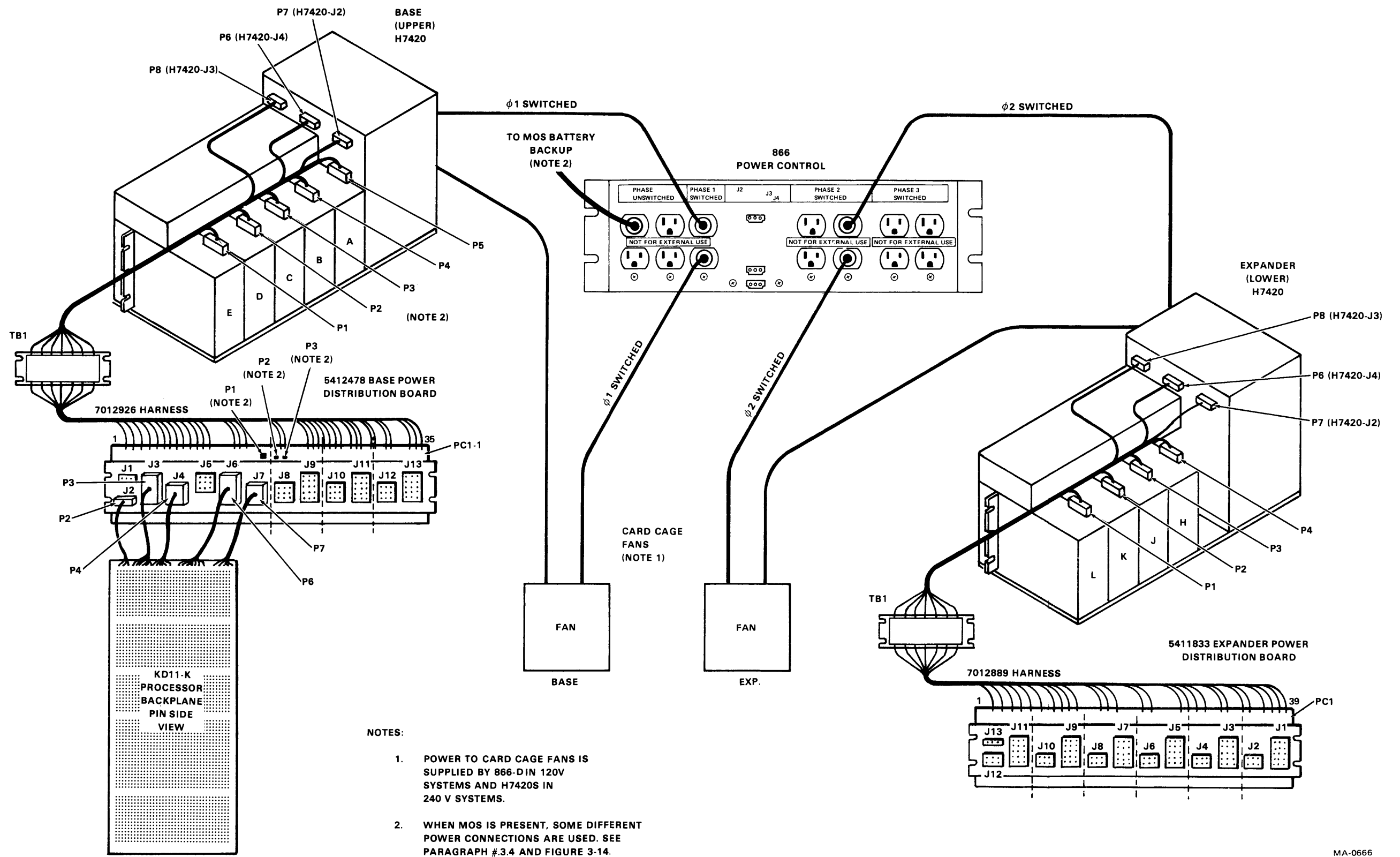
In addition to the regulators discussed in Table 1-1, each H7420 contains a 54-11086 regulator. The 54-11086 regulators provide -15 V and power fail signals AC LO and DC LO in the event of a low voltage input to either 54-11086 regulator. Refer to Paragraph 3.3.1 for a detailed description of the 54-11086 regulator.

Completing each H7420 power supply are the input terminal block and transformer assembly. The input terminal block provides 120 Vac to the power supply fans (one for the transformer and three for the regulators) and to the transformer primary. It also provides 120 Vac to the card cage fans in 240 V systems.

Two power distribution cable harnesses distribute the power and signal outputs from the H7420s. A 70-12926 CPU harness assembly distributes them from the base H7420 power supply to the base power distribution board (P/N 54-12478) while a 70-12889 expander harness assembly distributes them from the expander H7420 to the expander power distribution board (P/N 54-11833). In addition to delivering dc voltages, the cables route AC LO and DC LO signals to the card cages. Figure 1-3 illustrates how the power distribution cables connect the 866 and the H7420 with the base and expander distribution boards.

From the power distribution boards, the power is routed to the backplanes via wires which are connected to the power distribution boards with Mate-N-Lok connectors and are connected to the backplanes by direct soldering. The etching of the backplanes then carries the power to the individual modules which are plugged into the backplanes.

A more detailed description of ac and dc power systems is given in Chapters 2 and 3.



MA-0666

Figure 1-3 PDP-11/60 Power Connections

### **1.2.2 PDP-11/60 Corporate Cabinet (Mechanical)**

The PDP-11/60 is available in several standard system configurations. These configurations vary in voltage, line frequency, type of internal memory, type of mass storage, and type of cabinet used in the system. The voltage comes in 120 Vac and 240 Vac variations. The line frequency can be either 50 or 60 Hz. Either MOS or core memory is available as internal memory while either RK05 or RK06 disk drives can be used for mass storage; some configurations are available with no mass storage unit. Both double-width low-boy and double-width high-boy cabinets are available. Various system configurations are described in detail in Chapter 4.

The addition of some features beyond those in the standard system requires extra cabling. Chapter 5 describes the procedures for cabling in the PDP-11/60.

Various types of expansion cabinets may be added onto a PDP-11/60. These can be made to house either card cages or peripherals. In some cases, power supplies and controllers must be added in the expansion cabinets to power the options. For more information regarding the types of expansion cabinets and their installation procedure, refer to Chapter 4.

## **1.3 PDP-11/60 SYSTEM DOCUMENTATION**

This paragraph provides a list of PDP-11/60 system related documents that are available to computer users and maintenance engineers. While none of these documents was written explicitly for training, their organization and readability should simplify that function.

### **1.3.1 Operator/User**

The following documentation is provided to support PDP-11/60 operators and users:

1. *PDP-11/60 Installation and Operator's Manual (EK-11060-OP-002)*  
Chapter 3 of this manual describes the use of the PDP-11/60 programmer's console. This includes power-up, start/stop, switches and indicators, and the operation of internal console registers (as they affect the operator). Also included are examples of console use. Available on microfiche.
2. *PDP-11/60 Processor Handbook*  
This handbook is prepared by marketing and is subject to annual revision and reorganization. The *PDP-11/60 Processor Handbook* describes the PDP-11/60 instruction set and operating features. This handbook is useful for the macro level programmer. Not on microfiche.
3. *PDP-11/60 Microprogramming Specification*  
This manual is prepared by engineering to assist purchasers of the PDP-11/60 writable control store option (WCS) in writing microprograms. Available on microfiche.

### **1.3.2 Field Service Engineer**

The following documentation is provided to support the branch level service engineer who is not a specialist on the PDP-11/60 (i.e., the "generalist").

1. *PDP-11/60 Installation and Operator's Manual (EK-11060-OP-002)*  
This manual describes the various PDP-11/60 system configurations, unpacking information, power requirements, system checkout, and programmer console operation. Available on microfiche.
2. *KD11-K Processor (PDP-11/60) Technical Description - Section 6, Maintenance Features*  
This manual describes the use of the Diagnostic Control Store maintenance feature, the processor status and error registers, the individual processor diagnostics, a troubleshooting flowchart, and a microcode sequence for processor startup/initialization. (Note that the last feature is provided to support the "specialist.") Available on microfiche only.

3. *DCS Fault Directory (MAINDEC-11-DQKUBB)*  
This document is prepared by engineering and product support to identify the most probable source of a failure detected by the Diagnostic Control Store module option. This document provides a brief description of the DCS use and the functional partitioning within the KD11-K modules

The following documentation supplements the preceding documentation to support the PDP-11/60 product-specific support "specialist."

1. *KD11-K Processor Detailed Technical Description Manual*  
This manual provides a detailed description of the KD11-K processor at a gate level. This manual makes reference to specific logic signals and logic levels. Available on microfiche.
2. *KD11-K Print Set*  
The KD11-K print set contains functional block diagrams and tables to supplement the logic.
3. *KD11-K Microcode Listing (EP-KD11-K-FD-D)*  
This engineering document describes the standard microprogram instructions that control the processor and the execution of each processor operation and instruction. The microcode listing contains descriptions of its use, explanations of the various microcode routines, and several cross reference listings. Available on microfiche.
4. *PDP-11/60 Microprogramming Tools Reference Manual (AA-C815A-TC)*  
This manual describes the use of the PDP-11/60 WCS microprogram assembler, loader, and debugging tool.

### 1.3.3 Other Manuals

The following manuals support the PDP-11/60 systems:

<b>Title</b>	<b>Document Number</b>
FP11-E Floating-Point Processor User's Guide (optional)	EK-FP11E-OP
FP11-E Floating-Point Processor Technical Manual (includes extra power supply description)	EK-FP11E-TM
KU116BB Option Diagnostic Control Store Technical Manual (optional)* Extended Control Store (optional) Diagnostic Control Store (optional)	EK-M7871-TM
DL11-W Serial Line Unit/Real-Time Clock Option Maintenance Manual†	EK-DL11W-MM
M9301 Bootstrap/Terminator Module Maintenance and Operator's Manual†	EK-M9301-TM
PDP-11 Family Field Installation and Acceptance Procedure Manual	EK-FS003-IN
MR11-W/WP Core Memory System Maintenance Manual	EK-MF11W-MM

\*Under development; as of this printing, not available on microfiche.

†These manuals are available on microfiche.

MF11S-K MOS Memory Technical Manual*	EK-MF11K-TM
LA36/LA35 DECwriter II Maintenance Manual*	EK-LA36-MM
RK611 Controller Technical Manual	EK-RK611-TM
RK06 Disk Drive Technical Description Manual*	EK-RK06-TD
RK05/RK05J/RK05F Disk Drive Maintenance Manual*	EK-RK5JF-MM
PDP-11/60 Wire List*	EP-KD11K-K-WL

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## CHAPTER 2 PRIMARY AC POWER 866 POWER CONTROLLER

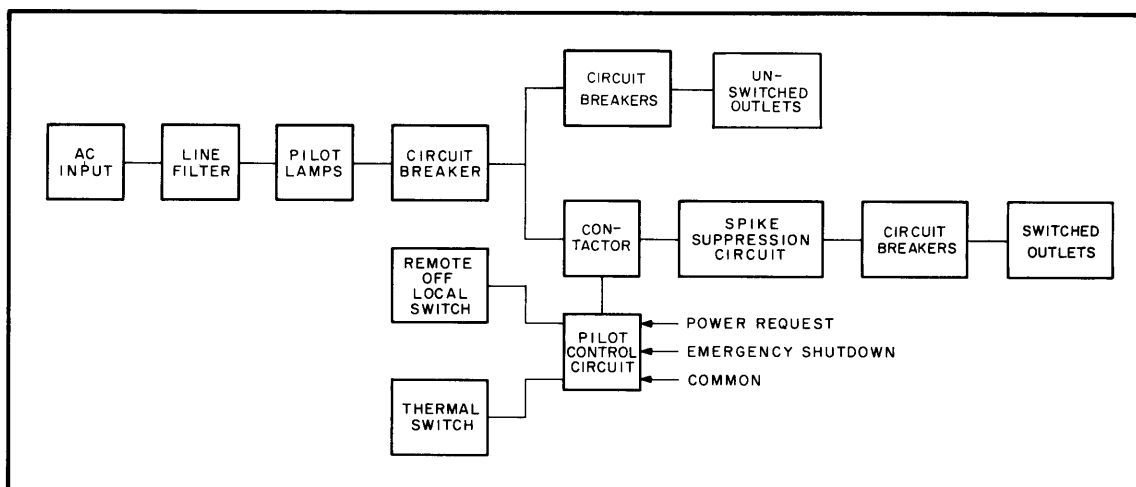
### 2.1 GENERAL DESCRIPTION

Power from the building mains is applied to the system components in the base and expander card cages through an 866-D/E power controller unit. It is located at the bottom rear left of the double-width cabinet.

Figure 2-1 is a simplified block diagram of the 866-D/E power controller. Four basic functions are performed:

1. Control of large amounts of power by control signals of small power content.
2. Convenient distribution of primary power to controlled devices.
3. Filtering of primary power to controlled devices.
4. Automatic removal of primary power from controlled devices in case of overload or over-temperature conditions.

Circuit descriptions of the 866-D and 866-E are given in Paragraphs 2.4.1 and 2.4.2; ac power and remote power control connections are described in Paragraph 2.3.



11-3029

Figure 2-1 866 Power Controller Simplified Block Diagram

## 2.2 POWER CONTROLLER SPECIFICATIONS

Power controller specifications are listed in Table 2-1.

**Table 2-1 Power Controller Specifications**

<b>Parameter</b>	<b>Specification</b>
<b>Mechanical and Environmental</b>	
Dimensions	12.9 cm h × 48.3 cm w × 20.3 cm d (5.1 in h × 19 in w × 8 in d)
Weight	12.25 kg (approx.) (27 lb)
Cooling Method	Convection
Mounting	Rack (standard 48.26 cm, 19 in)
Ambient Temperature (recommended temperature)	
Operating	0° to 60° C (32° to 140° F)
Storage	-40° to 71° C (-40° to 160° F)
Relative Humidity	95 percent max (no condensation)
Altitude	365.8 m (12,000 ft)
<b>Electrical</b>	
Input Power Voltage (phase to neutral of 3-phase wye)	866-D: 90 Vac-132 Vac 866-E: 180 Vac-264 Vac
Frequency	47-63 Hz
Current	866-D: 24 A per phase 866-E: 12 A per phase
<b>Power Requirements</b>	
Full Load	8640 VA
No Load	10 VA maximum
Inrush Current Capability	866-D: 500 A peak for 1/2 cycle 50 Hz, per phase 866-E: 270 A peak for 1/2 cycle 50 Hz, per phase
Overvoltage Transients Magnitude	866-D: 150 Vac 866-E: 300 Vac
Duration	1 second

**Table 2-1 Power Controller Specifications (Cont)**

<b>Parameter</b>	<b>Specification</b>
Leakage Current	1.5 mA max
Input Circuit Breaker	Delayed action, manual reset, magnetic 866-D: 30 A; 866-E: 15 A
Thermoswitch	Opens at 71.1° C (160° F), automatically resets at 49° C (120° F) (exposed to ambient air external to controller)
Input Power Connection	866-D: NEMA L21-30P (Table 2-2) 866-E: NEMA L22-20P (Table 2-2)
<b>Remote Power Control (DEC Power Control Bus)</b>	
Remote Switching Control Connectors	Three female, AMP 1-48034-0 (DEC 12-09350-03) with AMP 61117-4 (DEC 12-09379) pins or equivalent. These mate with AMP 1-480305-0 (DEC 12-09351) connectors with AMP 61118-4 (DEC 12-09378) pins or equivalent.
Remote Control Cable	DEC 70-10695
Leakage Current	<20 $\mu$ A at a $V_{in}$ of +40 V
Open Circuit Voltage	<+35 V when measured with a meter with at least 10 megohms input resistance
Short Circuit Current	Between 5 and 20 mA when held at ground
Interpreted as a Low	Source current >5 mA but <20 mA when held at +1.6 V
Interpreted as a High	Source current <1.0 mA and voltage more positive than 1.6 V (The voltage interpreted as a high is dependent on the implementation and can range from 1.6 V to 35 V.)
General Requirements	
Transient Current in a High-to-Low Transition	No more than that contained in a 200 pF capacitor charged to 35 V
Transient Voltage in a Low-to-High Transition	Not greater than 35 V peak
Reference Time Between Pin 3 and Pin 1 or 2	2 minutes maximum with no damage when referenced through 13 kilohms to 110 Vac, 60 Hz.
<b>Output</b>	
Duplex Outlets (power)	7 (5 switched, 2 unswitched)
Duplex Outlet Current Ratings	866-D: 15 A/duplex outlet, 24 A/phase 866-E: 12 A/duplex outlet, 15 A/phase

### 2.3 POWER AND POWER CONTROL CONNECTIONS

The H7420 power supplies are connected to switched outlets of the 866 power controller. The upper H7420, which is the base card cage power source, is plugged into a phase 1 switched outlet on the 866 power controller (Figure 2-2). The lower H7420, which is the expander card cage power source, is plugged into a phase 2 switched outlet. The base card cage blower in 120 V systems is connected to a phase 1 switched outlet, while the expander card cage blower in 120 V systems is connected to a phase 2 switched outlet. (In 240 V systems, the card cage blowers are connected to 120 Vac outputs of the H7420s.) If MOS memory is used, the H775 MOS battery backup unit is plugged into a phase 1 unswitched outlet. If the floating-point option is present, the H7421 FP11-E power source is plugged into a phase 2 switched outlet. Mass storage devices are connected to phase 3 switched outlets.

The 866-D/E power controller allows power in all cabinets of the system to be controlled from the processor console rotary switch or from emergency shutdown devices (i.e., thermal sensors). The remote power control cables (DEC power control buses) used to interconnect the system cabinets contain three conductors and connect to 3-pin Mate-N-Lok connectors that are plugged into the 866 backpanel (Figure 2-2). The following signals are routed to the pins:

- Pin 1      POWER REQUEST – A low on this line activates the switched power control circuits.
- Pin 2      EMERGENCY SHUTDOWN – A low on this line turns off switched power.
- Pin 3      GROUND RETURN – This is the ground return for the preceding two signals.

The three power control bus connections on the power controller are connected in parallel. When power is turned on at the processor console, a low is routed via the power request line to all remote devices, causing all switched outlets to be energized.

A more detailed description of the power control bus is contained in Paragraph 2.3.2.

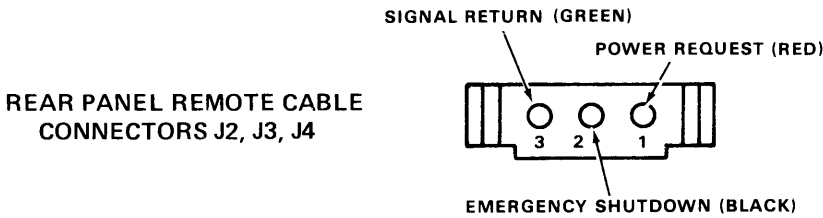
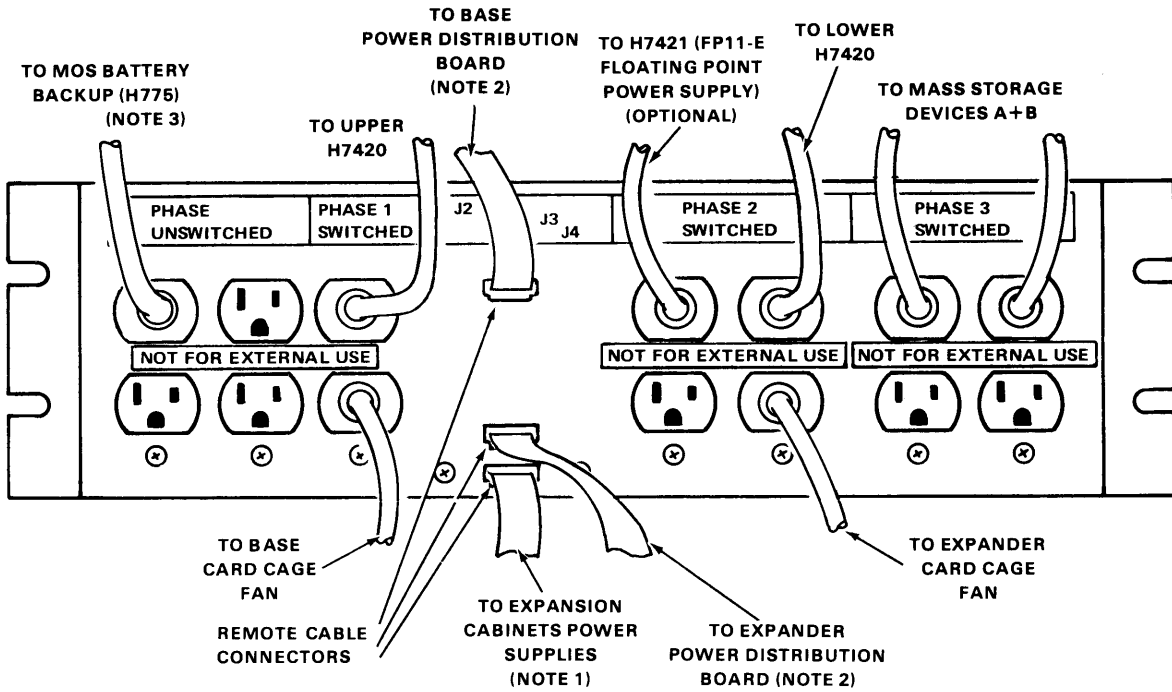
#### 2.3.1 Primary AC Power Connections

Both 866 power controller versions supplied with the PDP-11/60 are equipped with an input power cable and connector. This cable is 4.6 m (15 ft) long. The input power cable connector and receptacle part numbers are listed in Table 2-2. The primary power outlet (receptacle) at the installation site must be compatible with the input power cable connectors on the power controller. Figure 2-3 shows the power control connectors and receptacle outlines in addition to wire coding information.

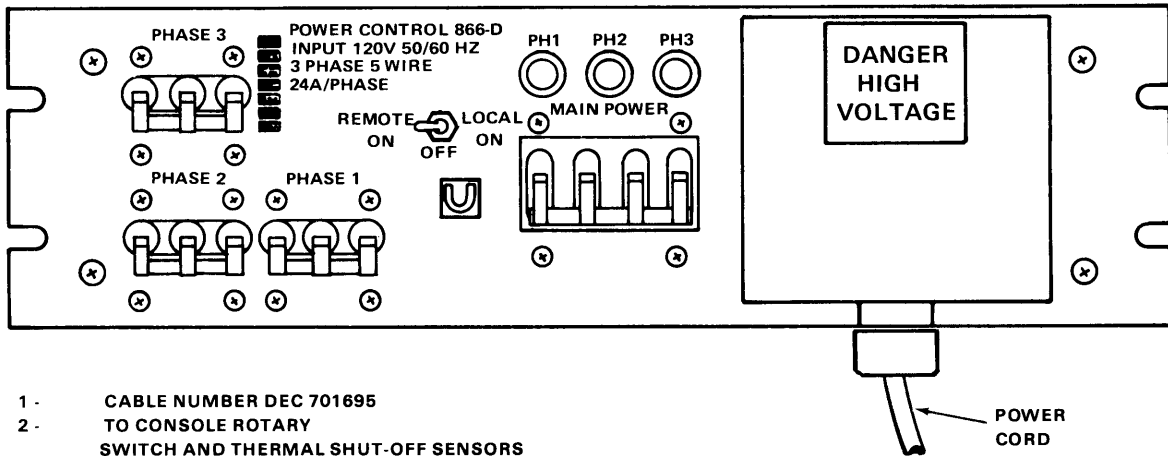
**Table 2-2 Input Power Connectors**

Power Controller	Description			Poles	Wires	
866-D	125 Vac, 3-phase, 30 A, 5-prong twist lock			4	5 No. 10 AWG	
866-E	277 Vac, 3-phase 20 A, 5-prong twist lock			4	5 No. 14 AWG	
Power Supply	Plug			Receptacle		
	NEMA	DEC No.	Hubbell No.	NEMA	DEC No.	Hubbell No.
866-D	L21-30P	12-12314	2811	L21-30R	12-12315	2810
866-E	L22-20P	12-14034	2521	L22-20R	12-14033	2521

**REAR PANEL**



**FRONT PANEL**



- 1 - CABLE NUMBER DEC 701695
- 2 - TO CONSOLE ROTARY SWITCH AND THERMAL SHUT-OFF SENSORS ONLY USED ON MOS CONFIGURED VERSIONS OF PDP-11/60
- 3 -

MA-0715

Figure 2-2 PDP-11/60 Power and Remote Control Connections

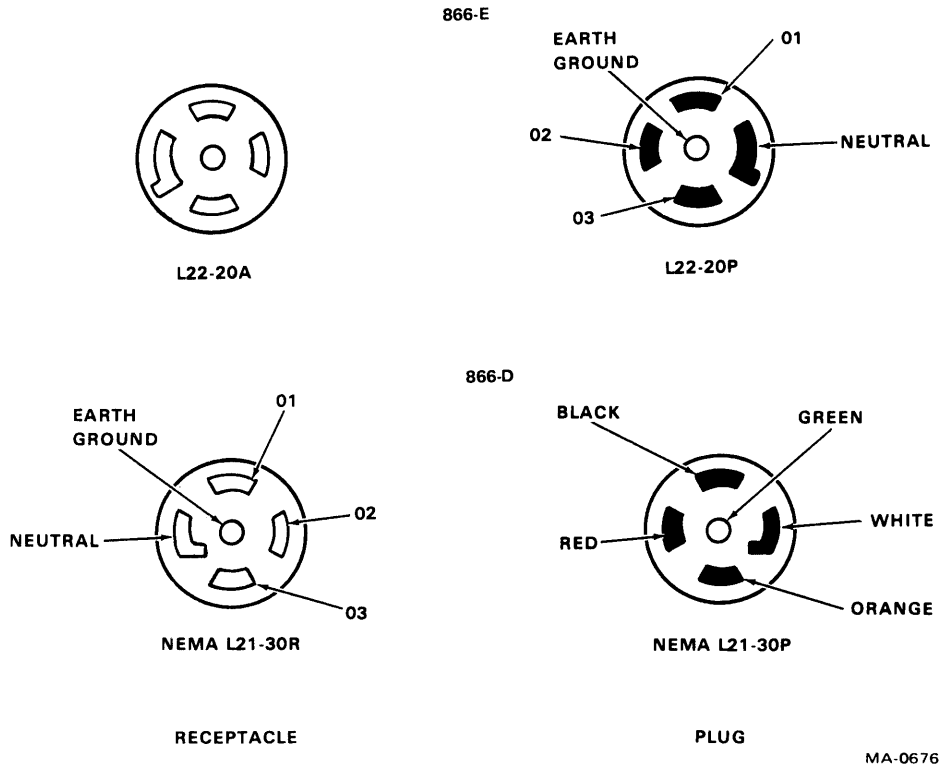


Figure 2-3 Power Control Connector Outlines

### 2.3.2 Remote Power Connections

The main cabinet and some optional expansion cabinets in PDP-11/60 systems have one 866-D or 866-E power controller. All the power controllers are connected by a 3-wire bus (DEC power control bus) that carries three signals: Power Request (line 1), Emergency Shutdown (line 2), and Ground (line 3). These signals appear on pins 1, 2, and 3, respectively, of the power controller's J2, J3, and J4 connectors. Operation occurs as follows:

1. Connection between line 1 and line 3 energizes the power control relay and applies power to the switched outlets. When the LOCAL/OFF/REMOTE switch on the power control is in LOCAL, line 1 and line 3 are connected.
2. Connection between line 2 and line 3 overrides all other conditions to disconnect input power from the switched outlets.
3. If no connection exists between either lines 1 or 2 and line 3, the components will remain in the power off state unless the LOCAL/OFF/REMOTE is in LOCAL.

Table 2-3 summarizes these connections.

Three identical parallel-wired Mate-N-Lok connectors are provided on each power controller. A 91.44 cm (3 ft) cable, DEC part number 70-10695, is supplied with each cabinet to connect the power controller of that cabinet to the power controller in the next cabinet (Figure 2-4). Because each power controller must be capable of connecting to the power controllers in the preceding and following cabinets (except for the PDP-11/60 system cabinet), two Mate-N-Lok connectors are reserved for the intercabinet cables; a third connector is provided for connection to thermal switches and other shut-off devices within the cabinet.

Refer to DEC STD 123 (power control bus) for more remote power connection information.

**Table 2-3 Power Control Operation**

Connections Between Control Lines	Switch Positions		
	LOCAL	OFF	REMOTE
None	ON	OFF	OFF
1-3	ON	OFF	ON
2-3	OFF	OFF	OFF
1-3, 2-3	OFF	OFF	OFF

#### 2.4 POWER CONTROLLERS 866-D AND 866-E

Two versions of the power controller are available for use in the PDP-11/60 (Figure 2-5):

1. 866-D: 90–133 Vac, 47–63 Hz, 3-phase, 24 A/phase (30 A circuit breaker)
2. 866-E: 180–264 Vac, 47–63 Hz, 3-phase, 12 A/phase (15 A circuit breaker)

Circuit schematics of the 866-D and 866-E power controllers are included in the engineering set (D-CS-866-D-1 and D-CS-866-E-1).

Both versions of the 866 are similar; however, they are discussed separately in Paragraphs 2.4.1 and 2.4.2 for clarification. The pilot control boards in the 866-D and 866-E are identical; they are described together in Paragraph 2.4.3.

##### 2.4.1 Type 866-D Circuit Description

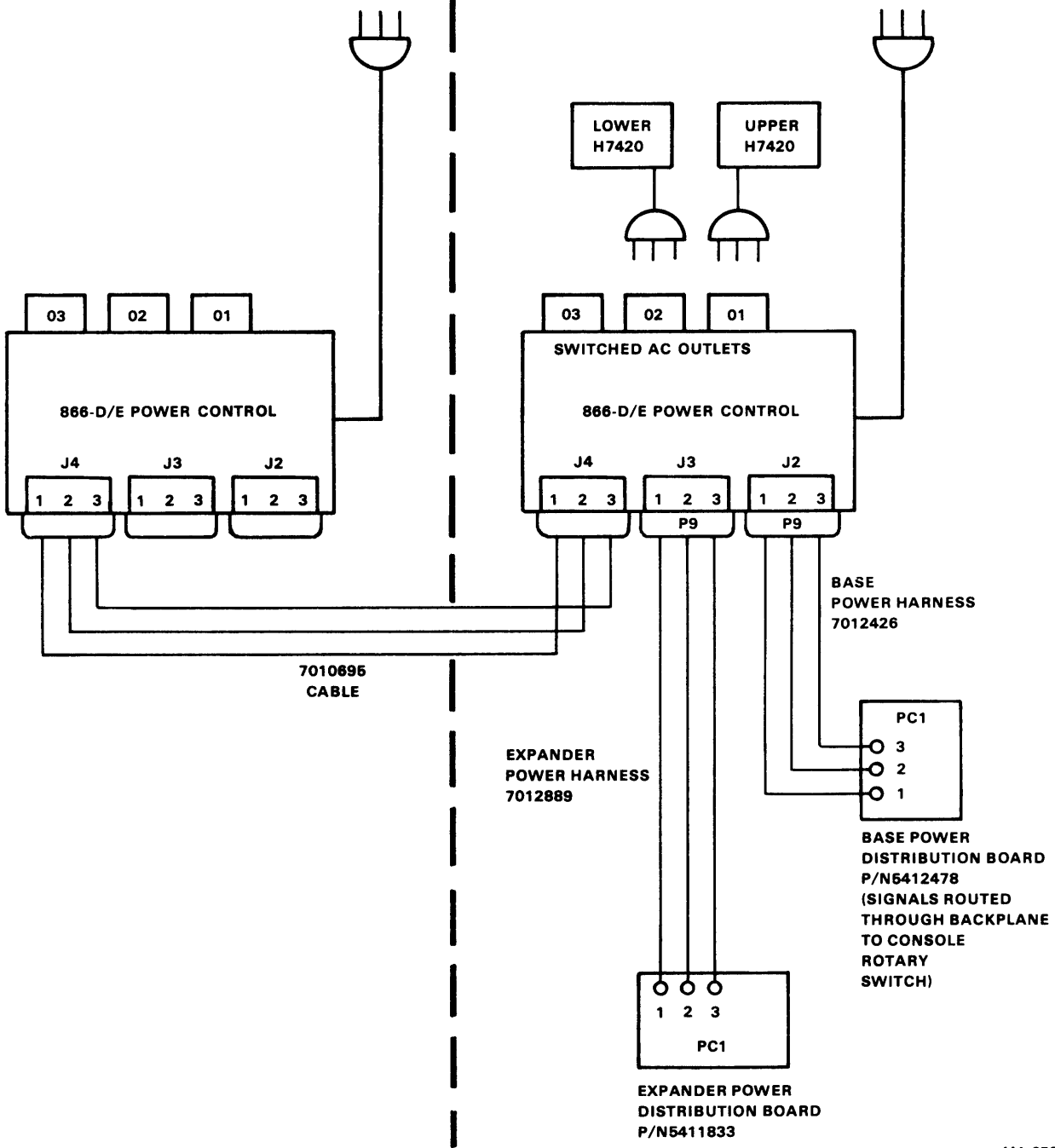
Figure 2-6 is an 866-D simplified circuit schematic. Figure 2-7 identifies the 866-D's components. The 866-D is a 90–132 Vac, 47–63 Hz, 3-phase power controller.

Power is applied to the terminal block mounted on the power line filter via a 4.6 m (15 ft) line cord or is hard-wired to the terminal block. The filter provides low-impedance paths to ground for high-frequency line components. If 120 Vac is present between phase 1 and neutral, I1 lights; similarly, if 120 Vac is present between phase 2 and neutral, I2 lights; if 120 Vac is present between phase 3 and neutral, I3 lights.

All three phase lines are connected to 30 A elements in circuit breaker CB1. All loads connected to the power controller (both switched and unswitched) are controlled by 20 A circuit breakers (CB2, 3, and 4) on each duplex outlet.

EXPANSION CABINET

11/60 CABINET



MA-0709

Figure 2-4 Example of Remote Power Control



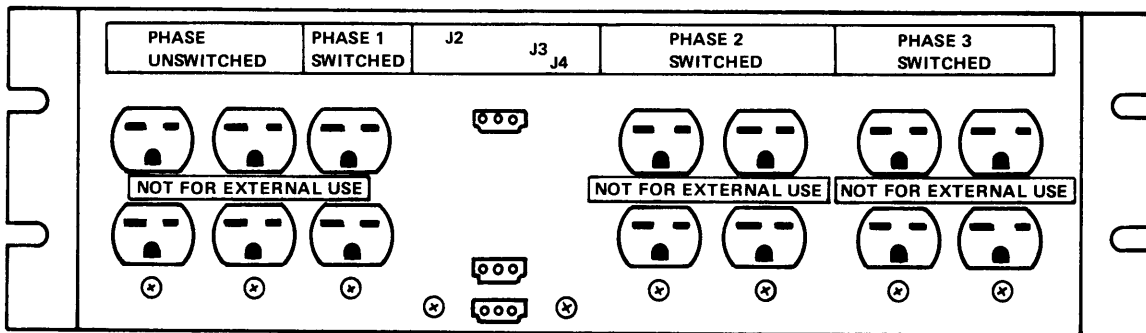
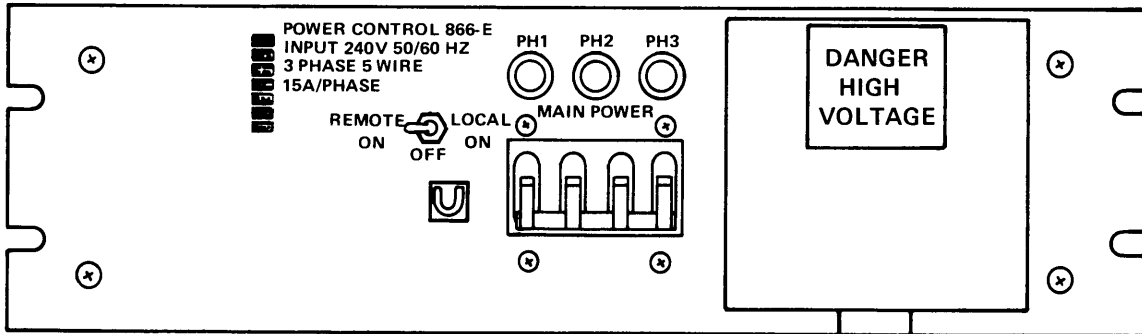
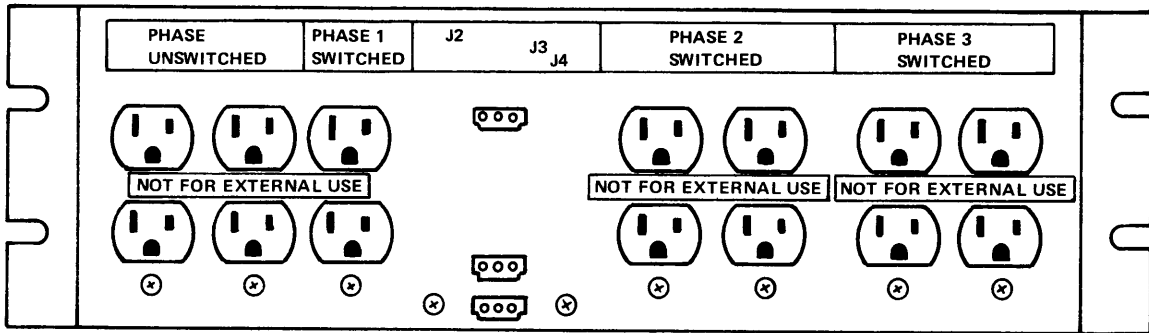
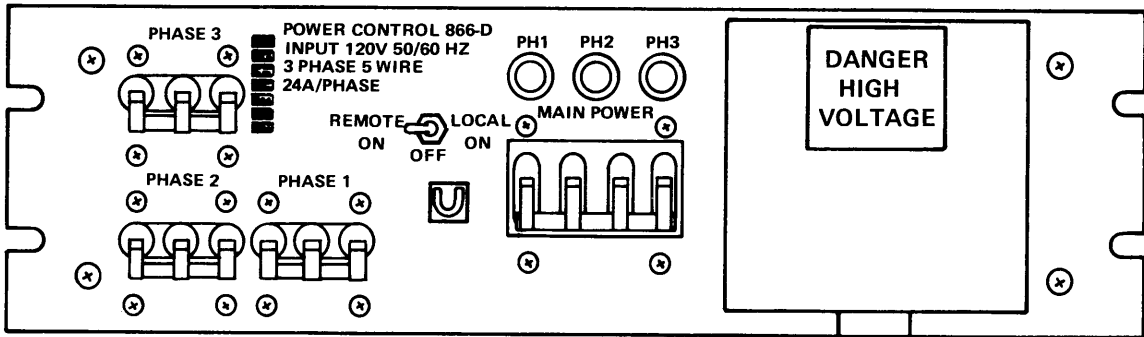


Figure 2-5 866-D/E Power Control Panels

MA-0714

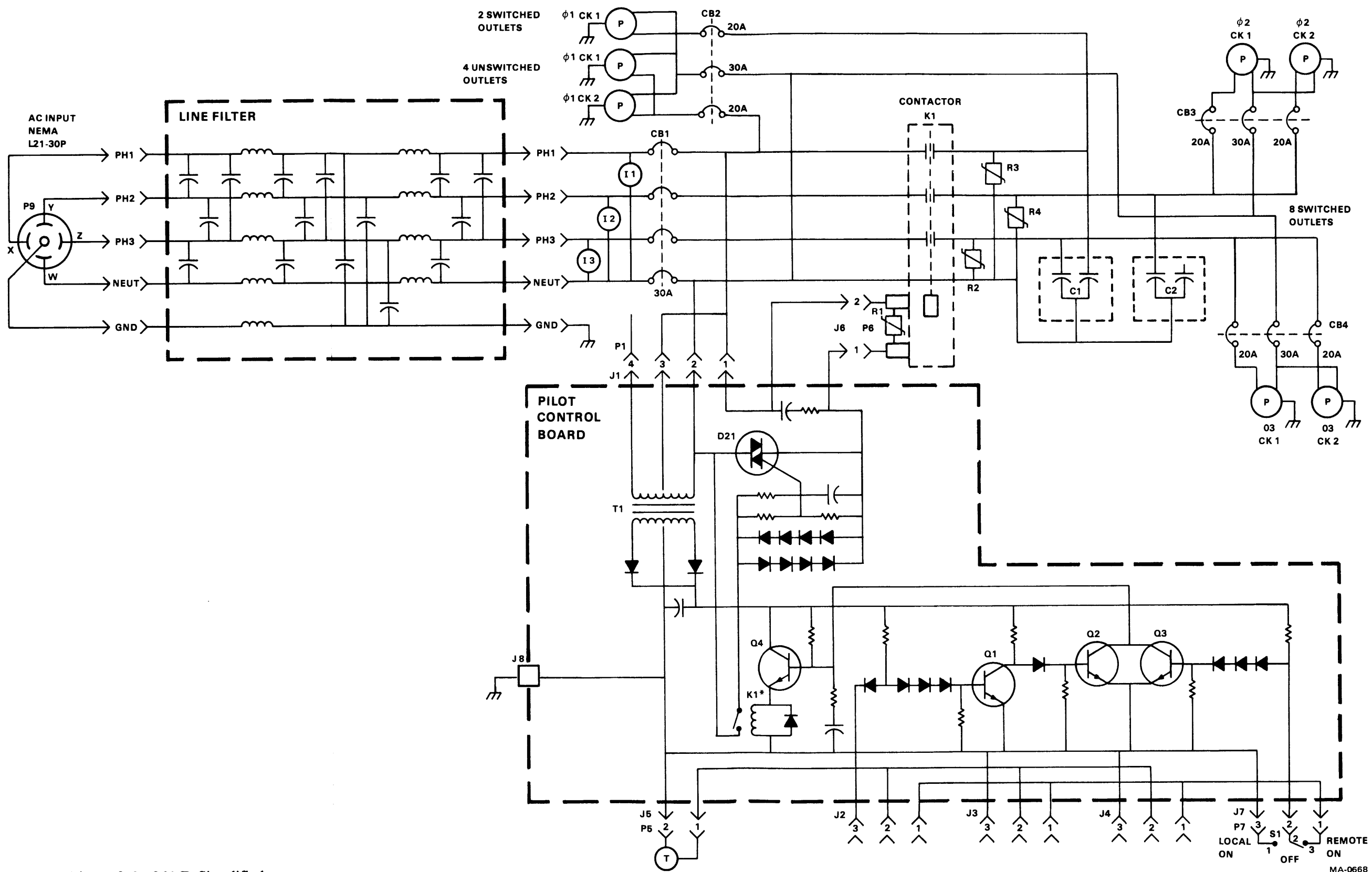
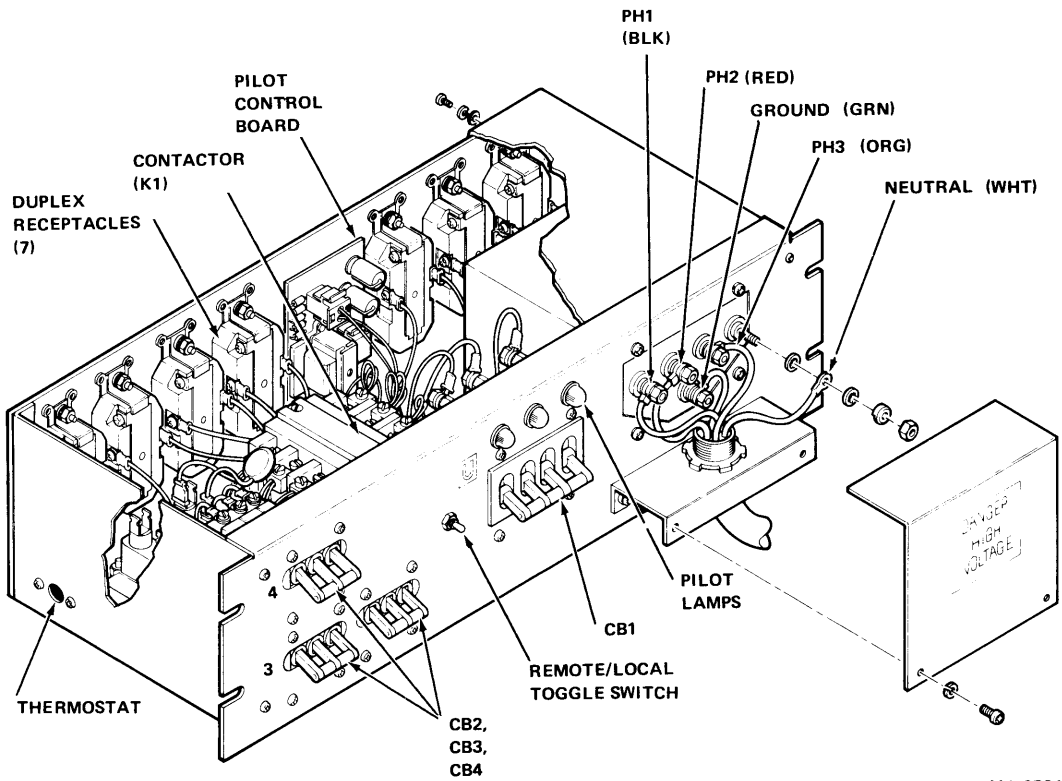


Figure 2-6 866-D Simplified Circuit Schematic



MA-0704

Figure 2-7 866-D Power Controller Component Identification

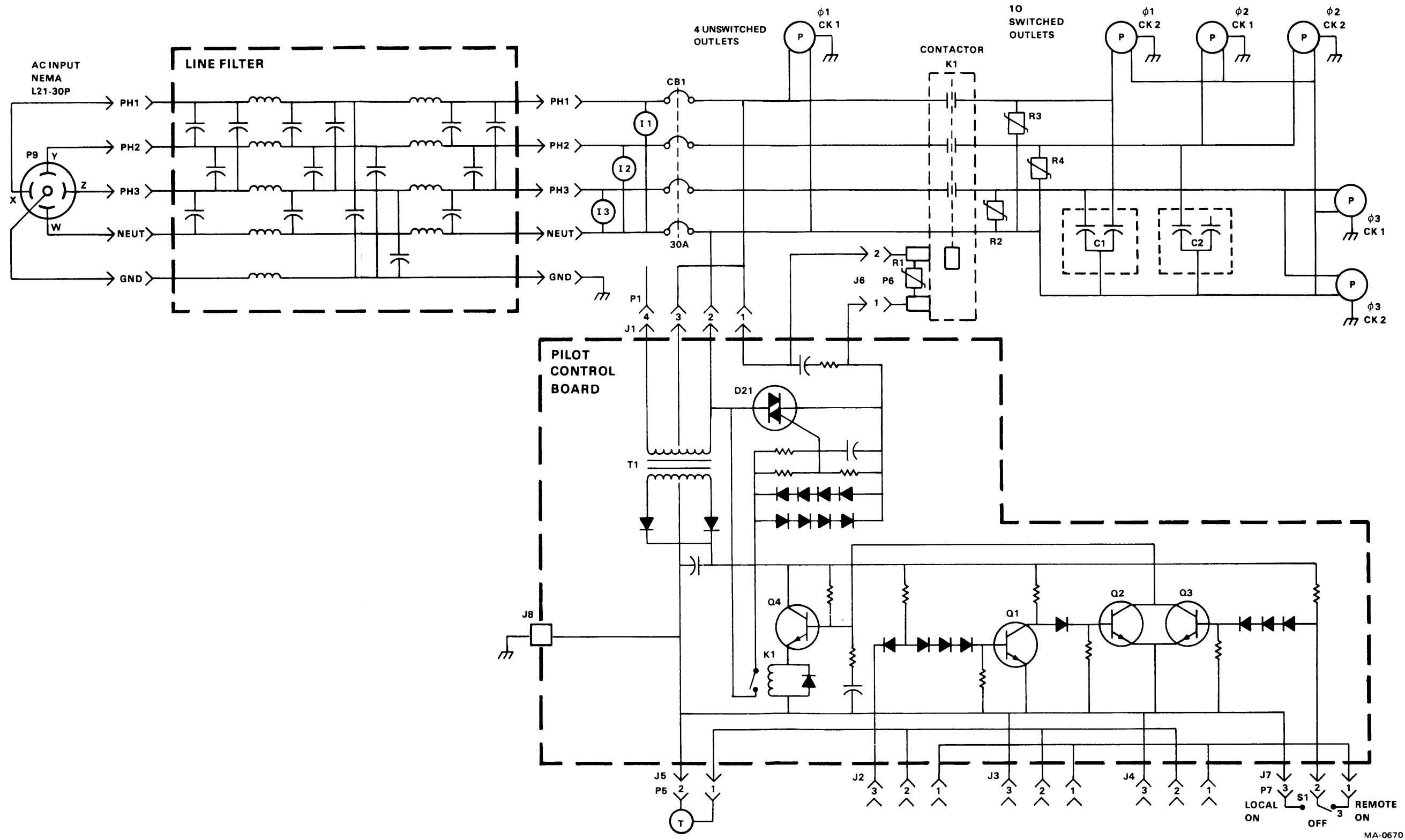
If the current through any of the outlets exceeds 20 A, the respective circuit breaker trips, removing power from the loads. The coil associated with K1 is energized by 120 Vac if a relay (K1\*) on the pilot control board is closed (Paragraph 2.4.3).

When K1 is closed, 120 Vac is applied across the switched outlets. The 0.1  $\mu$ F capacitors (C1 and C2) and the three MOVs (R2, R3, and R4) connected across the lines at the relay reduce the amplitude of voltage spikes at the output of the controller when switching inductive loads, thereby preventing interference to nearby electronic data processing equipment.

#### 2.4.2 Type 866-E Circuit Description

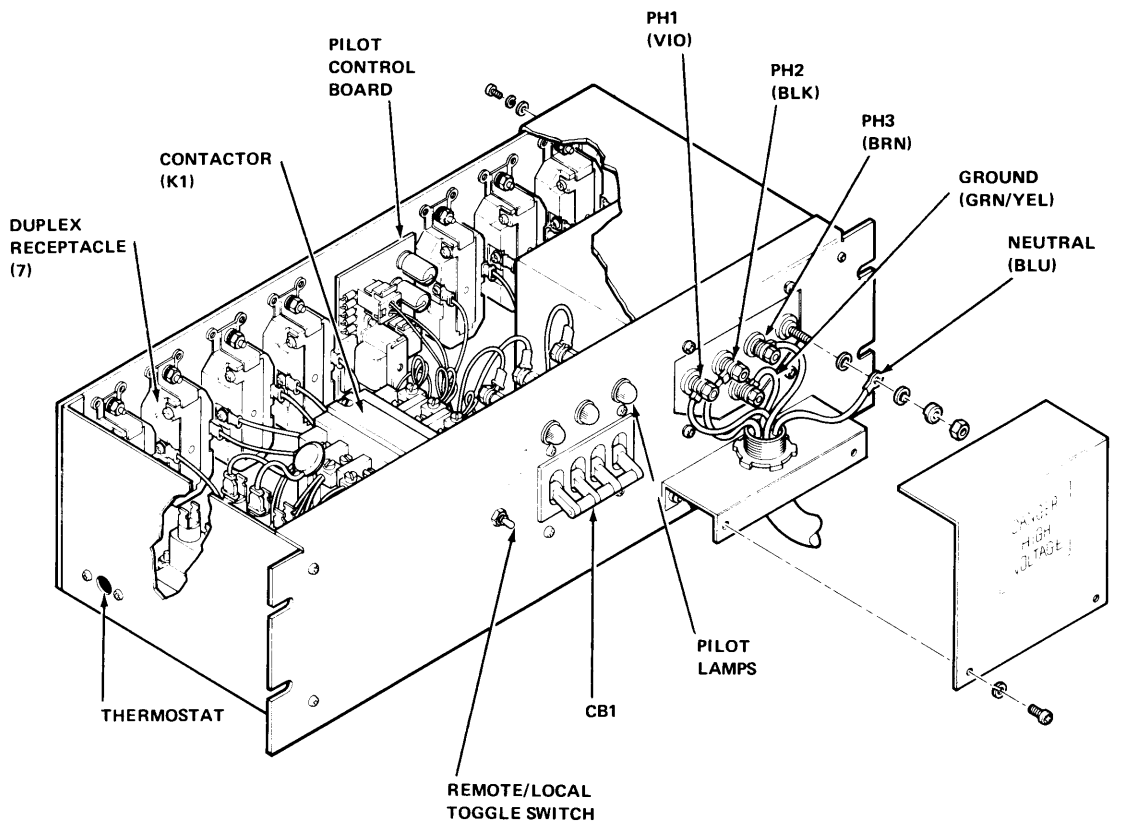
Figure 2-8 is a simplified circuit schematic of the 866-E, 240 Vac (416 Vac phase to phase), 47–63 Hz, 3-phase version of the power controller. Figure 2-9 identifies the 866-E's components.

Power is applied to the terminal block mounted on the power line filter. The filter provides low impedance paths to ground for high-frequency line components. If 240 Vac is present across each phase at the output of the line filter, I1, I2, and I3 light. Each side of the line connects to a 15 A element of circuit breaker CB1. All loads connected to the power controller (both switched and unswitched) are controlled by CB1. If the current through either line exceeds 15 A, CB1 trips, removing power from the load. Each output line from CB1 connects to a normally open contact on contactor K1. The coil associated with K1 is energized by 240 Vac from the output of CB1 if a relay (K1\*) on the pilot control board (Paragraph 2.4.3) is closed. When K1 is closed, 180–264 Vac is applied across the switched outlets. The 0.1  $\mu$ F capacitors (C1 and C2) and the three MOVs (R2, R3, and R4) connected across the lines at the relay reduce the amplitude of voltage spikes at the output of the control when switching inductive loads, thereby preventing interference to nearby electronic data processing equipment.



MA-0670

Figure 2-8 866-E Simplified Circuit Schematic



MA-0705

Figure 2-9 866-E Power Controller Component Identification

### 2.4.3 Pilot Control Board Circuit Description

Figures 2-6 and 2-8 show the pilot control board simplified schematic. Figures 2-7 and 2-9 show its locations within the 866-D and 866-E. The pilot control board contains the circuitry which allows remote turn-on and emergency turn-off of the switched power outlets in both 866 power controller versions. These functions are accomplished by controlling the voltage applied to the coil of relay K1 in the 866 power controller.

Basically the circuit consists of a triac operated by reed relay K1. Controlling this relay is a transistor network which is in turn controlled by inputs from connectors J2, J3, J4, J5, and J7. J2, J3, and J4 are 3-pin connectors which carry signals from the DEC power control bus. Pin 1 is the enable (power request) line from the power control bus. Pin 2 is the disable (emergency shutdown) line from the signal bus. Pin 3 is the common line. J7 is a 3-pin connector which carries signals from the LOCAL/OFF/REMOTE switch on the front panel of the 866. Two additional lines (from the thermal switch) are connected to pins 1 and 2 of J5.

When the LOCAL/OFF/REMOTE switch is in the REMOTE position and pins 3 and 1 on J2, J3, or J4 are connected, reed relay K1 is turned on, through the transistor network. There is a short turn-on delay caused by an RC network in the base circuit of Q4, the transistor driving K1. K1 in turn fires the triac, SCR D21. This causes an energizing potential to be applied, through connector J6, across the coil associated with contactor K1 in the power controller, thereby energizing the switched outlets. When pins 2 and 3 of J2, J3, or J4 are connected (emergency shutdown is true), K1 is turned off, turning off SCR D21. The resultant current through the coil is less than that required for holding the main relay closed. Therefore, energizing potential is not present at contactor K1 and power is removed from switched outlets.

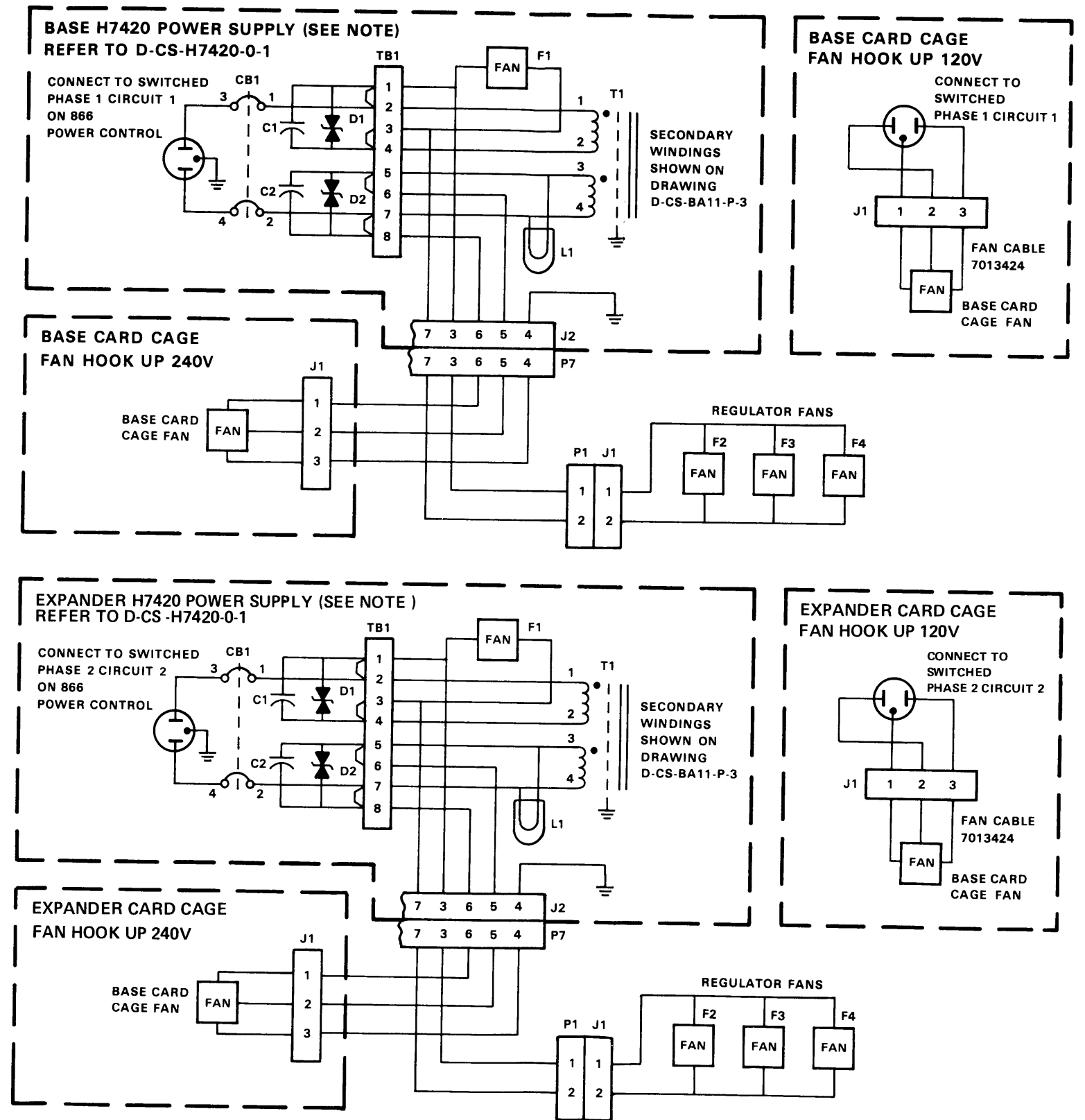
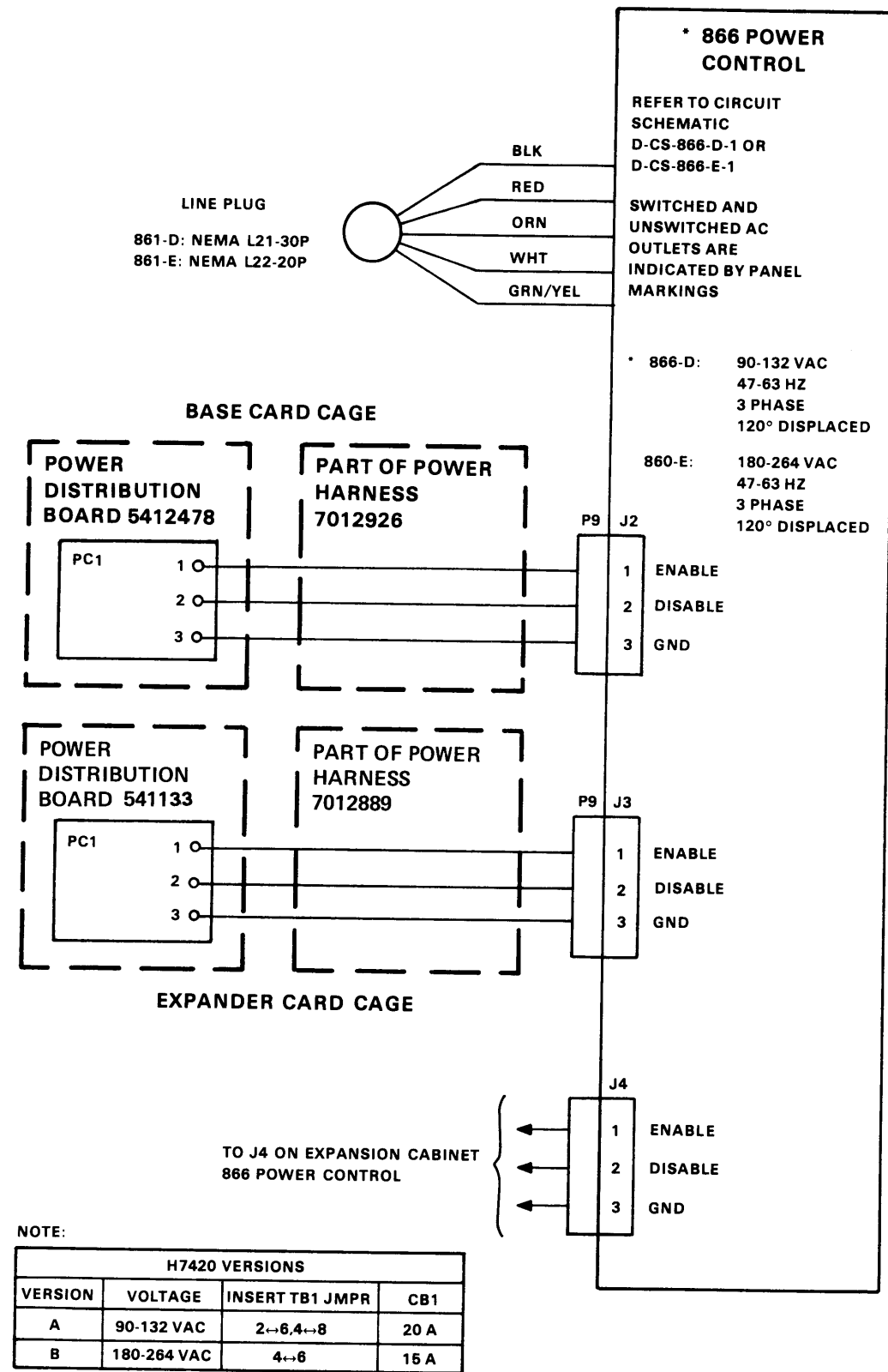
Closing T1 (the thermal switch) performs the same function as emergency shutdown (connects pins 2 and 3 together). This switch is exposed to the ambient air surrounding the power controller. Temperatures above 71° C (160° F) close the switch (disabling the switched outlets). The switch resets automatically when the temperature drops below 49° C (120° F).

Placing the LOCAL/OFF/REMOTE switch in the LOCAL position provides a connection to energize relay K1 regardless of the state of the power request line on the signal bus. This switch position is normally used for maintenance purposes; operations on the pilot control board are exactly the same for situations where a connection is provided between pins 3 and 1 of the signal bus connector due to closing of a circuit in an external device. A connection between pins 2 and 3 disables the switched outlets, regardless of the position of the LOCAL/OFF/REMOTE switch.

## **2.5 AC POWER DISTRIBUTION**

AC power distribution for both the base and expander card cages is depicted in Figure 1-2. In the power system, the base H7420 power supply is connected to a phase 1, circuit 1, switched outlet (Figure 2-10). The expander H7420 power supply is connected to a phase 2, circuit 2, switched outlet. If the floating-point option is present in the PDP-11/60, the H7421 floating-point power supply is plugged into a phase 2, circuit 1, switched outlet. If the PDP-11/60 is a version configured with MOS memory and battery backup is used, the H775 MOS battery backup is plugged into a phase 1, circuit 1, unswitched outlet. Mass storage devices are plugged into phase 3 switched outlets.

The base card cage fan and expander card cage fan have very similar power hookups. In 120 V systems, the fans obtain their power from switched outlets on the 866 backpanel. The base card cage fan is plugged into a phase 1 outlet while the expander card cage fan is plugged into a phase 2 outlet. The cables used are 70-13424 power cables. In 240 V systems, the power for the fans is supplied by the 120 Vac outputs of the H7420s. The source of the power is two terminal blocks (TB1) located in the base and expander H7420s. The electrical jumper configurations at these terminal blocks is determined by the input voltage to the H7420: 120 Vac from an 866-D or 240 Vac from a 866-E (Figure 2-10). The cables used are 70-13422 power cables. Power for the transformer and regulator fans is also routed through TB1.



MA-0671

Figure 2-10 AC Power Connections Block Diagram

## CHAPTER 3 DC POWER H7420 POWER SUPPLIES

### 3.1 GENERAL DESCRIPTION

Switched ac power from the 866-D/E power controller is routed to the H7420-A/B power supplies which generate the required dc voltage for the system (Figures 1-2 and 1-3). The outputs from the H7420 power supplies are channeled through two power harnesses to the base and expander power distribution boards. These connect by wires to the various backplanes present in the system. AC power to the regulators and regulator fans is also supplied through the power harnesses (Figure 1-2).

### 3.2 H7420 DC POWER SUPPLIES (BASE AND EXPANDER)

The upper and lower H7420 power supplies provide the base and expander card cages with the required dc voltage and low voltage signals. Each H7420 consists of a multiple output transformer, a power line monitor, -15 V regulator, and cooling for up to five power supply modules. Figure 3-1 is a simplified schematic drawing of the two H7420s in the PDP-11/60 (only on the unique parts of the lower H7420 are shown) and their connections to the base and expander power distribution boards.

Figure 3-2 shows an H7420 with four regulators installed. In Figure 3-3 all the regulators have been removed and the top cover and the PC mounting board bracket have been detached to show the interior of the H7420. A front view of the power supply is shown in Figure 3-4.

The H7420A and H7420B are both used on the PDP-11/60. The major specifications are listed in Table 3-1.

**Table 3-1 H7420 Versions**

Parameter	Version A	Version B
Voltage	90-132 Vac	180-264 Vac
CB1	20 A	15 A
TB1 Jumper Connections	2-6, 4-8	4-6
Apparent Input Power (max)	1.44 kVA	1.68 kVA
Transformer Assembly (DEC No.)	70-11211	70-11211
Transformer Output Load (max)	1220 VA	1220 VA
No. of Regulators	5	5

The 120/240 Vac power input to the H7420 is through a circuit breaker (CB1) and a terminal block (TB1). (Refer to this part of the power supply on Figure 2-10.) In the A version, CB1 is a 20 A circuit breaker; the B version uses a 15 A circuit breaker. TB1 contains eight double terminals; adjacent terminal pairs are common as shown in Figure 3-5. Also connected to TB1 are two capacitor-varistor assemblies (C1 and D1, C2 and D2) that function as input surge limiters.



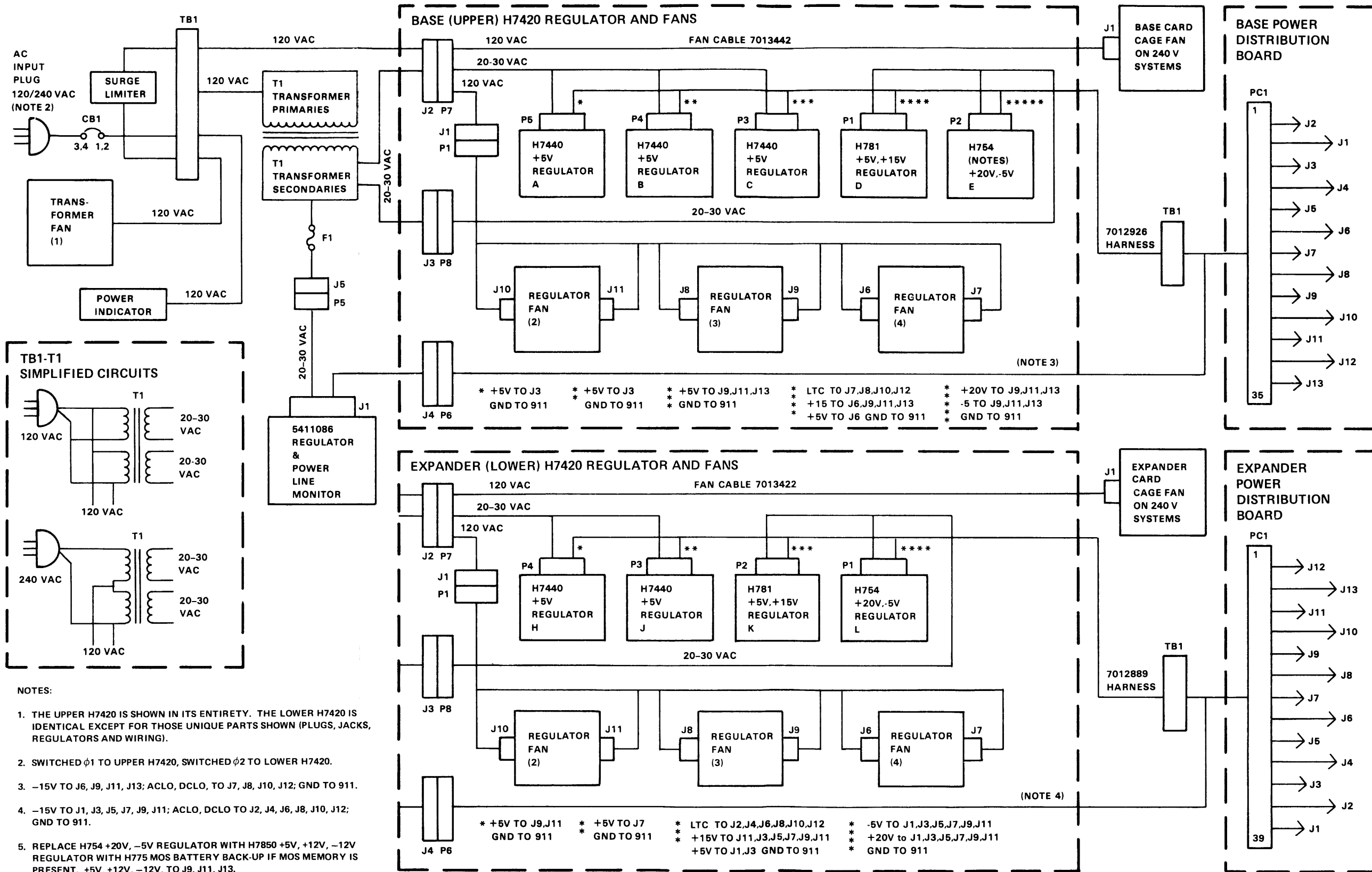
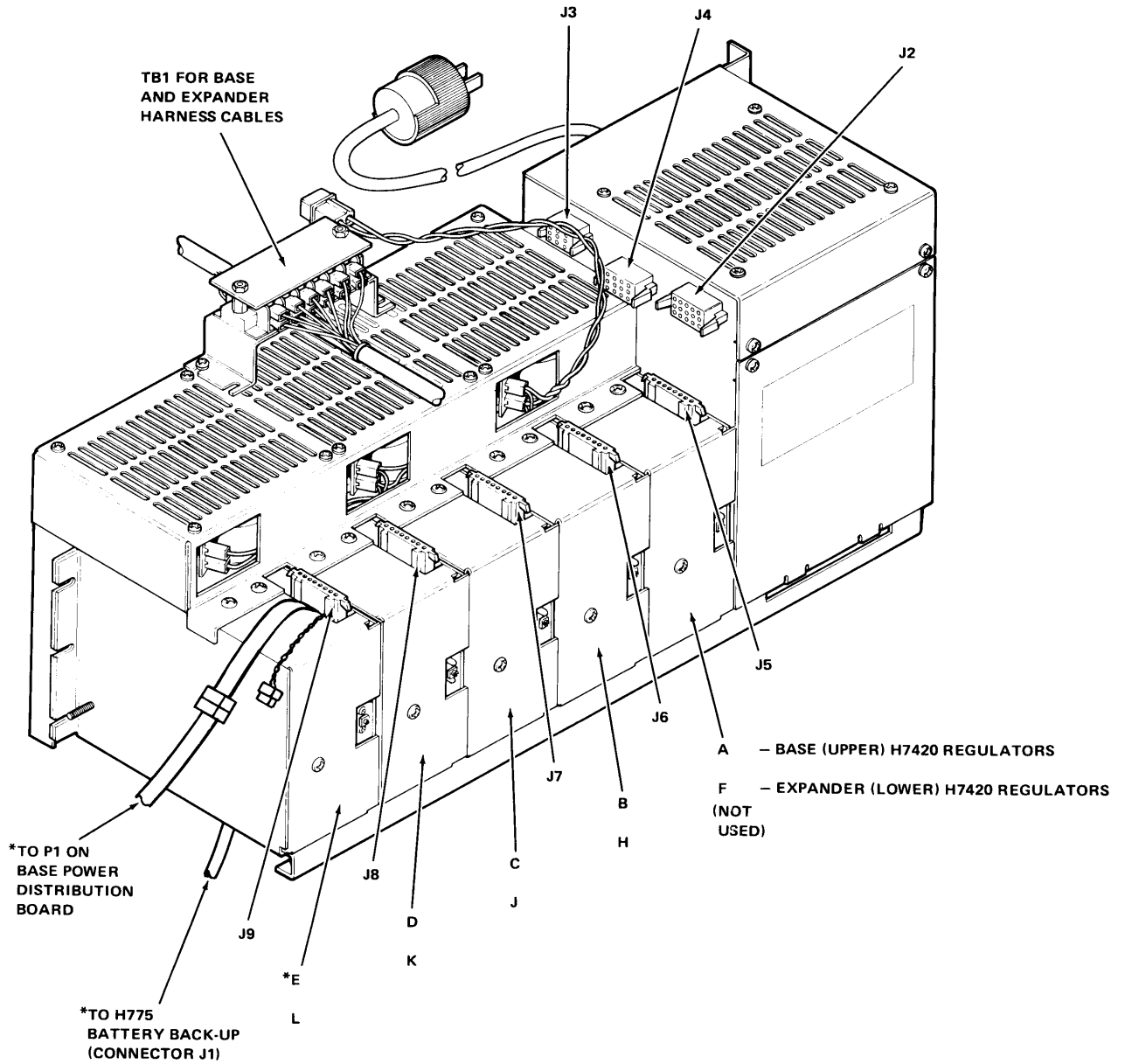


Figure 3-1 H7420 Power Supply Block Diagram



\*USED ONLY ON MOS CONFIGURED SYSTEMS.

MA-0712

Figure 3-2 H7420 Power Supply with Regulators

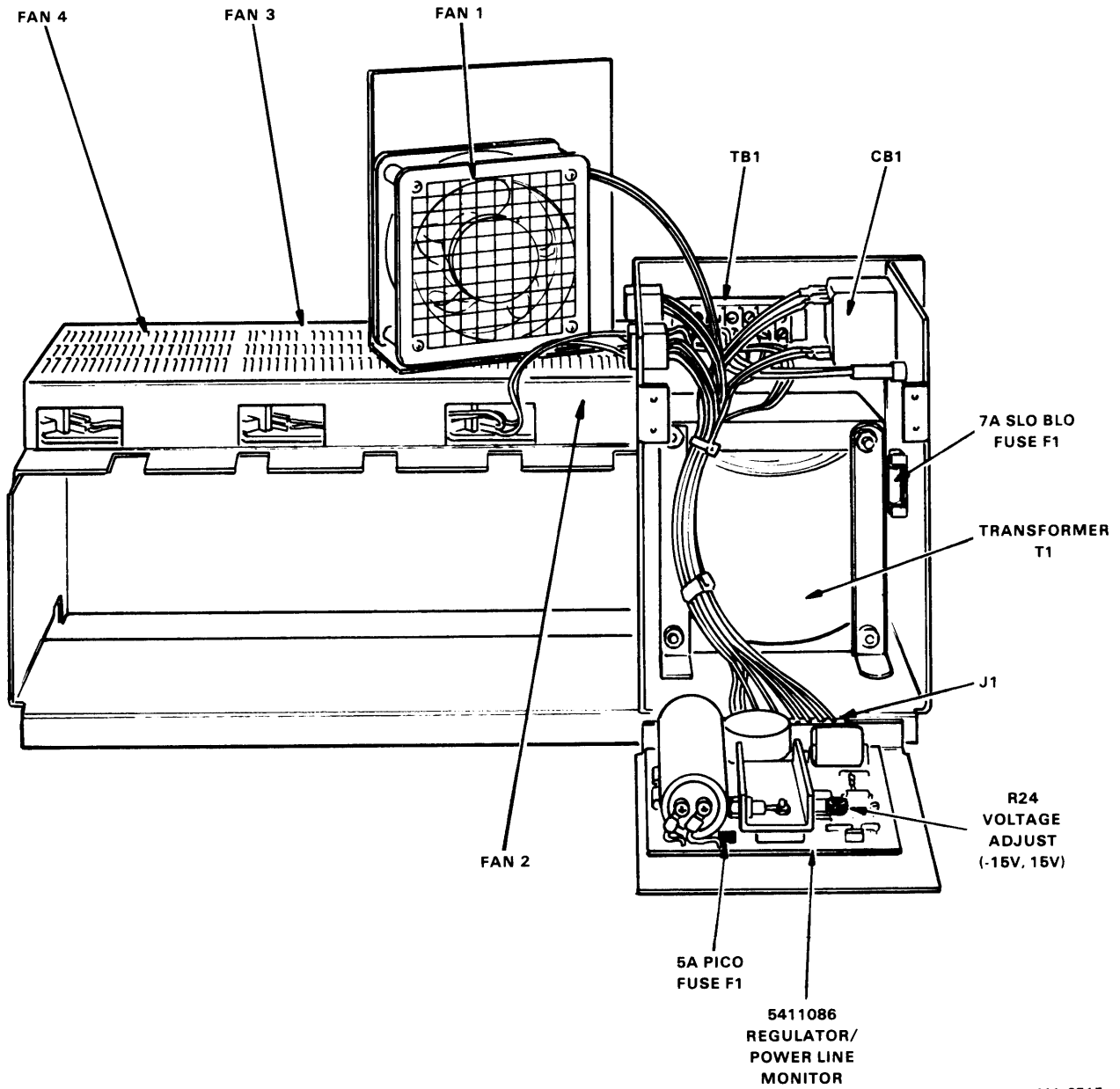


Figure 3-3 H7420 Power Supply (PC Mounting Board Bracket with Top Cover Removed)

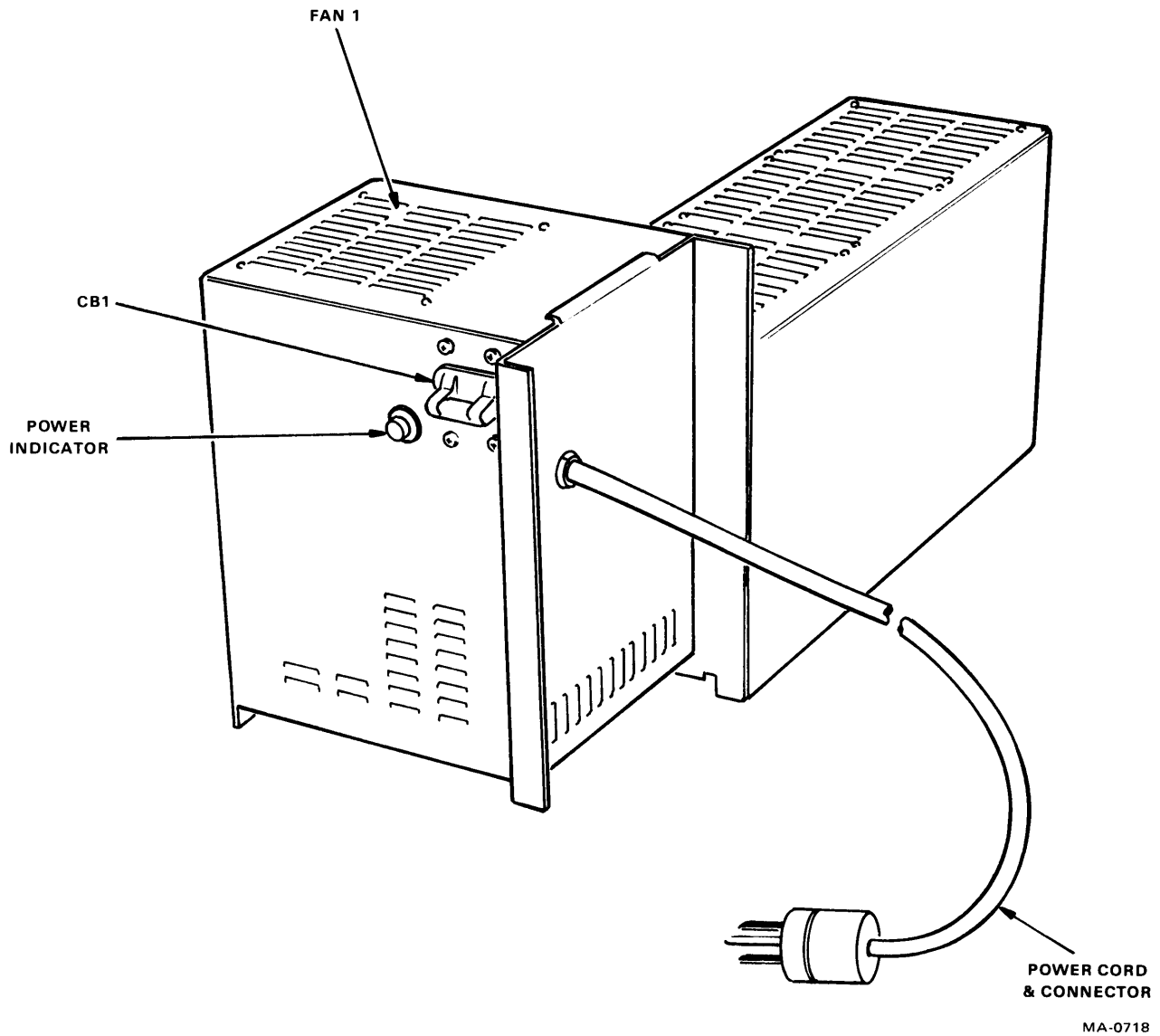
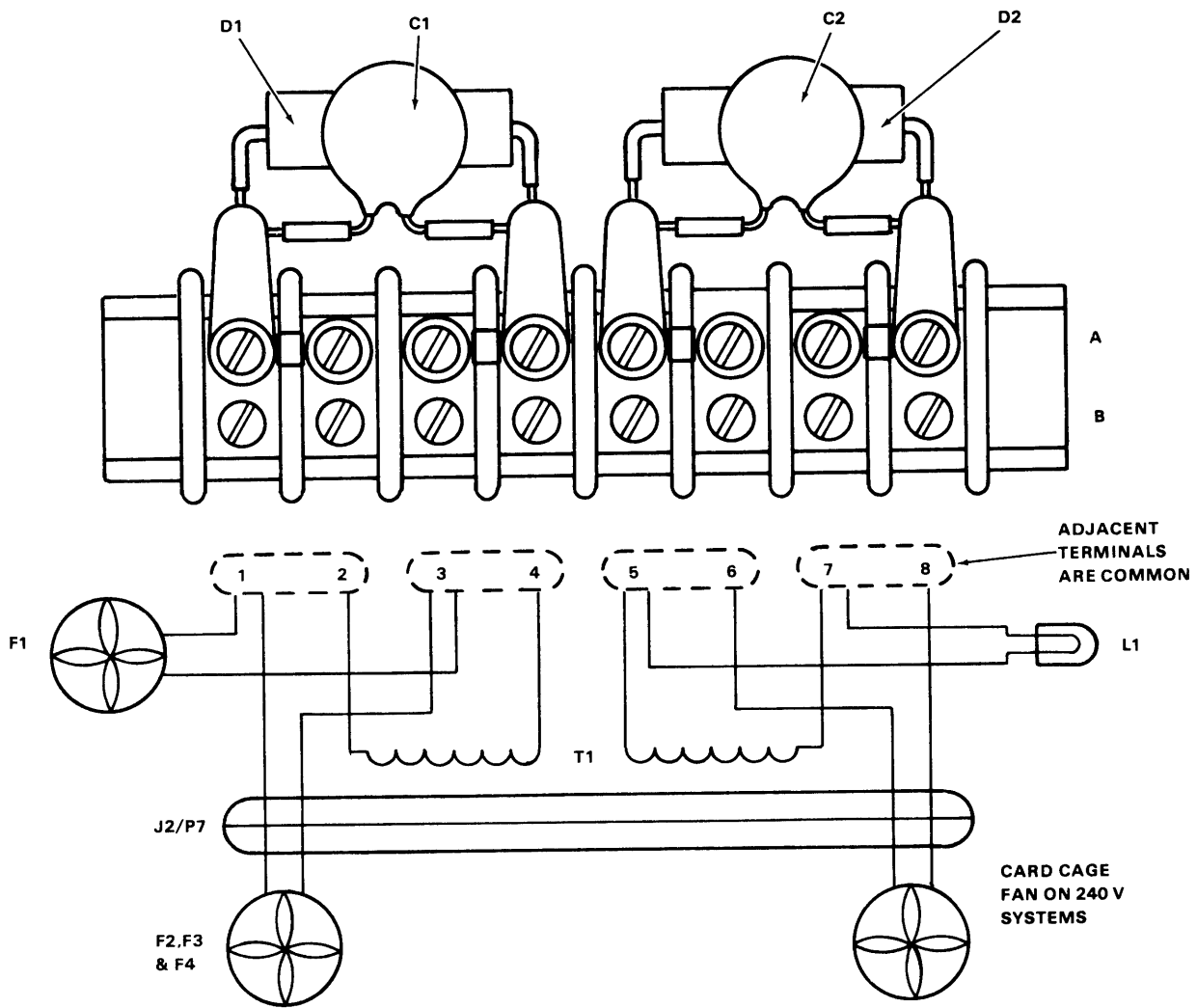


Figure 3-4 H7420 Power Supply, Front View



MA-0707

Figure 3-5 H7420 Power Supply's Terminal Block, TB1

The 120 Vac outputs from TB1 are connected to the two transformer primary windings, the regulator fans and the power indicator light (Figures 3-3, 3-4, and 2-10). The externally used outputs, the 120 Vac for the regulator fans, and the 120 Vac for the card cage fans in 240 V systems are routed through J2 on the H7420 box (Figures 3-2 and 2-10).

The transformer secondary windings are connected to J2 (15-pin Mate-N-Lok) and J3 (9-pin Mate-N-Lok) on the H7420 box, and J5 (2-pin Mate-N-Lok). The output to J5 is the only one that is fused. These transformer outputs are 20–30 Vac (26 Vac is the nominal voltage). The two wires from P5 (J5) are routed to J1 (15-pin Molex right angle edge connector) on the 54-11086 board (Figure 3-3).

J2 and J3 are mated with P7 and P8, respectively, in both the base and expander H7420s. The 20–30 Vac wires from these plugs are connected to the regulators in the H7420s.

The 54-11086 regulator and line monitor boards (one in each H7420) furnish –15 V along with AC LO and DC LO power fail signals to the base and expander backplanes (Notes 3 and 4 on Figure 3-1). These outputs are through J4/P6 (12-pin Mate-N-Lok connectors) on each H7420 box. The 54-11086, including the AC LO and DC LO circuits, is described in Paragraph 3.3.1.

Four 4-inch sleeve bearing fans provide air flow to cool each H7420. One is mounted above the transformer assembly and three are mounted above the regulators (Figures 3-1, 3-3, and 3-4). The regulator fans receive 120 Vac power through six connectors, J6 through J11. Refer to Table 3-2 for fan specifications.

Nine regulators are included in the power system: five in the base H7420 and four in the expander H7420. Slots A, B, C, H, and J contain H7440 +5 V regulators. H781 +5 V, +15 V regulators use slots D and K. Slots E and L both contain H754 +20 V, –5 V regulators unless MOS memory is used in the PDP-11/60. If MOS memory is used, then an H7850 +5 V, +12 V, –12 V regulator replaces the H754 in slot E (Paragraph 3.3.3). The positions and connections of the regulators are shown in Figures 3-1 and 3-2. The various regulators are described in the following paragraphs.

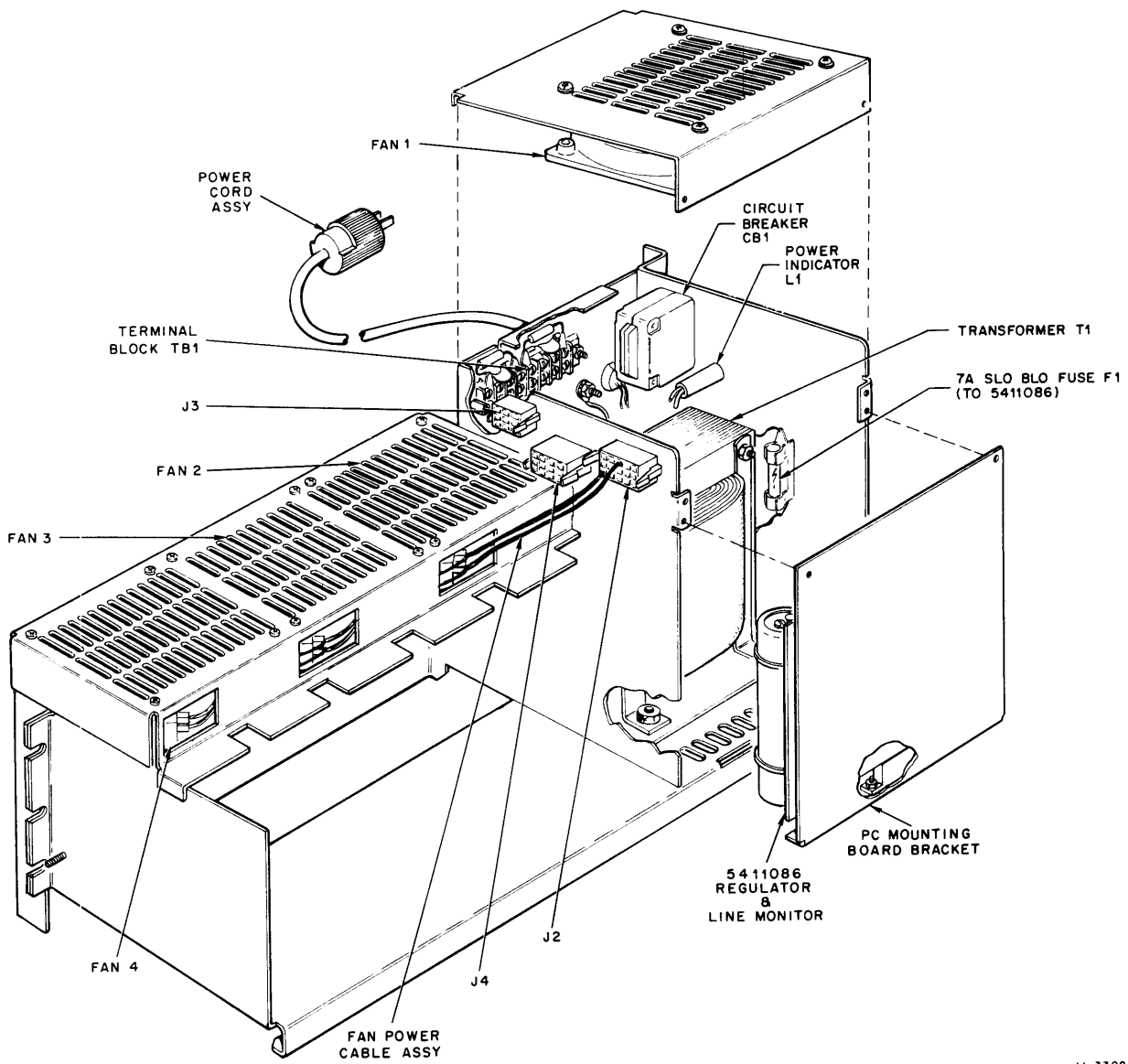
An 8-pin Mate-N-Lok connector on each regulator is used for both the 20–30 Vac input and the outputs to the power distribution boards. The connectors for the base H7420 regulators are P1 through P5. For the expander regulators they are P1 through P4 (Table 3-9). The connectors for the base H7420 and the associated wires, which are soldered onto the base power distribution board, are contained in the 70-12926 power harness (Figures 3-1 and 3-29). The connectors for the expander H7420 and the associated wires, which are soldered onto the expander power distribution board, are contained in the 70-12889 power harness (Figures 3-1 and 3-30).

To convert a 240 Vac version H7420 to a 120 Vac version, or a 120 Vac version to a 240 Vac version, it is necessary to change the following components:

1. Circuit Breaker CB1
2. The jumper configuration on TB1
3. The line cord and connector
4. The decal.

Refer to Table 3-1 and Figures 3-5 and 3-6 for component sizes and locations. The *H7420 Illustrated Parts Breakdown* (EK-H7420-IP-001) lists the appropriate part numbers. For a complete system voltage conversion procedure, refer to Appendix A.

Specifications for the H7420 are listed in Table 3-2. Refer to Engineering Specification A-SP-H7420-0-2 for additional information.



11-3309

Figure 3-6 H7420 Power Supply Component Identification

**Table 3-2 H7420 Power Supply Specifications**

Parameter	Specification
<b>Mechanical and Environmental</b>	
Dimensions	25.4 cm h × 58.42 cm w × 20.32 cm d (10 in h × 23 in w × 8 in d)
Weight	17.23 kg (38 lb), approximately, without regulators. Regulators are 1.18 kg (4 lb), approximately
Cooling	4-inch sleeve bearing fans, DEC Part No. 12-09403-01 (IMC No. WS2107F-110-01, ROTRON No. CT 3 A2) Power Requirements: 120 Vac, 0.24 A Air Delivery: 18.87 l/s (40 ft <sup>3</sup> /min)
Ambient Temperature Operating Storage	0° to 60° C (32° to 140° F) -40° to 70° C (-40° to 158° F)
Relative Humidity	10 to 90 percent (without condensation)
Altitude	3,048 m (10,000 ft) max
<b>Electrical</b>	
Input Power Voltage	90–132 Vac (H7420A) 180–264 Vac (H7420B)
Frequency	47–63 Hz
Current	12 A rms max at 120 Vac (H7420A) 7 A rms max at 240 Vac (H7420B)
Inrush Current	260 A peak for 1/2 cycle at 120 Vac (H7420A) 150 A peak for 1/2 cycle at 240 Vac (H7420B)
Power (Apparent)	1.44 kVA max (H7420A) 1.68 kVA max (H7420B)
<b>Conducted Noise (Noise on ac line)</b>	
Transients	Single transient, without system degradation: 300 V at 0.2 W Single transient, survival: 1000 V at 2.5 W max Average transient power survival: 0.5 W max
CW Noise	10 kHz–3 MHz: 3 Vrms 3 MHz–50 MHz: 1 Vrms 500 MHz–1000 MHz: 0.5 Vrms
RF Field Susceptibility	10 kHz–1000 MHz: 1 V/m



**Table 3-2 H7420 Power Supply Specifications (Cont)**

Parameter	Specification																																
Ride-Through Power	Upon power outage, the voltage outputs are maintained within specified limits for >20 ms. Control outputs are maintained within specified limits for >5 ms (Figure 3-10).																																
<b>Output Power</b>																																	
General	Output is through three Mate-N-Lok connectors J2, J3, and J4, described in Paragraph 3.2.																																
	<table border="0"> <thead> <tr> <th data-bbox="643 594 675 625"><b>J2</b></th> <th data-bbox="740 594 797 625"><b>Pins</b></th> <th data-bbox="1024 594 1122 625"><b>Voltage</b></th> <th data-bbox="1214 594 1328 625"><b>Max Load</b></th> </tr> </thead> <tbody> <tr> <td></td> <td data-bbox="740 657 857 688">1, 2, 8, 10</td> <td data-bbox="1024 657 1154 688">19-30 Vac</td> <td data-bbox="1214 657 1312 688">375 VA</td> </tr> <tr> <td></td> <td data-bbox="740 688 781 720">3, 7</td> <td data-bbox="1024 688 1170 720">90-132 Vac</td> <td data-bbox="1214 688 1279 720">N/A</td> </tr> <tr> <td></td> <td data-bbox="740 720 781 751">5, 6</td> <td data-bbox="1024 720 1170 751">90-132 Vac</td> <td data-bbox="1214 720 1263 751">4 A</td> </tr> <tr> <td></td> <td data-bbox="740 751 748 783">4</td> <td data-bbox="1024 751 1040 783">0</td> <td data-bbox="1214 751 1425 783">Chassis Ground</td> </tr> <tr> <td></td> <td data-bbox="740 783 797 814">9, 12</td> <td data-bbox="1024 783 1154 814">19-30 Vac</td> <td data-bbox="1214 783 1312 814">275 VA</td> </tr> <tr> <td></td> <td data-bbox="740 814 797 846">11, 13</td> <td data-bbox="1024 814 1138 846">Not used</td> <td></td> </tr> <tr> <td></td> <td data-bbox="740 846 797 877">14, 15</td> <td data-bbox="1024 846 1138 877">Not used</td> <td></td> </tr> </tbody> </table>	<b>J2</b>	<b>Pins</b>	<b>Voltage</b>	<b>Max Load</b>		1, 2, 8, 10	19-30 Vac	375 VA		3, 7	90-132 Vac	N/A		5, 6	90-132 Vac	4 A		4	0	Chassis Ground		9, 12	19-30 Vac	275 VA		11, 13	Not used			14, 15	Not used	
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	<table border="0"> <thead> <tr> <th data-bbox="643 909 675 940"><b>J3</b></th> <th data-bbox="740 909 797 940"><b>Pins</b></th> <th data-bbox="1024 909 1122 940"><b>Voltage</b></th> <th data-bbox="1214 909 1328 940"><b>Max Load</b></th> </tr> </thead> <tbody> <tr> <td></td> <td data-bbox="740 972 781 1003">1-8</td> <td data-bbox="1024 972 1154 1003">19-30 Vac</td> <td data-bbox="1214 972 1442 1150">375 VA Pins 1-2, 3-4, 5-6, and 7-8 are in parallel. Use only one set at one time.</td> </tr> <tr> <td></td> <td data-bbox="740 1182 748 1213">9</td> <td data-bbox="1024 1182 1138 1213">Not used</td> <td></td> </tr> </tbody> </table>	<b>J3</b>	<b>Pins</b>	<b>Voltage</b>	<b>Max Load</b>		1-8	19-30 Vac	375 VA Pins 1-2, 3-4, 5-6, and 7-8 are in parallel. Use only one set at one time.		9	Not used																					
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	<table border="0"> <thead> <tr> <th data-bbox="643 1245 675 1276"><b>J4</b></th> <th data-bbox="740 1245 797 1276"><b>Pins</b></th> <th data-bbox="1024 1245 1252 1276"><b>Voltage/Remarks</b></th> </tr> </thead> <tbody> <tr> <td></td> <td data-bbox="740 1308 748 1339">1</td> <td data-bbox="1024 1308 1138 1339">Not used</td> </tr> <tr> <td></td> <td data-bbox="740 1339 781 1371">2, 3</td> <td data-bbox="1024 1339 1122 1371">Ground</td> </tr> <tr> <td></td> <td data-bbox="740 1371 781 1402">4-6</td> <td data-bbox="1024 1371 1089 1402">-15 V</td> </tr> <tr> <td></td> <td data-bbox="740 1402 748 1434">7</td> <td data-bbox="1024 1402 1442 1455">AC LO, DC LO grounds con- nected to Pins 2 and 3</td> </tr> <tr> <td></td> <td data-bbox="740 1455 748 1486">8</td> <td data-bbox="1024 1455 1138 1486">AC LO 1</td> </tr> <tr> <td></td> <td data-bbox="740 1486 748 1518">9</td> <td data-bbox="1024 1486 1138 1518">DC LO 1</td> </tr> <tr> <td></td> <td data-bbox="740 1518 764 1549">10</td> <td data-bbox="1024 1518 1442 1581">AC LO 2 (not used on PDP- 11/60)</td> </tr> <tr> <td></td> <td data-bbox="740 1581 764 1612">11</td> <td data-bbox="1024 1581 1138 1612">Not used</td> </tr> <tr> <td></td> <td data-bbox="740 1612 764 1644">12</td> <td data-bbox="1024 1612 1442 1675">DC LO 2 (not used on PDP- 11/60)</td> </tr> </tbody> </table>	<b>J4</b>	<b>Pins</b>	<b>Voltage/Remarks</b>		1	Not used		2, 3	Ground		4-6	-15 V		7	AC LO, DC LO grounds con- nected to Pins 2 and 3		8	AC LO 1		9	DC LO 1		10	AC LO 2 (not used on PDP- 11/60)		11	Not used		12	DC LO 2 (not used on PDP- 11/60)		
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54-11086 Regulator	Refer to Paragraph 3.3.1																																
AC LO, DC LO Circuits	Refer to Paragraph 3.3.1																																

### 3.3 DC REGULATORS AND BATTERY BACKUP

#### 3.3.1 54-11086 Regulator and Power Line Monitor

The 54-11086 power line monitor (Figure 3-7) is a 15 V switching regulator that also produces power fail (AC LO and DC LO) signals. AC LO L indicates that the line voltage is below a prescribed minimum. DC LO L indicates that the line voltage is below the minimum operating tolerance and that the dc regulator circuits cannot be expected to produce an output within specified normal operating limits.

The 15 V output can be connected to provide either a -15 V or a +15 V source. If connected as a -15 V source, the LTCL and +8 V terminals should not be used. This is the case in the PDP-11/60 power system. The 54-11086s in the base and expander H7420s produce only -15 V and the AC LO, DC LO signals.

#### NOTE

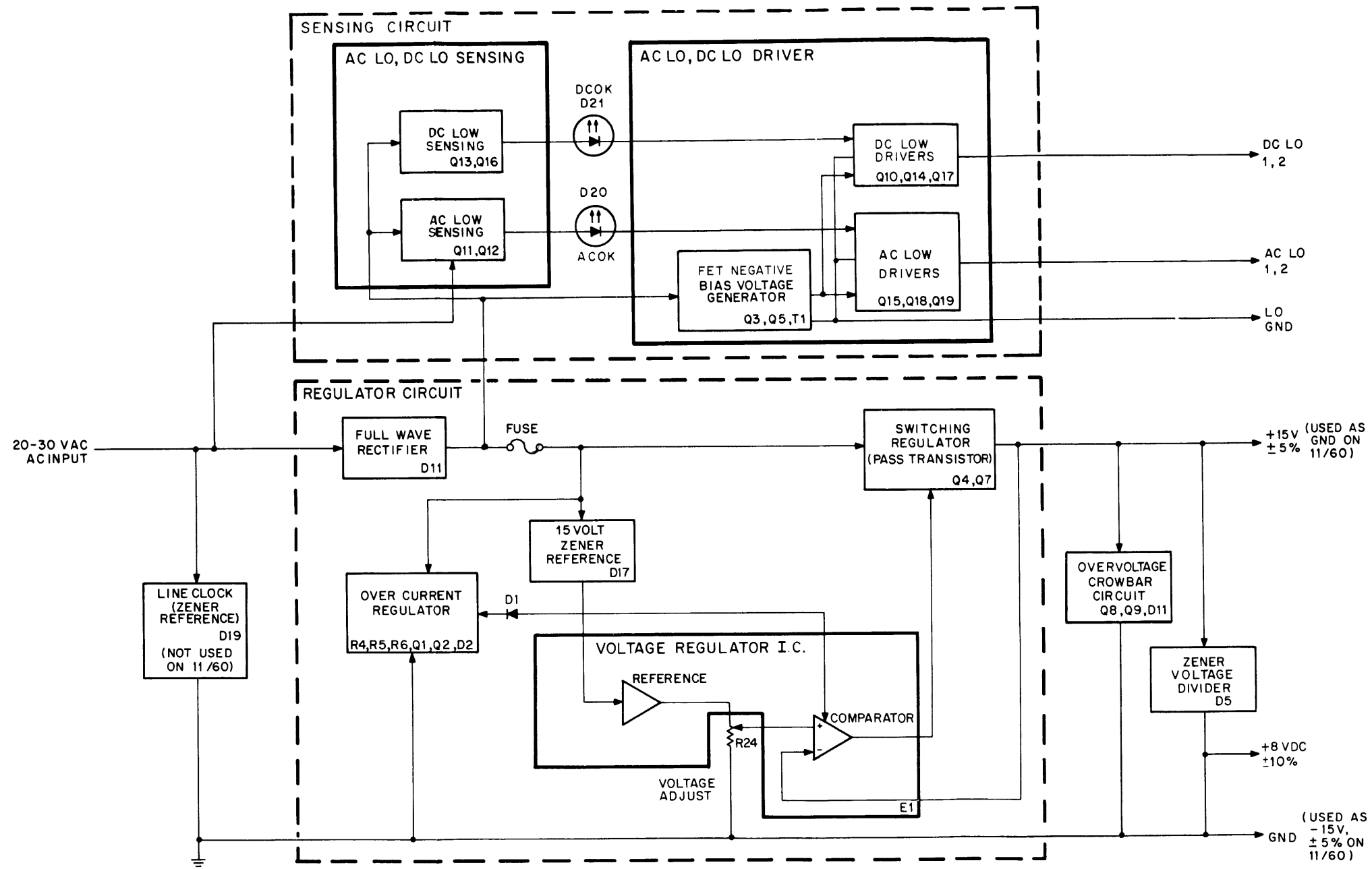
The following circuit description for the 54-11086 regulator and power line monitor discusses it as a +15 V source. When this is the case, +15 V is provided to pins P6-2, 3 and GND is provided to pins P6-4, 5, 6. The PDP-11/60, though, uses the 54-11086 as a -15 V source. The -15 V is obtained by considering pins P6-2, 3 to be GND. Since voltage potential is always at +15 V, pins P6-4, 5, 6 are -15 V, relative to the GND at pins P6-2, 3. This provides a -15 V source to the computer without altering the circuit by simply changing the location of ground.

The specifications for the 54-11086 are listed in Table 3-3. Drawing D-CS-5411086-0-1 is a circuit schematic of the 54-11086.

Table 3-3 54-11086 Specifications (-15 V)

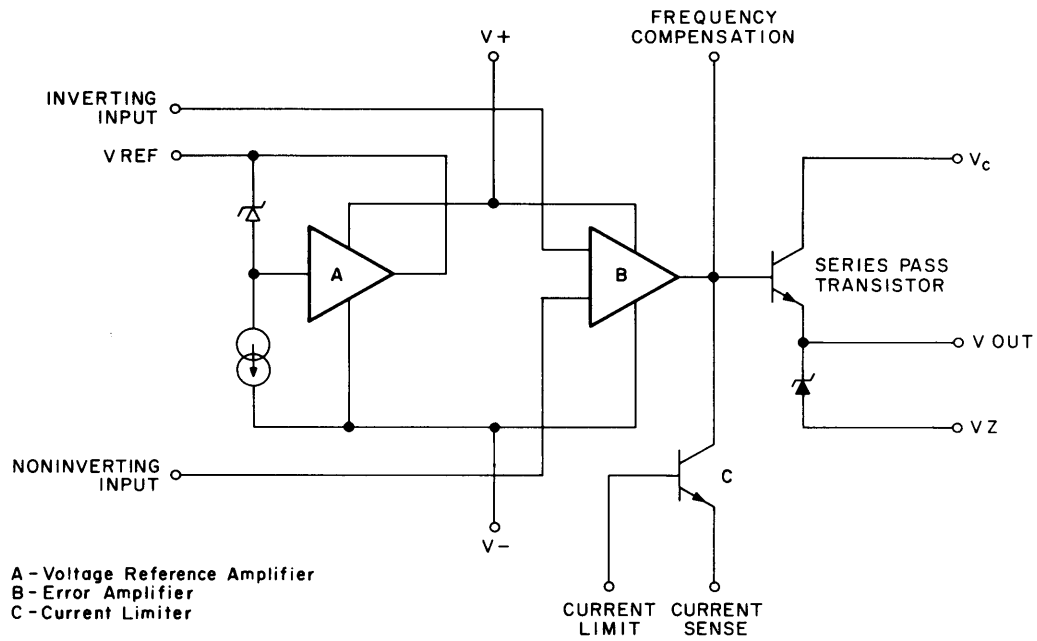
Parameter	Specification
Input Voltage, Frequency	20-33 Vac rms, 47-63 Hz
Input Power	120 W (at nominal line, full load)
Output Voltage	-15 Vdc $\pm$ 5%
Output Load	-15 V: 0-4.0 A
Adjustment	-15 V $\pm$ 1.5 V (R24)
Ripple	0.45 V peak-to-peak maximum
Backup Fuse	5.0 A
Overvoltage Protection	SCR crowbar trips at -16.5 V to -19.5 V
Output Signals	AC LO (2), DC LO (2)
Indicators	2 LEDs (AC OK, DC OK)

In the regulator circuit, the 20-30 Vac input is full-wave rectified by bridge D11 to provide dc voltage (25 to 45 Vdc, depending on line voltage and load on +15 V) across filter capacitor C1 and bleeder resistor R15. Operation centers on voltage regulator E1, which is configured as a positive switching regulator. A simplified schematic of E1 is shown in Figure 3-8. E1 is a monolithic integrated circuit that is used as a voltage regulator. It consists of a temperature-compensated reference amplifier, an error amplifier series pass power transistor, and the output circuit required to drive the external transistors. In addition to E1, the regulator circuit includes pass transistor Q7, predriver Q4, and level shifter Q6. Zener diode D17 is used with R11 to provide +15 V for E1.

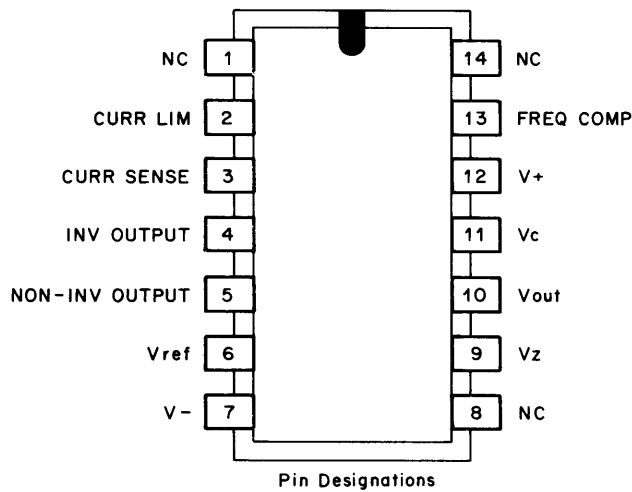


11 - 4301

Figure 3-7 54-11086 Block Diagram



Simplified Schematic



11-1895

Figure 3-8 Voltage Regulator E1, Simplified Diagram

The output circuit is standard for most switching regulators and consists of free-wheeling diode D12, choke coil L1, and output capacitor C10. These components make up the regulator output filter. Free-wheeling diode D12 is used to clamp the emitter of Q7 to ground when Q7 shuts off, providing a discharge path for L1.

In operation, Q7 is turned on and off, generating a square wave of voltage that is applied across D12 at the input of the LC filter (L1 and C10). Basically, this filter is an averaging device, and the square wave of voltage appears as an average voltage at the output terminal. By varying the period of conduction of Q7, the output (average) voltage may be varied or controlled, thus supplying regulation (Figure 3-9). The output voltage is sensed and fed back to E1, where it is compared with a fixed reference voltage. E1 turns pass transistor Q7 on and off, according to whether the output voltage level approaches its upper and lower limits (approximately +15.15 V and +14.85 V, respectively, to pins P6-2, 3 or -14.85 V and -15.15 V, respectively, to pins P6-4, 5, 6, depending on which output pins are considered ground).

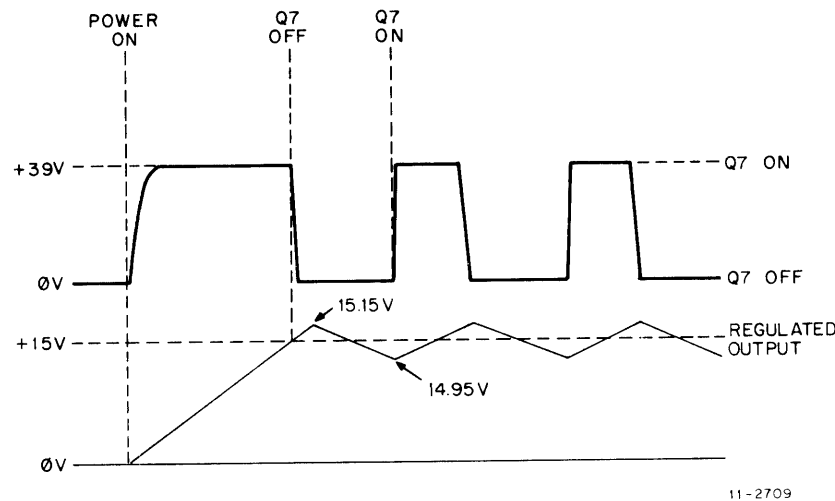


Figure 3-9 54-11086 Regulator Waveforms

During one full cycle of operation, the regulator operates as follows: Q7 is turned on and a high voltage (approximately +30 V) is applied across L1. If the output is already at +15 V level, then a constant +15 V is present across L1. This constant dc voltage causes a ramp of current to build up through L1. At the same time, output capacitor C10 absorbs this changing current, causing the output level (+15 V at this point) to increase. When the output, which is monitored by E1, reaches approximately +15.15 V, E1 shuts off, turning Q7 off; the emitter of Q7 is then clamped to ground. L1 reverses polarity and discharges through D12 into capacitor C10, and the load. Predriver Q4 is used to increase the effective gain of Q7.

Conversely, once Q7 is turned off and the output voltage begins to decrease, a predetermined value of approximately +14.85 V will be reached, causing E1 to turn on; E1, in turn, causes Q7 to conduct, beginning another cycle of operation.

Thus, a ripple voltage is superimposed on the output and is detected as predetermined maximum (+15.15 V) and minimum (+14.85 V) values by E1. This type of circuit is called a ripple regulator.

The overcurrent regulator circuit functions as a current regulator when the current, monitored at D11, exceeds 5 A. The current regulator consists of R4, R5, R6, Q1, Q2, and D2. During normal operation, Q1 and Q2 are not conducting. Q2 starts conducting when the voltage drop across R5 and R6 (sensed by D2) exceeds approximately 0.6 V. When Q2 conducts, D1 becomes forward biased and E1 is shut off, turning off pass transistor Q7 and predriver Q4. The conduction of Q2 will also turn on Q1, providing a constant current source (1 mA) to the base of Q2. Q1 will hold Q2 on until the current across R5 and R6 drop below approximately 4 A.

With Q1 and zener D2 tied to the +15 V zener reference for E1, the conduction of Q1 will hold E1 off. When Q1 and Q2 stop conducting, E1 will turn on, enabling the current to exceed the regulator limits. With a continuous overcurrent condition, Q1 and Q2 will be turning on and off, causing the circuit to become a constant current regulator.

The +15 V overvoltage crowbar circuit consists of the following components: zener diode D18, silicon-controlled rectifier (SCR) Q8, Q9, R38, R40, C13, and Q9. Under normal output voltage conditions, the trigger input to SCR D7 is at ground because the voltage across zener diode D3 is less than 18 V. If the output voltage becomes dangerously high (above 18.0 V), diode D18 conducts, turning Q9 on, and the voltage drop across R40 causes Q8 to draw gate current and triggers the SCR. The SCR fires, short circuits the output to ground, and turns off E1 by shorting out the +15 V reference at D17, through D4.

The AC LO and DC LO sensing circuit has a 20–30 Vac input from a secondary winding of transformer T1. The sensing circuits are shown on drawing D-CS-5411086-0-1, sheet 3; a simplified version is shown in Figure 3-7. The ac input is rectified by diodes D15 and D16, and filtered by capacitors C20 and C24. A common reference voltage is derived by zener diodes D13 and D14. Both sensing circuits operate similarly: each contains a differential amplifier and associated circuits. The major difference is that the base of Q12 and Q13 in the AC LO circuit differential amplifier is at a slightly lower value than that of Q16 in the DC LO differential amplifier. The operation of both sensing circuits depends on the voltage across capacitor C8. For AC LO and DC LO timing during power-up and power-down, refer to Figure 3-10. Table 3-4 lists some of the characteristics of the AC LO and DC LO circuits.

**Table 3-4 AC LO and DC LO Circuit Specifications**

Parameter	Specifications
Static Performance at Full Load Input Voltage Increasing	DC LO goes high at 70–80 Vac AC LO goes high at 85–90 Vac
Input Voltage Decreasing	AC LO goes low (asserted) at 83–88 Vac DC LO goes low (asserted) at 73–78 Vac
Hysteresis	2–4 Vac (approximately)
Output Characteristics Load	J FETs can sink 100 mA (max)
Rise/Fall Times	1 μs (max)

The AC LO and DC LO driver circuit produces the power fail signals that are sent to the backplanes. When an ac low condition is sensed, the output of differential amplifier Q12 turns off Q19. Q19 in turn gates on FETs Q15 and Q18, generating AC LO 1 and AC LO 2 signals.

Approximately 7 ms after ac low is sensed, the dc low sensing circuit will generate DC LO. The dc low sensed output from differential amplifier Q16, turns off Q10. Q10 in turn gates on FETs Q14 and Q17, generating DC LO 1 and DC LO 2 signals.

The +25 Vdc to +45 Vac from rectifier D11 is applied to T1, Q3, and Q5. Q3 and Q5, due to their switching action, create a pulsating dc which is applied to the primary of transformer T1. The output from the secondary of T1 (approximately 15 V) is rectified by D6, D7, D8, and D9, producing -10 Vdc to -15 Vdc. The -10 Vdc to -15 Vdc is a negative bias used to gate off J FETs Q15, Q18, Q14, and Q17 via Q19 and Q10. Unlike most transistors, the negative bias is used to turn off the J FETs. The J FETs are turned on when there is 0 V between gate (G) and source (S) terminals.

Light-emitting diodes D20 (AC OK) and D21 (DC OK) are normally lit. When AC LO L and/or DC LO L are asserted, the light-emitting diodes go off, indicating that this regulator is the source of the AC LO L or DC LO L on the Unibus. (The location of D20 and D21 on the H7420 54-11086 is shown in Figure 3-3.)

The following paragraphs describe AC LO and DC LO interconnections in the PDP-11/60. Figure 3-11 shows the routing of these signals through the system.

Both H7420 power supplies contain a 54-11086 power line monitor board. The ac power monitor circuits (AC LO and DC LO) are on this board. AC LO and DC LO both have two independent open collector output drivers on each 54-11086. Refer to the engineering print set for a schematic of this circuit.

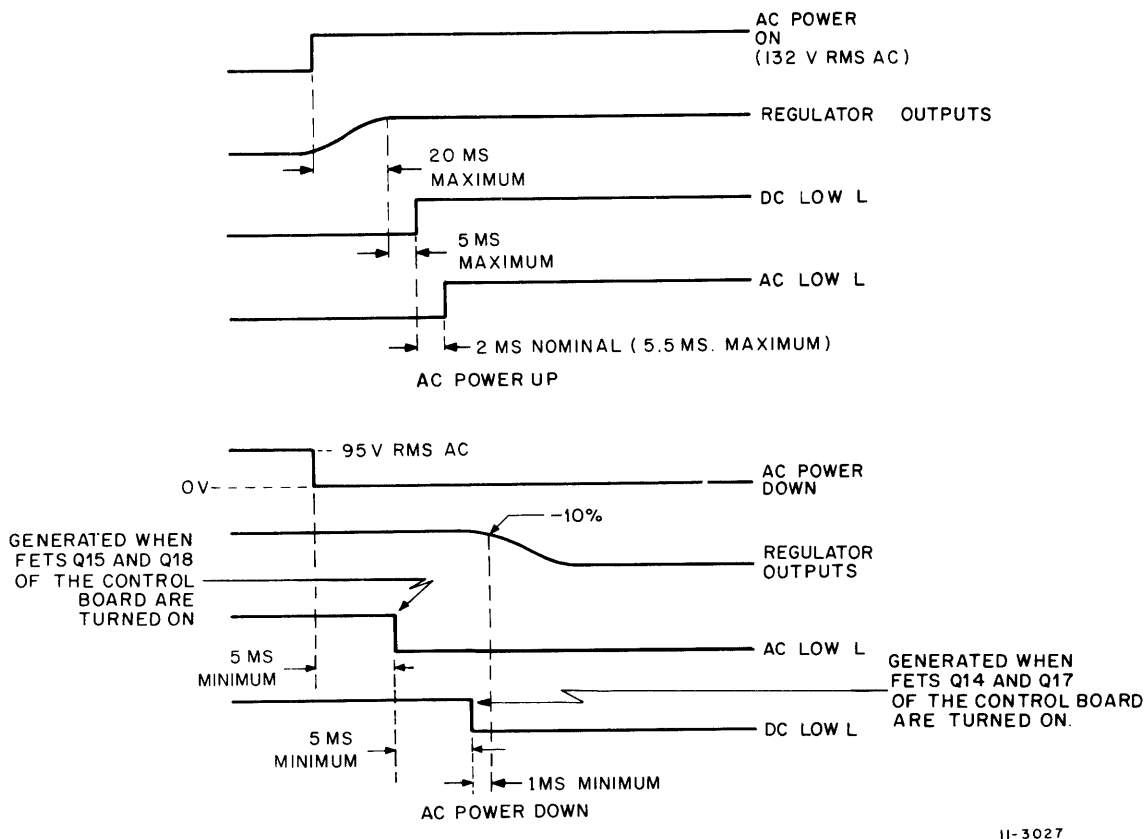
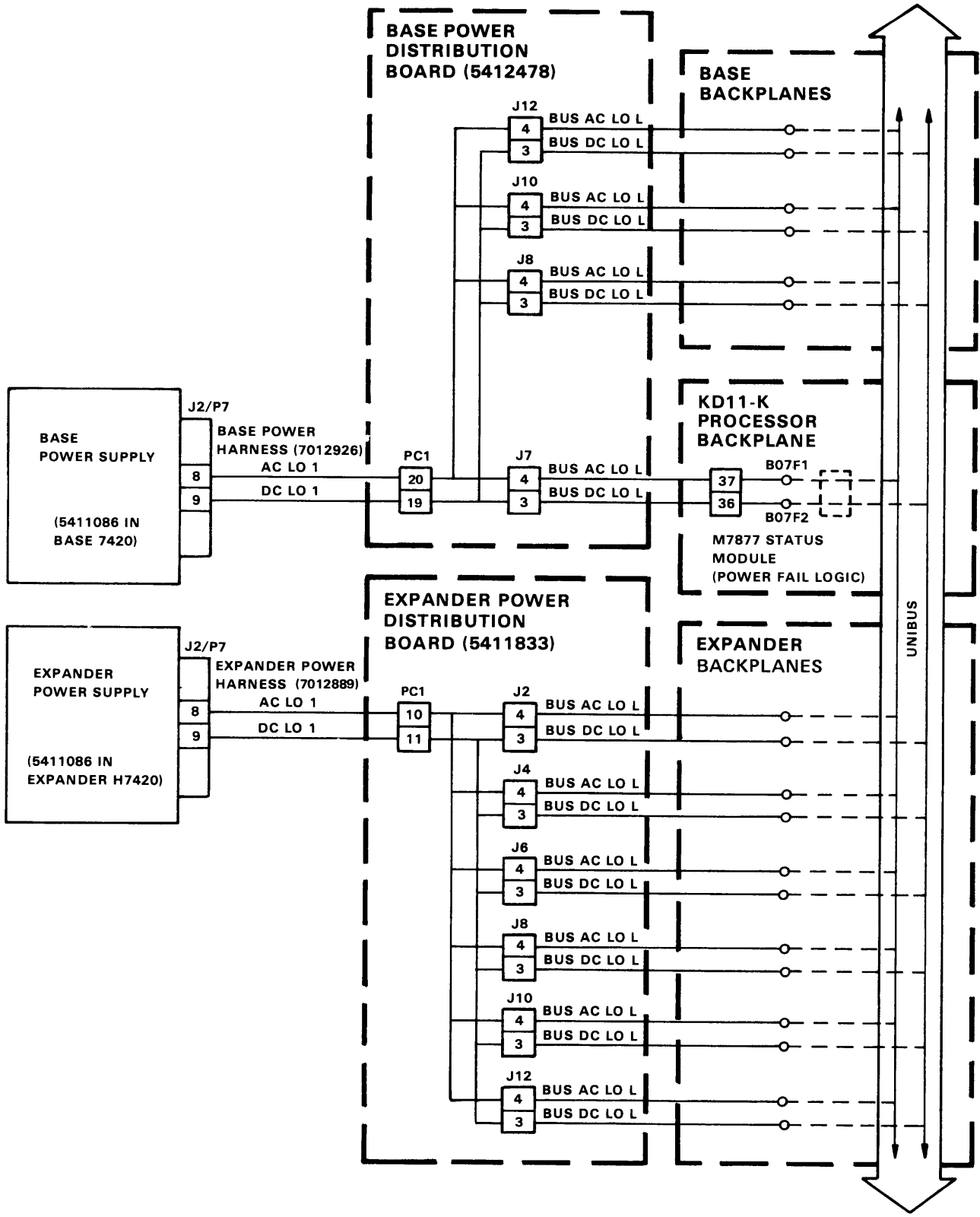


Figure 3-10 54-11086 Power-Up and Power-Down



MA-0692

Figure 3-11 AC LO and DC LO Circuits



Table 3-5 lists the AC LO and DC LO signals.

**Table 3-5 AC LO and DC LO Driver Outputs**

Signal Name	Unit	Connector-Pin
AC LO 1	Base H7420	P2/J7-8
AC LO 2	Base H7420	P2-10 (not used)
AC LO 1	Expander H7420	P2/J7-8
AC LO 2	Expander H7420	P2-10 (not used)
DC LO 1	Base H7420	P2/J7-9
DC LO 2	Base H7420	P2-12 (not used)
DC LO 1	Expander H7420	P2/J7-9
DC LO 2	Expander H7420	P2-10 (not used)

Single AC LO and DC LO circuits are formed by interconnecting all BUS AC LO L and BUS DC LO L signals on the Unibus. AC LO and DC LO signals are sent from the H7420s to the power distribution boards by way of the power harnesses. They are routed through the power distribution board connectors to the backplane in the system unit they are assigned. Both the AC LO and DC LO circuits are then interconnected from all BUS AC LO L and BUS DC LO L as the backplanes are interconnected by the Unibus.

In the KD11-K processor backplane, BUS AC LO L and BUS DC LO L are used in the PDP-11/60's power fail logic. They are routed to the M7877 status module through backplane pins B07F1 and B07F2 respectively.

### 3.3.2 H7440/H781 Regulators

There are three H7440 regulators in the base power system and two in the expander power system (Figure 1-3). Those in the base power system are placed in slots A, B, and C of the base H7420 power supply. Those in the expander power system are placed in slots H and J of the expander H7420 power supply. There is one H781 regulator in each of the base and expander systems (Figure 1-3). They are housed in slot D of the base power system and slot K of the expander power system.

These regulators are secured to the power supply chassis with three screws and are installed with the heat sink toward the back of the H7420. The mounting screws pass through the chassis holes and screw into the regulator. Visual inspection of the regulator components is permitted when the regulator is removed from the chassis. The fuses are located on the component side for easy accessibility. Table 3-6 lists the output power characteristics of the H7440 and H781 regulators.

The H7440 and H781 are very similar as they both use similar regulator boards (Paragraph 3.3.2.1) to supply +5 V to various destinations on the backplane (Table 1-1). The H7440 uses a 54-11793-YA version while the H781 uses a 54-11793-0 version. The differences between the two versions are eight components which are not used in the -YA version and which are used in the -0 version. These components are used in the H781 to produce line clock (LTC) signals and to support the H781's +15 V daughterboard. The +15 V daughterboard (P/N 54-11774) plugs into connector J2 on the -0 version of the +5 V regulator board in the H781 (Paragraph 3.3.2.2).

Circuit schematics for the regulator boards used in the H7440 and H781 regulators are shown in drawings D-CS-5411793-0-1 and D-CS-5411774-0-1.

The following paragraphs describe the regulator circuits, overcurrent sensing circuit, and the over-voltage crowbar circuit for the 54-11793 +5 V regulator board and the 54-11774 +15 V daughterboard.

**Table 3-6 Regulator Output Characteristics**

Regulator	Voltage	Tolerance	Output Current (maximum per regulator)	Peak-to-Peak Ripple	
				Maximum	Typical
H7440	+5 Vdc	-5%, +12%	25 A	5%	3.5%
H781	+5 Vdc	-5%, +12%	15-25 A*	5%	3.5%
H754	+15 Vdc	-4%, +10%	4 A	3%	2%
	-5 Vdc	±5%	1-8 A†	5%	3%
H7850	+20 Vdc	±5%	8 A	5%	3%
	+5 VBB		2.5 A		
	+12 VBB		0.1 A		
	-12 VBB		0.15 A		

\*Maximum +5 V current depends on +15 V current. It is equal to  $[15 A + (4 - I_{+15}) / 0.4]$  where  $I_{+15} = +15 V$  load current.

†Maximum -5 V current depends on +20 V current. It is equal to 1 A plus the current of the +20 V supply, up to a total of 8 A.

**3.3.2.1 54-11793 +5 V Regulator Board (H7440, H781)**– The 54-11793-YA +5 V regulator board is used on the H7440 regulator while the 54-11793-0 is used in the H781 regulator. The only differences between these versions are the components added on the -0 version to produce line clock signals and to support the +15 V daughterboard in the H781.

In the basic 54-11793 regulator board, the 20-30 Vac input is full-wave rectified by bridge D1 to provide dc voltage across filter capacitor C2 and bleeder resistor R3. Q1 and its associated components then generate +21 V to run the control circuitry. This is zenered down to create a 5.1 V reference for quad comparator E1. E1 is a monolithic integrated circuit (339) that is used as a voltage regulator. It consists of a current sense circuit, a voltage sense and regulation circuit, and the output circuit required to drive the external transistors. In addition to E1, the regulator circuit includes parallel pass transistors Q2 and Q3 and driver transistors Q4, Q5, and Q6.

In operation, Q2 and Q3 are turned on and off, generating a square wave of voltage that is applied across inductor L1. L1 and its associated components act as an averaging device and the square wave of voltage appears as an average voltage at the output terminal. By varying the period of conduction of Q2 and Q3, the output (average) voltage may be varied or controlled, thus supplying regulation (Figure 3-12). The output voltage is sensed and fed back to E1 where it is compared with the fixed reference voltage. E1 turns pass transistors Q2 and Q3 on and off, according to whether the output voltage level approaches its upper and lower limits (approximately +5.1 V and +4.9 V respectively).

During one full cycle of operation, the regulator operates as follows. Q2 and Q3 are turned on and a high voltage is applied across L1. If the output is already at a +5 V level, then a voltage equal to the input voltage minus the output voltage would be present across L1. This constant dc voltage causes a linear ramp of current to build up through L1. At the same time the output capacitor absorbs this changing current, causing the output level (+5 V at this point) to increase. When the output, which is monitored by E1, reaches the reference value of 5.1 V, E1 shuts off, turning off pass transistors Q2 and Q3. L1 then reverses polarity and discharges through D6 and the output capacitor and load, causing the current and voltage to ramp down. The voltage will ramp down until it goes below 4.9 V, turning on E1 which turns on the pass transistors, beginning another cycle of operation.

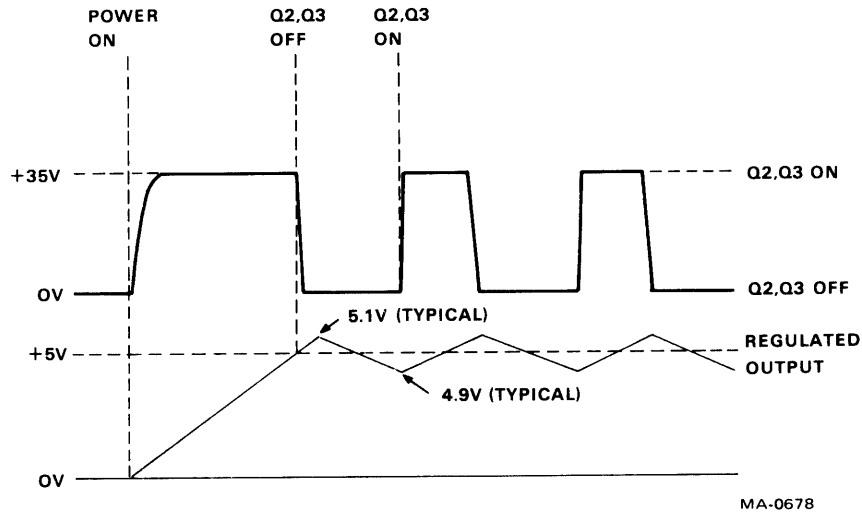


Figure 3-12 H781 and H7440 +5 V Regulator Waveforms

Transformer L2 controls the noise generated by flyback diode D6 when the pass transistor turns on. During the time between the pass transistor turning on and the flyback diode turning off, the full dc input voltage is imposed across the primary of L2, causing a linear ramp of current through the pass transistor and D6. When the pass transistor turns off, the energy stored in the primary of L2 is transferred back to the input capacitor through the secondary of L2 and diode D18. C9 and R27 absorb the energy remaining due to the leakage inductance of L2.

The overcurrent regulator circuit functions as a current regulator when the output current exceeds 32 A. The current regulator consists of R27, R28, R29, R33, Q7, E1, and their associated components. It works as follows: when the drop across R27, which is fixed by the output voltage level, is equal to the voltage across current sense resistors R28 and R29, pin 1 on E1 will pull low. This turns on Q7, pulling pin 2 on E1 high and turning off the pass transistors. The regulator is thus shut down. R25 provides hysteresis, keeping the pass transistors off until the output current decays to a preset value. Since the reference voltage across R27 is derived from the output voltage, as the output voltage falls the overcurrent point decreases, providing a foldback type overcurrent circuit. R26 provides a slight positive bias to pin 7 of the 339 to limit the foldback point, under short circuit conditions, to approximately 10 A.

The overvoltage crowbar circuit consists of SCR Q8, D13, and their associated components. Under normal output conditions, the trigger input to SCR is at ground because the voltage across zener diode D14 is less than 5.7 V. If the output voltage becomes dangerously high (above 5.7 V), diode D14 conducts, bringing up the gate of D13. When the output voltage reaches 6.2 V, D13 will fire, triggering SCR Q8. The SCR fires, pulling down the output through diode D12. It also pulls the output of the current sense comparator low through diode D10 to shut down the regulator. Resistor R6 provides holding current to the SCR, causing the regulator to latch if an overvoltage occurs.

There are two fuses on the 54-11793 +5 V regulator board. Fuse F1, a 15 A slow-blow fuse, protects the transformer in the H7420 in the event that the input bridge shorts. Fuse F2, a 15 A fast-blow fuse, protects the semiconductors in the event of regulator failure.

D15 is an LED that indicates that a +5 V regulator output is present. It is the upper of the two LEDs located on the right side of the regulator.

In the -0 version, which is used in the H781 regulator, eight components are added. These components output a line clock signal and support the +15 V daughterboard by providing the following circuitry: an indication if +15 V output is present, crowbar circuitry, and connector J2 for the daughterboard to plug into. The line clock signal (LTC L) is derived from input ac by voltage divider R1 and zener diode D2. The clock output is a 3.5 to 5.0 V square wave at the line frequency of the power source (47 to 63 Hz). The clock signal is used to drive the DL11-W clock option. The LED indicator which tells that a +15 V output from the daughterboard is present is D16 on the +5 V board. It is the lower of the two LEDs located on the right side of the regulator. The crowbar circuitry for the +15 V daughterboard is also present on the +5 V board. Diode D17 on the +5 V board crowbars the +15 V daughterboard when the Q8 fires. Q8 may be fired by 15 V through connector J2-4.

**3.3.2.2 54-11774 +15 V Daughterboard (H781)** – The 54-11774 +15 V daughterboard is used in the H781 regulator. It plugs into connector J2 on the 54-11793-0 +5 V regulator board (motherboard) (Paragraphs 3.3.2 and 3.3.2.1). The daughterboard supplies +15 Vdc through J2 on the +5 V board to all system units. It receives +22 to +42 Vdc and the reference voltage from the motherboard through J2 (Table 3-7).

**Table 3-7 J2 Pin Connections from 54-11793 Motherboard to 54-11774 Daughterboard**

Pin	Connection	Pin	Connection	Pin	Connection
Pin 1	+15 V	Pin 5	+V	Pin 9	GND
Pin 2	+15 V	Pin 6	V ref	Pin 10	GND
Pin 3	Not Used	Pin 7	Shutdown	Pin 11	+22 to +42 Vdc
Pin 4	Crowbar Trip	Pin 8	GND	Pin 12	+22 to +42 Vdc

The functioning of the daughterboard is very similar to that of the motherboard. E1 (339) is again used as a voltage regulator which consists of a current sense circuit, a voltage sense and regulation circuit, and the output circuit to drive external transistors. In addition to E1, the regulator circuit includes pass transistor Q1 and driver transistors Q3 and Q4.

To generate a square wave of voltage across L1, Q1 is turned on and off. L1 and its associated components act as an averaging device and the square wave of voltage appears as an average voltage at the output terminal. By varying the period of conduction of Q1, the output (average) voltage may be varied or controlled, thus supplying regulation (Figure 3-13). The output voltage is sensed and fed back to E1 where it is compared with the fixed reference voltage which comes from pin J2-6, through resistor R12, to E1. E1 turns pass transistor Q1 on and off, according to whether the output voltage level approaches its upper and lower limits (approximately +15.15 V and +14.85 V, respectively).

The cycle of operation of the +15 V daughterboard is practically the same as that of its motherboard. The major difference is that in the daughterboard L2 is just an inductor instead of a transformer as it is in the motherboard. Instead of transferring the stored energy back to the input line, it is dissipated through R3 in the daughterboard.

The overcurrent regulator circuit functions as a current regulator when the output current exceeds 6 A. The current regulator consists of R17, R18, R19, Q5, E1, and their associated components. Its operation is practically identical to that of the motherboard's overcurrent regulator. When the drop across R17, which is fixed by the output level, is equal to the current sense resistor, R19, pin 1 on E1 will pull low. This turns on Q5 which turns off the pass transistor and shuts down the regulator. The current will then fold back to approximately 2 A under short circuit conditions.

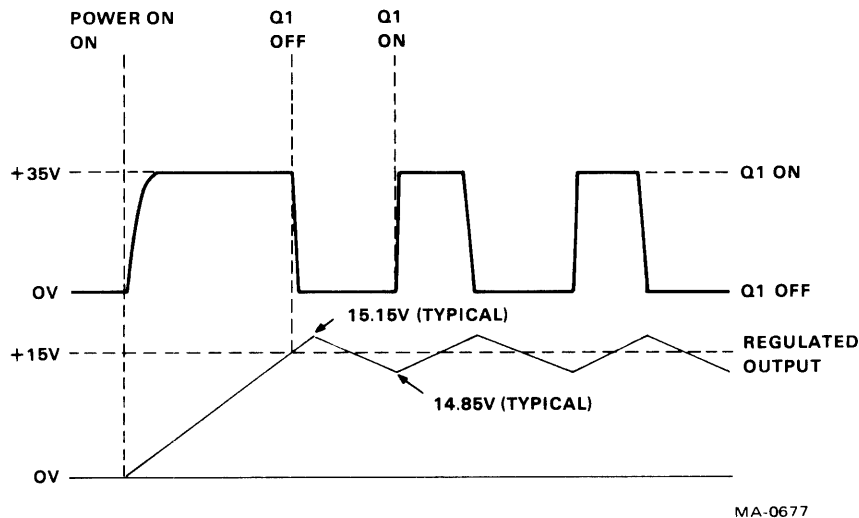


Figure 3-13 H781 +15 V Regulator Waveforms

The overvoltage crowbar circuit for the +15 V daughterboard is tied into the main overvoltage crowbar circuit on the motherboard. The overvoltage sensor circuit for the daughterboard is composed of Q6, D7, R25, and R26. If the output voltage becomes dangerously high (above 18 V), zener diode D7 conducts, turning on Q6. The voltage then passes through pin J2-4 to turn on Q8 on the motherboard. When the SCR on the main board fires, regardless of whether the overvoltage failure is on the +5 V or +15 V boards, pin 1 of E1 on the daughterboard will be pulled low through D6 (through J2-7). This turns on Q5, which turns off the pass transistor and shuts down the daughterboard.

The fuse on the 54-11774 +15 V daughterboard is a 5 A fast-blow fuse. It protects the regulator from an overcurrent input from the motherboard.

### 3.3.3 H754 Regulator

There is one H754 regulator in each of the base and expander power systems (Figure 1-3). The one in the base power system is placed in slot E while the one in the expander power system is placed in slot L. However, if a MF11S-KF MOS memory system is used in the PDP-11/60, the H754 regulator in the base power system is replaced by an H7850 regulator. (An H775 MOS battery backup is also added in MOS-configured systems. Refer to Paragraph 3.4 for more MOS configuration power system information.)

These regulators are secured to the power supply chassis with three screws and are installed with the heat sink toward the back of the H7420. The mounting screws pass through the chassis holes and screw into the regulator. The fuse is located on the component side. Table 3-6 lists the output power characteristics of the H754 regulator.

Circuit schematics for the H754 regulators is shown in drawing D-CS-H754-0-1.

The following paragraphs describe the regulator circuit, overcurrent sensing circuit, and the overvoltage crowbar circuit for the H754 regulator.

The regulator circuit in the H754 has a voltage double input, but the output consists of two shunt regulator circuits, one for the +20 V, the other for the -5 V. The +20 V shunt regulator consists of transistors Q4, Q10, and Q11; the -5 V shunt regulator consists of Q6 and Q9. Q10 and Q11 are the pass transistors.

The output of the basic regulator is 25 V (-5 to +20 V). The shunt regulators are connected across this output, with a tap to ground between pass transistors Q9 and Q10. The voltage at the bases of Q6 and Q4 will vary with respect to ground, depending on the relative amount of current drawn from the +20 V and -5 V outputs of the regulator. If the +20 V current increases while the -5 V current remains constant, the output voltage of the +20 V output will tend to go more negative with respect to ground; this will also cause the -5 V output to go more negative, since the output of the basic regulator is a fixed 25 V. This change is sensed at the bases of Q6 and Q4; Q6 will conduct, causing Q9 to conduct also, increasing the current between -5 V and ground until the balance between the +20 V and the -5 V is restored. At this time, neither Q6 nor Q4 will be conducting. If the -5 V current increases, Q4 and Q10 will conduct to balance the outputs.

The H754 has two crowbar sense circuits: Q7 and its associated components for the +20 V and Q12 its circuitry for the -5 V. Either one will trigger SCR D9.

The H754 overcurrent circuit comprises Q1, Q8, Q13, Q14, and associated circuitry. The total peak input current is sampled through R4. When the peak current reaches approximately 14 A, Q1 turns on sufficiently to establish a voltage across R7 and R38, firing Q8. This pulls the voltage on pin 4 of the 723 up above the reference voltage on pin 5, shutting off Q2. D6 now conducts, and the current through R37 turns on Q14, which turns on Q13. This keeps Q8 on for a time which is determined by the output voltage and L1. This action, in turn, allows the off-time to increase as the overload current increases, thereby changing the duty cycle in proportion to the load. The output current is thus limited to approximately 10 A.

### **3.4 MOS MEMORY CONFIGURATION POWER SYSTEM**

MOS memory configurations in the PDP-11/60 have different power requirements which cannot be handled by the core memory PDP-11/60 power system configuration. The requirements include +5 VBB, +12 VBB, and -12 VBB to power the memory, as well as a battery backup unit (BBU) to allow information stored in memory to be retained in the event of a power failure. In order to fulfill these requirements, additions and changes must be made to the system. The main differences between the MOS and core power configurations are the following:

1. An H7850 +5 VBB, +12 VBB, -12 VBB regulator is placed in slot E of the base H7420 power supply, replacing the H754 +20 V, -5 V regulator used in the core systems.
2. An H775 battery backup unit (BBU) is added to the system.

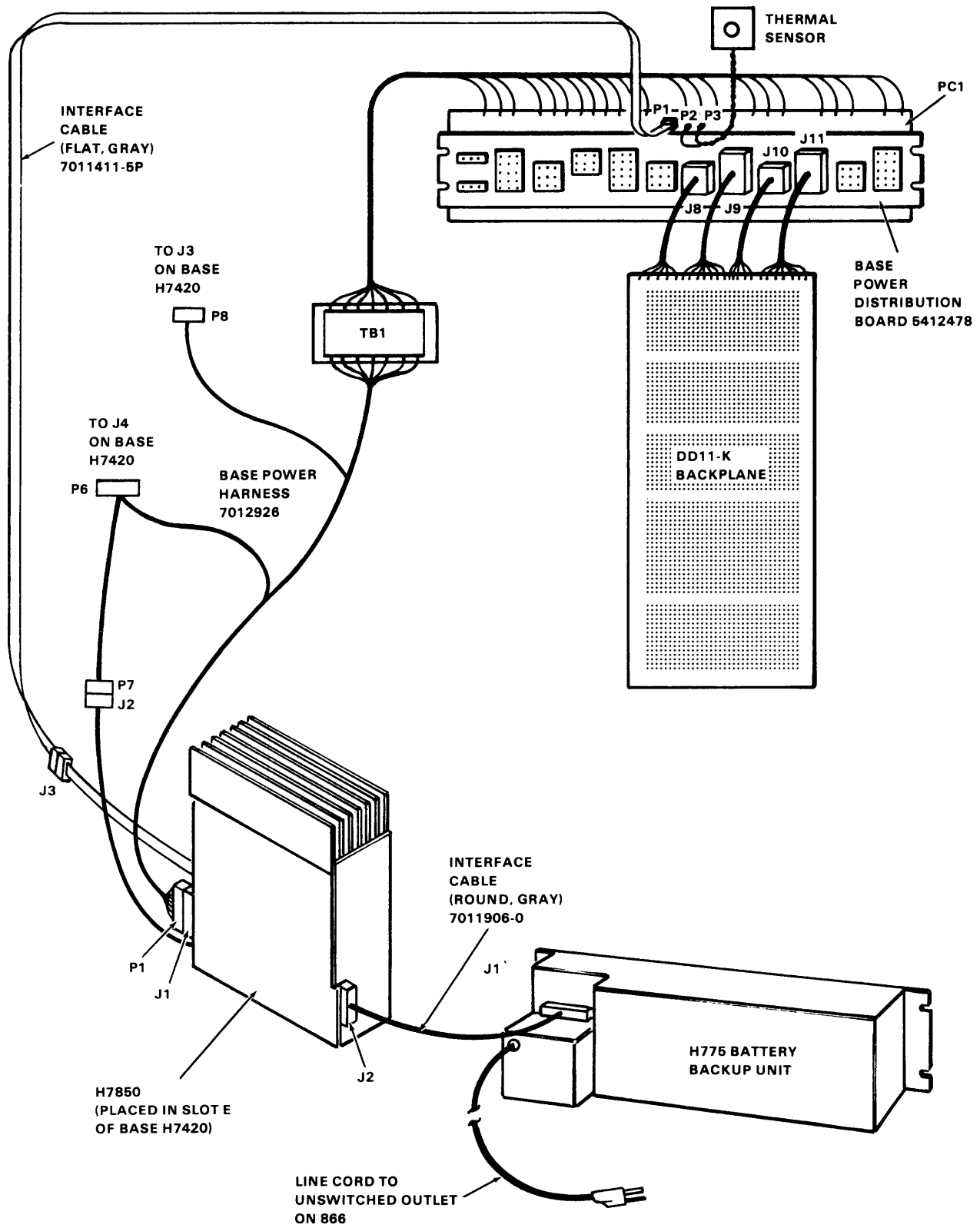
The H775 battery backup unit will take over and provide battery input voltage to the MOS regulator for a limited time in two cases:

1. When powering down and the console rotary switch is set to STD BY (standby mode).
2. During an ac power failure and the console rotary switch is set to either POWER or STD BY.

The console rotary switch located on the KY11-P console of the PDP-11/60 can be defined as follows:

POWER	All logic and fans are powered.
STD BY	MOS refresh voltage buses are powered. All other power is off.

Refer to Figure 3-14 for MOS memory configuration interconnections. These interconnections are described in the following paragraphs.



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Figure 3-14 PDP-11/60 MOS-Configured Power Connections

The MF11S-KF MOS memory DD11-K backplane is housed in system units 4 and 5 of the base card cage in the basic PDP-11/60 system. The modules which plug into the backplane contain the MOS memory arrays and controller. Power is supplied to the backplane via connectors J8, J9, J10, and J11 on the base power distribution board. These connectors obtain their power from the base power harness whose wires are soldered to PC1 on the base power distribution board. This harness is connected to the regulators in the base H7420 (including the H7850 regulator) where the necessary dc and battery backup voltages to run the MOS memory are obtained.

Connectors P1, P2, and P3 on the base power distribution board are also parts of the MOS memory configuration power system. The flat gray cable (P/N 70-11411-5F), which connects the H7850 regulator to the base power distribution board, plugs into connector P1. This connection keeps the processor informed of the battery and regulator status through connector J6 on the power distribution board. It also keeps the regulator informed of processor boot status, the position of the console rotary switch, and of the occurrence of an overtemperature over the MOS modules. Refer to Paragraph 3.4.1 for a description of the signals carried over the flat gray cable. P2 and P3 are the connections for the thermal sensor which monitors the temperature over the MOS modules.

The H7850 regulator has four external connectors: J1, J2, J3, and P7. These are used to connect the H7850 to the power distribution board, the H7420 power supply, and the H775 BBU. J3 is the connection on the H7850 for the flat gray cable (P/N 70-11411-5F) which goes to P1 on the power distribution board. J1 and P7 connect the H7850 with the H7420 power supply through the base power harness. J1 brings in 20–30 Vac while P7 accepts the AC LO/DC LO signals from the 54-11086 power line monitor to keep the H7850 informed of power status. J1 is also the connection which sends regulated voltages to the power distribution board for use by the MOS modules.

J2 connects the H7850 with the H775 BBU. This connector is mated with the round gray cable (P/N 70-11906). It accepts ac power from the H775 which obtains it from an unswitched outlet on the 866 power controller. The H7850 uses this to provide 28–48 V raw dc back to the BBU for use in trickle charging the batteries. Inputs to connector J2 also keep the H7850 informed of the battery status and charge mode in the BBU.

### **3.4.1 H7850 Regulator Physical Description**

In MOS-configured systems, an H7850 regulator is placed in slot E of the base H7420 power supply. It supplies +5 VBB, +12 VBB, and –12 VBB to the MOS memory modules. It also works in conjunction with the H775 battery backup unit to provide power to the MOS memory during a power failure or computer shutdown.

The regulator is secured to the power supply chassis with three screws and is installed with the heat sink toward the back of the H7420. The mounting screws pass through the chassis holes and screw into the regulator. Visual inspection of the regulator components is permitted as there is no cover on the component side. This also makes the fuse accessible.

There are four PC boards on the H7850: a 54-12343 battery backup regulator (motherboard), a 54-12385 control board, a 54-12411 input rectifier board, and a 54-13013 +12 V regulator board. The motherboard and the control board are connected at J4. The input rectifier board and the motherboard are connected at J5 and J6. The motherboard contains the regulator, overcurrent sensing, and overvoltage crowbar circuitry. The control board contains the AC LO, DC LO, battery monitor and boot enable circuitry. The input rectifier board contains the diodes necessary to rectify the ac input from the BBU and a fuse to protect the regulator.

The four external connectors on the H7850 regulator are labeled J1, J2, J3, and P7. J1 is located at the top of the regulator when it is mounted. Its connection is to the base power harness. J3 and P7 are located on wires running out of the top of the H7850 next to J1. J3 is the 8-pin connector which the flat gray cable to P1 on the power distribution board plugs into. P7 is a 2-pin connector which accepts the



AC LO, DC LO signals. Its connection is to P7 on the base power harness. The connection to the round gray cable to the BBU is J2, which is located on the bottom of the regulator. Access to J2 is through the hole below the H7850 on the bottom of the H7420 power supply.

The following paragraphs describe the circuits contained in the H7850 regulator. Table 3-6 lists the output power characteristics of the H7850.

### 3.4.2 Circuit Description (Refer to Print Set Schematics)

#### NOTE

**The print set schematics consist of four PC boards that contain the H7850 regulator circuitry:**

<b>Motherboard</b>	<b>D-CS-5412343-0-1</b>
<b>Control Board</b>	<b>D-CS-5412385-0-1</b>
<b>Rectifier Board</b>	<b>D-CS-5412411-0-1</b>
<b>+12 V Regulator Board</b>	<b>D-CS-5413013-0-1</b>

The H7850 regulator contains the following circuits:

- Regulator
- Overcurrent Sensing
- Overvoltage Crowbar
- AC LO, DC LO
- Flasher and Battery Monitor
- Boot Enable

**3.4.2.1 Regulator Circuit** – This regulator may receive inputs by any of three sources. The main 20–30 Vac input at J1-7 and 8 is taken from the secondary of transformer T1 in the base H7420 power supply. A second ac input (20–30 Vac) is taken from transformer T1 in the H775 BBU via J2-7 and 8 (if this option is connected to the system). The third input is also from the BBU via J2-3 if the BBU is used. This is a dc input from the battery pack and is available for a limited time should ac input power be removed or lost.

The main ac at J1-7 and 8 is full-wave rectified by bridge D1 through D4 and filtered by C1, providing raw dc at the anode of D9. If the BBU is in the system at this time, ac is also at J2-7 and 8. It is rectified by diodes D10 and D11, providing another source of raw dc. The third source of input power is pure dc (BAT IN) from the BBU battery pack. It is brought directly into the regulator at J2-3 and presented at the cathode of D9. This input is available only when the ac inputs are not present. The function of D9 is to prevent the battery backup power from going back out to the H775.

With raw dc (battery dc if necessary) present at the cathode of D9, Q1 is turned on and with its associated components provides a pre-dc regulation. This dc is fed to the center tap of the T2 primary and in conjunction with Q2, Q3, and C4 is chopped and induces a voltage into the T2 secondary. One part of the secondary voltage is rectified by bridge D13, D14, D17, and D18 and filtered by C12 and C13 to provide +15 V output to J1-1 and –12B to J1-6. The other part of the T2 secondary voltage is rectified by D15 and D16, filtered by C14, C15, and L3 and provides +5B output to J1-4. Feedback voltage is also taken from the +5B point to provide the actual regulation for all three voltage outputs, since they are fixed by the transformer windings turns ratio. This feedback is accomplished in the following manner. A line from J1-4 goes to the control board via pin 15 of P4/J4. This feedback connects to pin 2 of operational amplifier E3 via R24. E3 provides a correction factor at output pin 6. This is fed directly to the control (pin 3) of the modulator which is fed to the base of Q7 on the regulator board via R21 and pin 12 of P4/J4.

The basic operation of the H7850 regulator begins with the linear regulator on this board, which consists of Q5, D19, and R5. With raw dc present, Q5 is turned on and +14 V at the emitter is available to power the 555 timer chips and the operational amplifiers. E1 on the motherboard is the clock for the regulator. It produces a 20 kHz square wave output at pin 3. This output goes to two places.

1. To the junction of D2 and D3. This drives the outputs of Q8 and Q9, which increases the clock output current to the primary of the small driver transformer (T1). A voltage is induced into the T1 secondary (pins 3, 4, and 5), causing Q2 and Q3 to drive the primary of T2. Voltage is induced in the T2 secondary, the level of which is determined by the raw dc regulator voltage at pin 2 of the T2 primary (discussed earlier) and the amount of current through the T2 primary. A regulation is achieved from this situation by raising and lowering inputs to the output rectifier bridge (D13, D14, D17, and D18).

A second voltage is developed across the T1 secondary (pins 6 and 7) and rectified by D6, D7, D8, and D20 to provide a -3 V bias for operational amplifiers E2 on the motherboard and E3 on the control board. This is to prevent them from running into common mode problems when the inputs get close to the negative supply voltage.

2. To pin 2 of E2 on the control board via C9 and pin 1 of P4/J4. This pulse is differentiated by C9 on the motherboard and R19 and R21 on the control board to produce a negative-going spike to trigger E2. Output pin 3 goes high, turning on the power train that consists of Q1, Q4, and Q7, with Q1 being the main power switch. This train operates in the following manner. Output pin 3 from the pulse width modulator (E2) on the control board is fed to the base of Q7 on the motherboard via R21 and pin 12 of P4/J4. Q7 turns on, causing Q4 to turn on which drives Q1 on.

A small inductor (L2) from the base to emitter of the main power switch (Q1) provides a fast turn-off mechanism for Q1 when the output of E2 on the control board goes low. This operates as follows. When Q1 turns on, current starts to build up in L2 with the polarity next to R4 being more negative than at the base of Q1. When Q4 turns off, the polarity on L2 changes state and the current buildup now discharges through Q1, providing fast turn-off.

The turn-off point of the power train is determined by two conditions. One is the voltage on pin 5 of E2 on the control board which is output pin 6 of E3. The other means of providing turn-off is determined by the charge on capacitor C7. When the charge in C7 approaches the voltage at pin 5 of E2, output pin 3 goes low and E2 shuts off until the next trigger pulse arrives at pin 2.

The charge on C7 is determined by the raw dc input. R17 at the high side of C7 looks at the raw dc input on the motherboard via pin 10 of P4/J4 (BAT IN). If the raw dc is around 20 V, C7 would take a fixed amount of time to charge up. Pins 6 and 7 being directly connected to this same point would equal this voltage. When the voltage on pins 6 and 7 approaches the voltage on pin 5, the 555 changes state and shuts off.

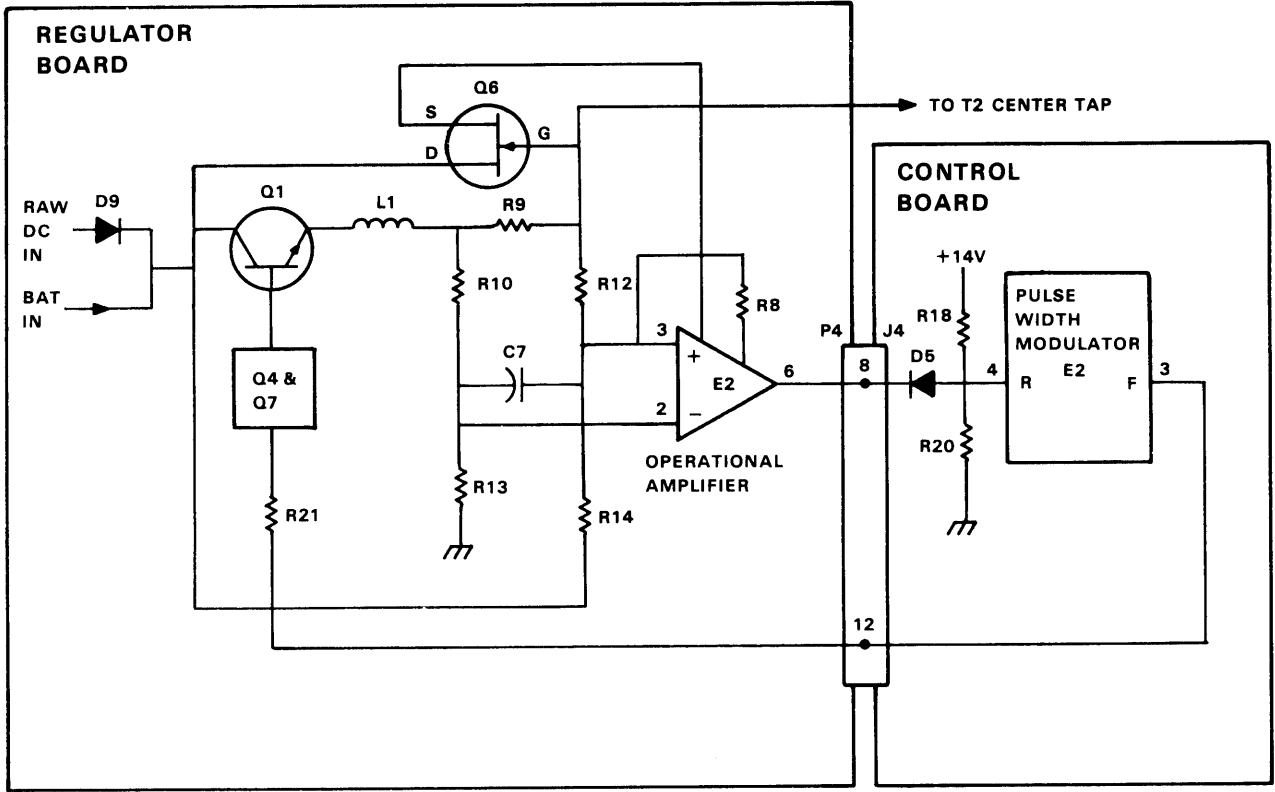
If the same raw dc input was at 40 V instead of 20 V, C7 would charge up in a shorter time. The voltage on pins 6 and 7 would approach the pin 5 voltage in less time, thereby causing a narrower input pulse, and E2 would remain off for a relatively longer time, causing narrower pulse width outputs at pin 3 of E2.

The voltage at pin 5 of E2 is a feedback voltage generated by the operational amplifier E3 on the control board and operates in the following manner. Pin 3 of E3 provides reference voltage that is set by R22 on the motherboard. When the +5B output voltage of the H7850 increases or decreases, it is sensed at pin 2 of E3. It is then compared with the reference voltage at pin 3 and a correction output occurs at output pin 6. The E3 output is directly fed to pin 5 of E2, providing the turn-off voltage level for the 555.

**3.4.2.2 Overcurrent Sensing Circuit** - The overcurrent sensing circuit consists mainly of the components shown in Figure 3-15. For more overall circuit detail, refer to print set schematics.

When current through Q1 increases above the regulator's specifications, it is sensed by resistor R9, which places the input to operational amplifier E2 more positive. Output pin 6 of E2, which is normally at approximately +14 V, goes low and pin 8 of P4/J4 is pulled low, causing diode D5 to be forward biased. The reset, pin 4 of pulse width amplifier E2, is pulled near ground, shutting off E2. Output pin 3 goes low and remains in this state until the reset goes high.

The associated components of the overcurrent sensing circuit perform the following functions: R8 adds hysteresis; R10, R12, R13, and R14 provide proper bias for the appropriate trip point so that current-limiting occurs at the proper value. C7 is used to suppress noise at input pins 2 and 3. The field effect transistor (FET Q6) maintains the voltage at pin 7 of E2 at a higher voltage than the input voltage at pins 2 and 3 for E2 to operate.



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Figure 3-15 H7850 Overcurrent Sensing Circuit

**3.4.2.3 Overvoltage Crowbar Circuit** – The overvoltage crowbar circuit consists mainly of the components shown in Figure 3-16. For more overall circuit detail, refer to the print set schematics.

As the voltage on the +5B line increases, it is sensed by zener diode D15. When voltage across D15 increases to approximately 6.0 V, D15 conducts, causing the gate of SCR D14 to go positive via R29 and D14 turns on. This clamps reference zener diode D11 to ground, thus providing two means of shutting off the regulator.

1. Pin 3 of error amplifier E3 is pulled down to approximately +1.0 V via P4/J4-20, R22, R1, and pin P4/J4-18, causing output pin 6 of E3 to go low.
2. The E1 clock is reset at the pin 4 input. This is due to D5 being reverse biased by the low on pin 20 of P4/J4.

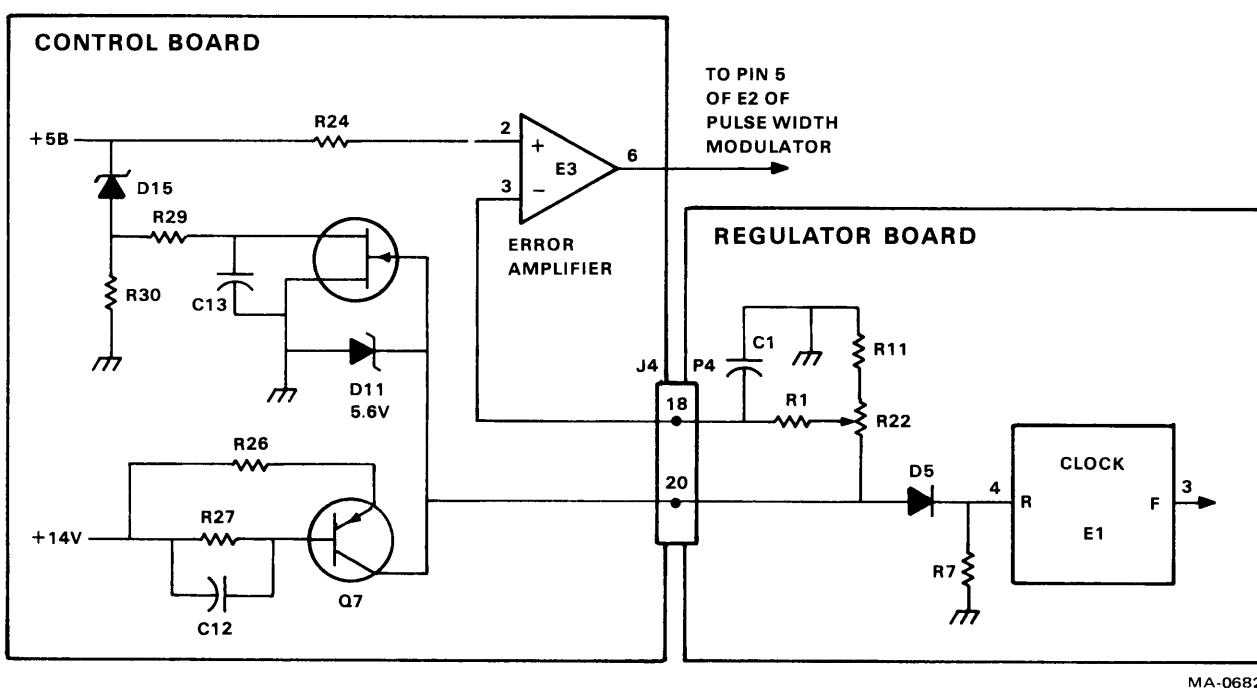


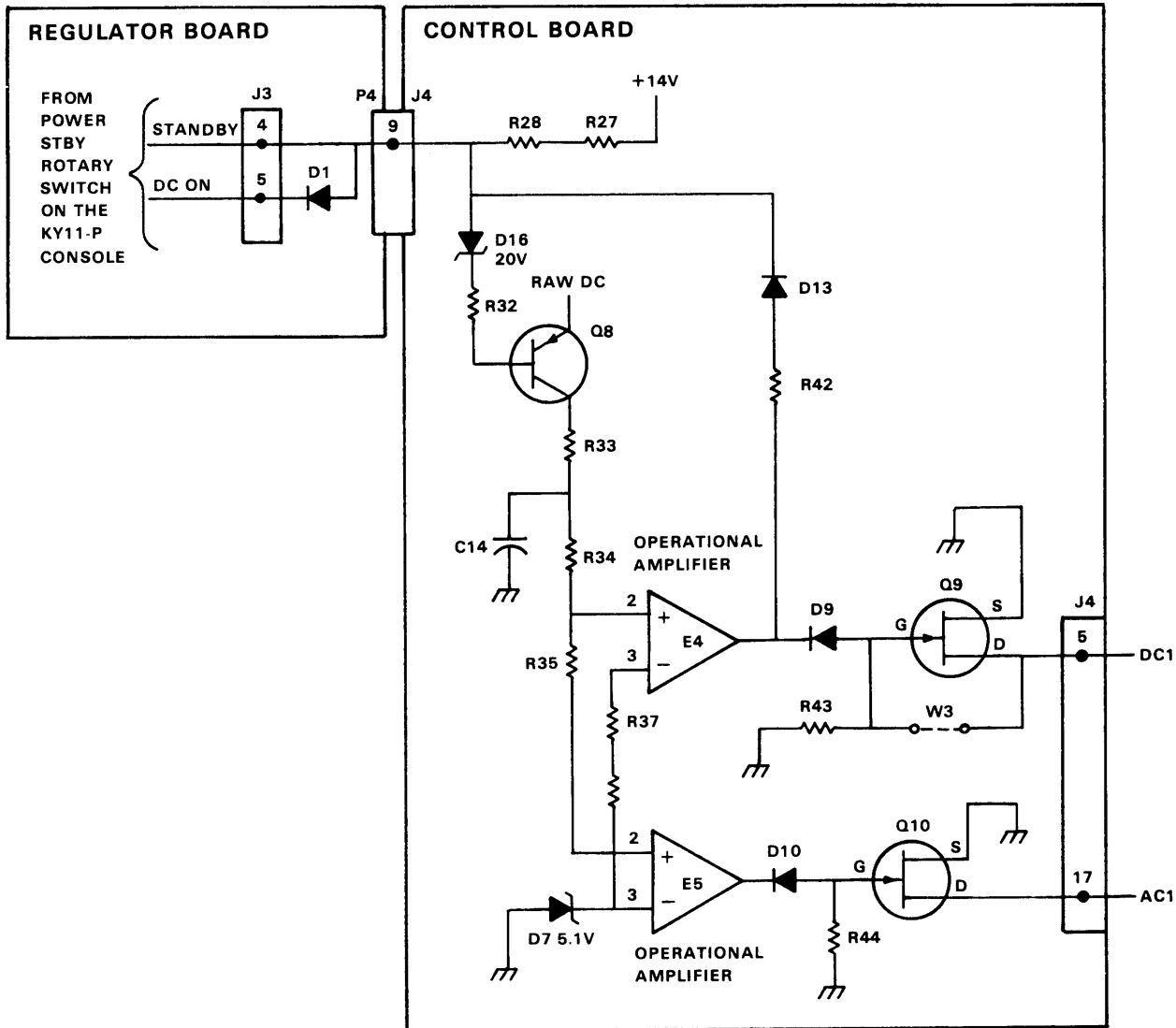
Figure 3-16 H7850 Overvoltage Crowbar Circuit

**3.4.2.4 AC LO, DC LO Circuit** – The AC LO, DC LO circuit consists mainly of the components shown in Figure 3-17. For more overall circuit detail, refer to print set schematics.

When the system is turned on, the anode of zener diode D16 is at ground via the POWER/STD BY rotary switch on the KY11-P console (switch set to POWER or STD BY). Raw dc is also available at the emitter of Q8.

When the threshold voltage across zener diode D16 is sufficient to turn on Q8, capacitor C14 charges up. A positive voltage is applied to pin 2 of the operational amplifiers (E4 and E5) and is compared to the fixed reference voltage on pin 3. When pin 2 approaches the voltage on pin 3, the amplifier changes state and output pin 6 goes low. This allows the gate of D9 and D10 to go low due to forward biasing of D9 and D10, causing field effect transistors (FET) Q9 and Q10 to turn off, DC LO to go high, then AC LO to go high.

When the CPU control panel switch is set to OFF, the anode of D16 is near +14 V, preventing Q8 from turning on. Pins 2 of the operational amplifiers (E4 and E5) remain low, keeping output pins 6 high. FETs Q9 and Q10 turn on and the outputs at J4-5 and 17 go to ground, causing AC LO to go low, then DC LO to go low.



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Figure 3-17 H7850 AC LO and DC LO Circuit

**3.4.2.5 Battery Flasher Circuit** – The battery flasher circuit consists mainly of the components shown in Figure 3-18. For more overall detail, refer to print set schematics.

This circuit is used to monitor the battery pack in the BBU. When the BBU option is used in the system, the MON EN (pin J2-6) is at ground. This places the base of Q1 at ground which enables the clock (E1) to turn Q1 on or off.

E1 can run at two frequencies: it can be latched high (on), or it can be off. The battery flasher output at J3-2 (BAT MON) corresponds to this operation and is monitored on the KY11-P console LED display. When the LED is OFF, it indicates that either the BBU is not connected in the system or that the battery pack is dead.

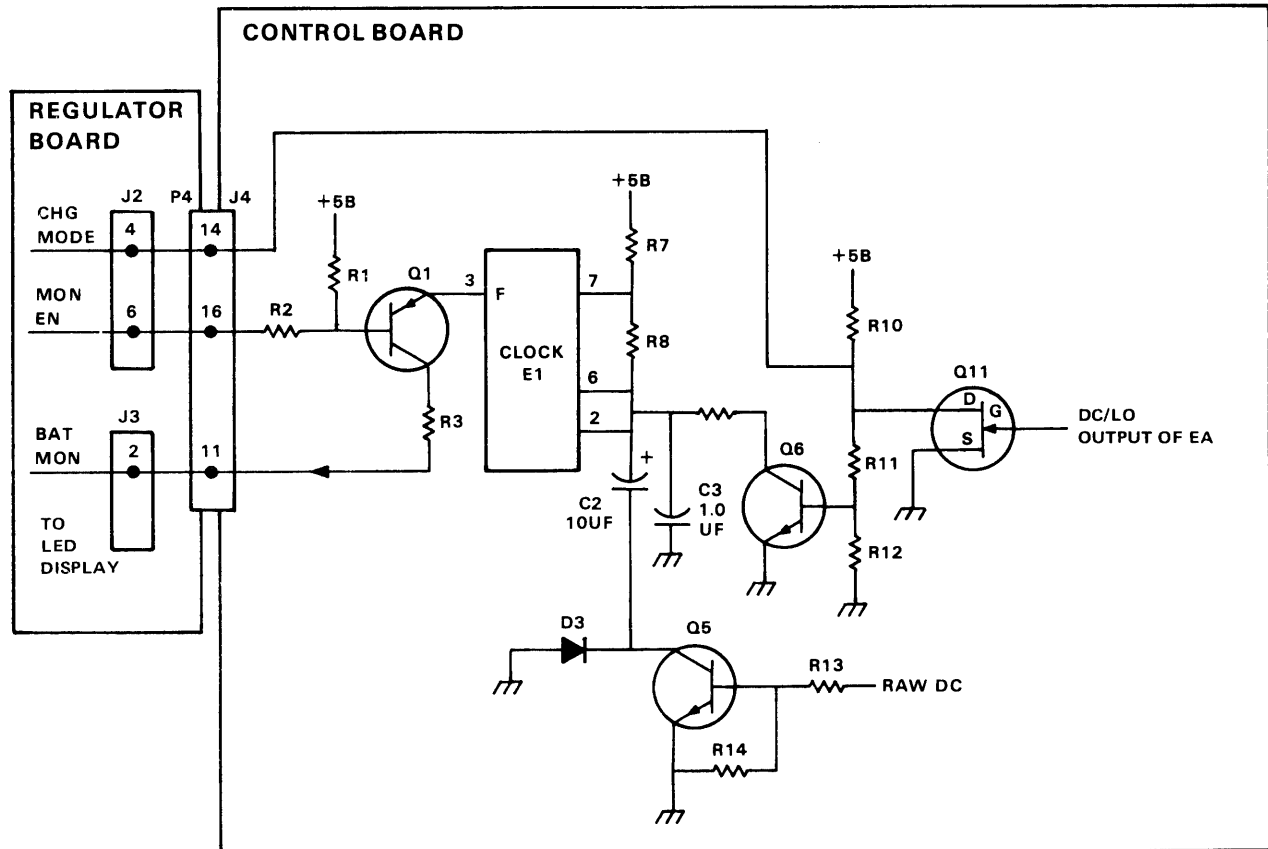
When the LED is flashing slowly, it indicates that the battery pack is being charged up at a fast rate. When the LED is flashing fast, it indicates that the battery pack is discharging. When the LED is on all the time, it indicates that the battery pack is fully charged or almost fully charged. Table 3-8 gives the operation of the battery monitor functions.

The circuit operates in the following manner. When raw dc is present, Q5 is turned on via R13 and Q6 is ON via R10. With Q5 on, C2 is placed in the circuit along with C3. The total capacitance of C2 and C3 provides slow trigger pulses to E1, with Q6 providing the discharge path. The slow operation of E1 causes the LED on the control panel to flash slowly. If raw dc decreases, Q5 will turn off, removing C2 from the circuit. The trigger pulses to E1 increase and the LED flashes fast. When the regulator is turned off, +5B is removed and Q6 is turned off. The gate of Q11 goes low, turning Q11 on. This guarantees that the CHG MODE at J2-4 remains low when the regulator is turned off.

**Table 3-8 H7850 Battery Monitor Operation**

MON EN	CHG MODE	RAW DC	State of LED	Interpretation of Battery Status
HIGH	X	X	Off	Battery is dead or H775A is off.
LOW	LOW	HIGH	Flashing slowly	Battery charge is less than 90 percent of capacity and increasing.
LOW	HIGH	LOW	Flashing fast	Battery is discharging.
LOW	HIGH	HIGH	On	Battery charge is over 90 percent of capacity and increasing.

X = don't care state



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Figure 3-18 H7850 Battery Flasher Circuit

**3.4.2.6 Boot Enable Circuit** – The boot enable circuit consists mainly of the components shown in Figure 3-19. For more overall detail, refer to print set schematics.

This circuit is used to monitor the output voltage to MOS memory when the system is running on the battery pack. If the voltage goes below +12 V, it signals the processor via J4-13 if memory remained intact while on battery power.

With proper +12 V at the regulator output and AC LO on J4-17 at ground, D1 is reverse biased and a current path exists from +5B through R4, D2, R5, and R6 to ground. At this time, +12 V is at J4-19, providing reverse base emitter bias to Q4, keeping it off via zener diode D17.

With Q4 OFF, its collector is floating. The -12 V at J4-3 is applied to Q3-G and Q2-D. This turns off Q3 and leaves its drain float to approximately +5 V via R4. With Q3 off, approximately +5 V is applied to the gate of Q2, which is turned off.

As the voltage at the base of Q4 goes to approximately 13 V, Q4 starts to conduct. As Q4 turns on, its collector is pulled to ground, causing Q3-G and Q2-D to go to ground. Q3 turns on and its drain goes to ground, putting J4-13 (BOOT EN) to ground. This causes D2 to be reverse biased and the gate of Q2 goes to ground, causing Q2 to turn on. At this point both Q2 and Q3 latches are latched on, regardless of the state of Q4. The BOOT EN at J4-13 will remain low until AC LO comes back up. If Q4 is off and AC LO goes high, the gate of Q2 will go high, releasing the drain of Q2, which in turn causes the gate of Q3 to go negative, shutting Q3 off and BOOT EN at J4-13 goes high.

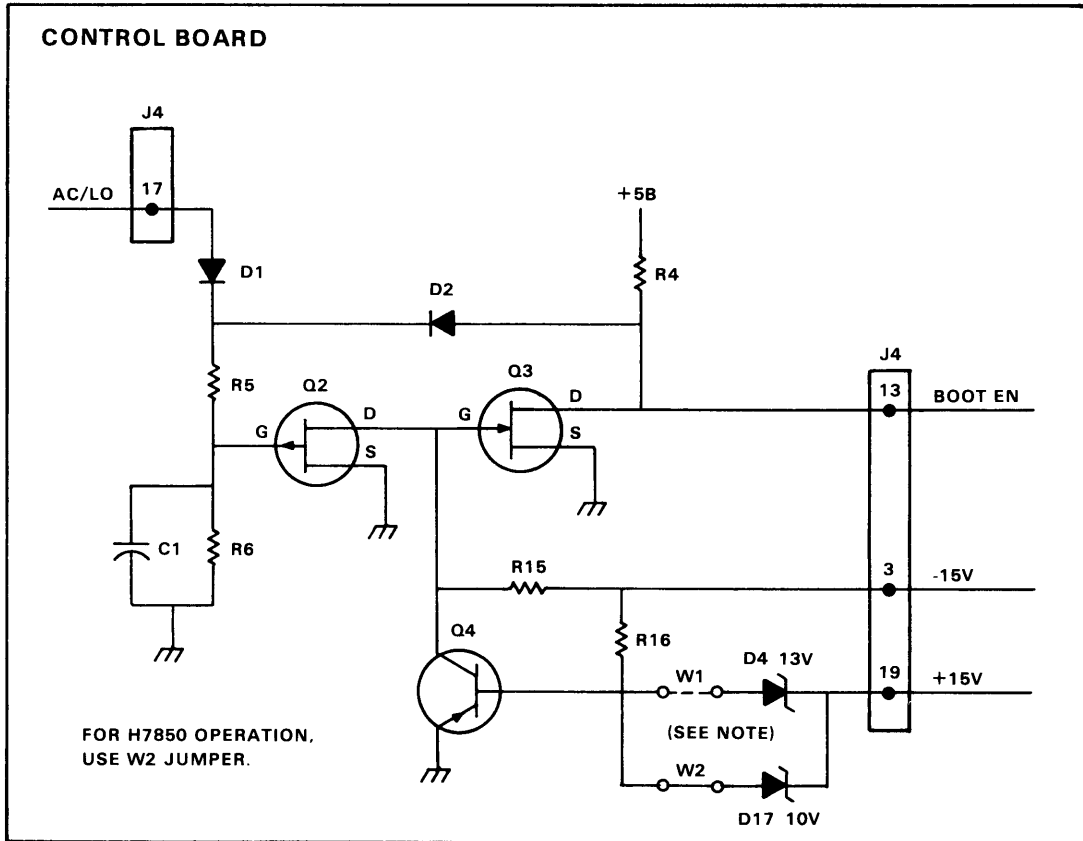


Figure 3-19 H7850 Boot Enable Circuit

### 3.4.3 H775 Battery Backup Unit

**3.4.3.1 Physical Description** – A self-contained battery backup unit, the H775 is offered as an option for use with the H7420 power supply. During an ac power failure, the H775 provides a battery input voltage to the H7850 MOS regulator, allowing only the  $\pm 12B$  and  $+5B$  outputs to stay operational. Therefore, the MOS regulator provides refresh power to MOS memory for a limited time after an ac power failure has occurred.

The battery backup is provided by two 12 V, 5 A-hr batteries connected in series. In this chapter for purposes of discussion, the two batteries are referred to as one 24 V battery rated at 120 W-hr. Due to protective circuitry in the H775, the battery is not allowed to discharge completely. The battery can supply up to 54 W instantaneously and will support 32K of MOS MF11S-KF memory (28 W) for a minimum of 2 hr.

When ac line voltage is present, the battery is charged by the raw dc voltage via the charging circuitry in the H775. Battery recharge time is 14–16 hr.

Externally accessible terminals are provided for the addition of an external battery if longer holdup time is necessary (over 2 hr) (Paragraph 3.4.3.2).



The H775 shown in Figure A-3 is housed in a rectangular box which measures 13.34 cm high by 10.8 cm long by 48.26 cm wide (5-1/4 in by 4-1/4 in by 19 in) and can be rack mounted. It is mounted directly above the 866 power controller (Figure 1-1).

A PC board containing the charging circuitry rests on a panel above the batteries. The batteries are electrically connected to the PC board at J3 and J4.

The ON-OFF switch is located on the front of the box and is a 2-pole magnetic circuit breaker with relay contacts which provides input and output overcurrent protection (10 A). The circuit breaker is electrically connected to the PC board at J2 (Figure 3-20).

All input/output connections between the H7850 and the H775 are made through one cable (P/N 70-11906). The cable is terminated at J2 on the H7850 regulator and an 8-pin connector on the battery backup designated as J1 (Figure 3-21).

An external battery can be electrically connected to the H775 by two binding posts designated as J5 and J7.

**3.4.3.2 Functional Description** – Figure 3-22 is a block diagram of the H775 battery backup unit. The H775 contains battery charging circuitry which consists of the voltage boost circuit, the regulator circuit, a charge rate switch, and a charge rate switch control.

The H775's ac input power cord is plugged into a phase 1 unswitched outlet on the 866 power controller. The ac input brought into the H775 transformer via the power cord is fed into the H7850 regulator in the base H7420 via the round gray interface cable. It is rectified to raw dc and then returned to the H775 through the interface cable for battery charging. The raw dc voltage from the H7850 (25–48 V) is stepped up to 45–48 V by the voltage boost circuit which is controlled by the regulator circuit.

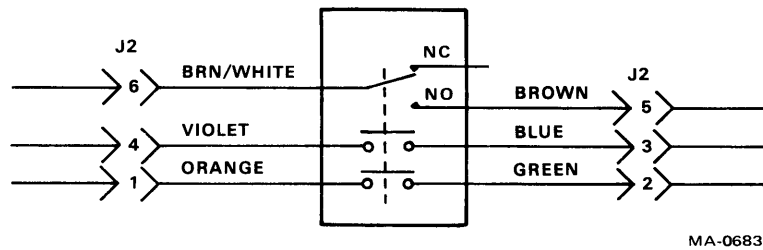
The charge rate switch control determines the rate at which the battery charges by turning the charge rate switch (Q7) on or off. When the battery is being charged, Q7 is initially turned on, yielding a high battery charge current and therefore charging the battery at a fast rate.

As the battery is charged, its voltage increases. Transistor Q7 is turned off when the battery voltage reaches approximately 30.1 V, which is equivalent to 90 percent of the battery charge capacity. Charging current is then supplied to the battery via a bypass resistor and the battery charges at a slow rate referred to as a trickle charge. The charge rate switch remains in the trickle mode (Q7 off) when the battery is fully charged.

When the ac line voltage fails, the raw dc voltage drops and the battery discharges. When the raw dc voltage drops below approximately 18 V, the charge rate switch control resets Q7; however, Q7 is not forward biased until the raw dc comes up again. Therefore, at the beginning of a battery charge the charge rate switch is in the fast mode.

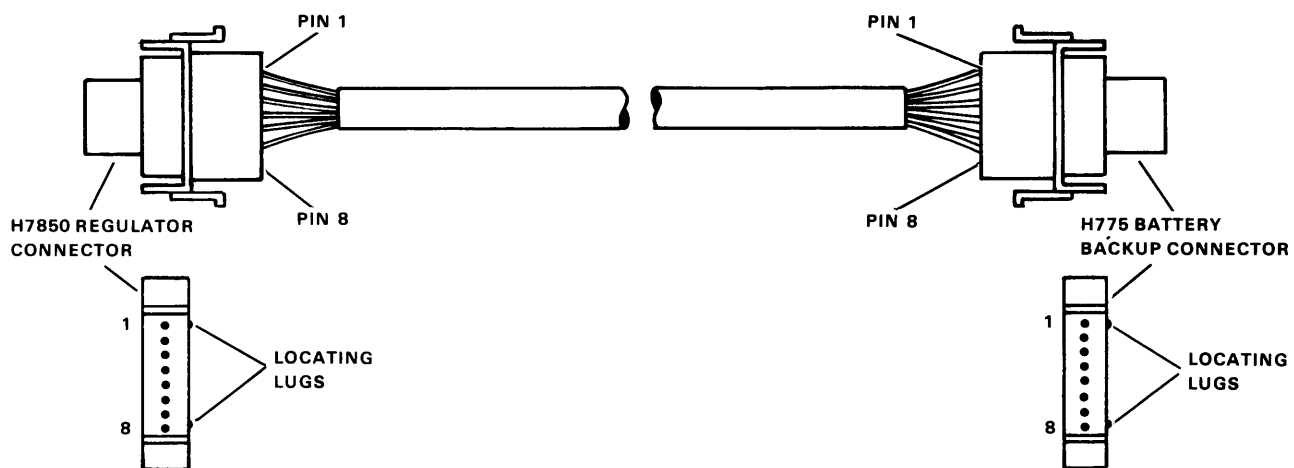
The charge status indicator generates the signal charge mode (CHG MODE), which is fed to the battery monitor circuit in the +5 V regulator of the H7850. The battery monitor circuit uses CHG MODE to determine the status of the battery. Signal CHG MODE is low when the battery is in the fast charge mode and high when the battery is trickle charged or discharging.

The battery backup voltage is provided to the H7850 MOS regulator via a silicon-controlled rectifier (SCR). When the raw dc voltage drops below approximately 18 V, the trigger circuit fires the SCR and the battery voltage replaces the raw dc as the power source to the MOS regulator *only*. The SCR is turned off when the raw dc voltage comes up above the battery voltage.



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Figure 3-20 H775 Input/Output Circuit Breaker



PIN	COLOR	
1	ORANGE	RAW DC
2	BLACK	GND
3	BLUE	H775A OUTPUT
4	GRAY	CHARGE MODE
5	RED	+5B
6	WHITE	MONITOR ENABLE
7	YELLOW	AC POWER
8	BROWN	AC POWER

MA-0702

Figure 3-21 H775 Input/Output Cable and Connectors

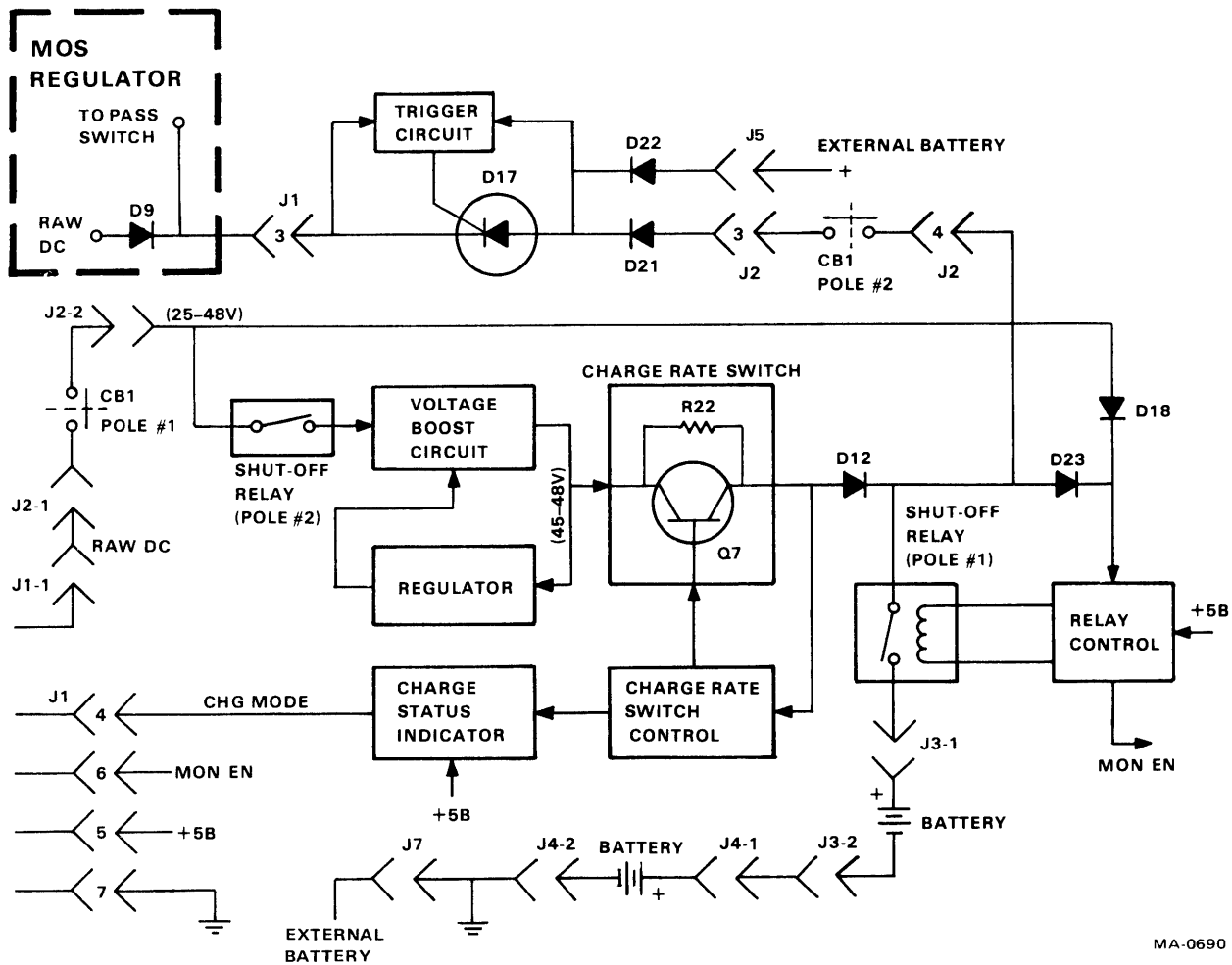


Figure 3-22 H775 BBU Block Diagram

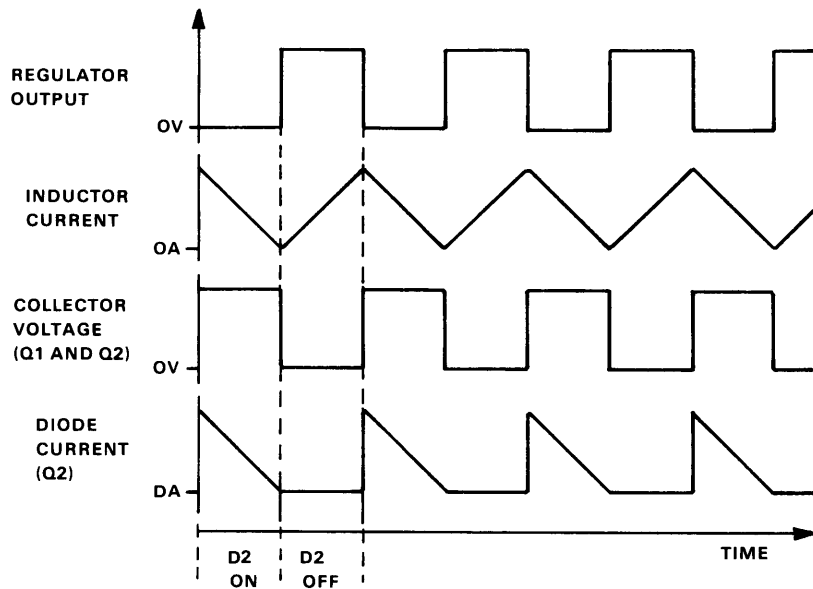
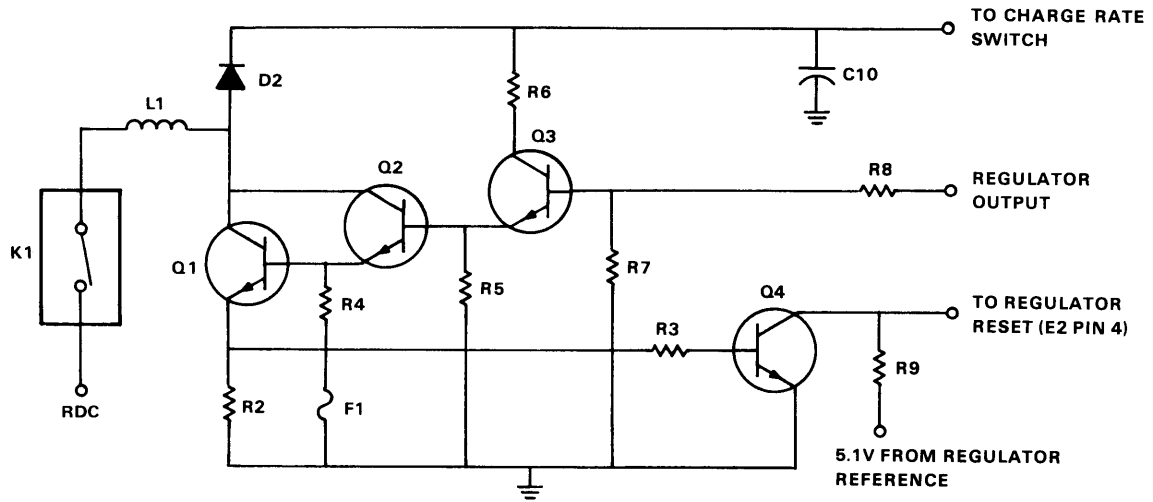
The batteries in the H775 are prevented from discharging completely by the shut-off relay and its control circuit. If the raw dc or the battery voltage is above 18 V, the relay is kept closed by the relay control circuit. However, if the battery is discharging and its voltage decreases to 18 V, the relay opens and therefore the battery current is cut off from its load (the H7850 MOS regulator) and the input to the charging circuit is open. The shut-off relay is also opened if raw dc (or ac input) to the H775 is turned off.

An external battery pack can be connected to the H775 if additional battery support is required (over 2 hr). However, the external battery is not protected from an overcurrent condition or a deep discharge condition.

### 3.4.4 H775 BBU Circuit Description

**3.4.4.1 Voltage Boost Circuit** – The voltage boost circuit shown in Figure 3-23 is an inductive flyback circuit. Transistors Q1, Q2, and Q3 form a current amplifier. When the regulator output goes high, Q1, Q2 and Q3 turn on and the raw dc voltage drops across L1. Diode D2 is reverse biased, the inductor current increases, and current to the charge rate switch is provided by C10. When Q1, Q2, and Q3 are turned off, D2 is forward biased and the inductor current flows to the charge rate switch.

Components R2, R3, and Q4 set up a peak current limit. Once the limit has been reached, the voltage across R2 is sufficient to turn on Q4 which resets the regulator, terminating the conduction time of Q1, Q2, and Q3.



MA-0689

Figure 3-23 H775 Voltage Boost Circuit and Waveform

**3.4.4.2 Regulator Circuit (Figure 3-24)** – The boosted voltage across C10 is fed back to the regulator which keeps the boosted voltage at approximately 48 V by setting the on and off time of transistors Q1, Q2, and Q3. The major components of the regulid are operational amplifier E2 and the 555 timers E1 and E2.

The boosted voltage is divided down by R24 and R18 and compared to a 5.1 V reference voltage by E3, which also amplifies the difference. The output of E3 is an error voltage which increases (decreases) if the boosted voltage decreases (increases). The 5.1 V reference generated by D4 is also used to bias Q5 and provide power to E1 and E2. Transistor Q5 converts the error voltage to a current level which is allowed to charge C6 when the timer output at E1 pin 3 is high. (The discharge transistor at E1 pin 7 is off). The capacitor voltage increases linearly from approximately 0.6 V until it reaches 3.3 V, at which time E1 is reset. The discharge transistor turns on, which retriggers the timer by clamping the voltage of E1 pin 2 and C6 to approximately 0.6 V. Therefore, the timer is triggered almost immediately after it is reset, resulting in a negative pulse at the timer output. The time interval between pulses is determined by the rate at which C6 is charged, which in turn depends on the magnitude of the error voltage.

The negative pulse at E1 pin 3 triggers E2, which is set up as a one-shot. When triggered, E2 pin 3 stays high for 25  $\mu$ s as determined by R10 and C3. Therefore, the regulator output has a fixed high time of 25  $\mu$ s and a variable low time determined by E1 and the error voltage.

**3.4.4.3 Battery Charge Rate Status and Control (Figure 3-25)** – Transistor Q7 is the charge rate switch and the major components of the charge rate switch control are transistor Q8 and Q11, which is a programmable unijunction transistor (PUT).

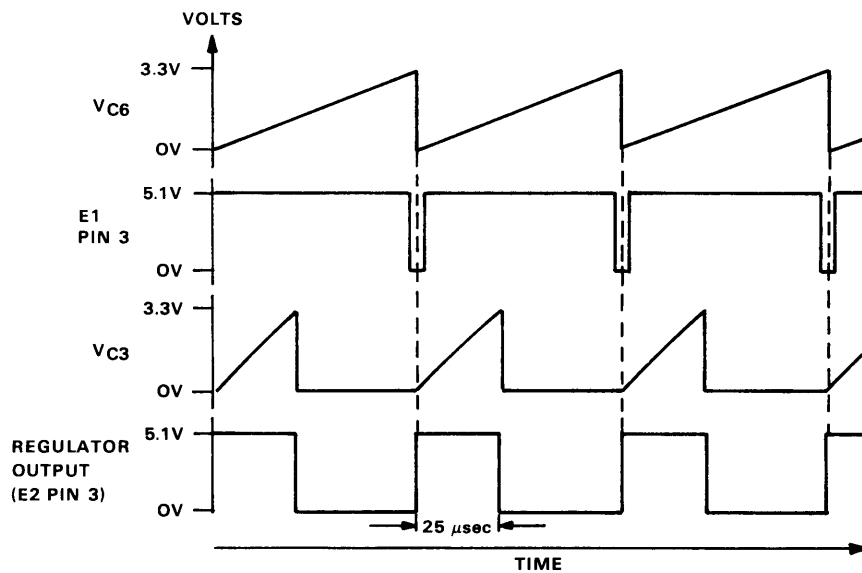
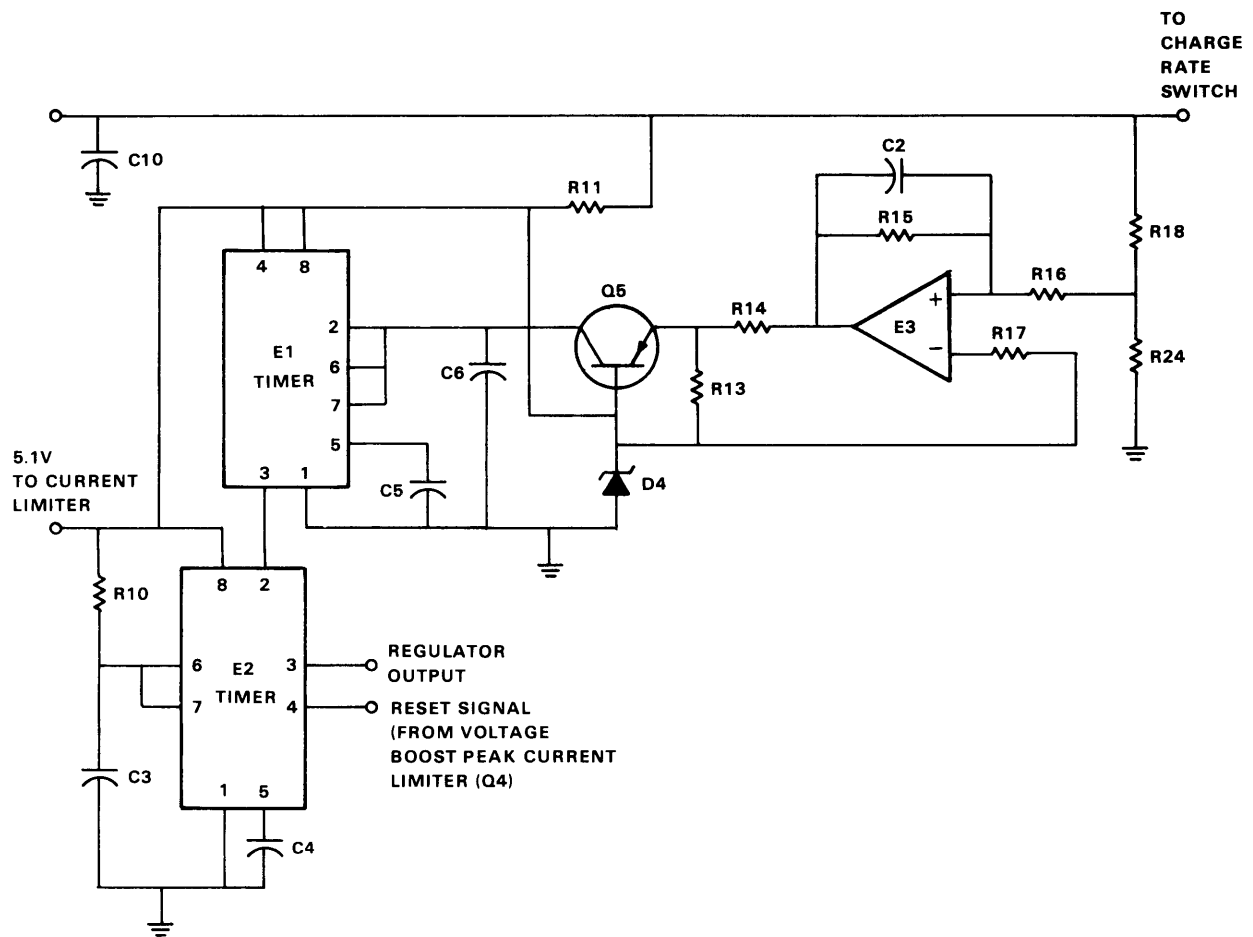
When the battery is charged from an initially low voltage, Q11 is off and Q8 and Q7 are turned on. A high charging current, nominally 500 mA, flows to the battery via R20, R19, Q7, and D12; therefore, the battery charges at a fast rate.

The gate voltage of Q11 is fixed at 5.1 V by D9 and the anode voltage of Q11 is determined by the battery voltage which is first divided down by R31 and R32. As the battery charges, its voltage increases. When the battery voltage reaches approximately 30.1 V, the anode-cathode voltage of Q11 becomes higher than the gate-cathode voltage, so Q11 turns on. The base drive to Q8 is bypassed to ground via D8 and Q11 and, therefore, Q8 and subsequently Q7 turn off. Note that when the battery has reached 30.1 V, it is charged to approximately 90 percent of its capacity.

When Q7 is turned off, the battery voltage immediately decreases to 27 V. The battery is then charged to its full capacity at a slower rate by the trickle charge current. The trickle current, which is nominally 50 mA, flows to the battery via R20, R19, R22, and D12. When the battery is fully charged, the charge rate switch remains in the trickle state (Q7 is off) and the battery voltage is approximately 31 V even though the battery is nominally rated at only 24 V.

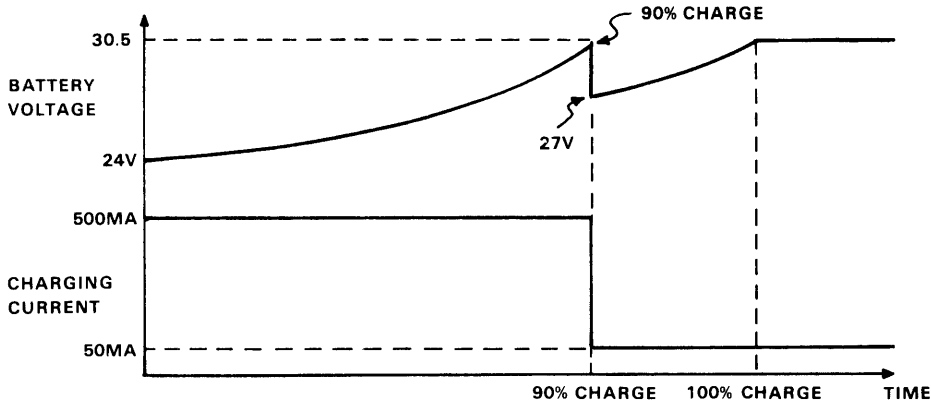
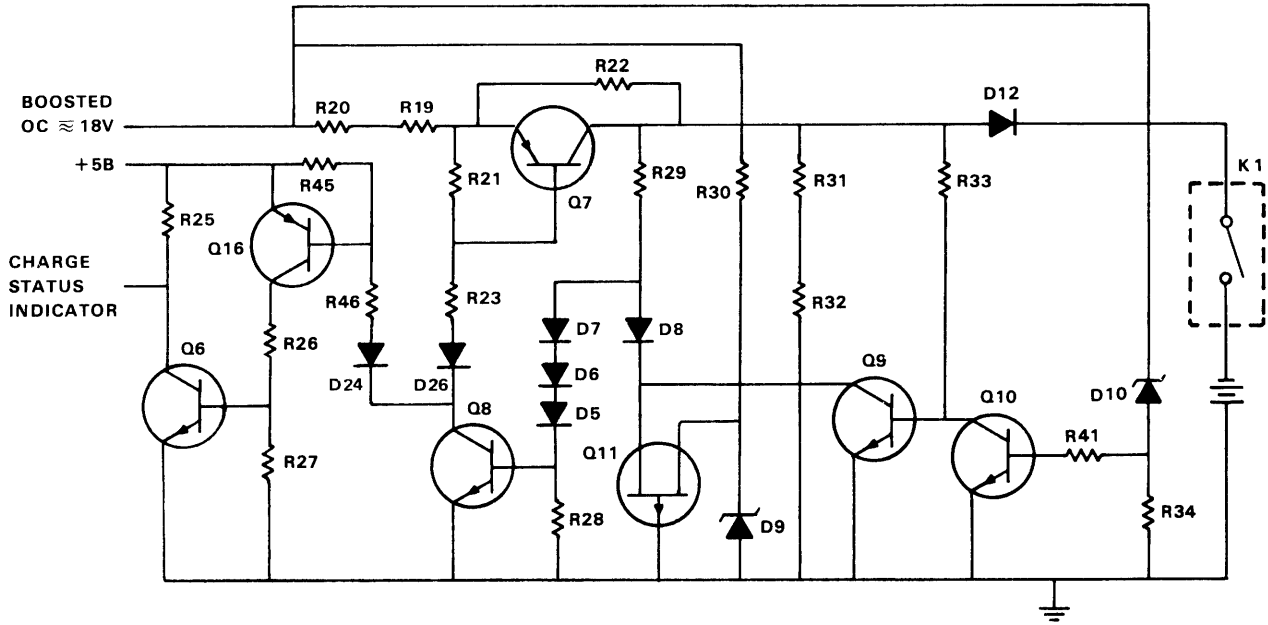
Assume that the raw dc voltage drops below approximately 18 V, which causes the battery to discharge. Diode D12 is reverse biased but voltage is present at the collector of Q7 until the boosted raw dc voltage decays across Q10. Zener diode D10 acts as a level shifter. When the raw dc drops below approximately 18 V, Q10 turns off and subsequently Q9 turns on and bypasses the anode current of Q11 to ground. The PUT (Q11) turns off but the base drive to Q8 is bypassed to ground via D8 and Q9, so Q8 and Q7 remain off. Since Q11 is off the charge rate switch will be in the fast mode (Q7 on) when the raw dc comes up again (Q9 off).

Transistors Q16 and Q6 are the major components of the charge status indicator circuit which generates signal CHG MODE. Transistor Q8 controls Q16 and Q6 as well as the charge rate switch (Q7). When Q8 is turned on, CHG MODE is low, which indicates that the battery is in the fast charge mode (Q7 on). When Q8 is turned off, CHG MODE is high, which indicates that the battery is either in the trickle charge mode or discharging. Note that Q16 and Q6 are powered by the +5B output of the H7850 MOS regulator which is operational when the battery is discharged during an ac power failure.



MA-0688

Figure 3-24 H775 Regulator Circuit and Waveform



MA-0687

Figure 3-25 Battery Charge Rate and Control

**3.4.4.4 Battery Discharge Switch and Control (Figure 3-26)** – The battery backup voltage is provided to the H7850 MOS regulator via D17 which is a silicon-controlled rectifier (SCR). Assume that D17 is initially off.

The battery supplies current to D15 which produces an 18 V threshold at the base of Q14. If the raw dc voltage drops below approximately 18 V, Q14 is forward biased, creating a current path through R40. Transistor Q14 turns on Q13, which fires D17, and the battery discharges through D17. The voltage at the cathode of D17 reverse biases Q14 and subsequently Q13 turns off. However, once the SCR is on, the gate current provided by Q13 is no longer necessary to keep it on.

The SCR (D17) turns off when the raw dc voltage (the SCR cathode voltage) is higher than the battery voltage (the SCR anode voltage) or when the battery current no longer flows to the SCR anode. Note that if the H775 is turned off or the H7850 MOS regulator draws over 10 A, the circuit breaker (CB1) opens and the battery power is cut off.

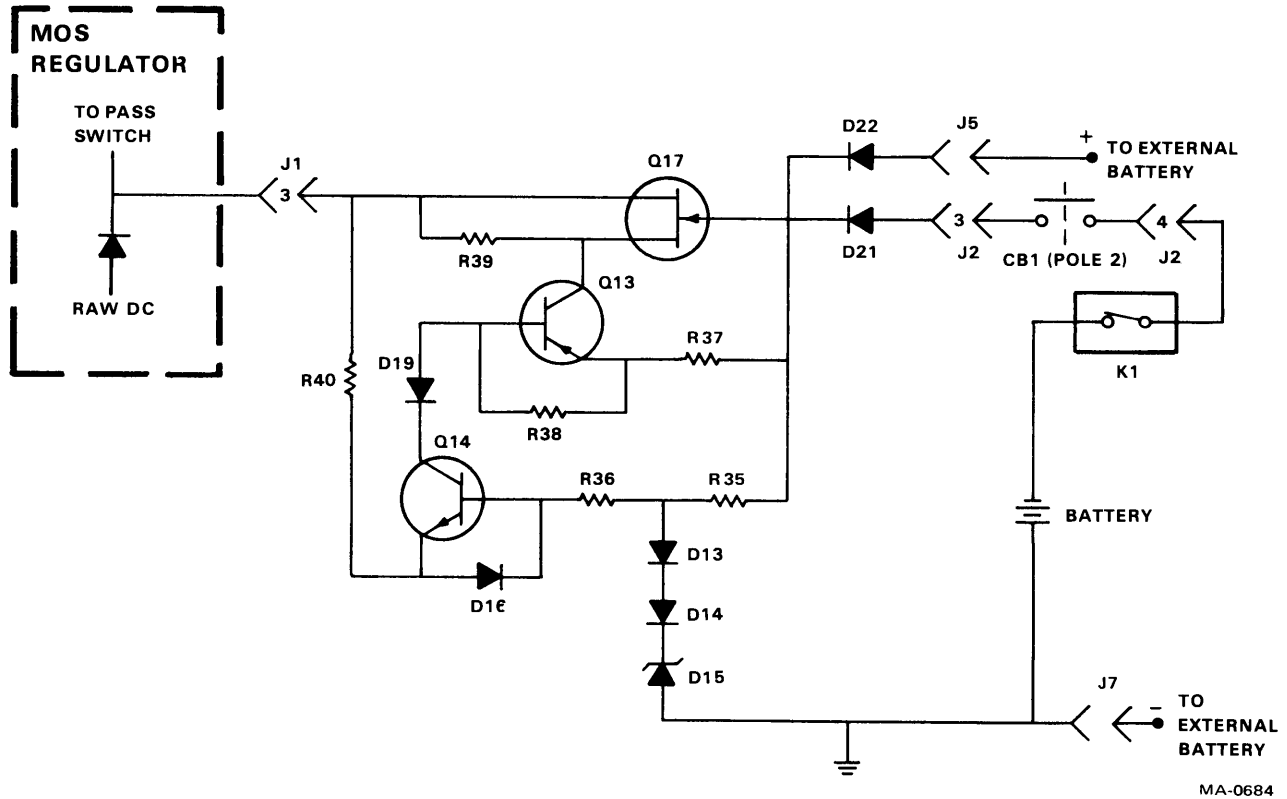


Figure 3-26 Battery Discharge and Control Circuit

**3.4.4.5 Battery Discharge Limit Circuit** – The major components of the circuit shown in Figure 3-27 are K1, Q12, Q15, and D25. Shut-off relay K1 is a normally open, double-pole, single-throw relay that is energized by Q12 under normal operating conditions. Therefore, K1 is closed and the battery can charge or discharge through it.

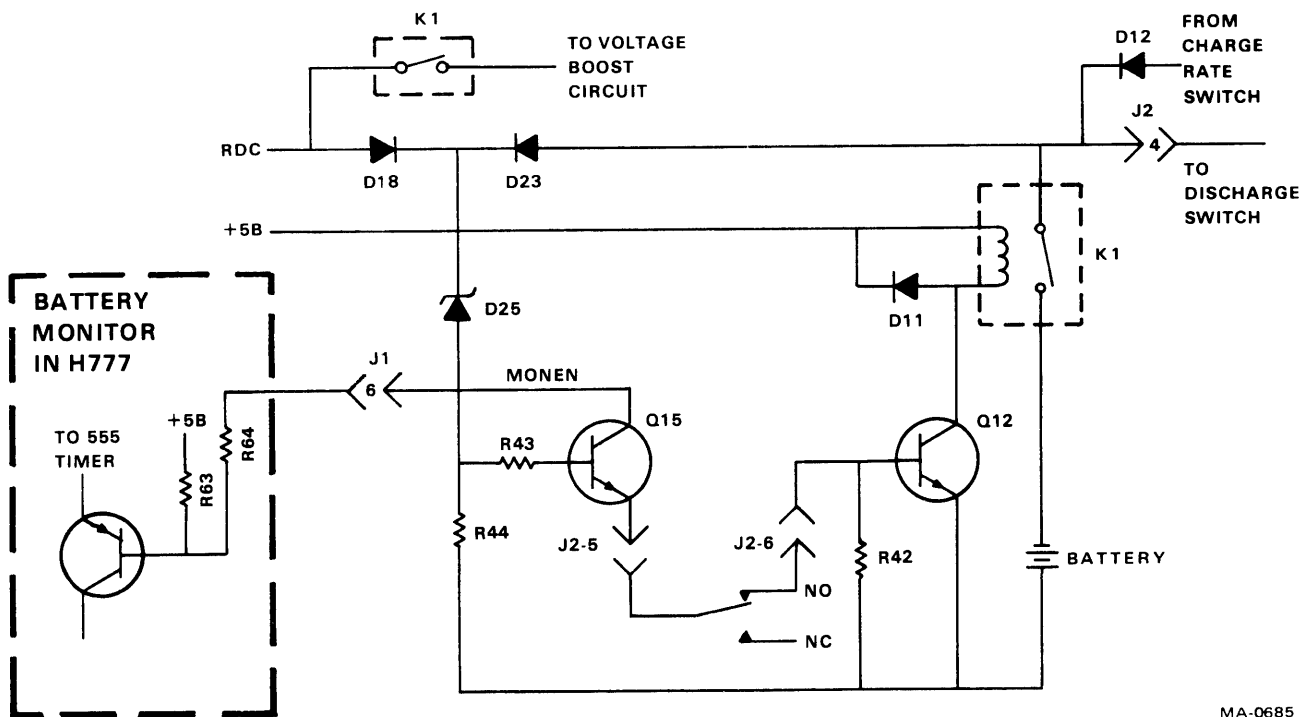
Zener diode D25 ( $V_z = 18\text{ V}$ ) acts as a level shifter that monitors either the raw dc D18 or the battery voltage via D23, whichever voltage is higher. If the raw dc is no longer present and the battery voltage decreases to 18 V, the base drive to Q15 is cut off. Transistor Q15 and subsequently Q12 turn off and K1 opens. The battery current is cut off from the load and the input to the charging circuit is open.

The magnetic circuit breaker (CB1) contains a double-throw relay. When the H775 is turned off or an overcurrent condition exists, CB1 is tripped so the relay in CB1 is deenergized and Q15 is disconnected from Q12. Transistors Q15 and Q12 turn off and K1 opens.

The monitor enable (MON EN) line connects the collector of Q15 to a pull-up register in the battery flasher circuit in the H7850. When Q15 is off, the MON EN signal is high, which disables the battery monitor circuit. Therefore, the LED on the KY11-P console is off.

Note that when the H7420 and therefore the H7850 are turned off, the +5B power from the H7850 MOS regulator is no longer present and therefore K1 is open so the battery cannot be charged or discharged.





MA-0685

Figure 3-27 Battery Discharge Limit Circuit

### 3.4.5 Removing Power from MOS Memories

In order to remove power from MOS memory on PDP-11/60 systems with battery backup, the following steps must be adhered to:

1. Turn the front panel key to STD BY.
2. Switch the circuit breaker on the H775 battery backup unit to OFF.
3. Switch the circuit breaker on the 866 power controller to OFF (main circuit breaker).

Reverse these steps to turn power on.

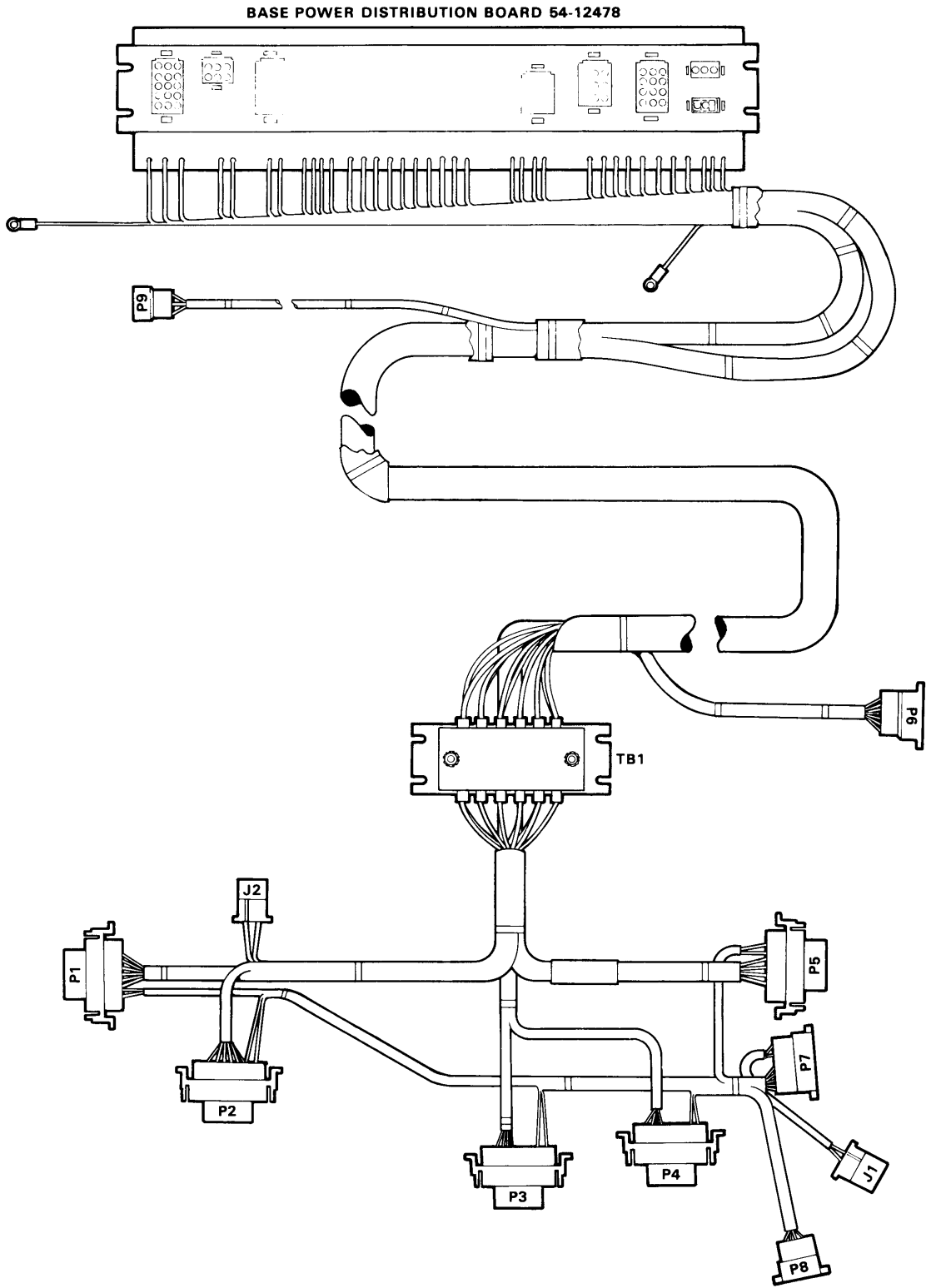
#### CAUTION

**If these steps are not followed, power is not completely removed from the MOS memory modules and they can be damaged when inserting and/or removing them.**

### 3.5 POWER DISTRIBUTION CABLE HARNESSES

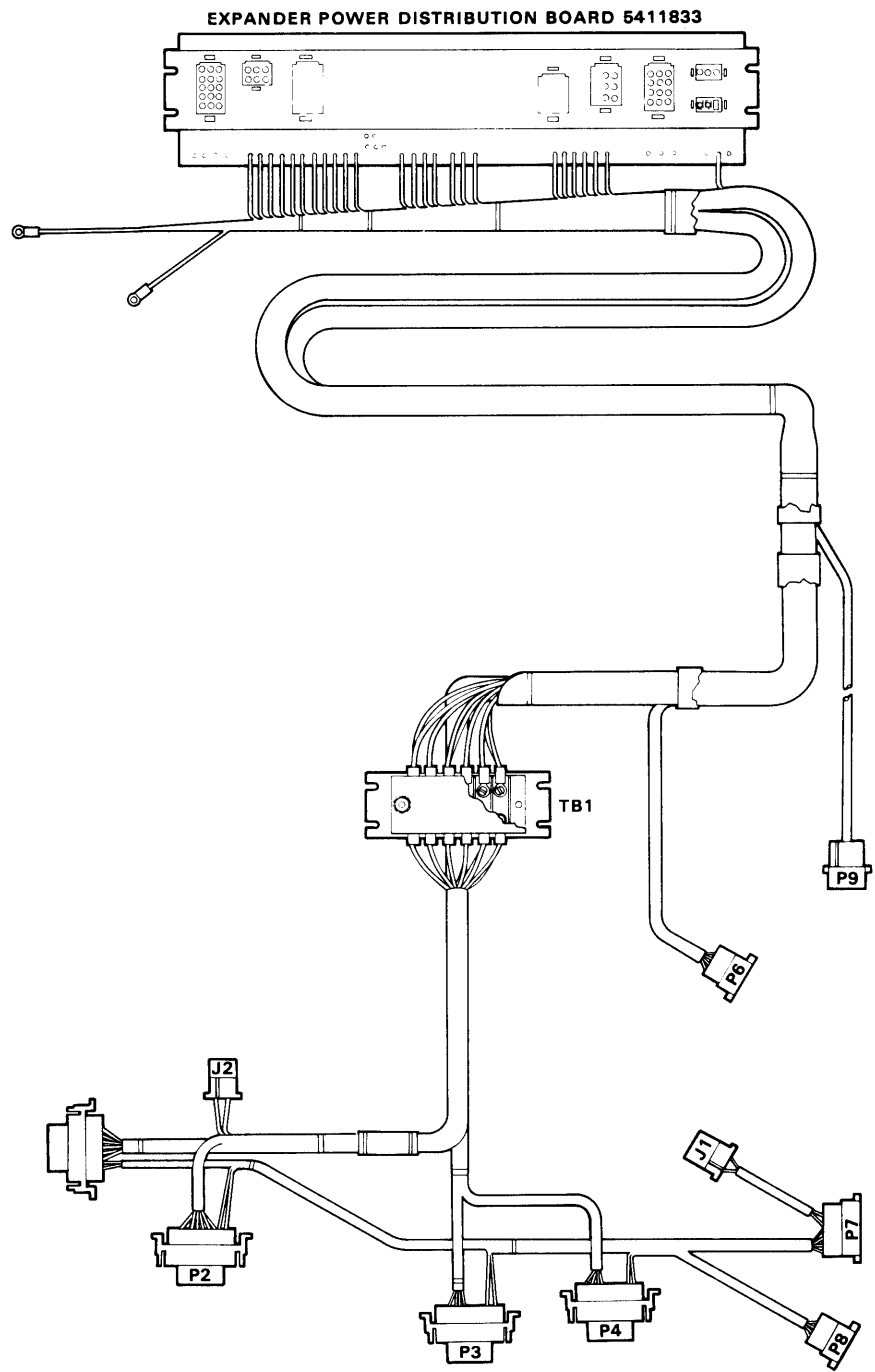
Two power distribution harnesses are used in the PDP-11/60: one in the base card cage power supply, P/N 70-12926 (Figure 3-28), and one in the expander card cage power supply, P/N 70-12889 (Figure 3-29). In general, the power harness connectors are assigned a number with a "P" prefix (e.g. P1, P2, etc.), whereas the connectors attached to the hardware (regulators, backplanes, etc.) have a "J" prefix. These harnesses contain several different types of Mate-N-Lok connectors (both male and female). They are shown in detail in drawings E-IA-7012926 and E-IA-7012889.

The 70-12926 base power distribution harness interconnects the base transformer assembly, regulators, and power distribution board. The 70-12889 expander power distribution harness interconnects the expander transformer assembly, regulators, and power distribution board. These harnesses route 30 Vac to the regulators and regulated dc voltage to the power distribution boards.



MA-0713

**Figure 3-28 Power Distribution Cable Harness  
(Base Power Supply 70-12926)**



MA-0711

Figure 3-29 Power Distribution Cable Harness  
(Expander Power Supply 70-12889)

### **3.6 POWER DISTRIBUTION BOARDS**

The base and expander power distribution boards (P/Ns 54-12478 and 54-11833, respectively) take voltages and signals from the regulators via the power harnesses and distribute them to various system units in their respective card cages. They also send power-off signals from thermostiches and the processor console to the power controller (Paragraph 2.3) and the H7850 MOS regulator (Paragraph 3.4).

Power and signals are applied to the base and expander power distribution boards via the power harnesses (Paragraph 3.5) to solder points on the boards. On the base power distribution board there are 35 solder points labeled PC1-1 to PC1-35. On the expander power distribution there are 39 solder points labeled PC1-1 to PC1-39. Table 3-9 lists the inputs to each of these solder points. Figures 3-28 and 3-29 show the power distribution boards and their connections to the power harnesses.

Etching on the power distribution boards carries the voltages and signals from the solder points to 13 connectors on each board (labeled J1 to J13). (Note that the etching also makes all the grounds common.) Each of these connectors makes the voltages and signals which are applied to it available to the system units it is assigned. For a listing of voltage and signal connections from the regulators and power controller to the power distribution board and which system units they are used in, see Table 3-9.

Short cables are used to bring the voltages and signals from the connectors on the power distribution boards to the backplanes in the various system units. These cables have a plug on one end which plugs into a connector on the power distribution board and Faston tabs or bare wires on the other end which solder onto points on the back of the backplanes.

Three solder points on each power distribution board (PC1-1 to PC1-3) connect thermostiches and the console rotary switch to the 866 power controller (Figure 2-9).

Connectors P1, P2, and P3 on the base power distribution board are used with MOS memory. P1 is a connector for a cable which interconnects the base power distribution board with the H7850 MOS regulator, informing it of voltage and temperature status. P2 and P3 are the connectors of a thermostat assembly which is used in conjunction with P1 to shut down the MOS memory when an overtemperature condition occurs. These connections are described in more detail in Paragraph 3.5.

### **3.7 KD11-K PROCESSOR BACKPLANE POWER DISTRIBUTION**

Power is applied to the KD11-K processor backplane through cables which plug into connectors J2, J3, J4, J6, and J7 on the power distribution board and solder onto points on the back of the backplane. From these 39 solder points on the back of the backplane, the power is distributed to individual modules through internal backplane etching. The KD11-K row and slot assignments are shown in Figure 3-30; backplane connectors and pins are shown in Figure 3-31. Table 3-9 lists the connections from the regulators to the power distribution boards and in which system units the voltages and signals are used. Table 3-10 lists the connections from the power distribution boards to the KD11-K backplane. These connections are also shown on prints D-CS-BA11-P-3 and D-IA-7012953-0-0.

**Table 3-9 PDP-11/60 Voltage/Signal Connections  
(Figures 1-3 and 3-1)**

<b>Voltage/ Signal</b>	<b>H7440 Reg.</b>	<b>Regulator Plug-Pin</b>	<b>PC1 Connections (Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
+5 V	Slot A	P5-2, 5	4, 5	J3-1, 4, 5	Slots 1, 2
	Slot B	P4-2, 5	6, 7	J3-2, 3, 6	Slots 3, 4, 5
	Slot C	P3-2, 5	29, 30	J9, J11, J13-1, 4	SUs 4, 5, 6
	Slot H	P4-2, 5	19, 20	J9, J11-1, 4	SUs 1, 2
	Slot J	P3-2, 5	23, 24	J5, J7-1, 4	SUs 3, 4
Ground	Slot A	P5-3, 4	10, 11	Note 2	Note 4
	Slot B	P4-3, 4	8, 9	Note 2	Note 4
	Slot C	P3-3, 4	31, 31	Note 2	Note 4
	Slot H	P4-3, 4	17, 18	Note 3	Note 4
	Slot J	P3-3, 4	21, 22	Note 3	Note 4
<b>Voltage/ Signal</b>	<b>H781 Reg.</b>	<b>Regulator Plug-Pin</b>	<b>PC1 Connections (Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
+5 V	Slot D	P2-2, 5	14, 15	J6-1, 2	Slots 6, 7, 12-14 and console
	Slot K	P2-2, 5	32, 33	J1, J3-1, 4	SUs 5, 6
+15 V	Slot D	P2-8	22	J6-3, J9, J11, J13-2	Slots 12-14; SUs 4, 5, 6
	Slot K	P2-8	28	J1, J3, J5, J7, J9, J9, J11-2	All SUs
Ground	Slot D	P2-3, 4	12, 13	Note 2	Note 4
	Slot K	P2-3, 4	30, 31	Note 3	Note 4
Line Clock (LTC)	Slot D	P2-1	21	J7, J8, J10, J12-2	All SUs
	Slot K	P2-1	29	J2, J4, J6, J8, J10, J10, J12-2	All SUs
<b>Voltage/ Signal</b>	<b>H754 Reg.</b>	<b>Regulator Plug-Pin</b>	<b>PC1 Connections (Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
-5 V	Slot E (Note 5)	P1-3	35	J9, J11, J13-14	SUs 4, 5, 6
	Slot L	P1-3	27	J1, J3, J5, J7, J9, J11-14	All SUs
+20 V	Slot E (Note 5)	P1-5	34	J9, J11, J13-3	SUs 4, 5, 6
	Slot L	P1-5	25	J1, J3, J5, J7, J9, J11-3	All SUs

**Table 3-9 PDP-11/60 Voltage/Signal Connections (Cont)**

<b>Voltage/ Signal</b>	<b>H754 Reg.</b>	<b>Regulator Plug-Pin</b>	<b>PC1 Connections (Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
Ground	Slot E (Note 5)	P1-2	33	Note 2	Note 4
	Slot L	P1-2	26	Note 3	Note 4
<b>Voltage/ Signal</b>	<b>H7850 Reg.</b>	<b>Regulator Plug-Pin</b>	<b>PC1 Connections Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
+5 VBB	Slot E (Note 4)	P1-4	24	J9, J11, J13-10	SUs 4, 5, 6
+12 VBB		P1-6	25	J9, J11, J13-6	SUs 4, 5, 6
-12 VBB		P1-1	23	J9, J11, J13-15	SUs 4, 5, 6
-15 V	Base	P6-4, 5, 6	17, 18	J6-11, J9, J11, J13-13	Slots 12-14; SUs 4, 5, 6
	Expdr.	P6-4, 5, 6	12, 13	J1, J3, J5, J7, J9, J11-13	All SUs
Bus AC LO L	Base	P6-8	20	J7, J8, J10, J12-4	All SUs
	Expdr.	P6-8	10	J2, J4, J6, J8, J10, J12-4	All SUs
<b>Voltage/ Signal</b>	<b>H7420 Supply</b>	<b>Pwr. Supply Plug-Pin</b>	<b>PC1 Connections (Note 1)</b>	<b>Power Dist. Board Plug-Pin (Note 1)</b>	<b>KD11-K Slots/ System Units (Note 1)</b>
Bus DC LO L	Base	P6-9	19	J7, J8, J10, J12-3	All SUs
	Expdr.	P6-9	11	J2, J4, J6, J8, J10, J12-3	All SUs
Ground	Base	P6-2, 3, 7	26-28	Note 2	Note 4
	Expdr.	P6-2, 3, 7	14-16	Note 3	Note 4
<b>Voltage/ Signal</b>	<b>H7420 Supply</b>	<b>Power Supply Plug-Pin</b>		<b>Regulator Plug-Pin</b>	<b>Remarks</b>
20-30 Vac	Base	P7-1, 2		P5-6, 7	Regulator A
		P7-9, 12		P4-6, 7	Regulator B
		P7-8, 10		P3-6, 7	Regulator C
		P8-7, 8		P2-6, 7	Regulator D
	Expdr.	P8-1, 2		P1-7, 8	Regulator E
		P7-9, 12		P4-6, 7	Regulator F
		P7-8, 10		P3-6, 7	Regulator J
		P8-7, 8		P2-6, 7	Regulator K
		P8-1, 2		P1-7, 8	Regulator L

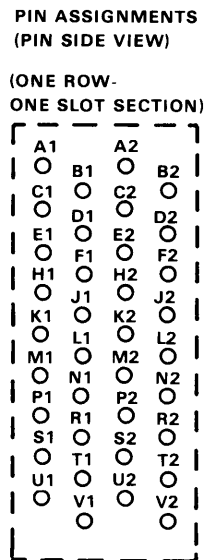
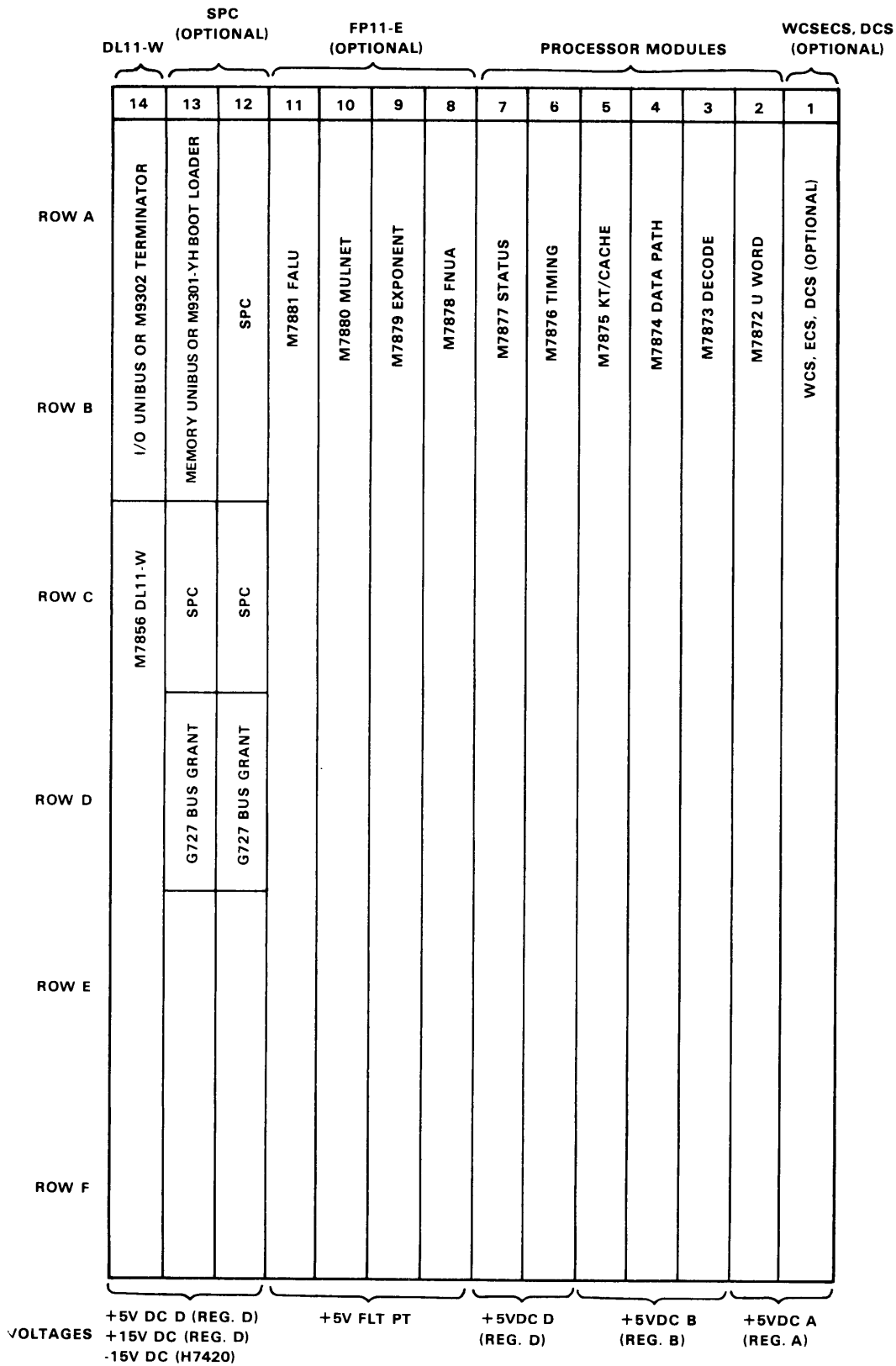
**Table 3-9 PDP-11/60 Voltage/Signal Connections (Cont)**

<b>Voltage/ Signal</b>	<b>H7420 Supply</b>	<b>Power Supply. Plug-Pin</b>	<b>H7420 Fan Connections</b>	<b>Remarks</b>
120 Vac	Base	P7-3, 7	J10, J11 J8, J9 J6, J7	Base H7420, Fan 2 Base H7420, Fan 3 Base H7420, Fan 4 Base Card Cage Fan on 240 V systems (Note 6)
		P7-4, 5, 6	J1	
	Expdr.	P7-3, 7	J10, J11 J8, J9 J6, J7	Expander H7420, Fan 2 Expander H7420, Fan 3 Expander H7420, Fan 4 Expander Card Cage Fan on 240 V systems (Note 6)
		P7-4, 5, 6	J1	

<b>Voltage/ Signal</b>	<b>866 Power Controller Plug-Pin</b>	<b>PC1 Connection</b>	<b>Power Dist. Board Plug-Pin</b>
Power ON/OFF	J2-1	1	J1, J2-1 (Base)
	J3-1	1	J13-1 (Expander)
Emergency Shutdown	J2-2	2	J1, J2-2 (Base)
	J3-2	2	J13-2 (Expander)
Common (not system ground)	J2-3	3	J1, J2-3 (Base)
	J3-3	3	J13-3 (Expander)

**NOTES:**

- Regulators in slots A, B, C, D, and E and the base H7320 provide voltages and signals to the power distribution board and system units in the base card cage. Regulators in slots E, H, J, and K and the expander H7420 provide voltages and signals to the power distribution board and system units in the expander card cage.
- J3-7 through 12; J4, J5-1, 2, 4, 5, 7, 8; J6-4, 6, 7, 10; J7, J8, J10, J12-1; J9, J11, J13-5, 7, 8, 9, 11
- J1, J3, J5, J9, J11-5, 7, 8, 9, 11; J2, J4, J6, J10, J12-1
- All ground connections are common.
- Replace H754 +20 V, -5 V regulator in slot E with H7850 +5 V, +12 V, -12 V regulator with H775 MOS battery backup if MOS memory is present. (See Paragraph 3.4 for MOS configuration information).
- On 120 V systems, card cage fans plug directly into 866 power controller (Paragraph 2.1.4).

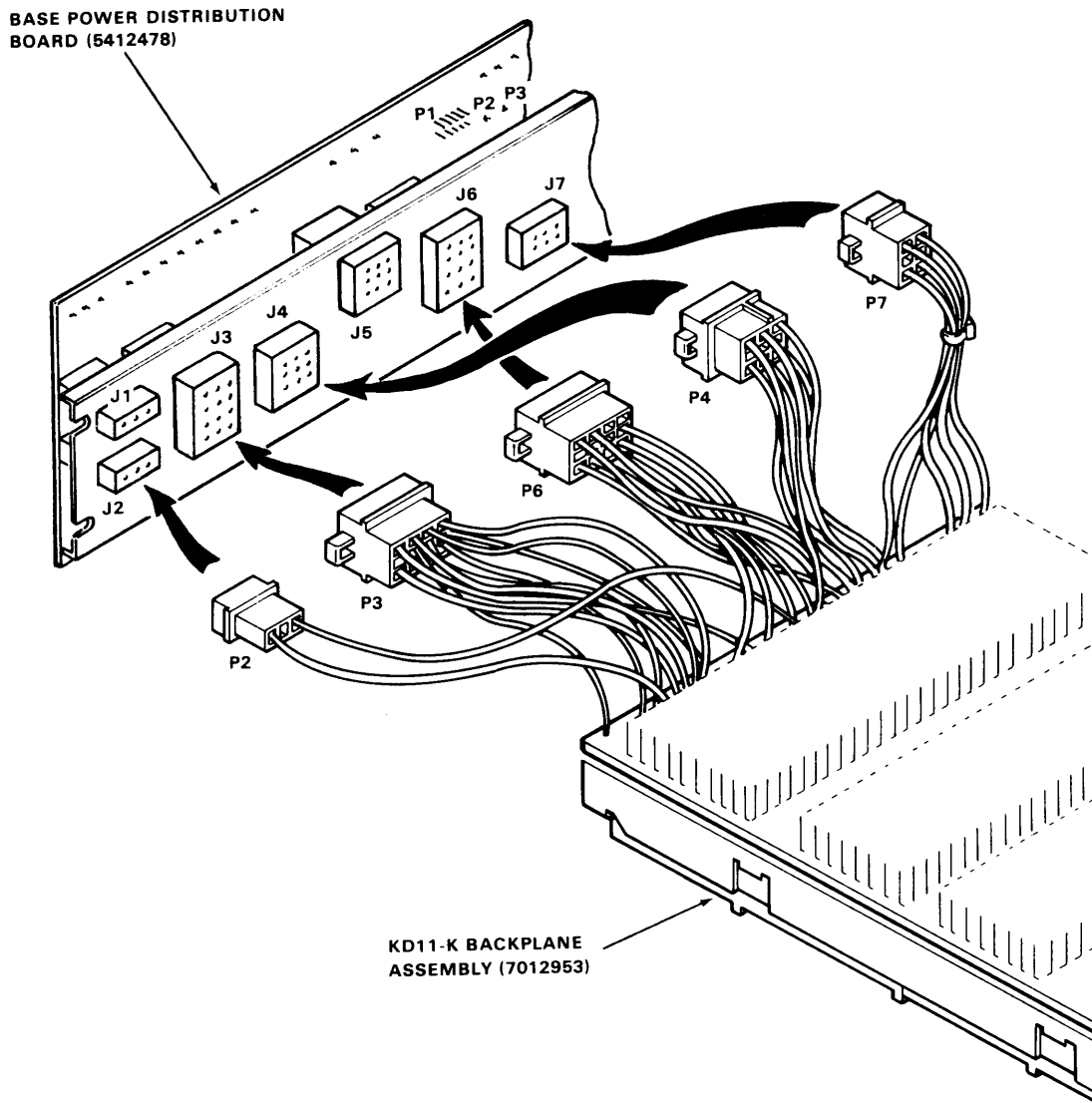


VIEW FROM MODULE SIDE

MA-0691

Figure 3-30 KD11-K Processor Backplane Slot and Row Assignments





MA-0703

Figure 3-31 KD11-K Processor Backplane Connections

**Table 3-10 Backplane Voltage/Signal Connections**

<b>Connector-Pin to Power Distribution Board</b>	<b>Backplane Solder Point</b>	<b>Backplane Voltage/Signals</b>
P2-1	8	SW CLOSURE 0 L
P2-3	15	SW CLOSURE 1 L
P3-1	5	+5 VDC A (Reg. A)
P3-2	12	+5 VDC B (Reg. B)
P3-3	13	+5 VDC B (Reg. B)
P3-4	6	+5 VDC A (Reg. A)
P3-5	7	+5 VDC A (Reg. A)
P3-6	14	+5 VDC B (Reg. B)
P3-7	9	GND POWER DISTRIBUTION
P3-8	10	GND POWER DISTRIBUTION
P3-9	11	GND POWER DISTRIBUTION
P3-10	18	GND POWER DISTRIBUTION
P3-11	19	GND POWER DISTRIBUTION
P3-12	20	GND POWER DISTRIBUTION
P4-1	32	GND POWER DISTRIBUTION
P4-3	29	+5V FLT PT
P4-4	33	GND POWER DISTRIBUTION
P4-6	30	+5V FLT PT
P4-7	34	GND POWER DISTRIBUTION
P4-9	31	+5V FLT PT
P6-1	16	+5 VDC D (Reg. D)
P6-2	17	+5 VDC D (Reg. D)
P6-3	4	+15 VDC
P6-4	3	GND POWER DISTRIBUTION
P6-5	1	LED (BATT OK) H
P6-6	21	GND POWER DISTRIBUTION
P6-7	22	GND POWER DISTRIBUTION
P6-8	2	DISCHARGED L
P6-9	25	DC ON
P6-10	24	GND POWER DISTRIBUTION
P6-11	38	-15 VDC
P7-1	23	GND POWER DISTRIBUTION
P7-2	39	LTC L
P7-3	36	BUS DC LO L
P7-4	37	BUS AC LO L
	26	Spare
	27	Spare
	28	Spare
	35	Spare

## CHAPTER 4

# PDP-11/60 SYSTEM CONFIGURATIONS

### 4.1 GENERAL DESCRIPTION

The PDP-11/60 system comes in four basic configurations. These basic systems vary according to the size of the H9500 corporate cabinet, the standard memories (MOS or core) used, the peripheral mass storage devices supplied, and the voltage and frequency of the system power supply line.

Three of the four basic PDP-11/60 configurations come in a low-boy style corporate cabinet. These are the PDP-11X60, the PDP-11S60 and the PDP-11T60. The PDP-11Y60 is identical to the PDP-11X60 except that it is contained in a high-boy cabinet.

The PDP-11S60 (Figure 4-1) comes with two RK06 disk drives and an RK611 controller. The PDP-11T60 (Figure 4-2) includes an RK05F and an RK05J disk drive, with an RK11 controller.

The PDP-11X60 and PDP-11Y60 do not include disk peripherals. Otherwise, the external configurations are the same as the PDP-11S60 and PDP-11T60.

All PDP-11/60 systems include a KY11-P programmer's console mounted in the top center of the front of the corporate cabinet. The console is shown in Figure 4-3. For a detailed, functional description of the console, refer to the *PDP-11/60 Processor Handbook*.

The PDP-11/60 systems that have core memories as standard equipment include models PDP-11X60-B, PDP-11Y60-B, PDP-11S60-B and PDP-11T60-B. Models with MOS memory include PDP-11X60-C, PDP-11Y60-C, PDP-11S60-C and PDP-11T60-C. Further details on these memories are included in Paragraph 4.3.1.

The PDP-11/60 corporate cabinets and expander cabinets are designed to house equipment that is self-cooled. The upper sections of each cabinet are intended for mounting peripheral devices with front-to-back air flow. The lower sections are designed for the BA11-P card cages (Paragraph 4.3.2) or other equipment designed to draw air through either the front cover or the rear door and exhaust it at the bottom of the cabinet. These cooling air flows are shown in Figure 4-4.

For most hardware servicing or for installation or additional items such as PCB modules or power supplies, it is necessary to remove the front panel or open the back of the cabinet. The cabinet was designed to discourage access by unauthorized personnel.

The release latches for the front panel are concealed behind the two end slots of the array of vertical slots on the panel. Insert a thin-bladed tool, such as a steel rule, into one of the end slots and push on the latch. At the same time, pull that corner of the cover forward. The latch on the other end is freed in the same manner.

A special tool, part number 12-13091, is required to open the back of the cabinet. This tool is illustrated in Figure 4-5. Insert the tool and turn it 1/4 turn counterclockwise. The door is removed by opening it until it is at a right angle to the cabinet, and then lifting it off the hinges, as shown in Figure 4-6.

There are two stabilizer legs, one on either side of the corporate cabinet, at the bottom. The MARK III Interlock system locks any slide-mounted equipment in the cabinet until at least one of the stabilizer legs has been fully extended. It also prevents the leg from being retracted until the slide-mounted equipment is returned to its normal position.

All PDP-11/60 systems can have the FP11-E floating-point processor option feature installed. For a detailed description of this option, consult the *PDP-11/60 Processor Handbook*; for a description of the installation process, see Paragraph 4.4.3 of this manual.

Other installation procedures are contained in Paragraph 4.4. The BA11-P installation process is described in Paragraph 4.4.1, and the expander cabinet installation procedure is detailed in Paragraph 4.4.2.

A description of the procedures necessary to supply the PDP-11/60 with appropriate cabling is contained in Chapter 5.

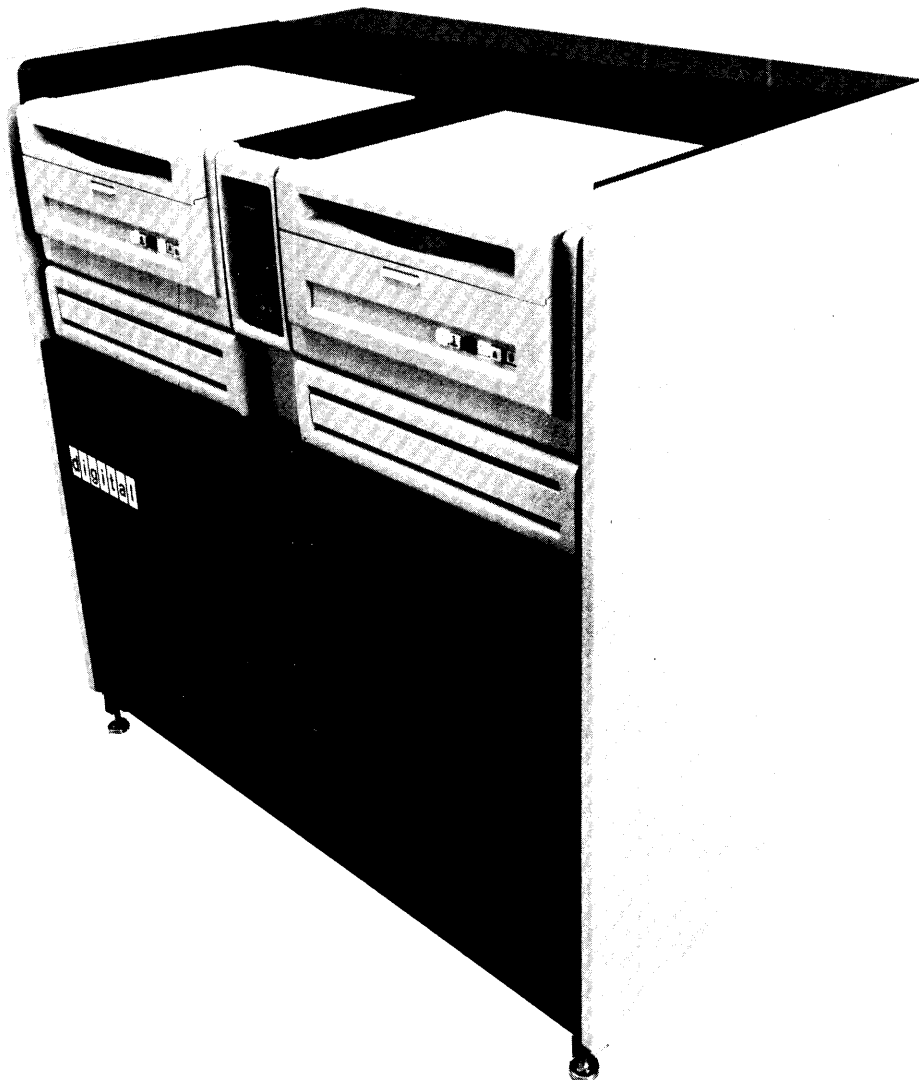


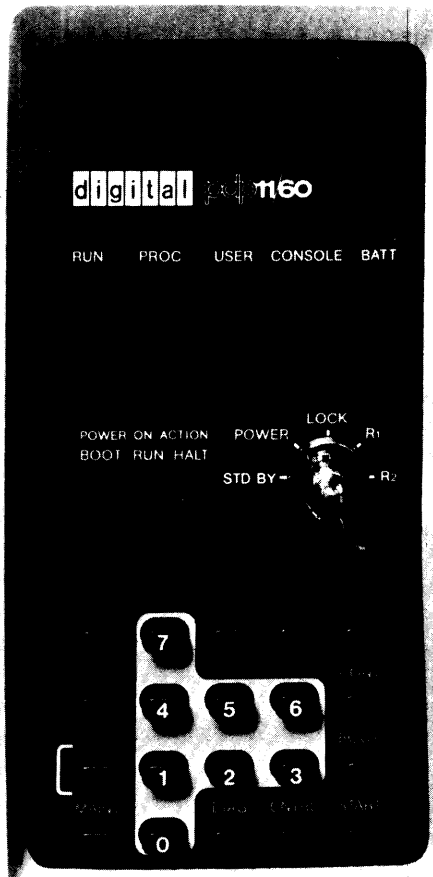
Figure 4-1 PDP-11S60

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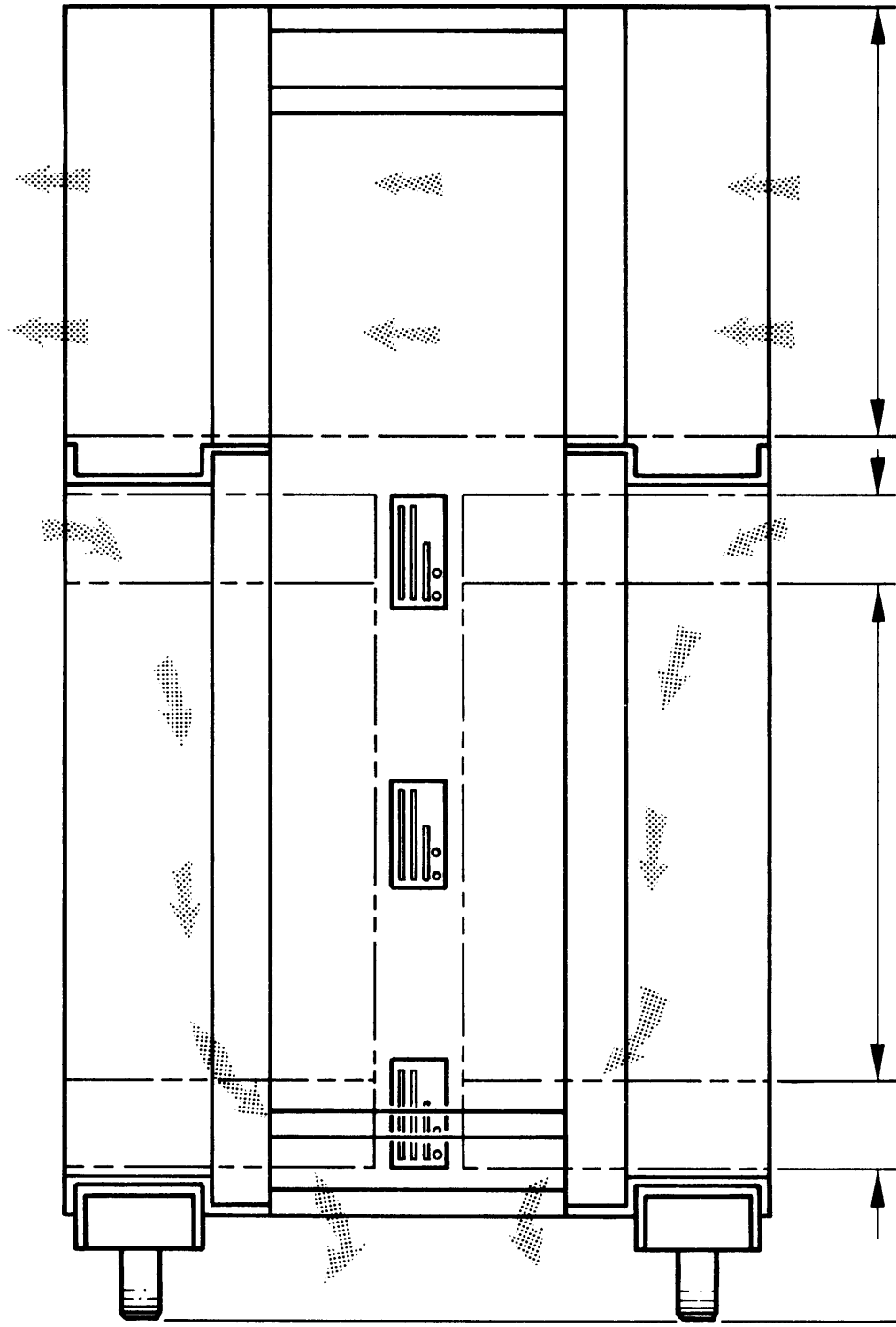
8811-7-A0041

Figure 4-2 PDP-11T60



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Figure 4-3 PDP-11/60 Console



MI-0436

Figure 4-4 Corporate Cabinet Cooling Patterns

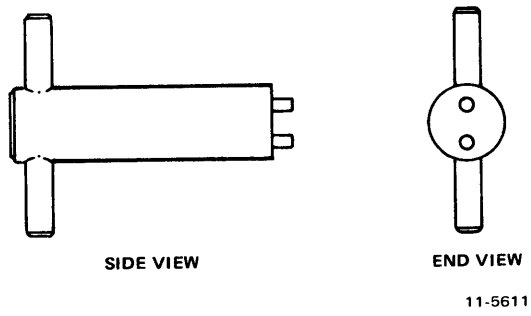


Figure 4-5 Rear Door Opening Tool

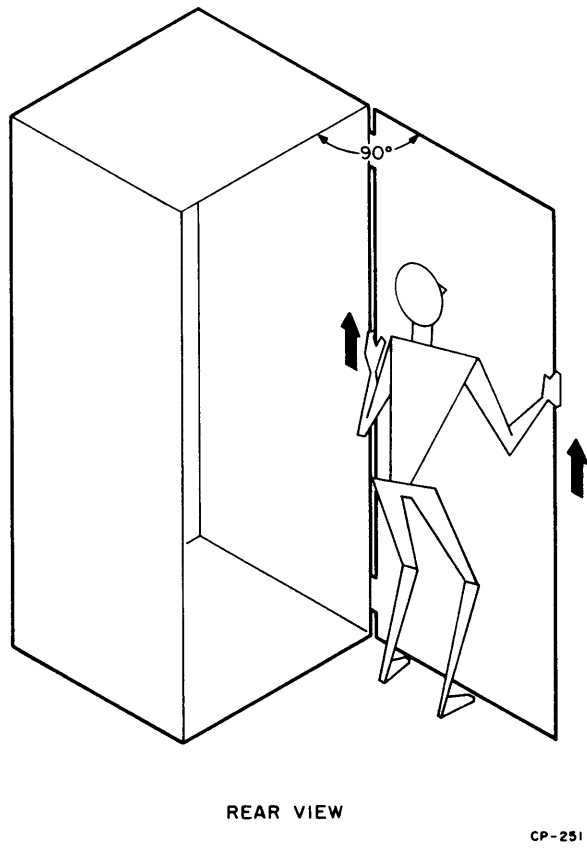


Figure 4-6 Removing Back Door



## 4.2 SPECIFICATIONS

Table 4-1 lists the specifications of all the PDP-11/60 variations.

## 4.3 OPTIONS

The PDP-11/60 system is available in a variety of configurations. These configurations are detailed in Table 4-1, but are basically different combinations of memory types and sizes, peripheral devices such as disk drives (and their corresponding controllers) and the various BA11-P card cages necessary for differences in memories, line voltages, and line frequencies. This paragraph details the various memories, disk drives and card cages that may be present in a standard PDP-11/60 system.

### 4.3.1 Memory

The basic PDP-11/60 system is supplied with 64K bytes of memory, either core or MOS. Systems that have core are supplied with an MF11-WP memory system. The basic 64K bytes may be expanded to a total of 256K bytes, in 64K byte increments.

Systems that have MOS are supplied with an MF11S-KF memory system. The MOS memory includes an error correction code (ECC), which contains single-bit error correction and double-bit error detection. The memory for this option may be expanded to 256K bytes, in 64K byte increments. There is no address interleaving with these MOS memories. Each of the various PDP-11/60 configurations available consists of this basic package in addition to other memory, peripheral, and controller options.

### 4.3.2 BA11-P Card Cage

All of the basic PDP-11/60 systems described in Table 4-1 are supplied with one or two BA11-P card cage systems. The system includes the H9280 logic card cage box, a power distribution board mounted on top of the logic box, the necessary power supplies and power supply harnesses, and necessary cables and hardware for connecting the power supplies to the power distribution board. The H9280 logic box is described in detail in Paragraph 4.3.2.2. The power supplies are described in detail in Chapter 2. Power distribution to the modules via the power distribution board is described in Chapter 3.

Figure 4-7 shows the BA11-P without the power accessories. The cables to connect the power supplies to the power distribution board are visible in the foreground. The board itself is on top of the logic box, and can be seen more clearly in Figure 4-8. This illustration also shows the 29 module slots in the H9280 logic box.

There are several different models of the BA11-P available. The particular model necessary depends on the line voltage supplied to the PDP-11/60, as well as on the type of memory (MOS or core) that the card cage will contain. These different models are described in Paragraph 4.3.2.1.

The BA11-P cage that mounts on the left side of the PDP-11/60 corporate cabinet is called the base cage, and contains the basic PDP-11/60 processor and, in the PDP-11X60-C, PDP-11Y60-C, PDP-11S60-C, and PDP-11T60-C, MOS memory PCB modules. The card cage that mounts on the right side of the cage is called the expander cage, and, in the PDP-11X60-B, PDP-11Y60-B, PDP-11S60-B, and PDP-11T60-B, contains core memory modules. The PDP-11X60-C, PDP-11Y60-C, and PDP-11T60-C are not supplied with an expander card cage as part of the basic PDP-11/60 system, although it may be installed in the field for expansion. See Paragraph 4.4.1 for a description of this process.

**Table 4-1 PDP-11/60 Configurations Data Sheet**

Model	Description	Cabinet Style	Size (in/cm) H×W×D	Weight (lbs/kg)	Operating Temp (°C)	Relative Humid (%)	Line Volt/Freq	Logic Card Cages	Amps at +5 V Available	DC Power Supplies	Comments
11X60-BA	11/60W, MF11-WP, DL11-W, 866-D	DWLB	51×47×30 128×118×76	530/241	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PA BA11-PE	31.5 40	H7420A (7013050-0) H7420A (7013050-1)	7 S.U.s and 2 Quad SPC Expansion Space Available.
11X60-BB	11/60W, MF11-WP, DL11-W, 866-E	DWLB	51×47×30 128×118×76	530/241	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PB BA11-PF	31.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11X60-BA.
11X60-CA	11/60K, MF11S-KF, DL11-W, H775-BA, 866-D	DWLB	51×47×30 128×118×76	380/172	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PK	31.5	H7420A (7013050-8)	1 S.U. and 2 Quad SPC Expansion Space Available in Base Card Cage.
11X60-CB	11/60K, MF11S-KF, DL11-W, H775-BB, 866-E	DWLB	51×47×30 128×118×30	380/172	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PL	31.5	H7420B (7013050-10)	Expansion Space Identical to the 11X60-CA. Expander Cage not included.
11Y60-KA	11/60W, MF11-WP, DL11-W, 866-D	DWHB	61×47×30 154×118×76	529/254	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PA BA11-PE	31.5 40	H7420A (7013050-0) H7420A (7013050-0)	Expansion Space Identical to the 11X60-BA.
11Y60-KB	11/60W, MF11-WP, DL11-W, 866-E	DWHB	61×47×30 154×118×76	529/254	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PB BA11-PF	31.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11X60-BA.
11Y60-LA	11/60K, MF11-SK, DL11-W, H775-BA, 866-D	DWHB	61×47×30 154×118×76	409/186	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PK	31.5	H7420A (7013050-8)	Expansion Space Identical to the 11X60-CA. Expander Cage not included.
11Y60-LB	11/60K, MF11-SK, DL11-W, H775-BB, 866-E	DWHB	61×47×30 154×118×76	409/186	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PL	31.5	H7420B (7013050-10)	Expansion Space Identical to the 11X60-CA. Expander Cage not included.
11S60-BA	11/60W, MF11-WP, MM11-WP, DL11-W/LA36-CE, RK611, 2-RK06-AA 866-D	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PA BA11-PE	16.5 40	H7420A (7013050-0)	5 S.U.s of Expansion Space Available.
11S60-BB	11/60W, MF11-WP, MM11-WP, DL11-W/LA36-CF, RK611, 2-RK06-AB, 866-E	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 240 V, 60 Hz	BA11-PB BA11-PF	16.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11S60-BA.
11S60-BC	11/60W, MF11-WP, MM11-WP, DL11-W/LA36-CH, RK611, 2-RK06-AC, 866-D	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 120 V, 50 Hz	BA11-PA BA11-PE	16.5 40	H7420A (7013050-0) H7420A (7013050-1)	Expansion Space Identical to the 11S60-BA.
11S60-BD	11/60W, MF11-WP, MM11-WP, DL11-W/LA3-CJ, RK611, 2-RK06-AD, 866-E	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PB BA11-PF	16.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11S60-BA.

**NOTE:** Maximum heat dissipation: 11X60, 11Y60 - 14,500 Btu/hr; 11S60 - 17,000 Btu/hr; 11T60 - 16,000 Btu/hr.

Table 4-1 PDP-11/60 Configurations Data Sheet (Cont)

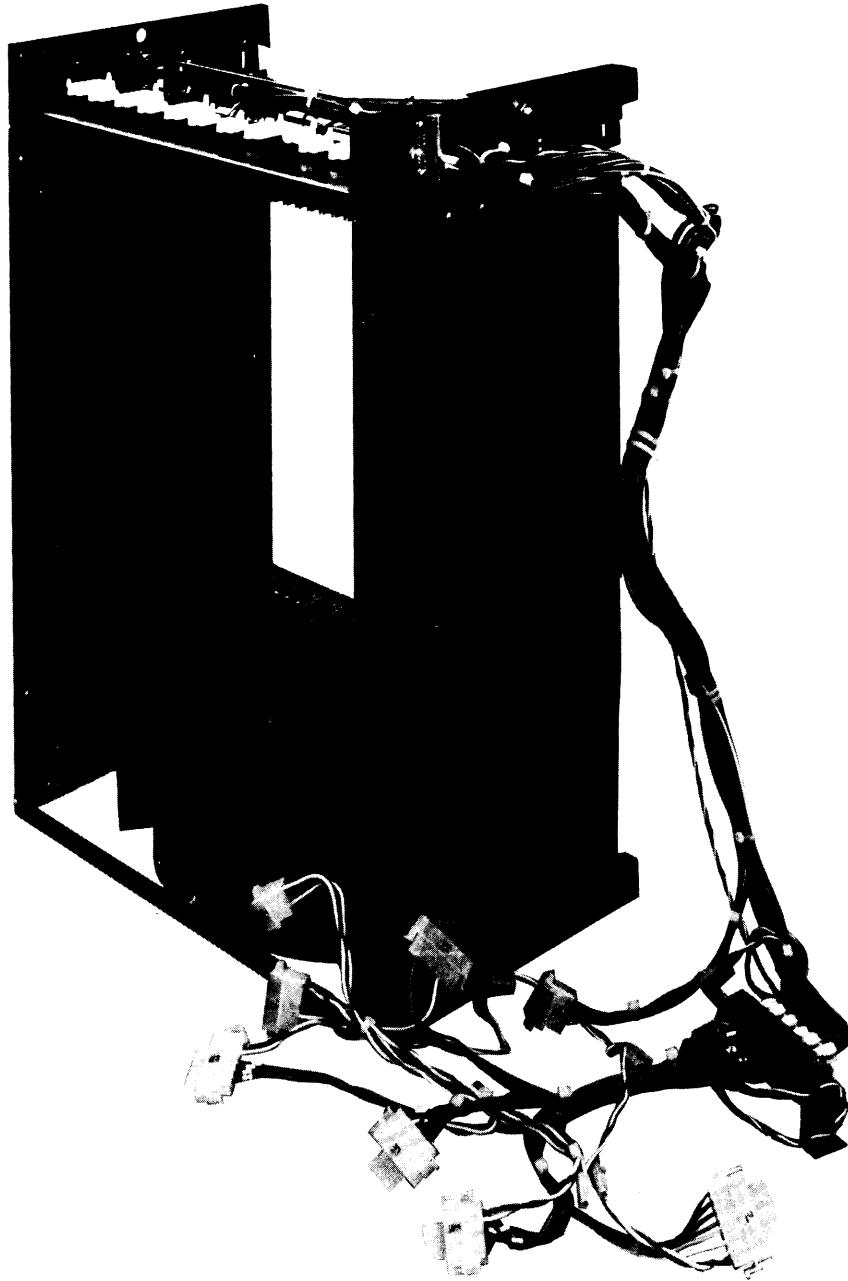
Model	Description	Cabinet Style	Size (in/cm) H×W×D	Weight (lbs/kg)	Operating Temp (°C)	Relative Humid (%)	Line Volt/Freq	Logic Card Cages	Amps at +5 V Available	DC Power Supplies	Comments
11S60-CA	11/60K, MF11S-KF, MM11S-KA, DL11-W/LA36-CE, RK611, 2-RK06-AA, H775-BA, 866-D	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PK BA11-PE	25 53	H7420A (7013050-8) H7420A (7013050-1)	Expansion Space Identical to the 11S60-BA.
11S60-CB	11/60K, MF11S-KF, MM11S-KA, DL11-W/LA36-CF, H775-BB, RK611/2-RK06-AB, 866-E	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 240 V, 60 Hz	BA11-PL BA11-PF	25 53	H7420B (7013050-10) H7420B (7013050-3)	Expansion Space Identical to the 11S60-BA.
11S60-CC	11/60K, MF11S-KF, MM11S-KA, DL11-W/LA36-CH, H775-BA, RK611/2-RK06-AC, 866-D	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 120 V, 50 Hz	BA11-PK BA11-PE	25 53	H7420A (7013050-8) H7420A (7013050-1)	Expansion Space Identical to the 11S60-BA.
11S60-CD	11/60K, MF11S-KF, MM11S-KA, DL11-W/LA36-CJ, H775-BB, RK611/2-RK06-AD, 866-E	DWLB	51×47×30 128×118×76	930/423	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PL BA11-PF	25 53	H7420B (7013050-10) H7420B (7013050-3)	Expansion Space Identical to the 11S60-BA.
11T60-BA	11/60W, MF11-WP, 866-D, RK11D/RK05J-AA/RK05-FA, DL11-W/LA36-CE	DWLB	51×47×30 128×118×76	710/323	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PA BA11-PE	22.5 40	H7420A (7013050-0) H7420A (7013050-1)	6 S.U.s of Expansion Space Available.
11T60-BB	11/60W, MF11-WP, 866-E, RK11D/RK05J-AB/RK05-FB, DL11-W/LA36-CF	DWLB	51×47×30 128×118×76	710/323	10 - 40	20 - 80	3 Phase 240 V, 60 Hz	BA11-PB BA11-PF	22.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11T60-BA.
11T60-BC	11/60W, MF11-WP, 866-D, RK11D/RK05J-AC/RK05-FC, DL11-W/LA36-CH	DWLB	51×47×30 128×118×76	710/323	10 - 40	20 - 80	3 Phase 120 V, 50 Hz	BA11-PA BA11-PE	22.5 40	H7420A (7013050-0) H7420A (7013050-1)	Expansion Space Identical to the 11T60-BA.

Table 4-1 PDP-11/60 Configurations Data Sheet (Cont)

Model	Description	Cabinet Style	Size (in/cm) H×W×D	Weight (lbs/kg)	Operating Temp (°C)	Relative Humid (%)	Line Volt/Freq	Logic Card Cages	Amps at +5 V Available	DC Power Supplies	Comments
11T60-BD	11/60W, MF11-WP, 866-E, RK11D/RK05J-AD/ RK05-FD, DL11-W/LA36-CJ	DWLB	51×47×30 128×118×76	710/323	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PB BA11-PF	22.5 40	H7420B (7013050-2) H7420B (7013050-3)	Expansion Space Identical to the 11T60-BA.
11T60-CA	11/60K, MF11S-KF, 866-D, RK11D/RK05J-AA/ RK05-FA, DL11-W/LA36-CE, H775-BA	DWLB	51×47×30 128×118×76	560/254	10 - 40	20 - 80	3 Phase 120 V, 60 Hz	BA11-PK	6.5	H7420A (7013050-8)	2-Quad SPC Expansion Space Available. Expander Cage not included.
11T60-CB	11/60K, MF11S-KF, 866-E, RK11D/RK05J-AB/ RK05-FB, DL11-W/LA36-CF, H775-BB	DWLB	51×47×30 128×118×76	560/254	10 - 40	20 - 80	3 Phase 240 V, 60 Hz	BA11-PL	6.5	H7420B (7013050-10)	Expansion Space Identical to the 11T60-CA. Expander Cage not included.
11T60-CC	11/60K, MF11S-KF, 866-D, RK11D/RK05J-AC/ RK05-FC, DL11-W/LA36-CH, H775-BA	DWLB	51×47×30 128×118×76	560/254	10 - 40	20 - 80	3 Phase 120 V, 50 Hz	BA11-PK	6.5	H7420A (7013050-8)	Expansion Space Identical to the 11T60-CA. Expander Cage not included.
11T60-CD	11/60K, MF11S-KF, 866-E, RK11D/RK05J-AD/ RK06-FD, DL11-W/LA36-CJ, H775-BB	DWLB	51×47×30 128×118×76	560/254	10 - 40	20 - 80	3 Phase 240 V, 50 Hz	BA11-PL	6.5	H7420B (7013050-10)	Expansion Space Identical to the 11T60-CA. Expander Cage not included.

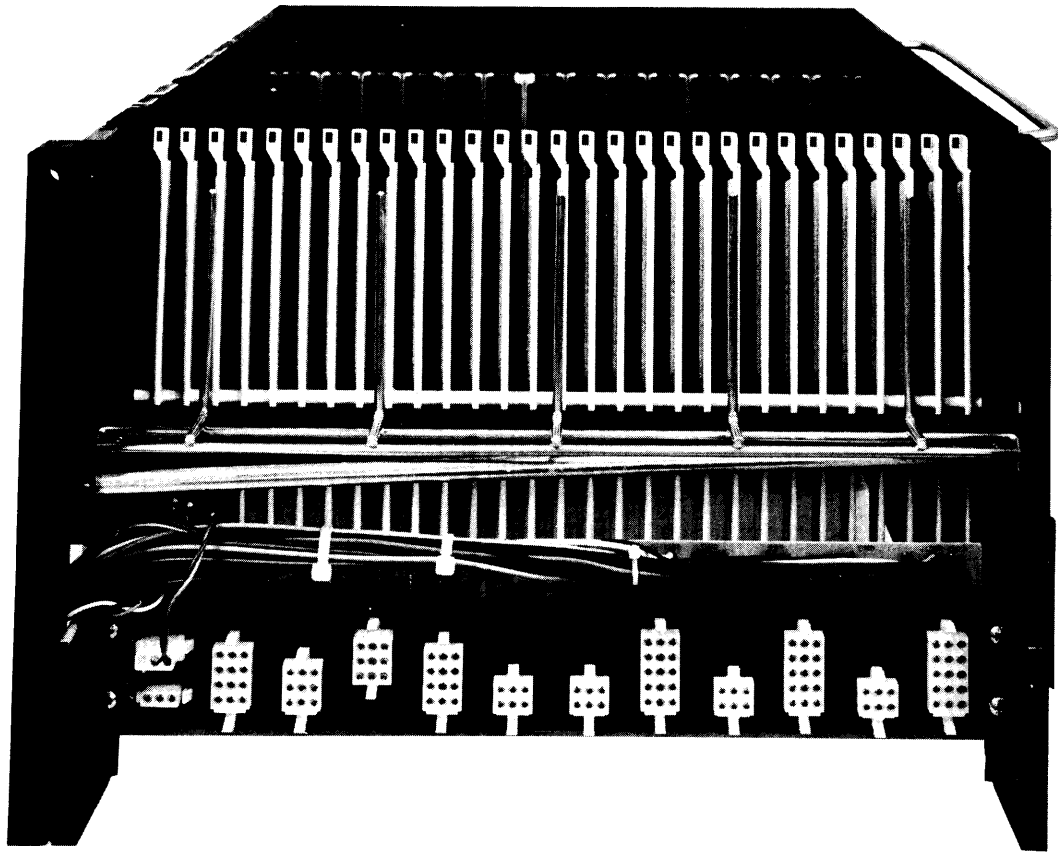
**Table 4-1 PDP-11/60 Configurations Data Sheet (Cont)**

Model	Description	Cabinet Style	Size (in/cm) H×W×D	Weight (lbs/kg)	Operating Temp (°C)	Relative Humid (%)	Line Volt/Freq	Logic Card Cages	Amps at +5 V Available	DC Power Supplies	Comments
H9600-AA	Expansion Cabinet with 866-D	DWHB	61×47×30 154×118×76		10 - 40	20 - 80	3 Phase 120 V, 60 Hz				BA11-P Card Cage not included; configured without end panels.
H9600-AB	Expansion Cabinet with 866-E	DWHB	61×47×30 154×118×76		10 - 40	20 - 80	3 Phase 240 V, 50 Hz				BA11-P Card Cage not included; configured without end panels.
H9601-AA	Expansion Cabinet with 866-D	DWLB	51×47×30 128×118×76		10 - 40	20 - 80	3 Phase 120 V, 60 Hz				BA11-P Card Cage not included; configured without end panels.
H9601-AB	Expansion Cabinet with 866-E	DWLB	51×47×30 128×118×76		10 - 40	20 - 80	3 Phase 240 V, 50 Hz				BA11-P Card Cage not included; configured without end panels.
H9602-BA	Expansion Cabinet with 861-D	SWHB	61×27×30 154×70×76		10 - 40	20 - 80	1 Phase 120 V, 60 Hz				BA11-P Card Cage not included; configured without end panels.
H9602-BB	Expansion Cabinet with 866-E	SWHB	61×27×30 154×70×76		10 - 40	20 - 80	1 Phase 240 V, 50 Hz				BA11-P Card Cage not included; configured without end panels.
H9603-BA	Expansion Cabinet with 866-D	SWLB	51×27×30 128×70×76		10 - 40	20 - 80	1 Phase 120 V, 60 Hz				BA11-P Card Cage not included; configured without end panels.
H9603-BB	Expansion Cabinet with 866-E	SWLB	51×27×30 128×70×76		10 - 40	20 - 80	1 Phase 240 V, 50 Hz				BA11-P Card Cage not included; configured without end panels.
H9603-CA	Expansion Cabinet	SWLB	51×27×30 128×70×76				N/A				BA11-P, Power Controller and end panels not included.



8277-2-A0039

Figure 4-7 BA11-P Card Cage (Base, Rear View)



8277-1-A0040

Figure 4-8 BA11-P Card Cage (Top View)

**4.3.2.1 Model Variations** – Table 4-2 summarizes the different models of the BA11-P available, and the PDP-11/60 models in which they are supplied as part of the basic package.

**Table 4-2 BA11-P Model Variations**

<b>Model</b>	<b>Supply Voltage</b>	<b>Type of Cage</b>	<b>PDP-11/60 System</b>
BA11-PA	120 V	Base	11X60-BA 11Y60-KA 11S60-BA (BC) 11T60-BA (BC)
BA11-PB	240 V	Base	11X60-BB 11Y60-KB 11S60-BB (BD) 11T60-BB (BD)
BA11-PE	120 V	Expander	11X60-BA 11Y60-KA 11S60-BA (BB) 11S60-CA (CC) 11T60-BA (BC) 11T60-CA (CC)*
BA11-PF	240 V	Expander	11X60-BB 11Y60-KB 11S60-BB (BD) 11S60-CB (CD) 11T60-BB (BD) 11T60-CB (CD)*
BA11-PK	120 V	Base	11X60-CA 11Y60-LA 11S60-CA (CC) 11T60-CA (CC)
BA11-PL	240 V	Base	11X60-CB 11Y60-LB 11S60-CB (CD) 11T60-CB (CD)

\*Expanded card cage not included with basic PDP-11T60-CA (CC) or PDP-11T60-CB (CD).



**4.3.2.2 H9280 Logic Card Cage** – The H9280 logic card cage assembly is shown in Figure 4-9. The overall dimensions of the assembly are in Table 4-3.

**Table 4-3 H9280 Cage Dimensions**

Parameter	Dimension
Height	62.23 cm (24.50 in)
Width	40.00 cm (15.75 in)
Depth	30.78 cm (12.12 in)
Weight	
H9280 cage, empty	25.2 kg (56 lb)
Blower cooling unit	5.4 kg (12 lb)
Distribution panel	0.5 kg (1 lb)
Maximum weight (card cage, blower cooling unit, distribution panel, three 9-slot backplanes, 27 PCB modules, and 20 cables)	49.3 kg (109.6 lb)

The assembly may be mounted as a fixed unit or a hinge-mounted unit, with a right or left pivoting box (for a base BA11-P or expander BA11-P, respectively). There is a vertical handle attached to the pivoting unit, for easy movement. The total clearance necessary for pivoting requires that the space in which the box is mounted is at least 50.8 cm (20 in) wide.

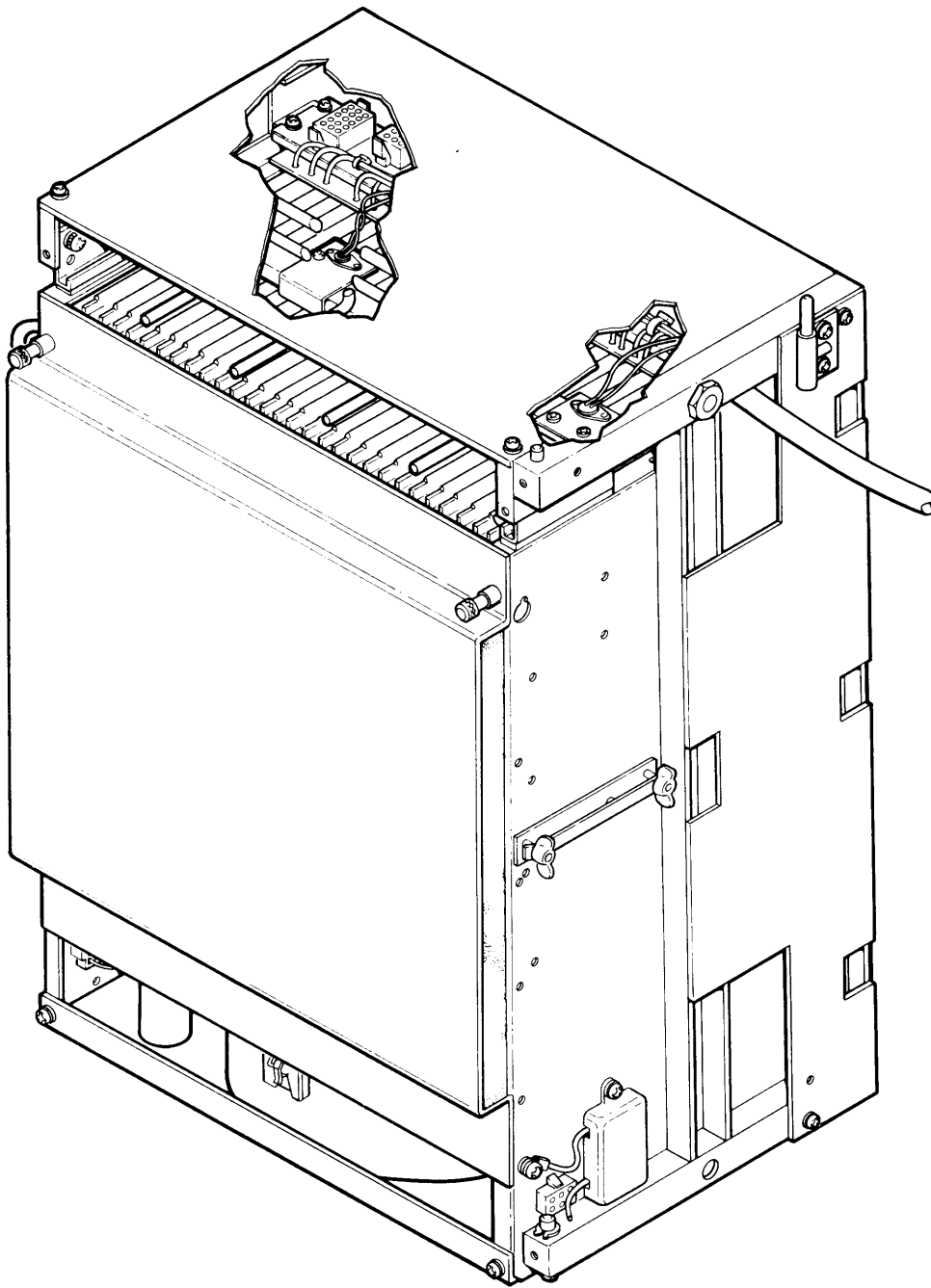
To view the logic boxes in the PDP-11/60, the front panel must be removed and the stabilizer legs extended. This process is described in Paragraph 4.1.4.

There are two latches on the logic box, one to hold the box in its normal position, and the other to hold it in the servicing position. One latch for the cage is located on the bottom corner of the cage, just below the handle. The second latch is on the top corner diagonally opposite the first latch. This second latch must be released before fully pivoting the cage, or else the latch may break when it hits the horizontal frame member. When the cage is swung 90 degrees from the cabinet, the second latch will hold it in this position.

The logic box is designed to hold a maximum of 29 standard hex PCB modules. Full-length continuous card guides at the top and bottom of the inside of the box will guide the PCB modules into place, to plug into the backplane.

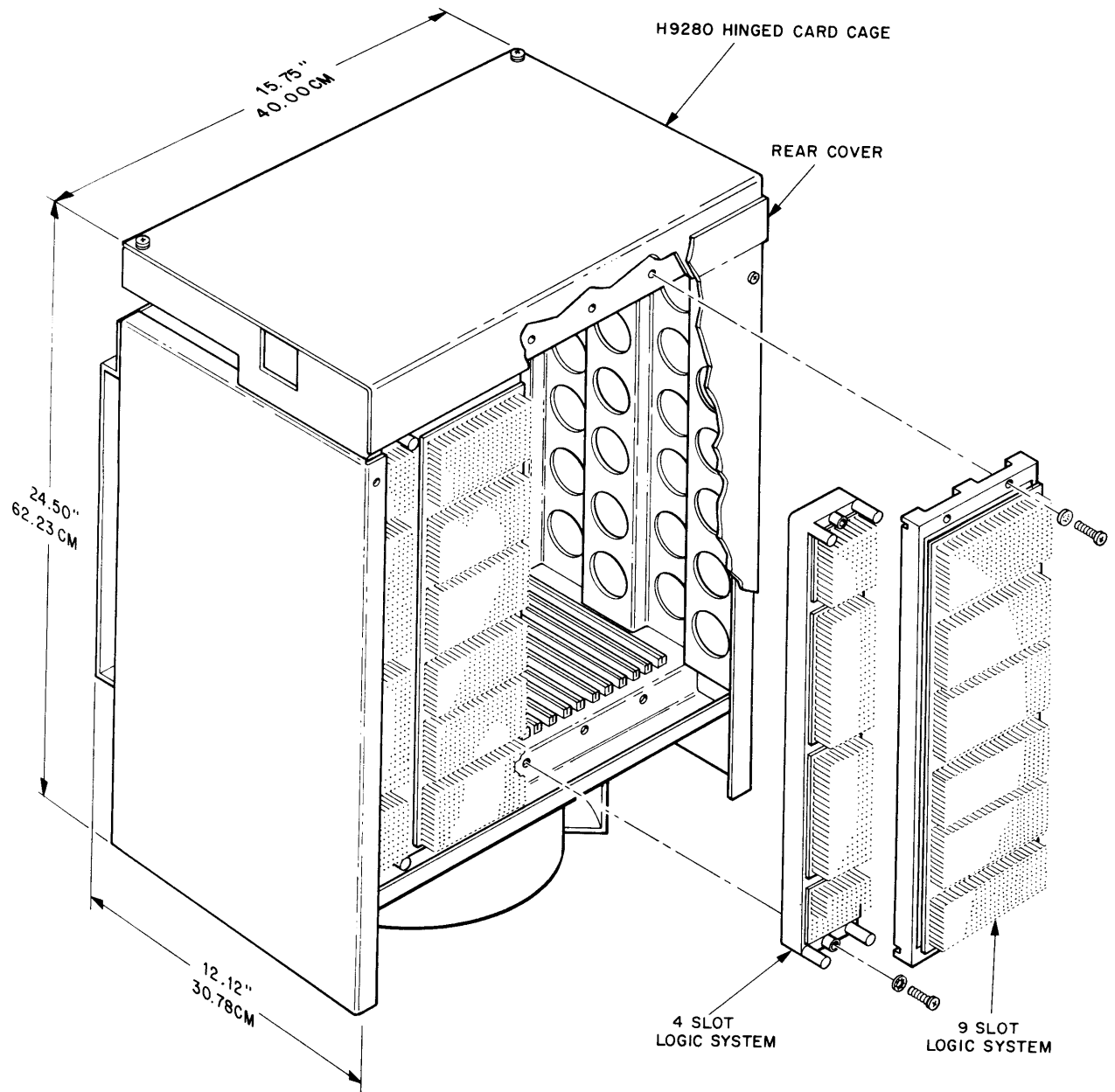
The logic box is designed to accommodate six single system units (SUs) or three double SUs. One single SU will generally occupy four slots, although an additional slot will become inaccessible because the SU's backplane is wider than four slots. One double SU will normally occupy nine slots. It is also possible to mount custom backplanes. All backplanes are mounted using the 8-32 standard holes provided in the card cage plane, as in Figure 4-10. There are 12 threaded holes, 6 in the top row and 6 in the bottom, spaced 6.35 cm (2.5 in) apart. The vertical spacing between these rows is 40.64 cm (16.1 in).

The H9280 logic card cage assembly is independently cooled, relative to the rest of the corporate cabinet. The cooling unit is a centrifugal blower system operating on an evacuation principle, and powered directly from the 866 power controller (H7420 in 240 V systems). The blower draws inlet air from the front cover vent through the upper part of the logic cage, down past the PCB modules, and through the screen in the bottom of the cabinet. This flow is shown in Figure 4-11. The logic box will cool logic modules having a maximum dissipation of 40 W per module. If the system contains less than the maximum number of modules, a baffle, DEC P/N 70-123304, can be cut to fit and installed to direct the air flow over the modules. This prevents the short circuiting of air past the modules.



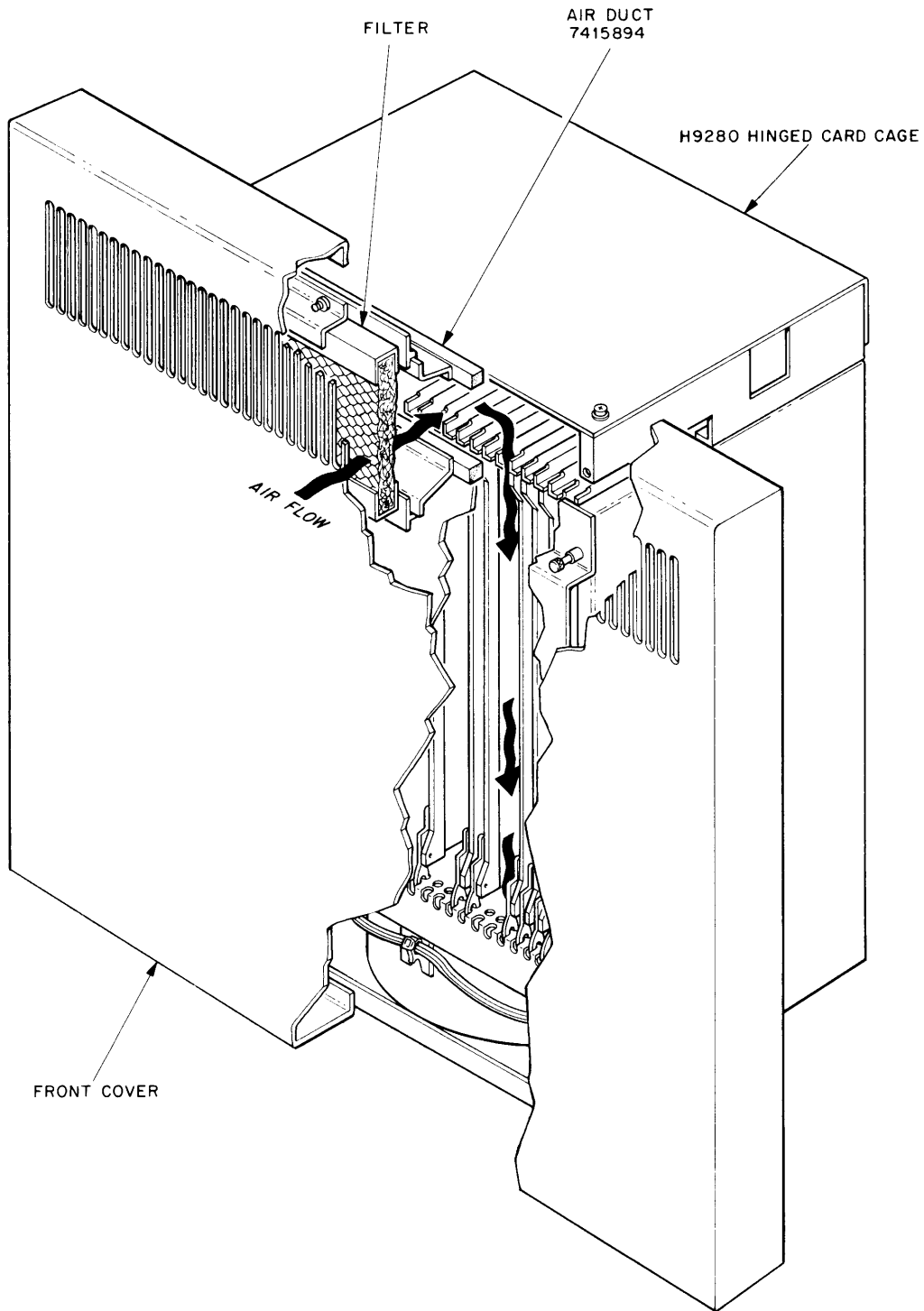
MA-0716

Figure 4-9 H9280 Logic Card Cage



CP-2893

Figure 4-10 BA11-P Backplane Mounting



CP-2894A

Figure 4-11 BA11-P Card Cage Air Flow Direction

### 4.3.3 Peripherals

There are three types of disk peripherals available with the standard PDP-11/60 system. The first, the RK05J disk drive, contains a removable cartridge that loads from the front of the cabinet. It has a capacity of 2.5M bytes. The second, the RK05F disk drive, does not have a removable cartridge, but it has a capacity of 5M bytes, twice that of the RK05J. The third disk drive is the RK06, which has a removable cartridge that is loaded from the top. It has a capacity of 14M bytes per cartridge.

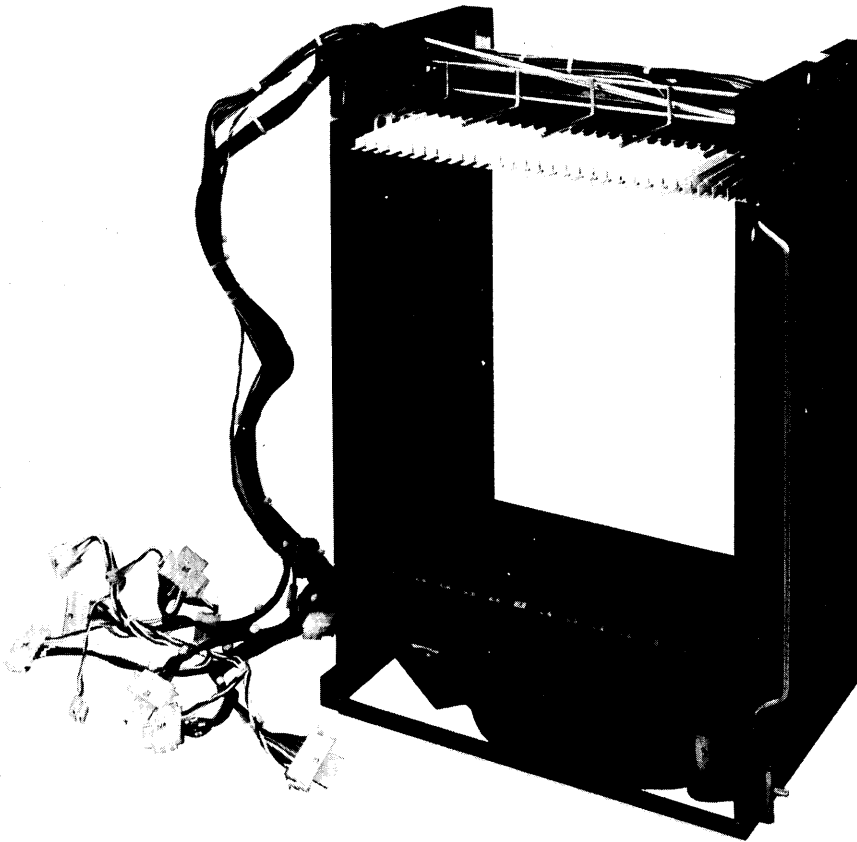
The RK05F is designed to appear, to the controller unit, as two "logical" RK05J drives. Because of this design, one RK05J disk drive controller can handle both the RK05F and the RK05J. This is the case in the PDP-11T60.

For further details on these disk peripherals, consult the *PDP-11 Peripherals Handbook* or the *RK06 Disk Drive Technical Description Manual* (EK-RK06-TD-001).

## 4.4 INSTALLATION PROCEDURES

### 4.4.1 BA11-P Installation

The "basic" PDP-11X60-C, PDP-11Y60-L, and PDP-11T60-C systems do not include a BA11-P\_ expander card cage. The expansion space for these basic systems varies from two quad SPCs to one SU with an additional two quad SPCs. For additional expansion space, the BA11-P\_ expander card cage may be installed in the field as an add-on option. The BA11-P\_ expander card cage includes the H9280 logic card cage, harness (expander harness and power supply harness assembled, Figure 4-12), H7420 (70-13050-XX) power supply, and blower cooling unit attached to the base of the H9280 card cage. The following paragraphs describe the installation of the card cage and power supply and the replacement of the blower unit.



8277-3-A0038

Figure 4-12 BA11-P Expander Card Cage (Front View)

**4.4.1.1 Card Cage Installation** – The parts that are shipped with the BA11-P\_\_ card cage are listed in Table 4-4. The items listed correspond to the items shown on Figure 4-13, which have to be assembled on site; also listed are items used for installation of the power supply (Paragraph 4.4.1.2).

**Table 4-4 BA11-P Accessories**

Item No.	Part Number	Description
1	90-08500-0-0	C Ring
2	90-06633-00	Washer, Int Tooth Lock #6
3	12-13126-01	Latch, Right-Hand
4	90-09174-10	Screw, Set #10, 32 × 0.25 lg
5	C-PS-1213001-0-0	Bushing Pivot
6	C-PS-1213000-0-0	Ramp and Lock
7	C-PS-1213002-0-0	Bushing Stop
8	B-MD-7409817-0-0	Plate Cable Clamp
9	90-06020-02	Screw, Phillips Flat Head 6-32 × 0.25
10	90-09789-00	Insert Thd Snap In 6-32
11	90-06022-01	Screw, Phillips Pan Head, 6-32 × 0.38
12	90-08203-1	Nut, Kep 1/4-20
13	B-MD-7418084-0-0	Shipping Plate
14	90-06444-0-0	Sems Screw 10-32 × 0.38
15	B-MD-7418356-0-0	Pivot Pin
16	A-DC-3613882-0-0	Label, Caution
17	90-06570-00	Wing Nut
18	C-IA-7419154-0-0	Bracket, Strain Relief Cable
19	C-MD-7415640-0-0	Bracket, Power Supply Mounting
20	90-07786	Retainer, Unit #10-32
21	90-06073-03	Screw, Phillips Head Truss #10-32 × 0.50
22	90-06664	Washer, Flat 0.437 d × 0.217 d × 0.06 thick
23	90-06565	Nut, Kep #10-32
24	90-06073-01	Screw, Phillips Head Pan #10-32 × 0.50

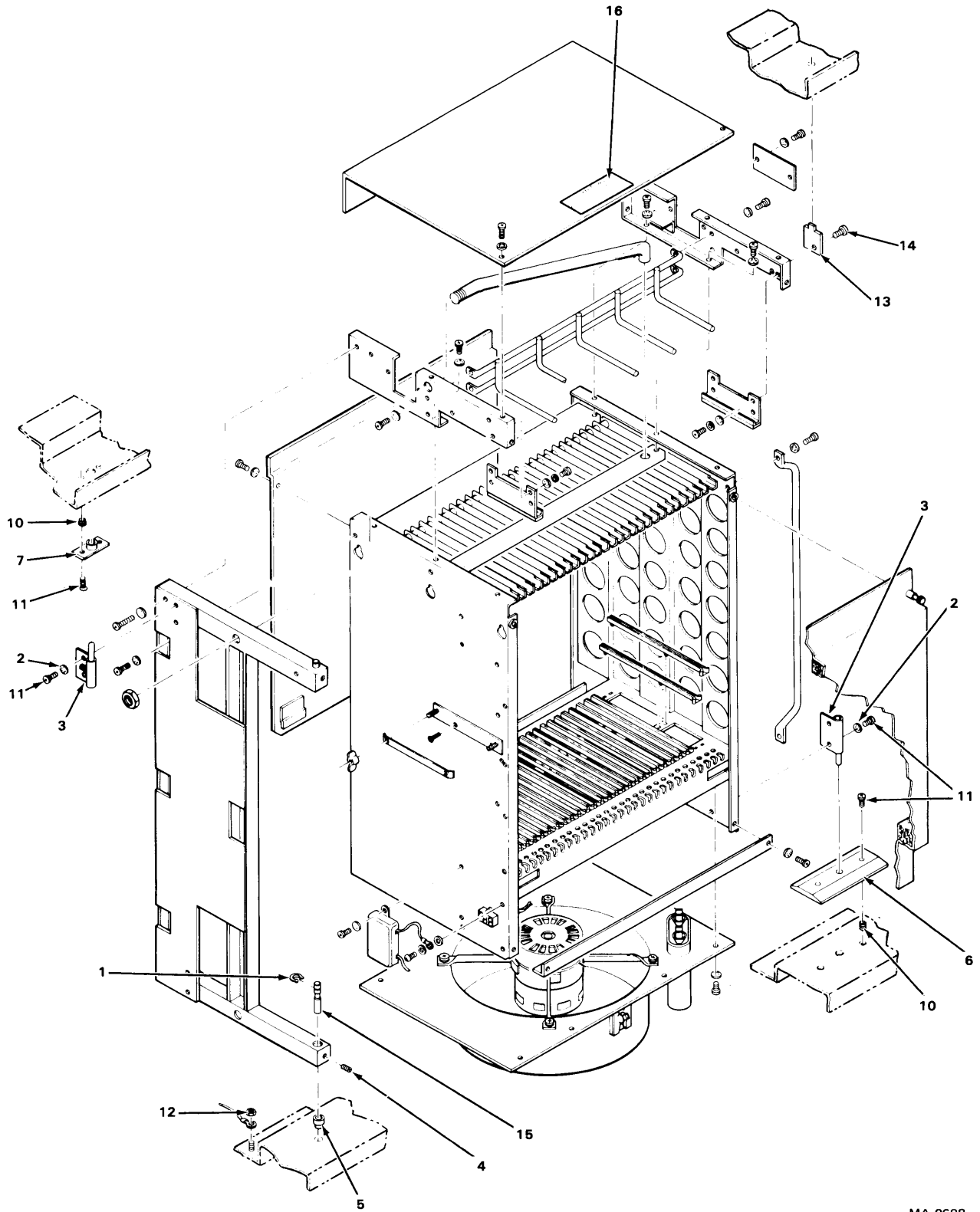
Perform the following procedure for installing the BA11-P\_\_ card cage.

1. Assemble parts from the kit to card cage [i.e., right-hand latch, items 2, 3, and 11: two places (Figure 4-13); lower pivot pin, items 1, 4, and 15, etc.] The ramp and lock, item 6, may be attached to the cabinet frame before or after the card cage is installed.

**NOTE**

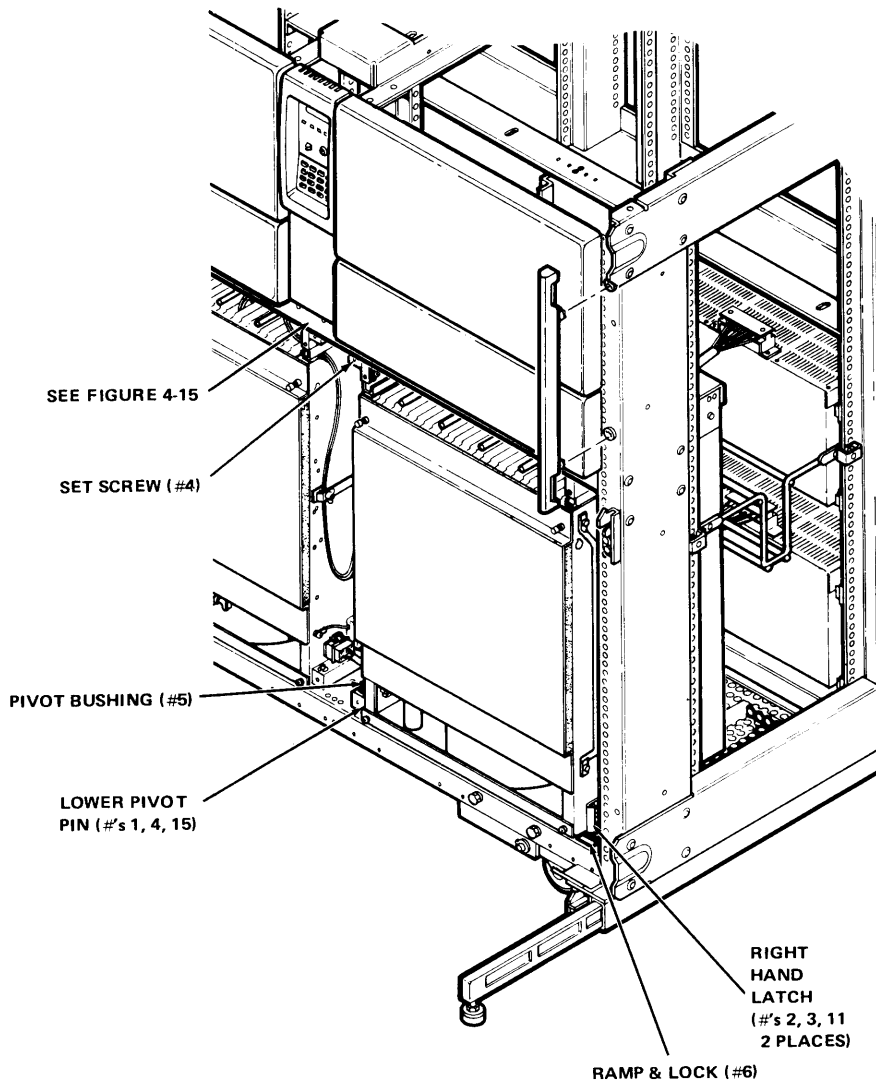
**Do not install upper pivot pin at this time. See Figure 4-13, item 15.**

2. Insert upper and lower pivot bushings (item 5), in bushing holes shown in Figure 4-14 and 4-15. Screw in the bushing stop (items 7, 10, and 11).
3. Lift the card cage assembly and position it in the cabinet with the lower pivot pin in the lower pivot bushing.



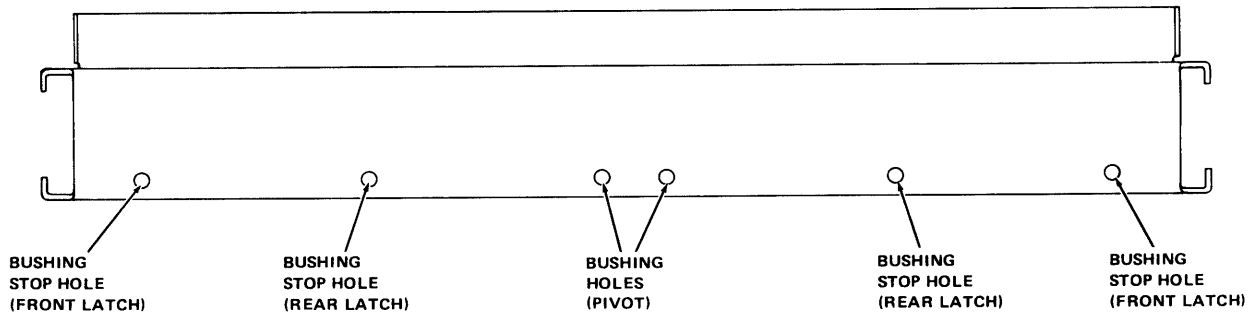
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Figure 4-13 H9280 Expander Card Cage (Exploded View)



MA-0721

Figure 4-14 BA11-P Expander Card Cage Ready for Installation



MA-0722

Figure 4-15 Upper Front Double Horizontal Frame Member



4. Line up the upper pivot pin hole on the card cage with the upper pivot pin bushing.
5. Insert the upper pivot pin from below the upper pivot pin hole and tighten the set screw (item 4).
6. Plug the fan cord into the card cage (Mate-N-Lok adjacent to the ground filter coil). Using stick-ons and medium tie wraps, dress the fan cord along the bottom of the cabinet to the back of the 866-D power controller. Plug it into a phase 2 switched outlet. If the system is 240 V/50 Hz, the fan cord dresses up the side of the pivot support along with the expander harness. This cord plugs into the bottom H7420's P7 connector, the green wire in hole 4 and the others in 5 and 6.
7. In the front of the cabinet there is a "Dakota" clamp mounted to the bottom of the middle crossbar; the harness for the expander card cage is dressed through this clamp to the back of the cabinet. In the back there is an L-shaped bracket with a 3/4-inch C-clamp. The expander harness drops down from the processor harness, which has already been dressed through this C-clamp.

#### **NOTE**

**Before attaching the "Jones strip," which is mounted on the H7420 power supply (Figure 4-16), and before connecting the expander harnesses Mate-N-Loks to the power supply, perform the power supply installation procedure described in Paragraph 4.4.1.2.**

8. Mount the "Jones strip" to the top of the H7420 (Figure 4-16), with two 6-32 × 1 inch Phillips pan head screws and #6 internal lock washers.
9. Connect expander harness Mate-N-Loks to the H7420 and regulators (Figures 1-3 and 3-14).
10. The long wire from the input filter coil is connected to the middle of the front lower frame member, adjacent to the central ground wire from the base card cage. The short wire from the input filter coil was attached during mounting of the coil in Step 1 to the bottom left side of the expander card cage (Figure 4-13).
11. The power cord for the H7420 is dressed with the remote cable for the expander box with one stick-on and tie wrap. From there they are dressed in with the other power cord and remote cable to the fourth stick-on. The power cord is cut down to the right length and plugged into the phase 2 switched outlet on the 866-D/E power controller. The remote cable is dressed under the 866 and plugged into one of the remaining Mate-N-Loks on the back of the 866 (Figure 2-2).

#### **WARNING**

**The installation of an H7420 power supply is a 2-man operation (Step 5). Damage to your person and/or the equipment may occur if this procedure is attempted alone.**

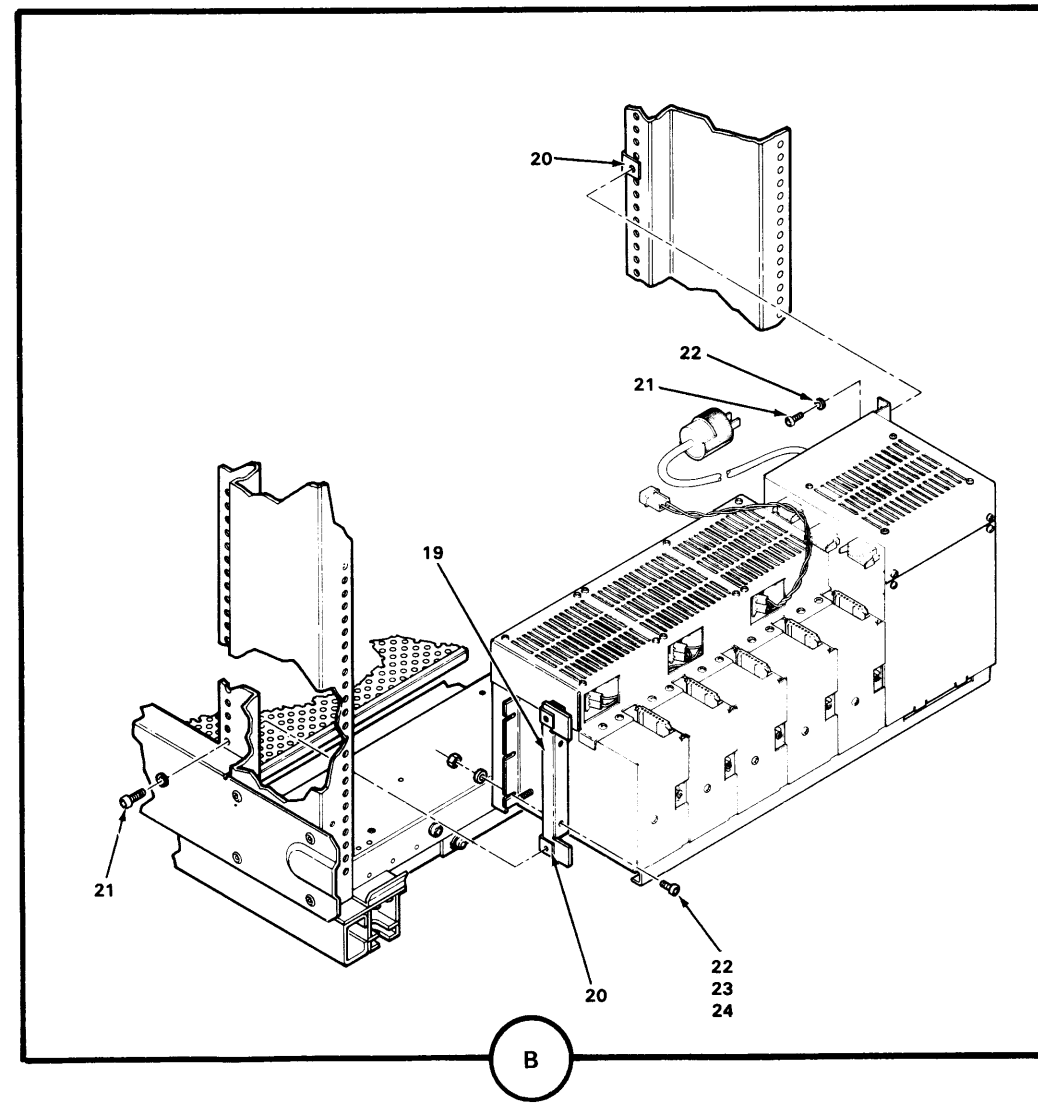
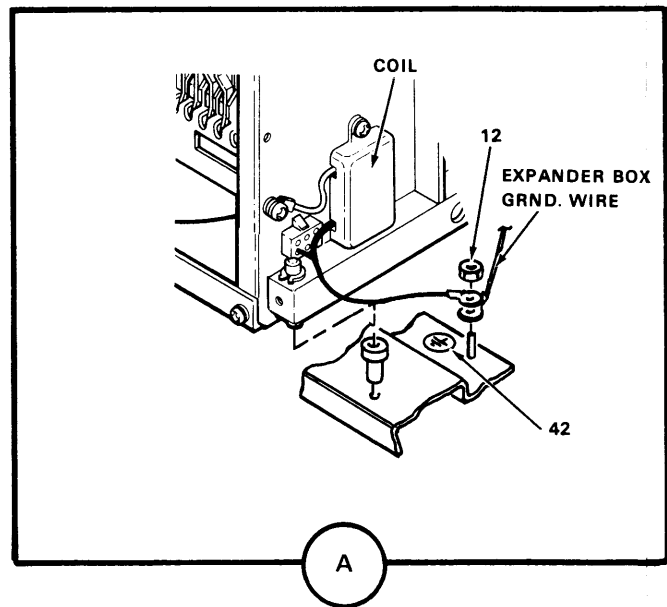
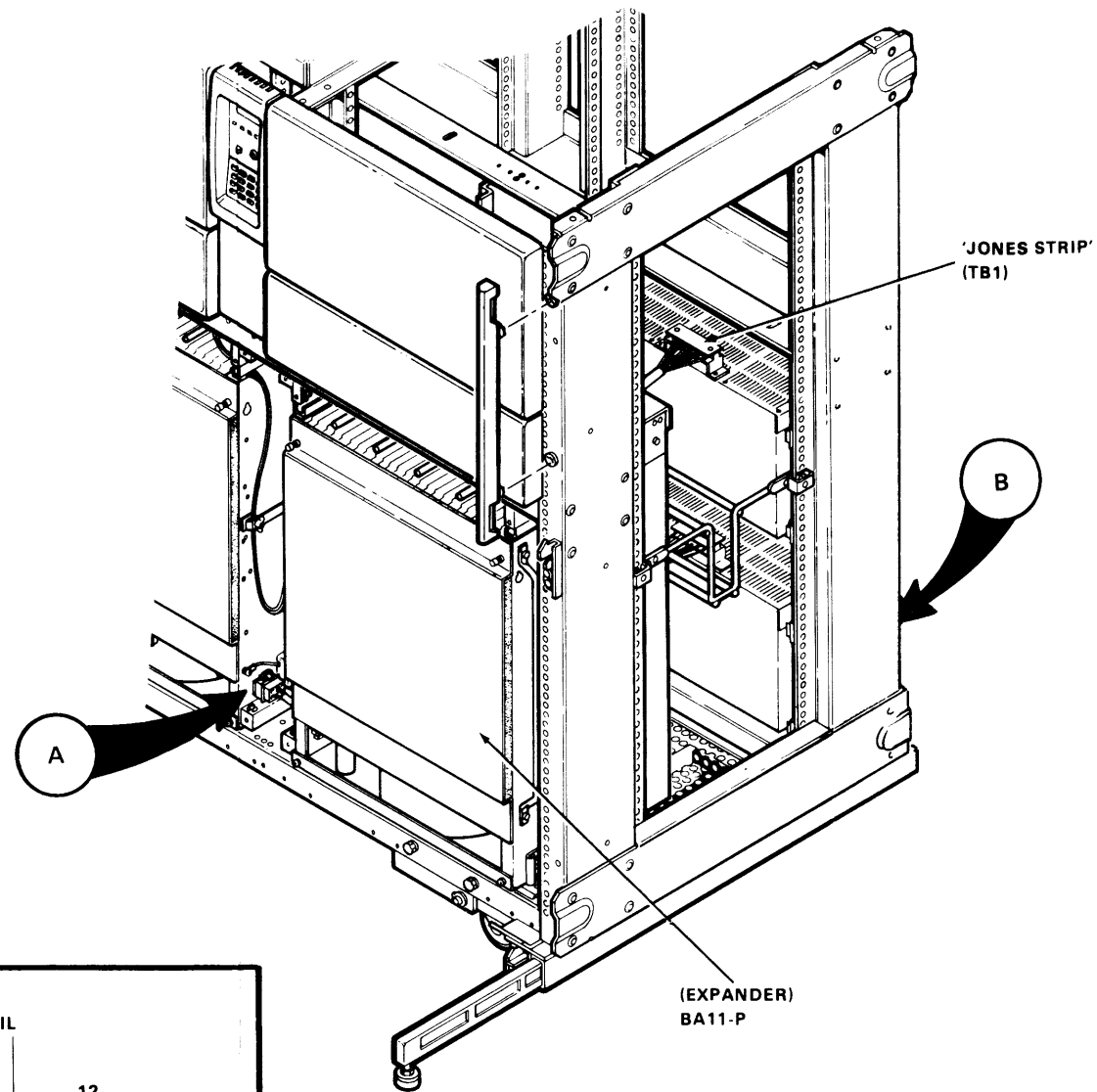


Figure 4-16 PDP-11/60 Expander  
Card Cage  
Installation Details

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#### **4.4.1.2 H7420A/B Expander Power Supply Installation**

1. Install four Tinnerman nuts (item 20, Detail A, Figure 4-16) in the rear center support of a double-width cabinet or in the right side support of a single-width cabinet. The nuts are installed over holes 24, 27, 33, and 36.
2. Insert two 10-32 × 1/2 inch screws into Tinnerman nuts that are over holes 24 and 27, leaving 1/4 inch of thread showing.
3. Install bracket (item 19, Detail B, Figure 4-16) to left side of power supply.
4. Install two Tinnerman nuts on the bracket (Detail B, Figure 4-16).
5. Position the H7420 so the keyhole slots on the right side of the power supply line up with the two extended 10-32 screws contained in the center support of the cabinet. Lower the power supply on the screws.
6. Level the H7420 and install two 10-32 support screws on the left side (Detail B, Figure 4-16.)
7. Install the remaining 10-32 support screws on the right side of the power supply and tighten all hardware.
8. Complete card cage installation (Step 8 of Paragraph 4.4.1.1).

**4.4.1.3 Replacement of the Blower Unit** – To remove the blower unit under the card cage, the cage must be placed in the servicing position, i.e., latched 90 degrees from the corporate cabinet. Unplug the blower unit from the card cage. Remove the four screws in the blower unit mounting plate at the front (the module handle end) of the card cage. Then remove the remaining four screws holding the blower unit. The blower assembly toward the rear of the card cage will drop free and can be removed from the front angle support by pulling it down toward the rear, as in Figure 4-17.

To install the blower unit, with the front edge of the blower unit housing resting on the angle support, engage the four screws that hold the blower unit mounting plate to the rear edge of the logic card cage. Next, secure the blower unit mounting plate at the front edge of the card cage with the four remaining screws. Tighten all screws and plug the connector into the receptacle on the logic card cage.

#### **4.4.2 Expander Cabinet Installation**

Because of the PDP-11/60 corporate and expander cabinet's self-contained shock mounts and the weight differences between cabinets, all cabinets must be leveled before they are bolted together. The cabinets must also be partially disassembled before they can be bolted together. The following paragraphs describe how to disassemble the cabinets (4.4.2.1), level the cabinets (4.4.2.2), bolt the cabinets together (4.4.2.3), and reassemble the cabinets (4.4.2.4).

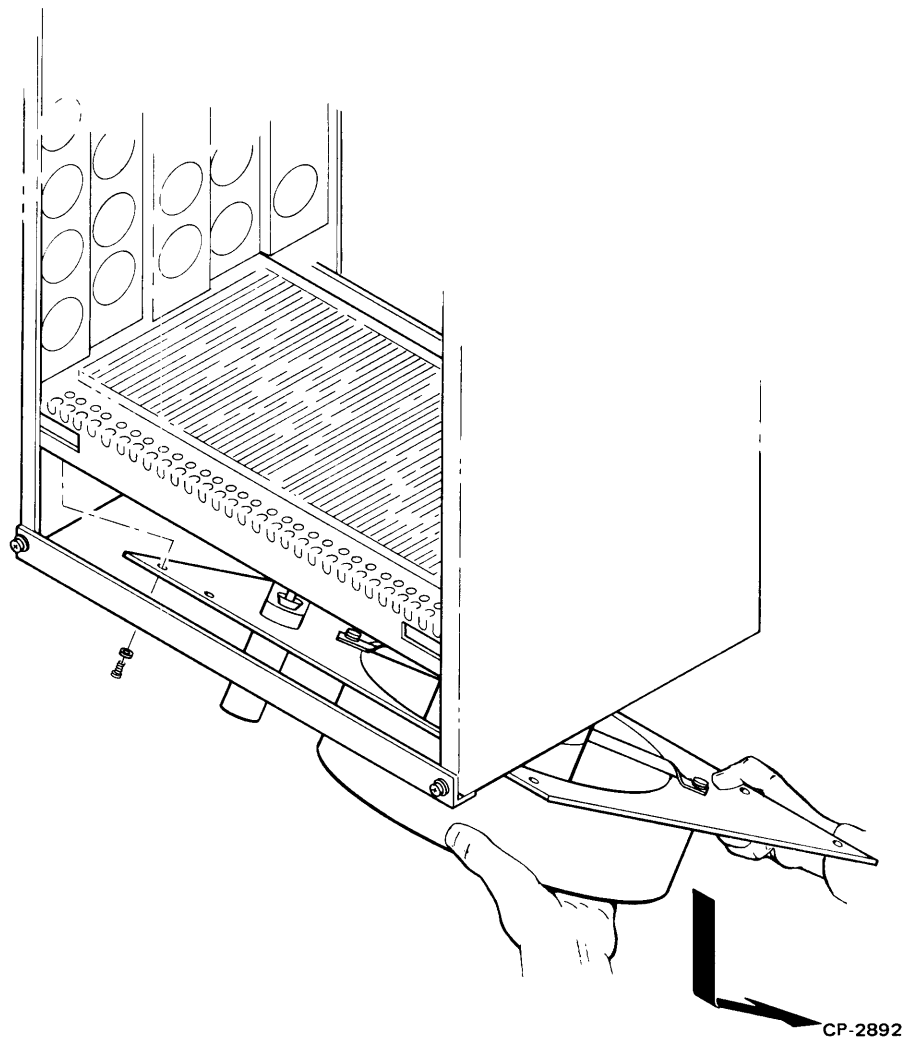
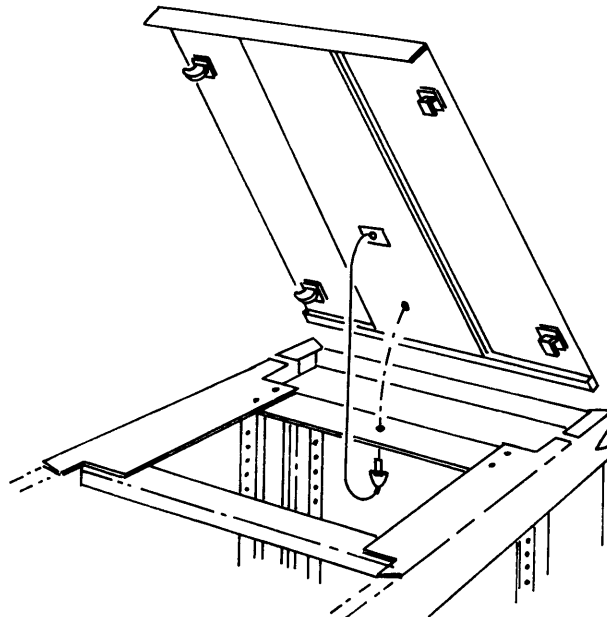


Figure 4-17 Blower Unit Removal

#### 4.4.2.1 Cabinet Disassembly

1. Remove the front panel and back doors as described in Paragraph 4.1. Disconnect the ground straps from the front panel, end panel(s), and back door to completely remove each panel from the cabinet.
2. Reach into the cabinet and find the fastener on the underside of the top cover. It is located as shown in Figure 4-18. If hard-mounted equipment is blocking access, the fastener was not installed. If slide-mounted equipment is blocking access, slide out the equipment. Release the top cover by turning the 1/4 turn fastener 1/4 turn in a counterclockwise direction. When released, the fastener will hang from the cover support by a wire. Push the top cover forward about 1/2 inch. Standing in front of the cabinet, lift the top cover off.
3. Remove each end panel by unscrewing the retaining screws in each of the four corners; grasp it on both sides and lift.
4. Use a Phillips screwdriver to remove the trim strips from the top, front, and rear edges of the cabinet.



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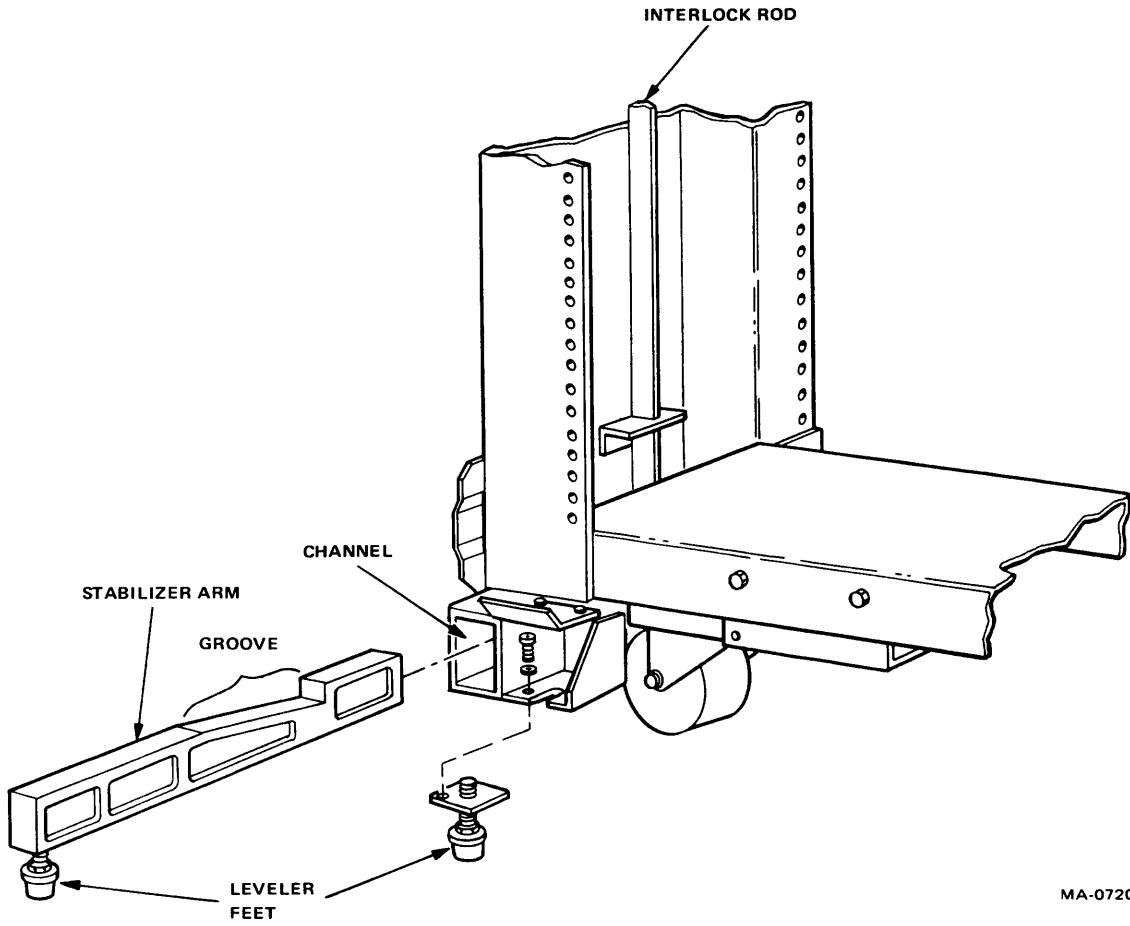
Figure 4-18 Top Cover Fastener

#### 4.4.2.2 Cabinet Leveling

1. Push the cabinets together.
2. Install leveler feet (shipped as loose pieces) into the cabinet frame (Figure 4-19).
3. Using a 9/16 wrench, lower the leveler feet until all four on each cabinet contact the floor.
4. Adjust the highest cabinet until most of its weight is shifted from the casters to the leveler feet. Due to the shock-isolating system, the casters will always touch the floor even when all of the cabinet's weight is transferred to the leveler feet.
5. Using a spirit level, adjust the leveler feet until the cabinet is level.
6. Adjust the adjacent cabinets in a similar manner.

#### 4.4.2.3 Bolting Cabinets Together – Each cabinet has four bolting plates, one on each upper and lower side edge (Figure 4-20). To bolt the cabinets together:

1. The bolting hole (the middle hole) at each end of each plate should align with the bolting hole on the plate of the adjacent cabinet.
2. Insert a  $1/4 \times 20$  bolt into the lined up bolting plate holes. Add a key nut and tighten. This will provide a good horizontal alignment across the cabinet system.



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Figure 4-19 Leveler Foot and Stabilizer Arm

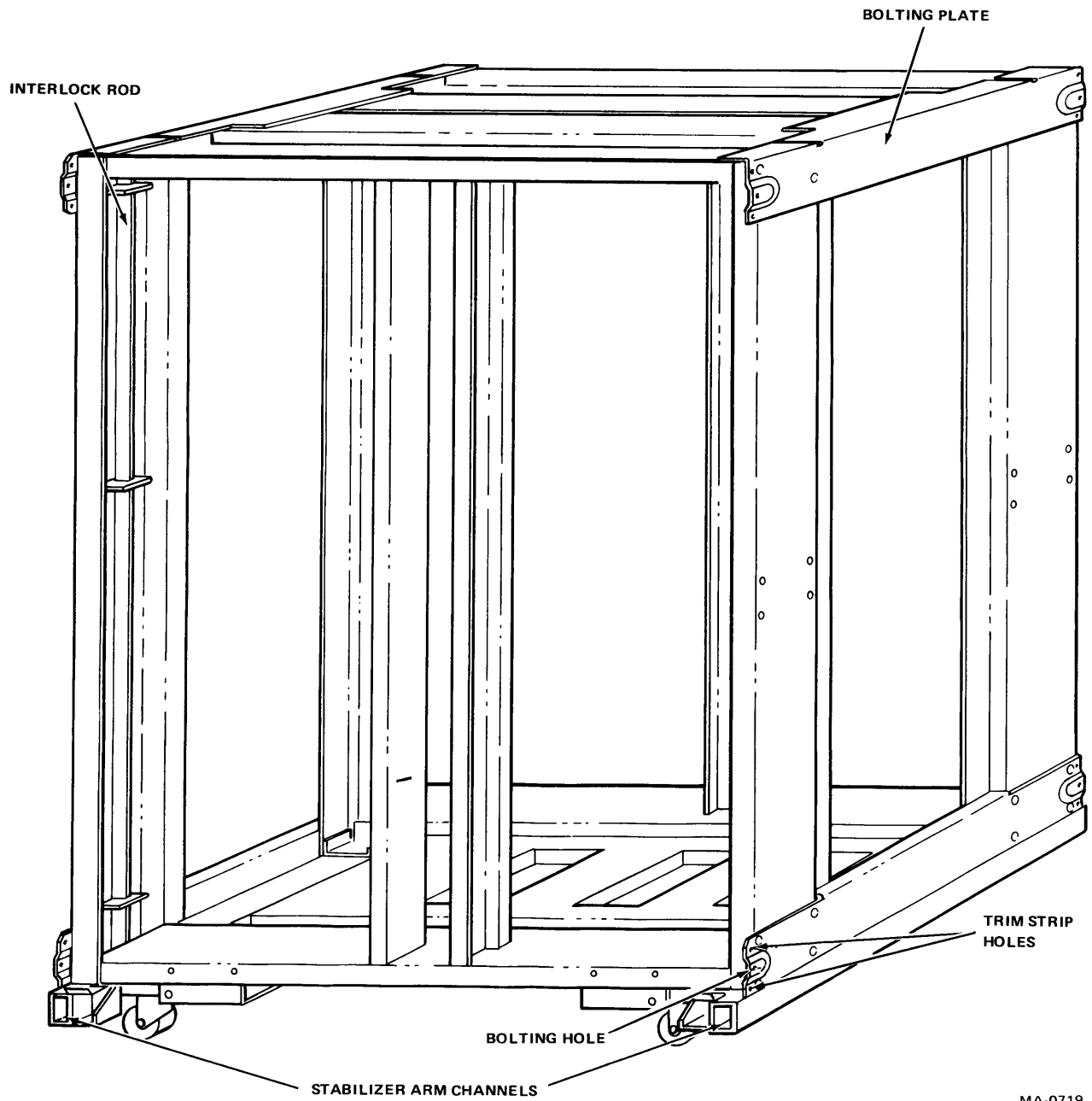


Figure 4-20 Cabinet Frame (Front View)

#### **4.4.2.4 Cabinet Reassembly**

1. Screw the top trim strips in place.
2. Add the front and rear vertical trim strips.
3. Remount all the panels and doors in the same way as they were removed. It must be done in this sequence:
  - a. End panels
  - b. Top covers
  - c. Rear doors
  - d. Front panels

#### **4.4.3 FP11-E Floating-Point Processor Option**

When installing the FP11-E floating-point processor option, the H7421A/B power supply is mounted in the back of the cabinet on the bottom right side in holes 36 and 40 from the bottom. Use four 10/32 × 1/2 PTH screws, #10 internal lock-washers and 10/32 Tinnerman nuts. The harness is dressed in with the harness for the CPU and plugs into the power distribution panel. The power cord for the power supply is dressed down the side of the cabinet and plugs into the switched side of the 866-D/E power controller.

There are four modules in the FP11-E option set. They are plugged into the base card cage, slots numbered 8–11 (in the CPU area). Module M7878 goes in slot 8; M7879 in slot 9; M7880 in slot 10; and M7881 in slot 11.



## CHAPTER 5 CABLING GUIDELINES

### 5.1 INTRODUCTION

The H9500 corporate cabinet was designed to allow cable installation with minimum probability of cable damage. The design also allows for convenience during servicing, as well as providing a neat appearance. This chapter describes the guidelines for installing cables in a PDP-11/60 corporate cabinet or expansion box. These guidelines will help reduce the possibility of cable damage. More detailed cabling information is contained in Chapter 6 of the *H9500 Corporate Cabinet Manual*.

#### 5.1.1 Cabinet Cable Troughs

The cabinet cable trough is an easily installed, metal wire structure designed to facilitate cable management throughout a cabinet system. It is capable of accepting all currently used I/O and Unibus cables. The trough can be mounted at various positions in the cabinets depending on system layout. Two versions have been designed to be used with single- and double-width cabinets (Figure 5-1).

#### 5.1.2 Cable Types Accommodated

The types and maximum quantities that can be accommodated in the card cage and card cage troughs are:

1. Eighteen flat PVC cables with widths up to 7.1 cm (2.8 in)
2. Twelve 0.98 cm (0.38 in) diameter round EIA cables)
3. Three 60-conductor flat polyester Unibus types
4. Power cables of various configurations having a maximum combined diameter not exceeding the equivalent of 2.54 cm<sup>2</sup> (1 in<sup>2</sup>) area
5. Flat PVC and round cables may be mixed, with four round cables replacing six flat cables until the maximums noted previously are reached.

### 5.2 HANDLING FLAT CABLES

This paragraph describes methods for folding and routing flat cables within the cabinet. The end of the cable requiring the greatest number of folds (at the end of the card cage for example) should be installed first.

Flat cables, unlike round cables, are limited to directional flexibility. Round cables can be routed at various angles without special attention. Flat cables, on the other hand, require special folding techniques to attain the proper attitude or change direction. Paragraphs 5.2.1 through 5.2.5 describe the basic folds that will make it possible to achieve almost any orientation of a flat cable.

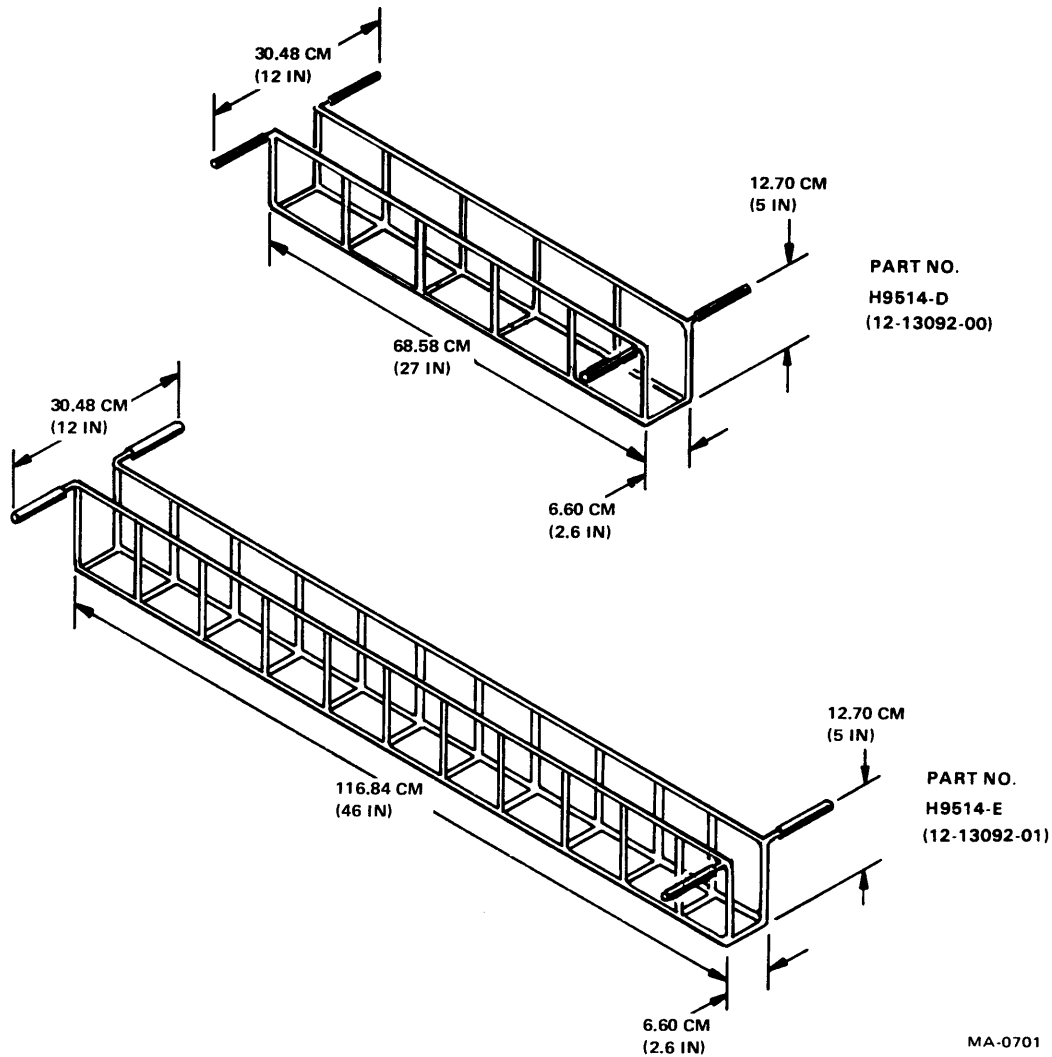


Figure 5-1 Single and Double Cable Troughs

**5.2.1 Straight Fold**

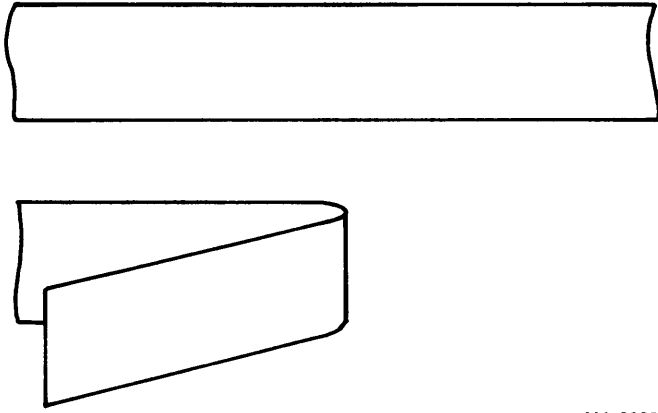
This fold, shown in Figure 5-2, changes the direction of the cable up to 180 degrees. It can be used, for example, to shorten a length of cable for storage purposes.

**5.2.2 90-Degree Fold**

This fold is shown in Figure 5-3. It changes the direction of the cable 90 degrees.

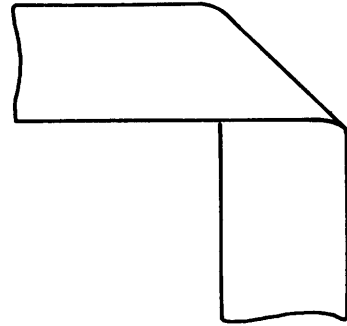
**5.2.3 90-Degree Fold With 90-Degree Axis Rotation**

This fold, illustrated in Figure 5-4, changes the direction of the cable 90 degrees as well as rotating the cable axis 90 degrees.



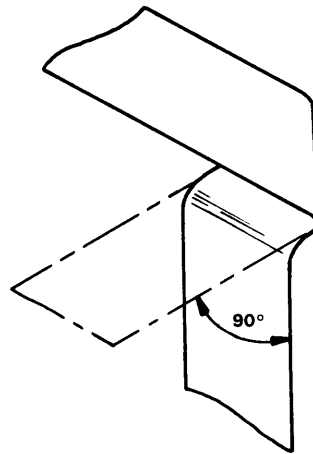
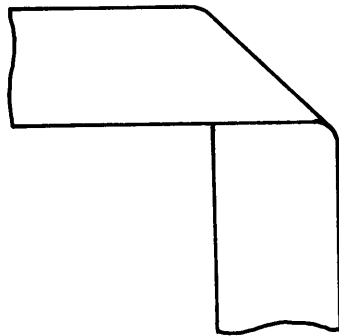
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Figure 5-2 Straight Fold



MA-0694

Figure 5-3 90-Degree Fold



MA-0695

Figure 5-4 90-Degree Fold with 90-Degree Axis Rotation

### 5.2.4 180-Degree Axis Rotation Fold

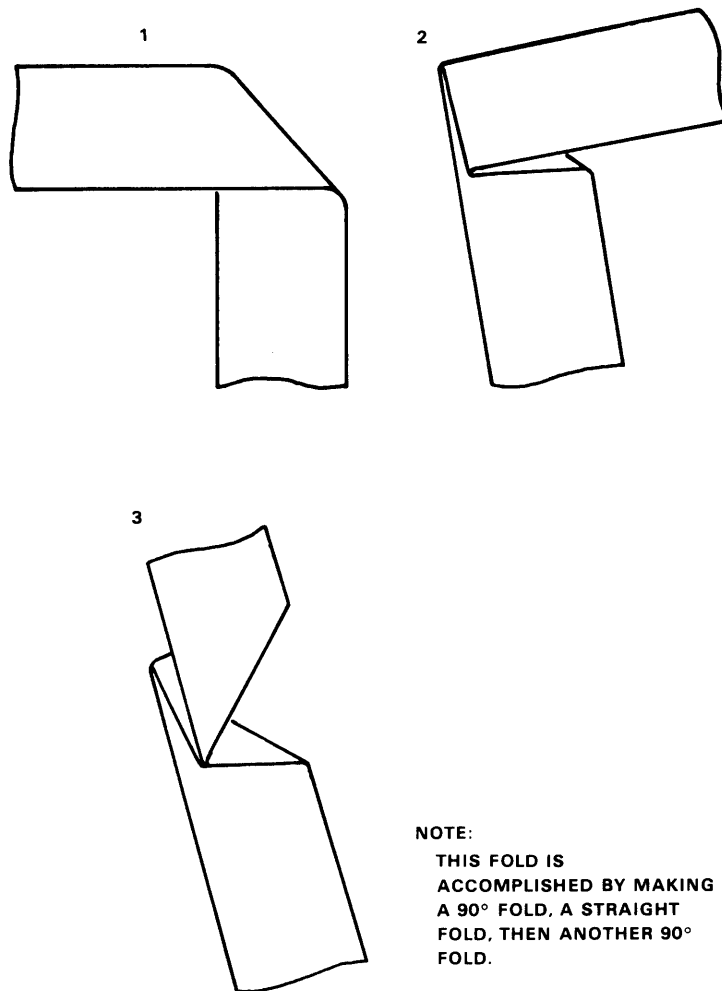
This fold is pictured in Figure 5-5. It alters the axis of the cable 180 degrees to permit the cable connector to correctly match the connector receptacle. The fold is accomplished by making a 90-degree fold, a straight fold, and then a second 90-degree fold.

### 5.2.5 Out-of-Sequence Fold

Figure 5-6 shows this fold. A cable can be installed with an out-of-sequence fold when the path to the designed area is blocked by a previously installed cable. This fold can also be used to install a replacement cable without completely removing the previously installed cable. It is accomplished with a 90-degree fold, two straight folds, and another 90-degree fold.

### 5.2.6 Installation of Cables in Card Cage

Flat cables must be installed in sequence in card cages. That is, the cable closest to the hinge point is installed first. Then each cable is installed sequentially, working away from the hinge point. The flat cable is draped across the top of the card cage, as shown in Figure 5-7. When the cable is installed in both cages, about 75 cm (30 in) of slack must be left between the cages, to allow the cages to be swung out for servicing.



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Figure 5-5 180-Degree Axis Rotation Fold

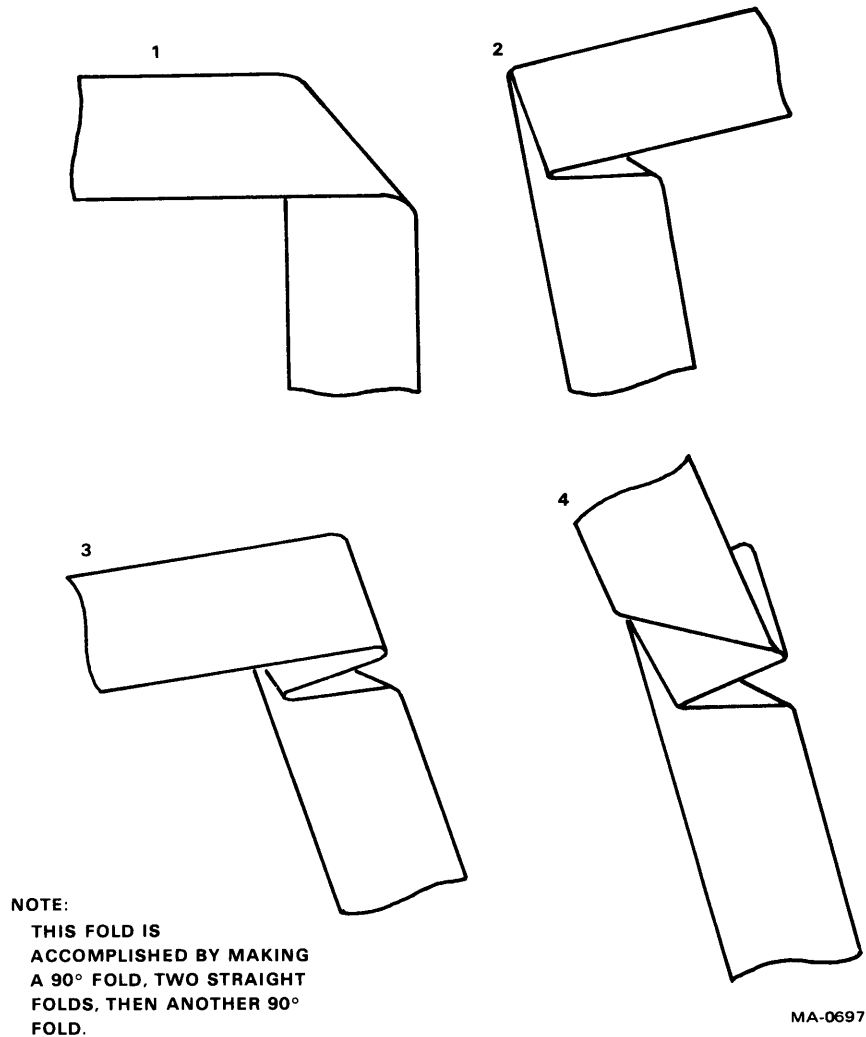
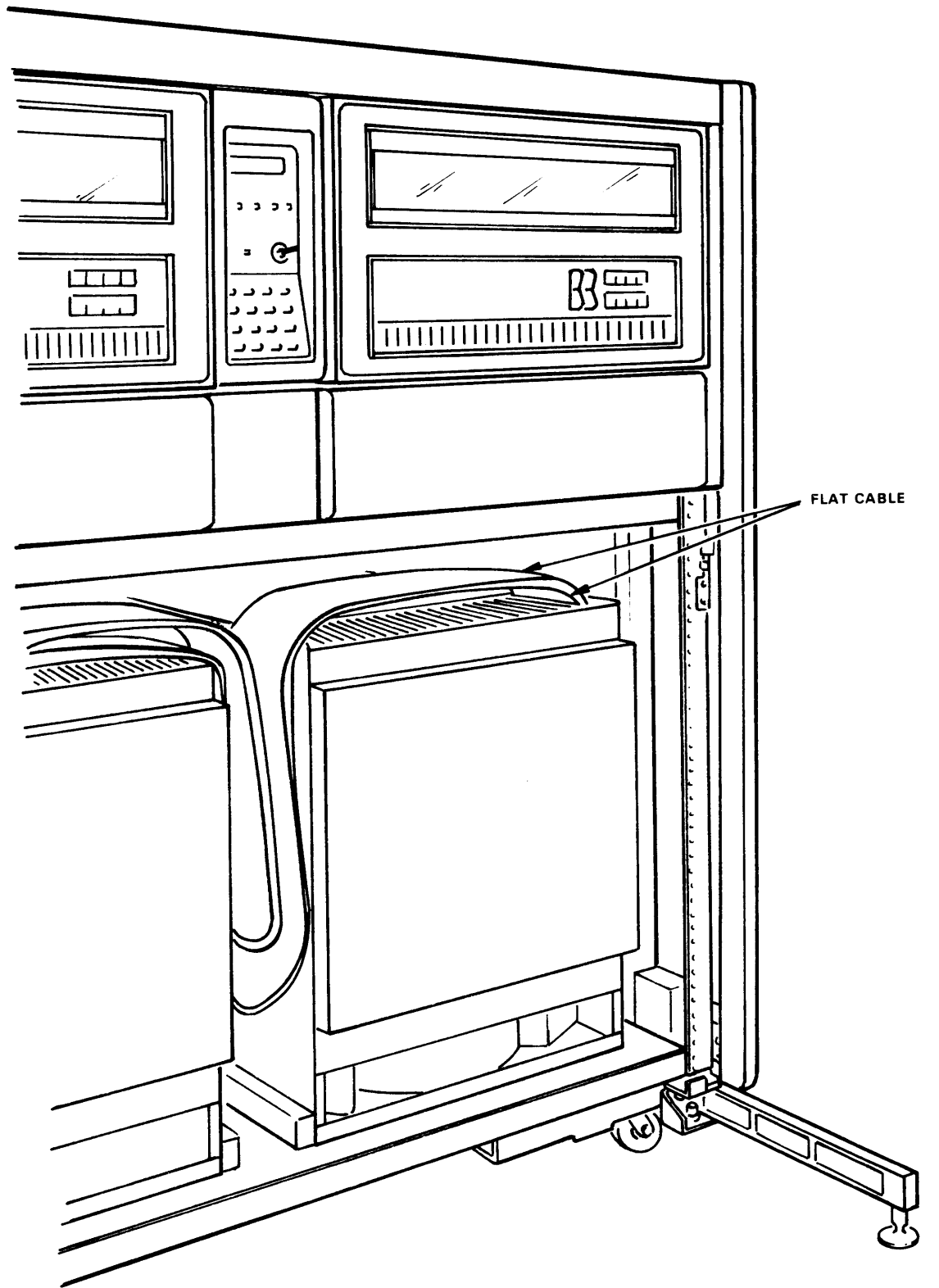


Figure 5-6 Out-of-Sequence Fold

### 5.3 PREPARATION OF SYSTEMS FOR SHIPMENT

When multicabinet systems must be separated for shipment, easy reinstallation of cables can be achieved by field service personnel at customer sites if the following procedure is used in preparing the system for shipment:

1. Remove cable or groups of cables from units and troughs in the cabinet containing the most accessible cabled group.
2. Tie-wrap cable or cables in groups by unit destination, maintaining the routing already established.
3. Neatly tie-wrap groups to side members of the cabinet in which they will be shipped.



MA-0710

Figure 5-7 Flat Cable Sequence in Card Cage

#### **5.4 SYSTEM CABLING CONSIDERATIONS**

The following considerations should be taken into consideration during the system layout and planning phases:

1. Minimize cabling between detachable cabinets.
  - a. Have card cage and I/O panels in same cabinet if a large number of cables is required between them.
  - b. Use double-width cabinets to minimize intercabinet cabling disassembly for shipments.
2. Keep cable lengths as short as possible.
  - a. When two or more peripherals are mounted one above the other, use the bottom unit for cables from the card cage (usually first on Unibus line). This precaution will keep cables short and prevent long service loops.
  - b. Keep units cabled together as close to each other as possible.
  - c. Use double-width cabinets as close to each other as possible [single = 137.16 cm (54 in), one double = 116.84 cm (46 in)].
3. Use roll bars and/or cable retractors whenever possible to prevent cable damage at sliding units.
4. Always install first that end of the cable that presents the most difficulty, e.g., the card cage.
5. Take up all excess cable length in cable troughs.
6. Protect cables from sharp edges.
7. Careful selection of system unit backpanel positioning in the card cage can minimize cable crossover and blocked paths in the troughs.
8. Keep functional cable families separate; for example:
  - a. AC power cables should be spaced as far as possible from dc power cables, and all power cables, both ac and dc, should be spaced as far as possible from all logic cables.
  - b. Peripheral cables should be dressed away from modular interconnect cables.
  - c. Flat cables, such as Unibus or unshielded flat grey cables, should be separated from each other and other cables with 0.33 (0.13 in) of foam.
  - d. Flat cables must be spaced away from flat metal surfaces.
  - e. If a cable is to be supported or clamped against a conducting surface, the surface contact is not to exceed 15.24 cm (6 in) for any 1.5 m (5 ft) length of cable.

## **APPENDIX A**

# **PDP-11/60 VOLTAGE CONVERSION PROCEDURE**

This procedure is designed to expedite conversion of the BA11-P from 120 V operation to 240 V operation. This procedure covers, in addition to the BA11-P, the FP11-E, H775, and 866 power controller. All materials required for these conversions are listed in this procedure.

### **A.1 BA11-P CONVERSION PROCEDURE**

Remove the 120 V fan cable, P/N 70-13424, which connects to the 866 power controller, and install the 240 V fan cable, P/N 70-13422. The input end of the 240 V cable connects to P7 of the power distribution harness (Figure 2-10) as follows:

<b>Fan Connector</b>	<b>Power Connector</b>
P1-1 BRN	P7-6
P1-2 BLU	P7-5
P1-3 YEL/GRN	P7-4

### **A.2 H7420 CONVERSION PROCEDURE**

To convert the H7420A (70-13050-XX) power supply to the H7420B (70-13050-XX) power supply, perform the following procedure:

1. Replace the 20 A circuit breaker, P/N 12-12124-01 (Figure 3-6), with a 15 A circuit breaker, P/N 12-12124-02.
2. Replace the line cord assembly 70-10727-1 with line cord assembly 70-10727-2.
3. Remove the jumpers from TB1-2 to TB1-6 and TB1-4 to TB1-8 (Figure A-1, solid lines).
4. Install a jumper from TB1-4 to TB1-6 (Figure A-1, dotted line).
5. Replace the H7420A decal with H7420B decal, P/N 74-13926.

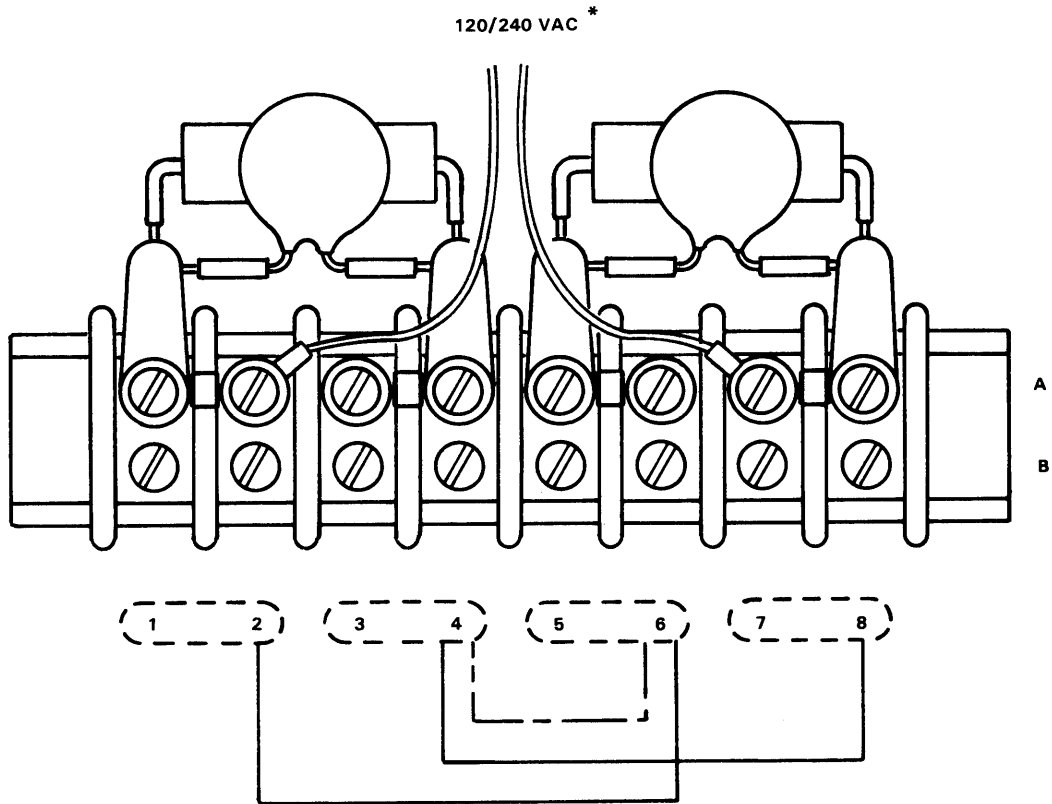
### **A.3 FP11-E CONVERSION PROCEDURE (H7421)**

Conversion of the FP11-EA (120 V, H7421A power supply) to the FP11-EB (240 V, H7421B power supply) is accomplished in the following manner:

1. Remove the jumpers from TS1-1 to TS1-2 and TS1-3 to TS1-4 (Figure A-2, Detail A).
2. Install a jumper from TS1-2 to TS1-3.
3. Remove the 120 V power cord assembly from line filter LF-1, terminals 2 and 4 (Figure A-2).



4. Install the 240 V power cord assembly by connecting the brown lead to pin 2 of LF-1, the blue lead to pin 4 of LF-1, and the green/yellow lead to chassis ground.
5. Replace the 5 A fuse with a 3 A fuse, P/N 90-07217.
6. Install a H7421B decal over the H7421A decal.



\* FOR 120 VAC INPUT JUMPER TERMINALS  
2-6 AND 4-8, FOR 240 VAC INPUTS  
JUMPER TERMINALS 4-6.

LEGEND

————— 120V  
- - - - - 240V

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Figure A-1 H7420 Terminal Block, TB1

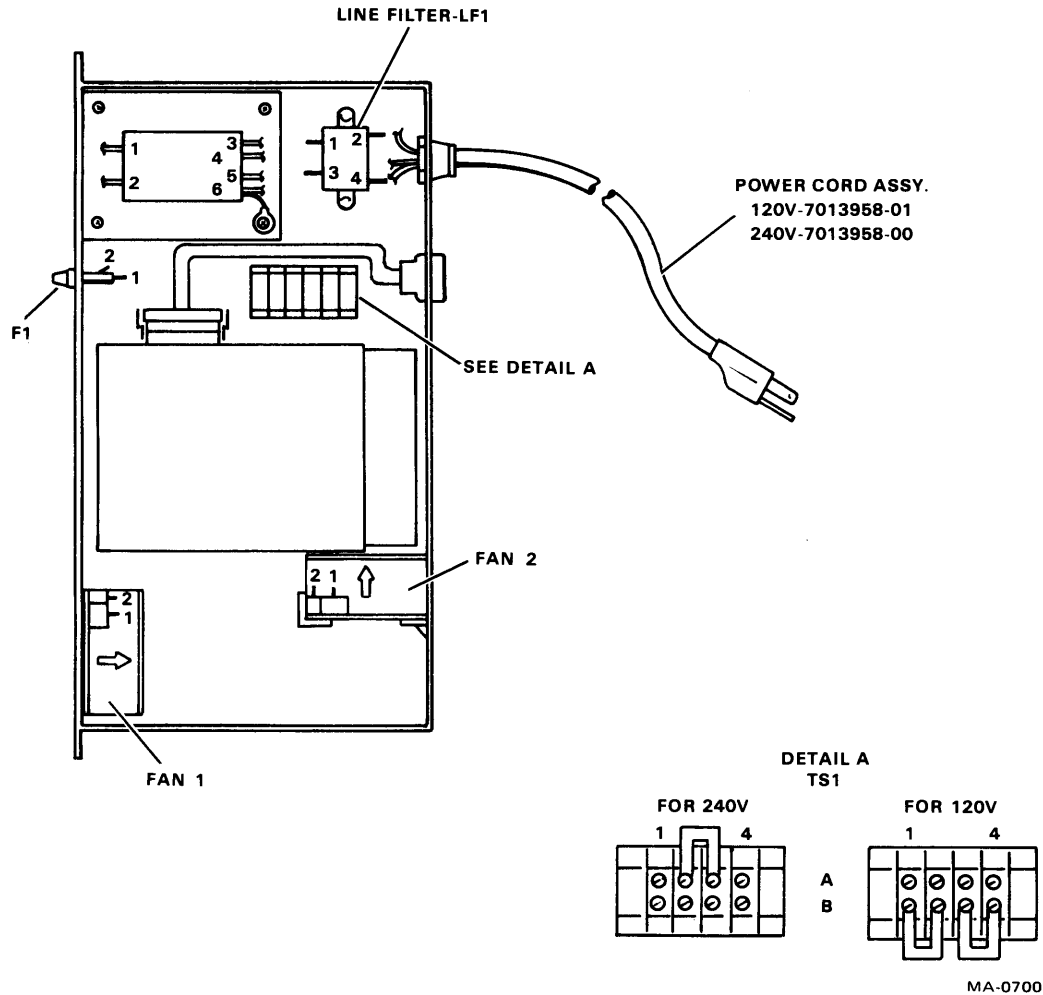


Figure A-2 H7421 Terminal Strip, TS1 Location

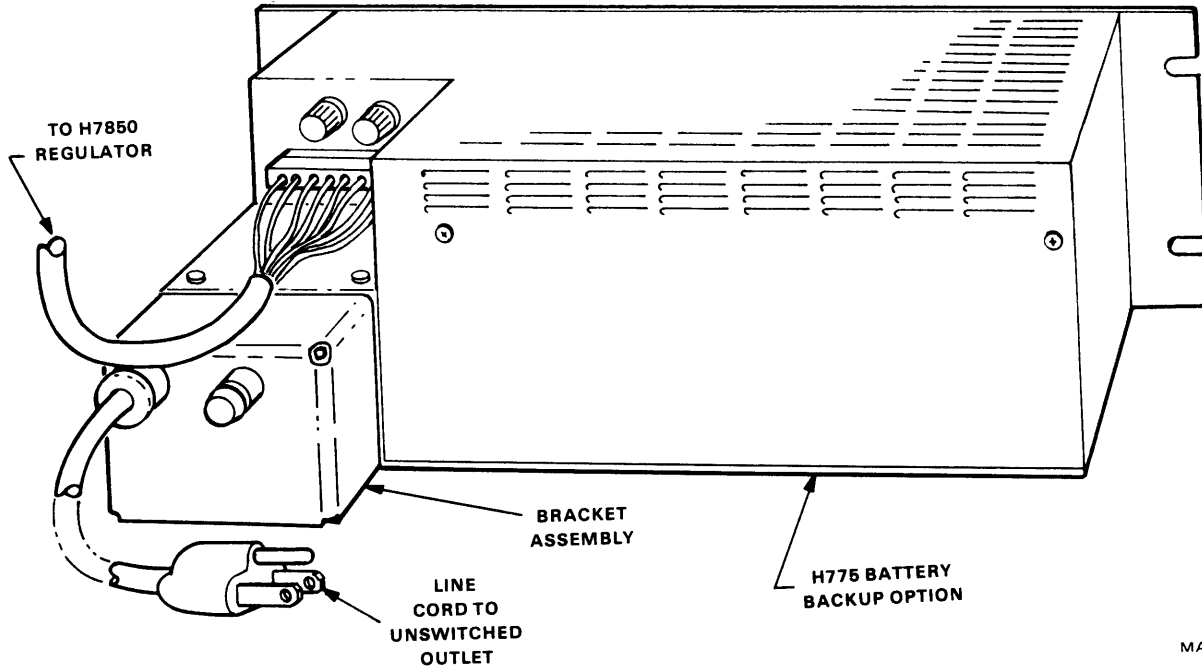
#### A.4 H775BA CONVERSION PROCEDURE

Conversion of the H775BA (120 V battery backup version) to the H775BB (240 V battery backup version) is accomplished in the following manner:

1. Remove the 120 V bracket assembly, P/N 70-13258-00, by removing the screws at the top of the bracket assembly, at the upper rear of the chassis, and at the lower right front of the chassis below the circuit breaker (Figure A-3).
2. Using a Mate-N-Lok extraction tool, remove pins 7 and 8 of J1 (Figures A-4 and A-5), located directly below the red and black binding posts at the left rear of the chassis.
3. Disconnect the Faston connector mounted on J7 of the battery charge board (Figures A-4 and A-5).
4. Install the 240 V bracket assembly, P/N 70-13258-01.

### A.5 866 POWER CONTROLLER CONVERSION

To convert the power controller from 120 V operation to 240 V operation, the 866-D power controller has to be replaced with an 866-E power controller. Refer to Chapter 2 for 866-D/E specifications and differences.



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Figure A-3 H775 Battery Backup, Rear View

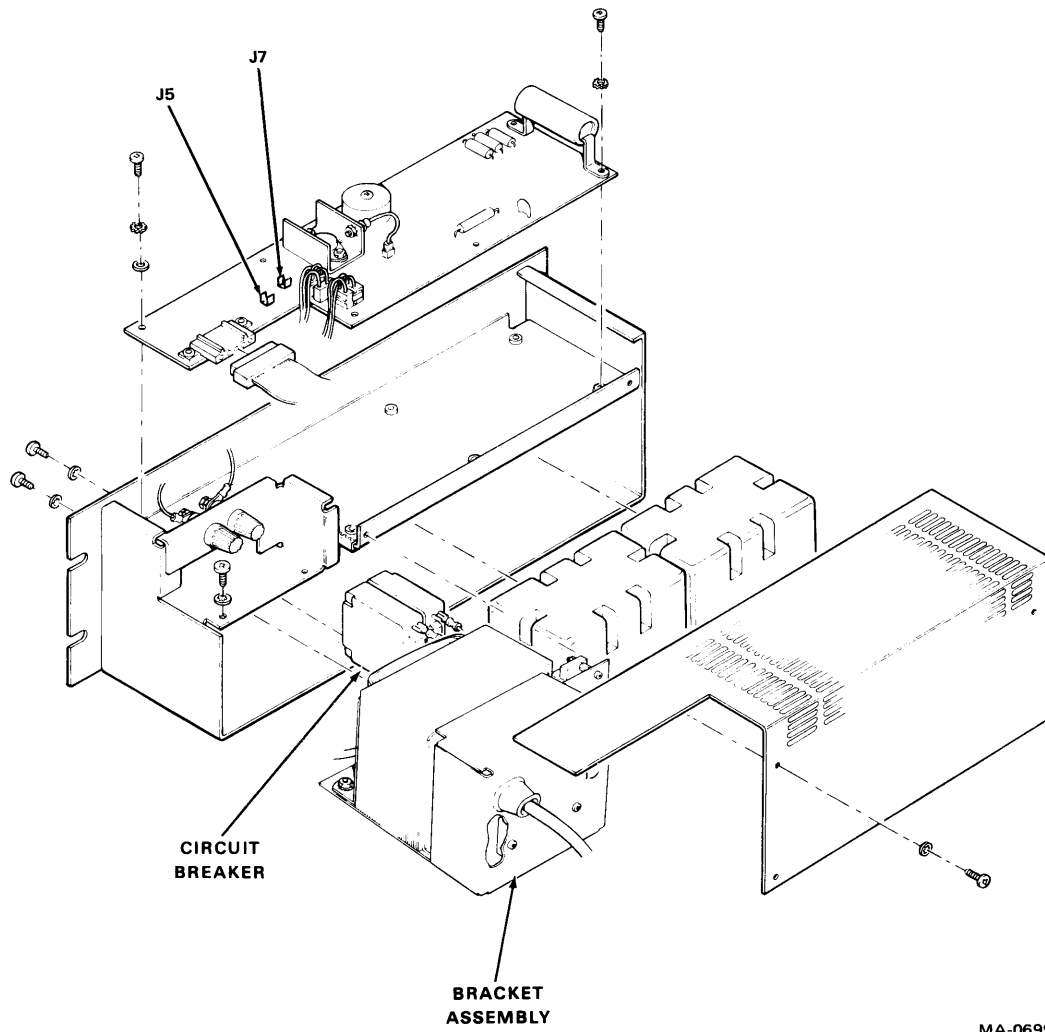
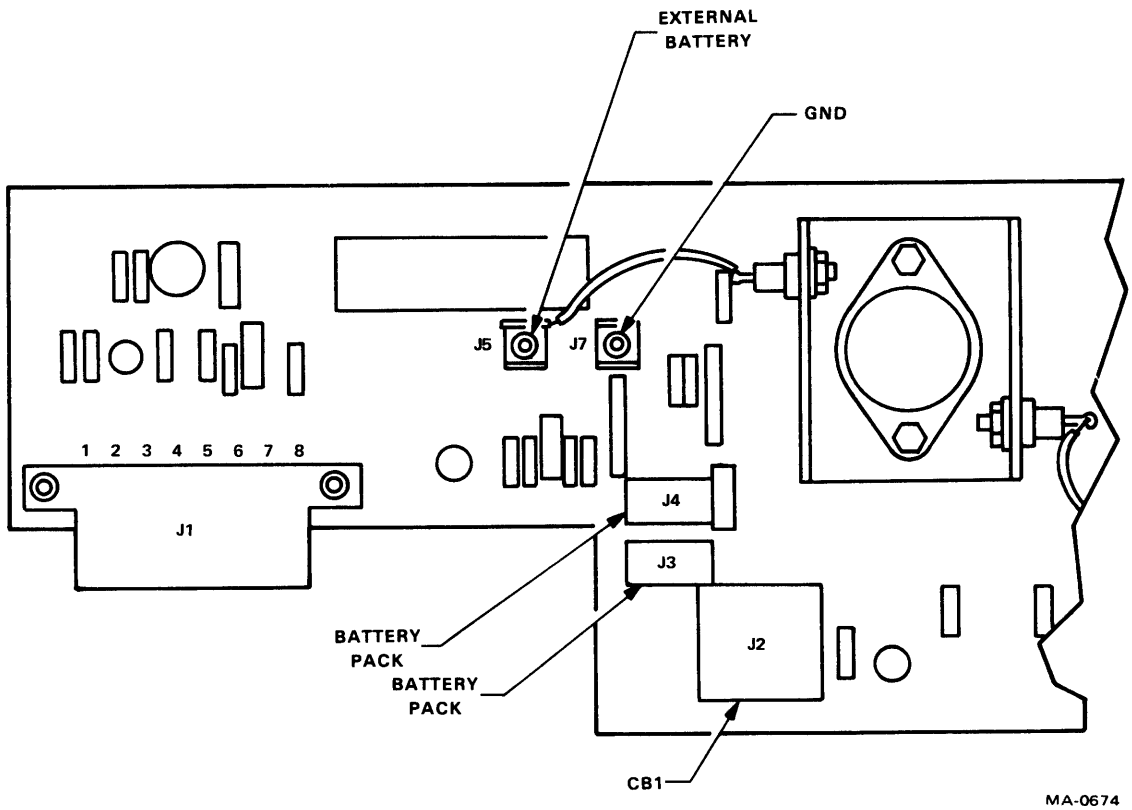


Figure A-4 H775 Battery Backup Assembly



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Figure A-5 Battery Charger Board Connector Location



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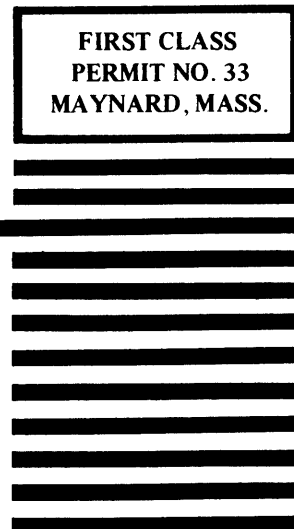
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