

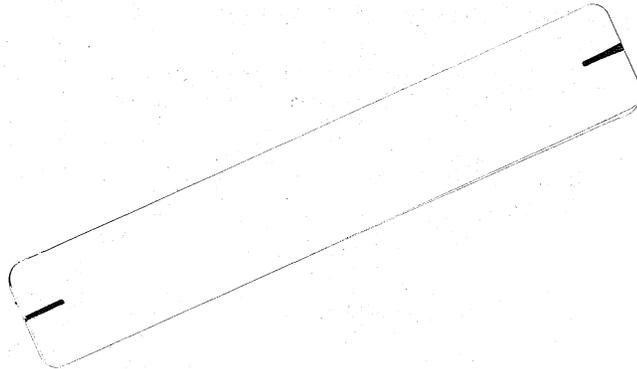
**BA11-K mounting box  
manual**

**pdp11**

**digital**



**BA11-K mounting box  
manual**



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## INTRODUCTION

This manual describes the general specifications, installation, theory of operation, and maintenance procedures that apply to the BA11-K Mounting Box. The basic BA11-K includes a 10-1/2 inch mounting chassis and power system. The 11/05S and 11/35S chassis and power system are similar to the BA11-K. This manual is used for maintaining and troubleshooting the PDP-11/05S and PDP-11/35S power system. The manual is organized as follows:

- Chapter 1 describes the characteristics and specifications of the BA11-K.
- Chapter 2 describes the system unit configurations, options, and option guidelines applicable to the BA11-K.
- Chapter 3 contains a mechanical description of the BA11-K and its contents, and describes the theory of operation.
- Chapter 4 describes the BA11-K power system maintenance procedures, and the replacement procedures for failed items.
- Chapter 5 details unpacking and BA11-K installation.



# CHAPTER 1

## BA11-K CHARACTERISTICS AND SPECIFICATIONS

### 1.1 GENERAL

The BA11-K is a standard, 19-inch, rack-mounted expander box. It is designed to house the DEC standard system units that make up a PDP-11 expansion system. The expansion system (mounting box) can contain memory, peripheral controllers, devices, or options compatible with the PDP-11 family. The BA11-K is modular in design. This enables a high degree of serviceability with minimum downtime.

The BA11-K can accept a maximum of five system units. There is a great degree of flexibility in selecting a system unit configuration, e.g., single and double system units may be mixed.

There are two basic versions of the mounting box; the BA11-KE for 115 Vac, and the BA11-KF for 230 Vac. These two variations are the result of two ac input boxes, one for each line voltage. The two ac input boxes can be interchanged within the same BA11-K mounting box without any other modifications.

### 1.2 PHYSICAL CHARACTERISTICS

#### 1.2.1 BA11-K Characteristics

Figure 1-1 shows the BA11-K mounted in a rack. It is basically composed of a main chassis and H765 Power System. The BA11-KE and BA11-KF are physically identical except for the ac input box in the H765. The BA11-KE (115 Vac) contains a 7009811-1 ac input box. The BA11-KF (230 Vac) contains a 7009811-2 ac input box.

Figure 1-2 is top view of the physical layout of the BA11-K. The mechanical and environmental specifications are described in Table 1-1.

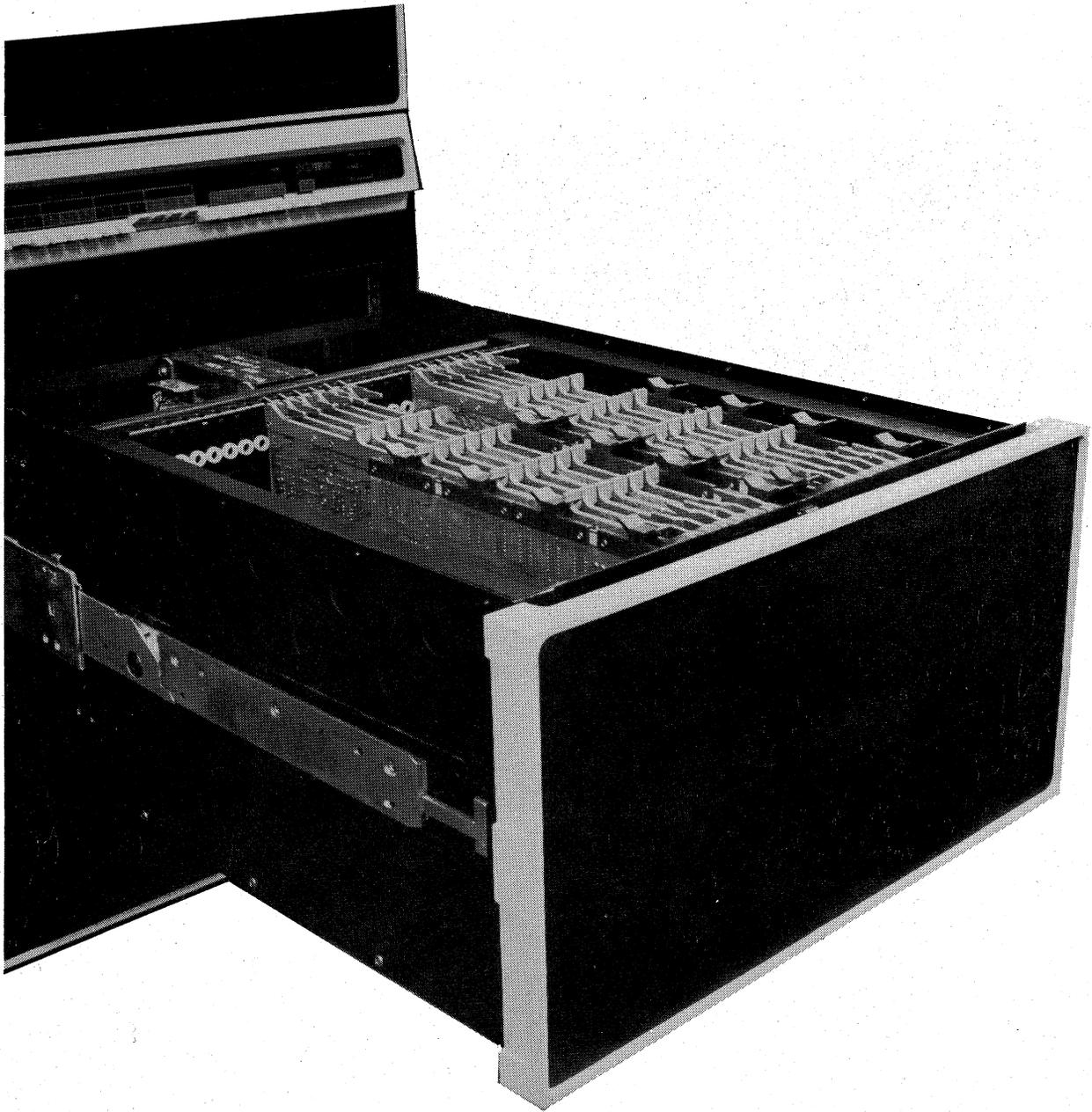
Table 1-1

#### BA11-K Physical and Environmental Characteristics

Item	Description
Chassis size (with H765 Power System, pop panel, and bezel)	10.44 in. high, 17.12 in. wide, 26.53 in. deep

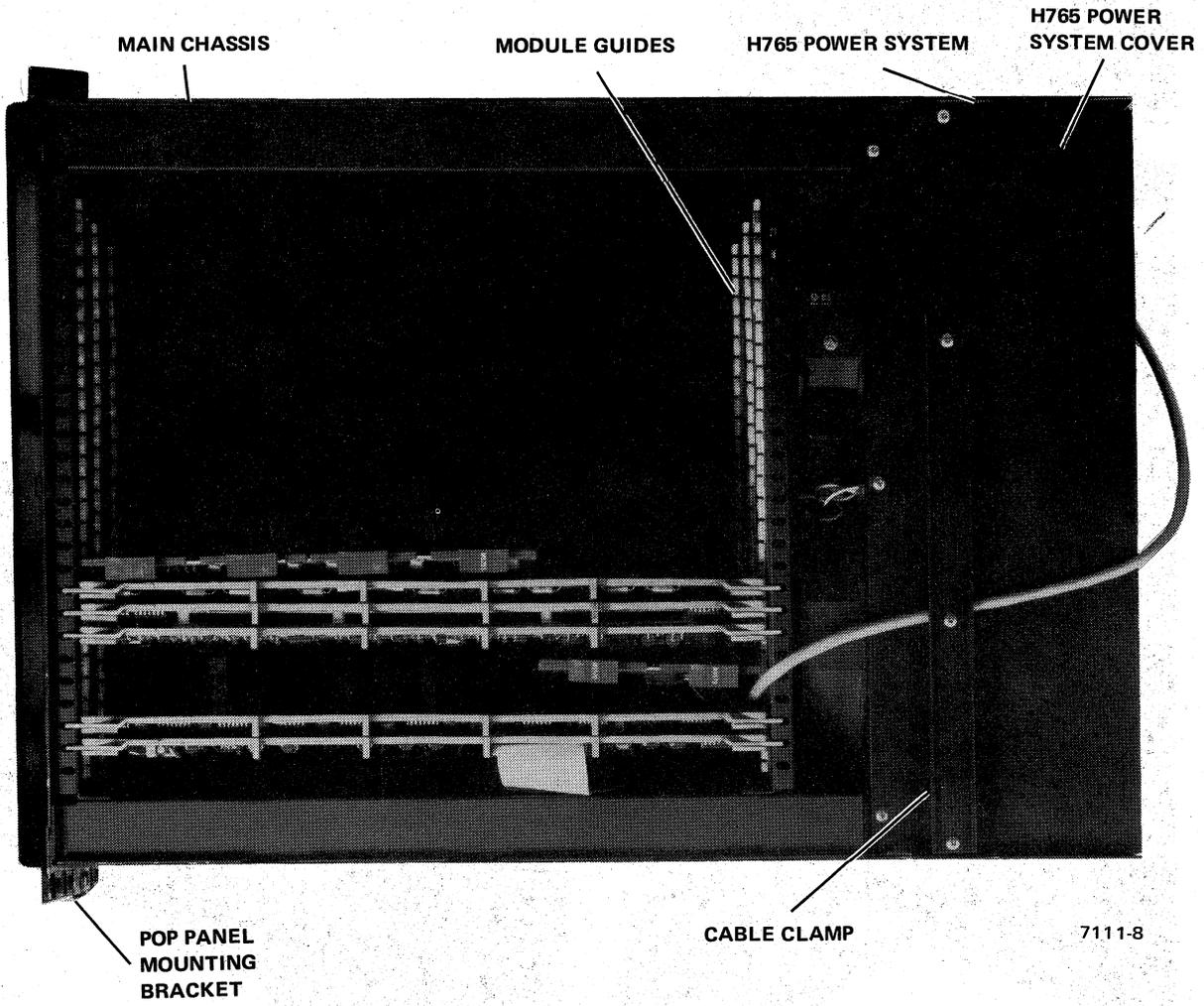
**Table 1-1 (Cont)****BA11-K Physical and Environmental Characteristics**

<b>Item</b>	<b>Description</b>
Chassis size (with H765 Power System; without console panel and bezel)	10.44 in. high, 17.12 in. wide, 25 in. deep
Chassis size (without H765 Power System, console panel and bezel)	10.44 in. high, 17.12 in. wide, 17.25 in. deep
Unconfigured BA11-K Expander Box chassis weight	87 lb
H765 Power System size	10.38 in. high, 17.12 in. wide, 7.75 in. deep
Slide extension (three-section slide)	27 in. maximum
Slide weight capacity (BA11-K fully extended)	150 lb
Three-section slide pivotal positions	Horizontal: 45 degrees and 90 degrees (front panel facing up)
Fan air movement direction	Horizontally toward rear of BA11-K
Module slots	22 maximum using DEC standard configuration backplanes
Operating temperature range	50°F – 104°F (10°C – 40°C)
Environmental, shock, and vibration characteristics	To be supplied.
Operating humidity	10 to 90% (no condensation)
Cooling efficiency for both fans at 90 Vac, 50 Hz	Temperature rise no greater than 18°F (10°C) from inlet air temperature to exhaust air



7111-24

Figure 1-1 BA11-K Mounting Box (Top Covers Removed)



Top View - Main Chassis Cover Removed

Figure 1-2 BA11-K Physical Layout

### 1.2.2 H765 Power System

The H765 Power System is self-contained in its own chassis. It is secured to the main BA11-K chassis with six screws. Two are special-purpose screws which function as hinges, enabling the H765 to be swung away from the main chassis during maintenance. The H765 Power System contains five regulators, two fans, an ac input box, a transformer assembly and a power distribution board. Four of the regulators are self-contained DEC standard modular types. The fifth regulator is a regulator board that is mounted in the ac input box. Paragraph 4.4 describes the removal procedures for the H765 Power System. Table 1-2 lists the H765 Power System's physical characteristics.

**Table 1-2**

**H765 Power System Physical Characteristics**

<b>Item</b>	<b>Description</b>
H765 Power System Contents	H744 Regulators (two) H745 Regulator H754 Regulator 5409730-YA Regulator 7010014 Transformer Assembly 7009811-1 or -2 AC Input Box with 5410993 Power Control Board 5410864 Power Distribution Board 1211714 Box Fans (two)
Fan size	6 in.
Fan type	Ball bearing
Fan capacity at 115 V, 50 Hz	260 cfm at 0 static pressure
Fan efficiency at 90 Vac, 50 Hz	60%
7010014 Transformer Assembly weight	25 lb

### 1.3 ELECTRICAL SPECIFICATIONS

#### 1.3.1 BA11-KE, BA11-KF Input Power Electrical Specifications

The BA11-KE and KF are electrically identical except for the ac input box. A BA11-KE expander box designation indicates that the input voltage is 115 Vac, and that a 7009811-1 AC Input Box is installed in the H765 Power System. A BA11-KF expander box designation indicates the input voltage is 230 Vac and that a 7009811-2 AC Input Box is installed in the H765 Power System. Tables 1-3 and 1-4 contain the input power electrical specifications of the BA11-KE and KF, respectively.

Table 1-3

BA11-KE Input Power Electrical Specifications

Parameter	Specification
Input power	90–132 Vac, 115 Vac nominal, 47–63 Hz
Inrush current	175 A peak for 10 ms max. at 115 V line voltage
Input power	1380 W at nominal line voltage. 12 A, 115 Vac (single phase)
Circuit breaker rating	20 A at 115 Vac
AC input noise	To be supplied
Overvoltage transients	To be supplied
Power factor at full load	To be supplied
Frequency stability	To be supplied
AC noise	___ : maximum random noise spike without causing loss of data or shutdown
Maximum overvoltage transients	500 V peak for a period of 10 ms

**Table 1-3 (Cont)**

**BA11-KE Input Power Electrical Specifications**

<b>Parameter</b>	<b>Specification</b>
Maximum overvoltage	____ V overvoltage for a period of 10 cycles
Power fail	H765 Power System is capable of withstanding power interruptions of any magnitude and duration without damage. Storage time of power supply at low line and full load shall be 20 ms $\pm$ 3 ms. Storage time is measured from the time the power outage occurs until the assertion of AC LO signals.

**Table 1-4**

**BA11-KF Input Power Electrical Specifications**

<b>Parameter</b>	<b>Specification</b>
Input power	180–264 Vac, 230 Vac nominal, 47–63 Hz
Inrush current	80 A peak for 10 ms max. at 230 Vac line voltage
Input power	1380 W at nominal line voltage, 7 A, 230 Vac (two phase)
Circuit breaker rating	10 A at 230 Vac
AC input noise	To be supplied
Overvoltage transients	To be supplied
Power factor at full load	To be supplied
Frequency stability	To be supplied
AC noise	____ : maximum random noise spike without causing loss of data or shutdown

**Table 1-4 (Cont)**

**BA11-KF Input Power Electrical Specifications**

<b>Parameter</b>	<b>Specification</b>
Maximum overvoltage transients	500 V peak for a period of 10 ms
Maximum overvoltage	___ V overvoltage for a period of 10 cycles
Power fail	H765 Power System is capable of withstanding power interruptions of any magnitude and duration without damage. Storage time of power supply at low line and full load shall be 20 ms $\pm$ 3 ms. Storage time is measured from the time power outage occurs until the assertion of AC LO signals.

**1.3.2 BA11-K Output Power Specifications**

The BA11-K output power is determined by the rating of the regulators listed in Table 1-5. Due to the great degree of flexibility and options available, each BA11-K configuration must be analyzed for total load requirements. Once the current drain of the options is totaled, it should be compared with the output currents listed in Table 1-5. (See Table 2-2 for a listing of some of the available options and their load requirements.) When configuring the expansion system, care must be taken to ensure that the options do not exceed the current capabilities of the regulators.

Table 1-5

BA11-K Output Power Characteristics

Regulator	Voltage and Tolerance	Output Current (Max)	Maximum Peak-to-Peak Ripple
H744	+5 Vdc $\pm$ 250 mV	25 A (each regulator, 50 A total)	200 mV
H745	-15 Vdc $\pm$ 750 mV	10 A	450 mV
H754	+20 Vdc $\pm$ 1 V	8 A	5%*
	-5 Vdc $\pm$ 250 mV	1 A - 8 A†	5%*
5409730-YA	+ 15 Vdc $\pm$ 1.5 V	1.5 A	

\* At backplane. Typical ripple  $\pm$ 3%.

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



## CHAPTER 2

### SYSTEM UNITS, OPTIONS AND HARNESSES

#### 2.1 SYSTEM UNITS

##### 2.1.1 Introduction

A system unit is a framed set of connector blocks attached to the mainframe and connected to the power supply. Each system unit has an array of six slots into which printed circuit boards or a combination of smaller modules can be plugged. Four slots are reserved for the Unibus connection.

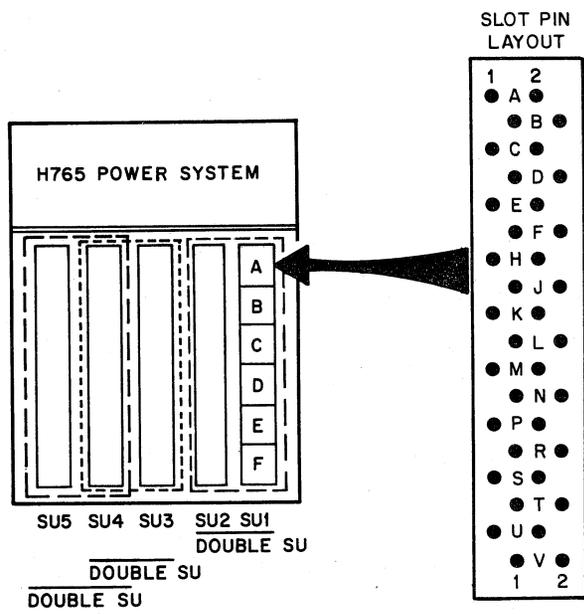
Three types of system units are employed in PDP-11 family processors:

1. **Dedicated** — Dedicated system units are prewired and tested for specific functions such as processor, memory, or disk controller.
2. **General Purpose** — General-purpose system units use a standard backplane wiring which has been established for the controllers of small peripherals, such as printers, card readers, and terminals. Each system unit has four small peripheral controller (SPC) slots with wiring provided for signal conditioning options. A variety of general-purpose interfaces, communications devices, and options are available for use in these SPC slots.
3. **Blank** — Unwired system units are made available for OEM use, enabling custom application.

##### 2.1.2 System Unit Configuration

Using DEC standard logic planes, the BA11-K has the following configuration capabilities (Figure 2-1).

1. Five single-system units, 20 slots. (A system unit is a four-slot logic backplane.)
2. One double-system unit and three single-system units. (A double system unit is a nine-slot logic backplane.)
3. Two double-system units and one single-system unit.



11-2564

Figure 2-1 System Unit Configurations

### 2.1.3 System Unit Installation

The installation of a system unit (SU) requires the items listed in Table 2-1.

**Table 2-1**

**SU Installation Requirements**

Quantity	Item	Remarks
1	Backplane	
1	Power Harness	See Table 2-2
1	M920 Unibus Jumper Module	Unless the SU is the first installed in a BA11-K expansion box.

The following steps outline the procedure to be used when installing a system unit.

1. Install the required number of system units in the BA11-K and secure them to the mounting boxes, using the screws provided. The system units are installed with slot A adjacent to the power distribution board.
2. Install a Unibus Jumper Module (M920) from slots A and B of the first SU to adjacent SU slots A and B (Figure 2-1). This extends the system Unibus continuity to each logic backplane in the BA11-K.
3. The Unibus In should be connected to the first slot (A1 and B1) of the first SU. The Unibus Out should be connected to the last slot of the last SU in the BA11-K.
4. Ensure that the M930 Terminator module is plugged into the last SU slot (Slots A and B) when terminating the Unibus.
5. Prior to module insertion, check the logic panels for power continuity.
6. Prior to power turn-on, ensure that the H744 regulators are not connected in parallel.

Table 2-2a

## PDP-11 Family Models and Options

Model/Option	Description	Current Needed						Power Dissipated
		+5 V (CPU)	+5 V (Options)	-15 V	+20 V	-5 V	+15 V	
H765 A/B	BA11-K Power Supply H744 H744 H745 H754 5409730-YA	25 A	25 A	10 A	8 A	8 A	1.5 A	1000 W
11/05-S	KD11-B MM11-U  2 M920s Total Amperes	8.0 A 6.1 A  2.5 A 16.6 A		0.25 A   0.25 A	4.4 A   4.4 A	0.51 A   0.51 A	0.05 A   0.05 A	250 W
11/35-S	KD11-A KE11-F KE11-E KJ11-A KT11-D KW11-L  M981 MM11-U M920 Total Amperes		7.3 A		4.4 A	0.51 A		450 W

Table 2-2a (Cont)  
PDP-11 Family Models and Options

Model/Option	Description	Current Needed						Power Dissipated
		+5 V (CPU)	+5 V (Options)	-15 V	+20 V	-5 V	+15 V	
*MF11-U/MM11-U	16 K Sense							
(Active)	Core Memory		6.1 A		4.4 A	0.51 A		
(Standby)	(Double SU)		4.5 A		0.56 A	0.41 A		
MF11-UP/MM11-UP	16 K Sense							
(Active)	Core with Parity		7.3 A		4.4 A	0.51 A		
(Standby)	(Double SU)		5.7 A		0.56 A	0.41 A		
MF11-L (MM11-L)	8 K Core							
(Active)	Memory		3.4 A	6.0 A				
(Standby)	(Double SU)		1.7 A	0.5 A				
MF11-LP (MM11-LP)	8 K Parity							
(Active)	Core Memory		4.9 A	6.0 A				
(Standby)	(Double SU)		1.7 A	0.5 A				
MM11-S	Same as MM11-L Except in SU Configuration (1 SU)							

\*Non-Interleaved.

Table 2-2b  
PDP-11 Family Options

Option	Mounting Code	Description	Power Harness	Current Needed					Power Dissipated
				+5 V	-15 V	+20 V	-5 V	+15 V	
AA11-D	1 SU	Digital to Analog Converter Subsystem	7009562	3.0 A					30 W
BA614	(AA11-D)	D/A Converter		3.0 A					30 W
BM792-Y	SPC	Bootstrap Loader		0.3 A					3 W
CD11-A/B	1 SU	1000 CPM, 80 Col. Card Reader Controller	7010117	2.5 A					28 W
CD11-E	1 SU	1200 CPM, 80 Col. Card Reader Controller	7010117	2.5 A					28 W
CM11	SPC	200 CPM, 80 Col. Card Reader Controller		1.5 A					15 W
CR11	SPC	300 CPM, 80 Col. Card Reader Controller		1.5 A					15 W
DA11-DB	1 SU	Unibus Link		4.0 A					40 W
DA11-F	1 SU	Unibus Window	7010117	5.0 A					50 W
DB11-A	1 SU	Bus Repeater	7009562	3.2 A					32 W
DC11-A	1 SU	Dual Clock and System Unit	7010117	0.2 A					2 W
DC11-DA	(DC11-A)	Full Duplex Module Set		2.0 A					20 W

Table 2-2b (Cont)  
PDP-11 Family Options

Option	Mounting Code	Description	Power Harness	Current Needed					Power Dissipated
				+5 V	-15 V	+20 V	-5 V	+15 V	
DD11-B	1 SU	Peripheral Mounting Panel	7010117	—					—
DH11-A	DLB SU	Prog. Async 16-Line Multiplexer	7010118	8.4 A	0.42				93 W
DJ11-A	1 SU	Async 16-Line MUX	7010117	5.0 A	0.48				57 W
DL11	SPC	Async Interface		1.8 A	.15 A			.016	21 W
DM11-B	(DH11)	16-Line Modem Control		2.8 A					28 W
DM11-D	(DH11)	Line Adapter		2.8 A					28 W
DN11-A	1 SU	Auto Calling System Unit	7009562						
DP11-D	1 SU	Half/Full Duplex Sync Interface	7009562	2.5 A	0.10 A				27 W
DP11-C	(DP11-D)	Data/Sync Register Extender							
DP11-K	(DP11-D)	Internal DP11 Clock							
DQ11-D	1 SU	Full/Half Duplex Sync Interface	7010117	5.7 A	0.07 A			0.04 A	60 W
DQ11-E	1 SU	Full/Half Duplex Sync Interface	7010117	5.7 A	0.07 A			0.04 A	60 W

Table 2-2b (Cont)  
PDP-11 Family Options

Option	Mounting Code	Description	Power Harness	Current Needed					Power Dissipated
				+5 V	-15 V	+20 V	-5 V	+15 V	
DQ11-K	(DQ11-D/A)	Crystal Clock							
DR11-B	SPC	General Purpose DMA	7009562	3.3 A					33 W
DR11-C	1 SU	General Purpose Digital Interface		1.5 A					15 W
DU11-D	SPC	Full/Half Duplex Sync Prog. Interface		2.2 A	0.06 A			0.06 A	24 W
DV11	DBL SU			8.5 A				1.0 A	105 W
KG11-A	SPC	Comm Arith Unit		1.5 A					15 W
KW11-L	(CPU)	Line Clock		0.8 A					8 W
KW11-P	SPC	Prog Line Clk		1.0 A					10 W
LC11-A	SPC	LA30 Control		1.5 A					15 W
LP11-R	SPC	1200 LPM Printer		1.0 A					10 W
LP11-S	SPC	900 LPM Printer		1.0 A					10 W
LP11-W	SPC	240 LPM Printer		1.5 A					15 W
LP11-V	SPC	300 LPM Printer		1.5 A					15 W
LS11-A	SPC	60 LPM Printer		1.5 A					15 W
LV11-B	SPC	Electrostatic Printer, 500 LPM		1.5 A					15 W

Table 2-2b (Cont)  
PDP-11 Family Options

Option	Mounting Code	Description	Power Harness	Current Needed					Power Dissipated
				+5 V	-15 V	+20 V	-5 V	+15 V	
MR11-DB	2 SPC	Bootstrap		0.6 A					6 W
PC11	SPC	Paper Tape		1.5 A					15 W
PR11	SPC	Paper Tape (Reader)		1.5 A					15 W
RH11	DBL SU	—		—					—
RK11-D	SU	Disk and Cntrl	7010115	7.5 A					75 W
TA11-A	SPC	Dual Cassette Interface		1.5 A					15 W

## 2.2 OPTIONS

The BA11-K expander box has the capability of accepting 22 modules. This allows for the various combinations of system unit configurations described in Paragraph 2.1. Table 2-2 lists some of the PDP-11 family options available and the unique characteristics of the options.

Two factors should be considered when installing or changing an option. First, various options have unique power harnesses. Table 2-2 lists the harnesses required for the appropriate option. Secondly, care must be taken to ensure that the options selected do not exceed the regulator outputs listed in Table 1-5. The maximum total BA11-K output power is 1000 W. This value represents the transformer secondary dc watts. Paragraph 1.3.2 describes the procedure used to determine a compatible power configuration.

## 2.3 POWER DISTRIBUTION WIRE COLOR CODING

Table 2-3 lists the standard colors used for dc power and signal distribution to the backplanes.

Table 2-3

### Power Distribution Wire Color Coding

DC Power/Signal	Color of Wire
Ground	Black
Line Clock (LTCL)	Brown
DC LO	Violet
AC LO	Yellow
+5 V	Red
-5 V	Brown
+15 V	Gray
-15 V	Blue
+20 V	Orange

## 2.4 CABLE ROUTING

To Be Supplied

To Be Supplied

---

Figure 2-2 Unibus Connection



## **CHAPTER 3**

### **H765 POWER SYSTEM**

#### **3.1 INTRODUCTION**

This chapter provides mechanical and functional descriptions of the H765 Power System. A detailed electrical interconnection diagram is included. The regulator circuits, which are part of the H765 Power System, are discussed in detail.

#### **3.2 MECHANICAL DESCRIPTION**

The power system consists of two H744 Regulators (+5 V), an H745 Regulator (-15 V), and H745 Regulator (+20 V, -5 V), a 5409730-YA Regulator (+15 V), a 7010014 Transformer Assembly, a 7009811-1, -2 AC Input Box, a 510864 Power Distribution Board, and 1211714 Fans. The contents of the power system are primarily housed in a welded steel chassis.

The chassis is rectangular and measures approximately 7-3/4 in. long by 10-1/2 in. high by 17 in. wide. The top power system cover is held in place by six screws. The main structural member contains cutouts and drill holes which enable screws to be inserted for securing the regulators, ac distribution box, transformer assembly, and fans. Cutouts for the regulators allow the regulator ON indicators to be monitored and the regulator output voltages to be adjusted.

##### **3.2.1 H744, H745, and H754 Regulators**

These regulators are secured to the H765 Power System chassis with three Phillips head screws. They are installed with the heat sink upward. The mounting screws pass through the H765 chassis holes and screw into the regulator. A plastic (Lexon) cover is installed on the component side of each regulator. This permits visual inspection of the regulator components once the regulator is removed from the H765 chassis. The fuse, which is located on the component side, is accessed by removing the plastic cover. Each regulator contains one potentiometer, with the exception of the H754, which contains two potentiometers. An output indicator lamp is located next to the potentiometer. The output of the regulators is terminated in a Mate-N-Lok connector.

### **3.2.2 7010014 Transformer Assembly**

This transformer assembly is located in the center of the H765 chassis. Two capacitors, two varistors, and two terminal boards are mounted directly on the transformer. The transformer base plate is used to bolt the transformer to the chassis. The area around the transformer is open, enabling ample air flow from the two fans across the transformer. A thermistor is mounted directly to the transformer frame, enabling over-temperature monitoring. Output leads from the transformer, which go to other modules, are terminated in Mate-N-Lok connectors. A cable clamp is used to secure these leads to the chassis.

### **3.2.3 7009811-1, -2 AC Input Box**

The ac input box is mounted in the center of the power supply chassis with three Phillips head screws. The center rear of the power supply chassis is cut out, exposing the rear of the ac input box. This enables easy access to the ac line cord, circuit breaker, and remote power control Mate-N-Lok. The 5410993 Power Control is physically mounted in the ac control box.

### **3.2.4 1211714 Box Fan**

Two six-inch ball bearing fans are utilized in the H765 Power System. They are mounted in the chassis between the module boards and regulators. Each fan is secured to the chassis with two screws.

### **3.2.5 5410864 Power Distribution Board**

This power distribution board is a multilayer printed circuit board. It contains 12 Mate-N-Lok connectors connected directly to the board and four Mate-N-Loks connected to flying leads. The power distribution board is grounded using a ground tab which is connected to a flying lead. The power distribution board is mounted on the bottom rear of the BA11-K chassis; four screws are used to fasten it in place.

## **3.3 SYSTEM FUNCTIONAL DESCRIPTION**

A functional block diagram of the power system is shown in Figure 3-1. Assume that the line cord is plugged in and the circuit breaker is on; line voltage is applied to the ac input box. The ac input box contains a circuit breaker, relay, and power control circuit. The circuit breaker is used as an ON/OFF switch as well as an overcurrent protection device. The relay and power control circuit allows remote

3-3

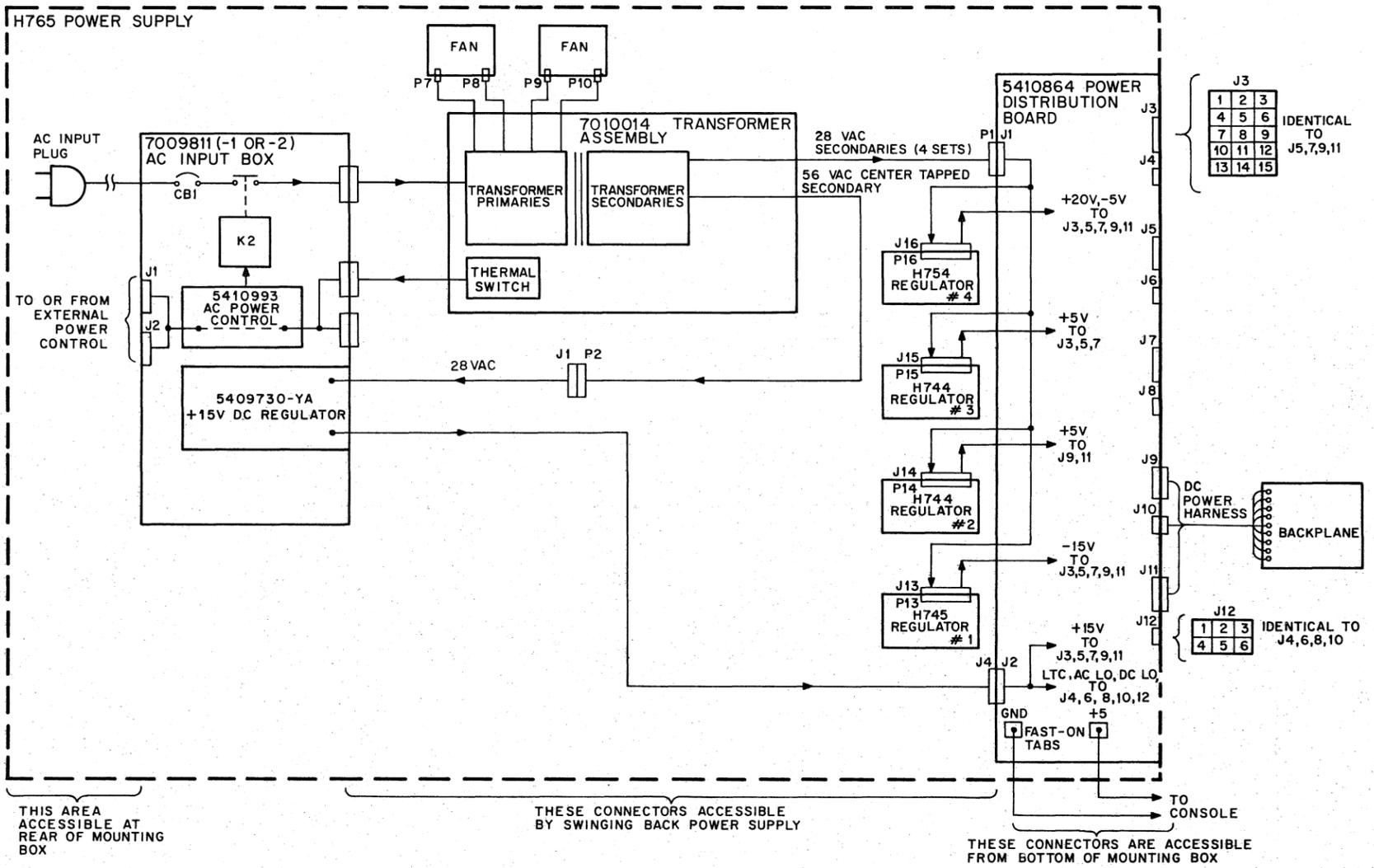
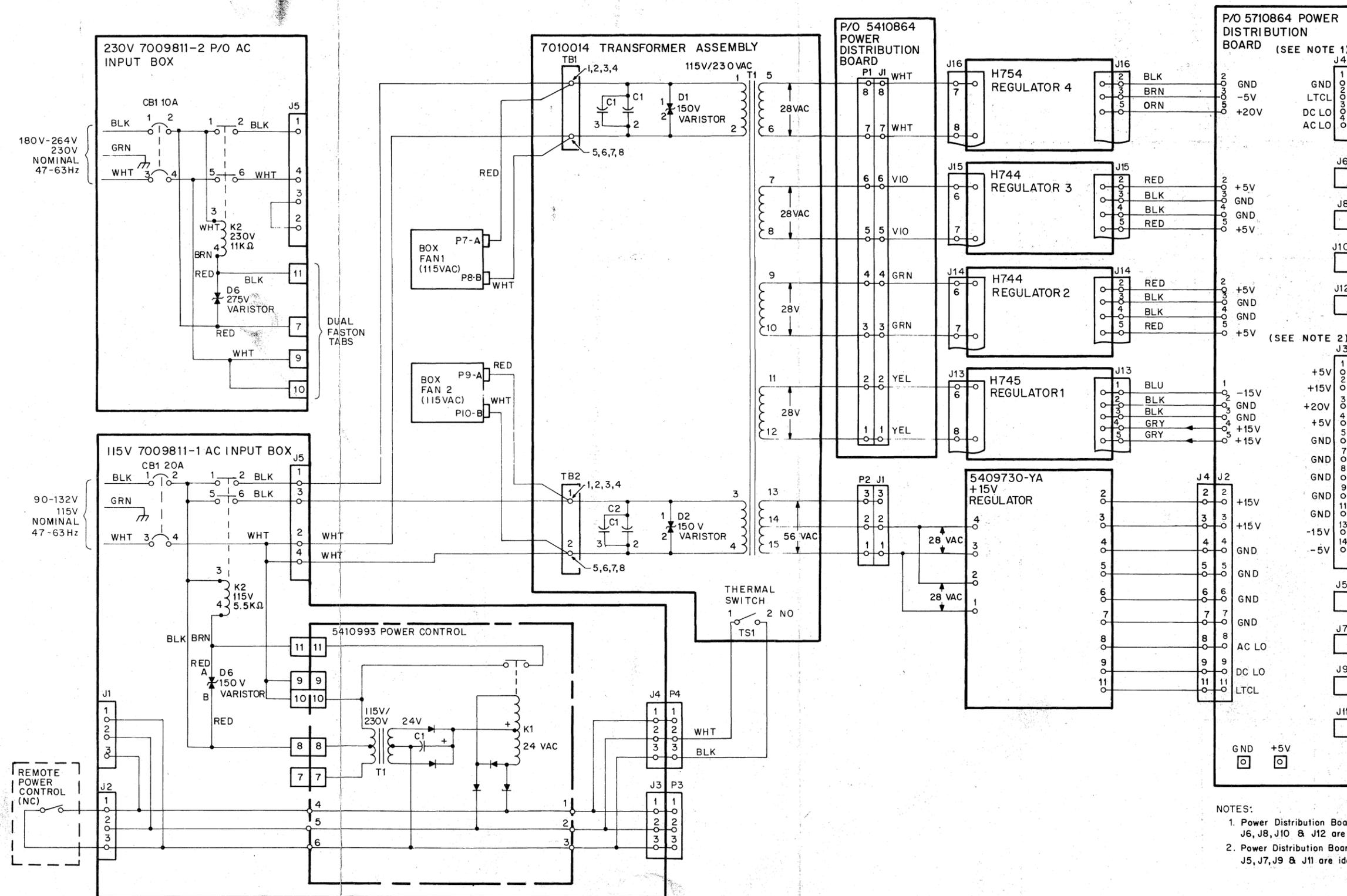


Figure 3-1 Power System Functional Block Diagram



NOTES:  
 1. Power Distribution Board Mate-N-Loks J6, J8, J10 & J12 are identical to J4  
 2. Power Distribution Board Mate-N-Loks J5, J7, J9 & J11 are identical to J3

Figure 3-2. Power System Detailed Diagram

control of ac power to the transformer assembly by means of a key switch or thermal switch. The transformer assembly steps down the voltage to approximately 28 Vdc and routes it to H744, H745, H754, and 5409730-YA regulators. In addition, the transformer assembly routes 115 Vac to box fans 1 and 2. The regulated dc outputs of the regulators are applied to the power distribution board, where they are distributed to the various backplane connections.

### **3.4 SYSTEM CIRCUIT DESCRIPTION**

This paragraph describes in detail the ac input box, transformer assembly, regulators and power distribution board. Figure 3-2 illustrates these circuits and their interrelationship.

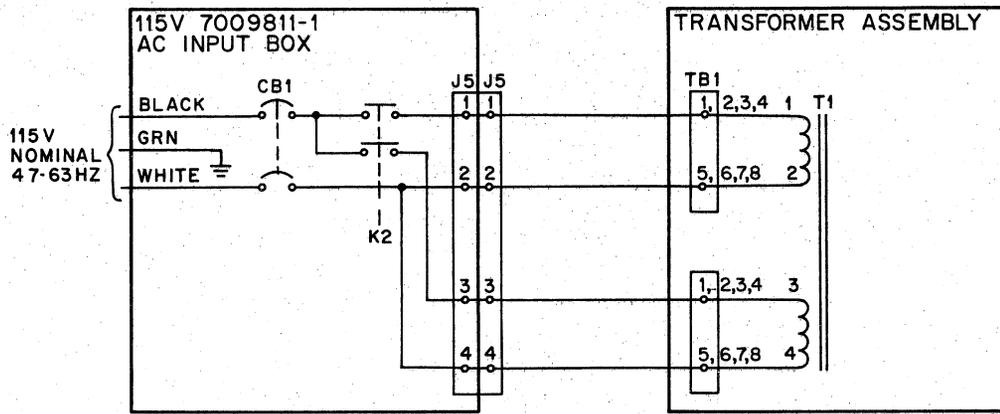
#### **3.4.1 AC Input Box**

The 115 V (7009811-1) and 230 V (7009811-2) ac input boxes are functionally identical. They differ physically in their components and in the way they are connected to the transformer assembly. Figure 3-3 is a simplified schematic of the 115 Vac power configuration. In this configuration, the power transformer windings are connected in parallel. In the 230 Vac power configuration (Figure 3-4), the power transformer windings are connected in series.

Utilizing the 115 Vac input box (7009811-1), the input line voltage is applied via a 20 A circuit breaker (Figure 3-2) to relay K2, and transformer T1 on the power control board. Transformer T1 steps down the voltage to 24 Vac. The 24 Vac is rectified and applied to relay K1. To energize K1 (Figure 3-5), the remote power switch contacts must be closed. Energizing K1 completes the path to K2, switching the 115 Vac to the transformer assembly. The normally open thermal switch (TS1) (located in the transformer assembly) closes when an over-temperature condition is sensed. Closing TS1 applies 24 Vdc to half the K1 relay coil. This creates two opposing fields, causing K1 to deenergize. Deenergizing K1 interrupts the ac power to the transformer assembly. The varistor (D6 or D7) across the coil (Figure 3-2) of K2 suppresses voltage spikes in excess of 150 Vac for AC Input Box 7009811-1, and 275 Vac for AC Input Box 7009811-2.

#### **3.4.2 Transformer Assembly**

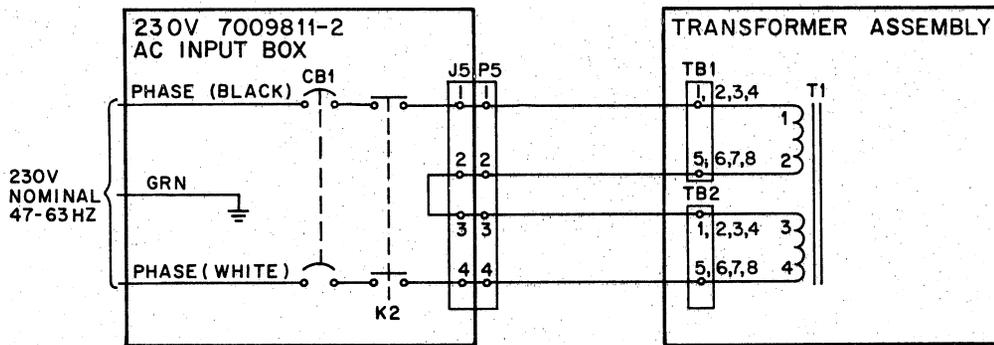
The primary function of the transformer assembly is to step down the 115 Vac or 230 Vac input voltage, (Figure 3-2) to 28 Vac. There are five separate secondary transformer windings, one for each regulator.



NOTE:  
Transformer windings are connected in parallel to the input power.

11-2546

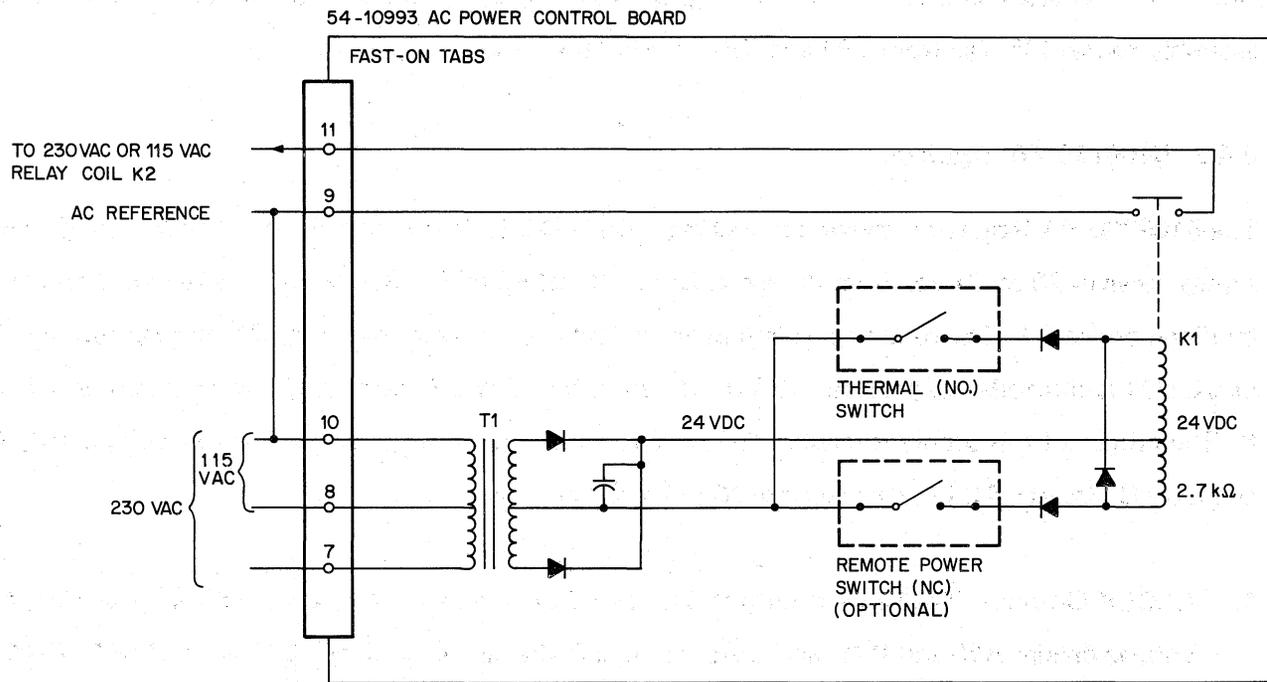
Figure 3-3 115 V Power Configuration



NOTE:  
Transformer windings are connected in series to the input power.

11-2545

Figure 3-4 230 V Power Configuration



**NOTE:**  
 THERMAL SWITCH AND KEY SWITCH ARE NOT PART OF  
 AC POWER CONTROL BOARD

11-2547

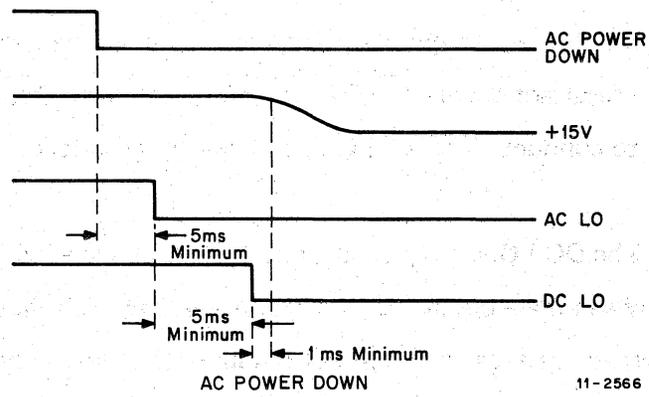
**Figure 3-5 Power Control Simplified Diagram**

Connected across the primary of T1 are capacitors and varistors. The capacitors (C1, C2) are input line filters. The varistors (D1, D2) suppress voltage spikes in excess of 150 Vac. In addition, the transformer assembly routes 115 Vac from TB1 and TB2 to box fans 1 and 2, respectively.

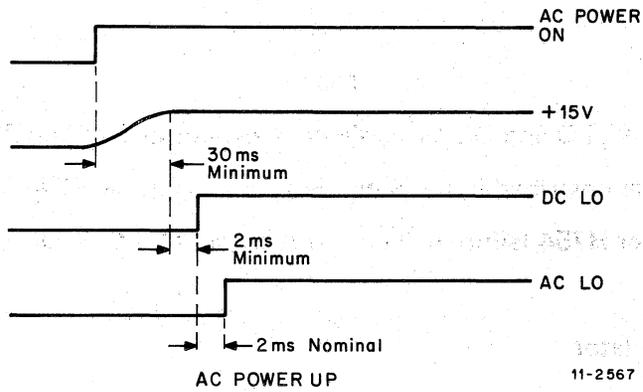
### 3.4.3 5409730-YA Regulator

The 5409730-YA Regulator, shown on drawing C-CS-5409730-YA-1, contains a +15 Vdc supply. The dc supply receives 20 to 30 Vac from the secondary of transformer T1. The ac input is full-wave rectified by diode bridge D1. The resultant dc is applied to Darlington voltage regulator Q1 through fuse F1. The bias on Q1 is controlled to provide +15 Vdc at output pins 2 and 3, with respect to output pins 4, 5, and 6. The output of this supply is rated at 1.5 A. The following paragraphs describe the clock output, AC LO and DC LO circuits, AC LO sensing, and DC LO sensing.

1. **CLOCK Output** – The CLOCK output is derived from one leg of full-wave rectifier bridge D1, by voltage divider R10 and R11, and Zener diode D2 (drawing C-CS-5409730-YA-1). The CLOCK output is a 0 to +5 V square wave, at the line frequency of the power source (47 to 63 Hz). The CLOCK output is used to drive the KW11-L Line Frequency and KW11-P Real-Time Clock options.
2. **AC LO and DC LO Circuits** – The 20–30 Vac input from the secondary of transformer T1 is applied to the AC LO and DC LO sensing circuits. The sensing circuits are shown on drawing C-CS-5409730-0-1. The ac input is rectified by diodes D8 through D11, and filtered by capacitor C3. A common reference voltage is derived by resistor R18 and Zener diode D12. Both sensing circuits operate similarly; each contains a differential amplifier, a transistor switch, and associated circuits. The major difference is that the base of Q6 in the AC LO circuit differential amplifier is at a slightly lower value than that of Q9 in the DC LO differential amplifier. The operation of both sensing circuits depends on the voltage across capacitor C3. For AC LO and DC LO timing during power up and power down, refer to Figure 3-6.
3. **AC LO Sensing** – The 20–30 Vac input is rectified and stored in capacitor C3, which will charge and discharge at a known rate whenever the ac power is switched on or off. Thus, the voltage applied to the emitters of differential amplifier Q6/Q7 through R17 is a rising or falling waveform of known value. For example, when power fails or is shut down, the dc voltage decays at a known rate,



11-2566



11-2567

Figure 3-6 5409730-YA Power Up and Power Down

as determined by the RC time constant. If the voltage decreases to the point where the base of Q6 becomes negative with respect to the base of Q7, the increased forward bias on Q6 causes it to conduct more, and the resultant decrease in Q7 causes it to cut off. This removal of voltage across R16 causes Q5 and Q4 to conduct. The AC LO line at pin 8 is grounded.

4. DC LO Sensing – The DC LO sensing circuit operates in a manner similar to that described for AC LO. The difference between these circuits is the voltage level at which they trip. For example, if the ac input starts to decrease, as a result of a power failure or shutdown, the AC LO lines are grounded before the DC LO lines. As power is restored, the ground is removed from the DC LO lines before it is removed from the AC LO lines.

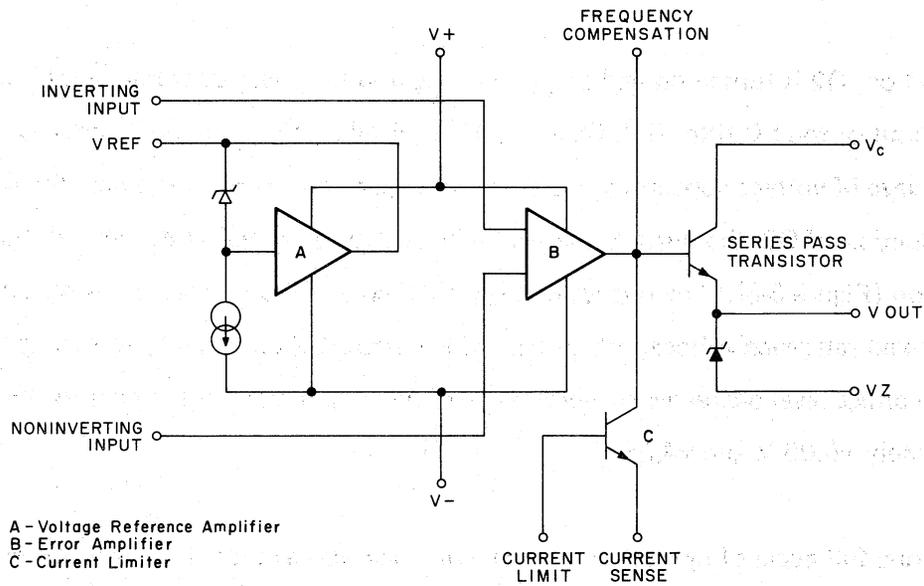
#### NOTE

AC LO and DC LO indicate the status of the 5409730-YA as described in the preceding paragraphs. A H744, H745, or H754 failure will not generate an AC LO or DC LO signal.

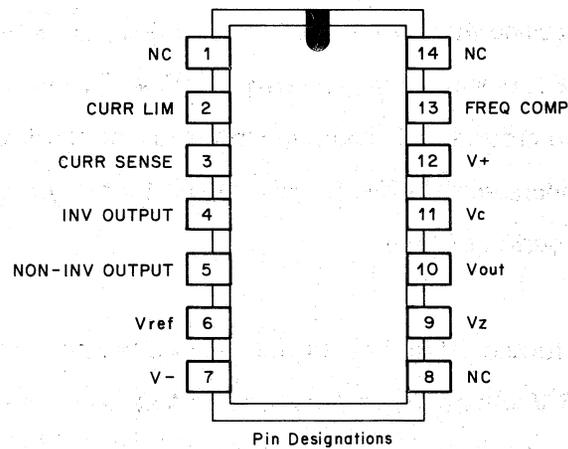
#### 3.4.4 H744 +5 V Regulator

Two H744 +5 V Regulators are used in the basic H765 power system. The H744 circuit schematic is shown in drawing \_\_\_\_\_ . The following paragraphs describe the regulator circuit, overcurrent sensing circuit, and overvoltage crowbar circuit.

1. Regulator Circuit – The 20–30 Vac input is full-wave rectified by bridge D1 to provide dc voltage (24 to 40 Vdc, depending on line voltage) across filter capacitor C1 and bleeder resistor R1. Operation centers on voltage regulator E1, which is configured as a positive switching regulator. A simplified schematic of E1 is shown in Figure 3-7. 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 Q2, predrivers Q3 and Q4, and level shifter Q5. Zener diode D2 is used with Q5 and R2 to provide +15 V for E1. Q5 is used as a level shifter; most of the input voltage is absorbed across the collector-emitter of Q5. This is necessary because the raw input voltage is well above that required for E1 operation. While this +15 V input



Simplified Schematic



11-1895

Figure 3-7 Voltage Regulator E1, Simplified Diagram

is supplied, D2, Q5, and R2 retain the ability to switch pass transistor Q2 on or off by drawing current down through the emitter of Q5.

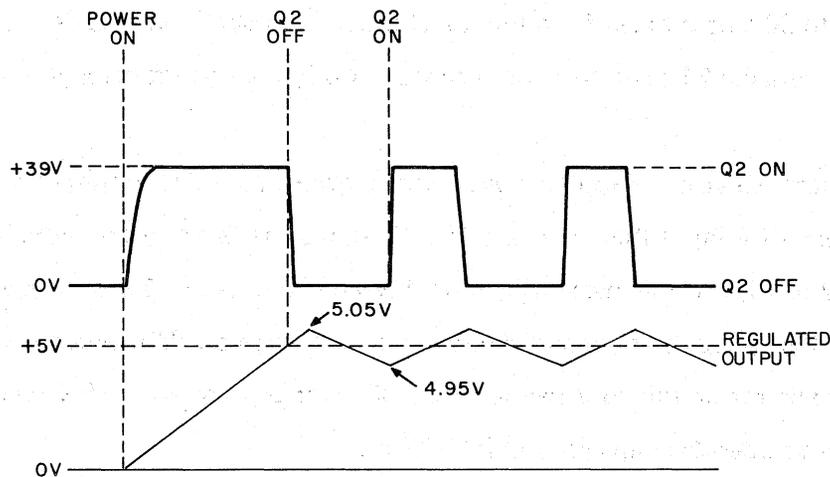
The output circuit is standard for most switching regulators and consists of free-wheeling diode D5, choke coil L1, and output capacitors C8 and C9. These components make up the regulator output filter. Free-wheeling diode D5 is used to clamp the emitter of Q2 to ground when Q2 shuts off, thus providing a discharge path for L1.

In operation, Q2 is turned on and off, generating a square wave of voltage that is applied across D5 at the input of the LC filter (L1, C8 and C9). 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 Q2, the output (average) voltage may be varied or controlled, thus supplying regulation (Figure 3-8). The output voltage is sensed and fed back to E1, where it is compared with a fixed reference voltage. E1 turns pass transistor Q2 on and off, according to whether the output voltage level decreases or increases. Defined upper and lower limits for the output are approximately +5.05 V and +4.95 V.

During one full cycle of operation, the regulator operates as follows: Q2 is turned on and a high voltage (approximately +30 V) is applied across L1. If the output is already at a +5 V level, then a constant +25 V would be present across L1. This constant dc voltage causes a linear ramp of current to build up through L1. At the same time, output capacitors C8 and C9 absorb this changing current, causing the output level (+5 V at this point) to increase. When the output, which is monitored by E1, reaches approximately +5.05 V, E1 shuts off, turning Q2 off; the emitter of Q2 is then clamped to ground. L1 discharges into capacitors C8, C9, and the load. Predrivers Q3 and Q4 are used to increase the effective gain of Q2, thus ensuring that Q2 can be turned on and off in a relatively short period of time.

Conversely, once Q2 is turned off and the output voltage begins to decrease, a predetermined value of approximately +4.95 V will be reached, causing E1 to turn on; E1 in turn, causes Q2 to conduct, beginning another cycle of operation.

Thus, a ripple voltage is superimposed on the output and is detected as predetermined maximum (+5.05 V) and minimum (+4.95 V) values by E1. When +5.05 V is reached, E1 turns Q2 off; when +4.95 V is reached, E1 turns Q2 on. This type of circuit action is called a ripple regulator.



11-0098

Figure 3-8 H744 Regulator Waveforms

2. +5 V Overcurrent Sensing Circuit – The overcurrent sensing circuit consists of Q1, R3 through R6, R25, R26, programmable unijunction Q7, and C4. Transistor Q1 is normally not conducting; however, if the output exceeds 30 A, the forward voltage across R4 is sufficient to turn Q1 on, causing C4 to begin charging. When C4 reaches a value equal to the voltage on the gate of Q7, Q7 turns on and E1 will be biased off, turning the pass transistor off. Thus, the output voltage is decreased as required to ensure that the output current is maintained below 35 A (approximately) and that the regulator is short circuit protected. The regulator continues to oscillate in this new mode until the overload condition is removed. C4 then discharges until E1 is again allowed to turn on and the cycle repeats.
  
3. +5 V Overvoltage Crowbar Circuit – The following components comprise the overvoltage crowbar circuit: Zener diode D3, silicon-controlled rectifier (SCR) D7, D8, R22, R23, C7 and Q6. Under normal output voltage conditions, the trigger input to SCR D7 is at ground because the voltage across Zener diode D3 is less than 5.1 V. If the output voltage becomes dangerously high (above 6.0 V), diode D3 conducts, and the voltage drop across R23 draws gate current and triggers the SCR. The SCR fires and short circuits the +5 V output to ground.

### 3.4.5 H745 -15 V Regulator

Operation of the H745 is basically the same as that of the +5 V regulator (drawing \_\_\_\_\_). Input power (20 to 30 Vac is taken from the transformer secondary and input to full-wave bridge D1, whose output is a variable 24 to 40 Vdc input across capacitor C1 and resistor R1.

1. -15 V Regulator Circuit — Regulator operation is almost identical to that of the +5 V regulator; however, the +15 V input that is required for E1 operation is derived externally and is input across capacitor C2 to +1, and the inverting and noninverting inputs to E1 are reversed. In addition, the polarities of the various components are reversed. For example, Q5, which is used as a "level shifter," is an NPN transistor on the +5 V regulator; a PNP is required on the -15 V regulator, thus allowing the regulator to operate below ground (at -15 V).

Under normal operating conditions, regulator operation centers around linear regulator E1 and pass transistor Q2, which is controlled by E1. Predetermined output voltage limits are -14.85 V minimum and -15.15 V maximum. When the output reaches -15.15 V, E1 will shut off, turning Q2 off, and L1 discharges into C8 and C9. When the output reaches -14.85 V, E1 will conduct, causing Q2 to turn on, thus increasing the output voltage.

2. -15 V Overcurrent Sensing Circuit — The -15 V regulator overcurrent sensing circuit is basically made up of the same components used in the +5 V regulator, except Q1 is an NPN transistor in the -15 V regulator. Q1 is normally not conducting; however, once the output exceeds 15 A, Q1 will turn on and C3 will charge. When C3 reaches the same value as the gate of Q7, E1 will be biased off, which turns Q2 off, thereby stopping current flow and turning the -15 V regulator off. Thus, the regulator is short circuit protected.
3. -15 V Overvoltage Crowbar Circuit — When SCR D5 is fired, the -15 V output is pulled up to ground and latched to ground until input power or the +15 V input is removed. A negative slope on the +15 V line can be used to trip the crowbar for power down sequencing, if desired.

### 3.4.6 H754 +20, -5 V Regulator

One H754 Regulator is used in the basic H765 Power Supply. The H754 circuit schematic is shown in drawing \_\_\_\_\_ . The following paragraphs describe the regulator circuit, overvoltage crowbar circuits, overcurrent sensing circuits, and voltage adjustment procedure.

1. Regular Circuit — The circuit (schematic D-CS-H754-0-1) is similar to that of the other regulators: like the H746, it has a voltage doubler 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 Q9 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 at 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, thus 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.

2. Overvoltage Crowbar Circuits — There are two crowbar circuits in the H754: Q7 and its associated circuitry for the +20 V, and Q12 and its circuitry for the -5 V. Either one will trigger SCR D9.
3. Overcurrent Sensing Circuit — The overcurrent circuit comprises Q1, Q8, Q13, Q14, and associated circuitry. The total peak 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, thus firing Q8. This pulls the voltage on pin 4 of the 723 up above the reference voltage on pin 5, thereby 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.

4. Voltage Adjustment – The +20 V adjustment is located on the side of the H754; the –5 V potentiometer is on the top, next to the connector. To set the output voltages, power down, disconnect the load, power up, and adjust for a 25 V reading between the +20 and –5 V outputs with the 20 V potentiometer. Then set the –5 V between its output and ground. Power down, reconnect the load, power up, and then check and adjust the outputs again. This procedure is necessary because the +20 V potentiometer (R17) actually sets the overall output of the regulator (25 V from +20 V to –5 V), while the –5 V adjustment (R21) controls the –5 V to ground output. (See schematic drawing \_\_\_\_\_ .)

### 3.4.7 Power Distribution Board

The power distribution board (Figure 3-9) performs two primary functions: it routes the transformer assembly secondary output voltages to the regulators and routes the dc outputs of the regulators to the backplane.

Routing voltage to the regulators is accomplished via Mate-N-Lok J1/P1 and an etch on the power distribution board. Mate-N-Lok P1/J1 routes 28 Vdc from four separate transformer secondaries to H745, H754, and both H744 Regulators. The etch routes +15 Vdc from 5409730-YA Regulator to the H745 Regulator.

The regulator outputs are routed as follows:

1. H745 Regulator 1, –15 Vdc output, is routed via the power distribution board etch to 15-pin Mate-N-Loks J3, J5, J7, J9, and J11.
2. H744 Regulator 2, +5 Vdc output, is routed via the power distribution board etch to 15-pin Mate-N-Loks J9 and J11. H744 Regulator 3, +5 Vdc output, is routed via the power distribution board etch to 15-pin Mate-N-Loks J9 and J11. A unique configuration of the power system is that two H744 Regulators cannot be connected in parallel. Figure 3-10 is a simplified diagram illustrating the correct H744 to power distribution board configuration.
3. H754 Regulator 4, +20 Vdc, –5 Vdc outputs, are routed via the power distribution board etch to 15-pin Mate-N-Loks J3, J5, J7, J9, and J11.

MATE-N-LOKS J11, J9, J7, J5, J3

PIN DESIGNATIONS				
13	10	7	4	1
14	11	8	5	2
15	12	9	6	3

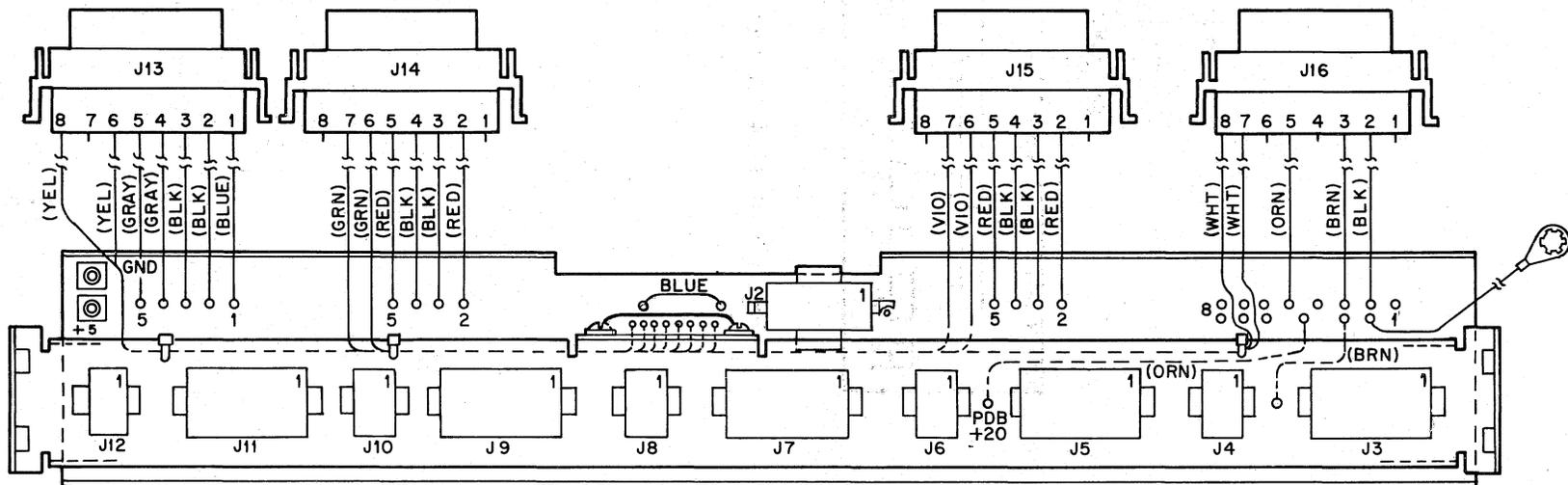
PIN	SIGNAL
1.	+ 5V
2.	+ 15V
3.	+ 20V
4.	+ 5V
5.	GROUND
6.	Not Used
7.	GROUND
8.	GROUND
9.	GROUND
10.	Not Used
11.	GROUND
12.	Not Used
13.	- 15V
14.	- 5V
15.	Not Used

MATE-N-LOKS J12, J10, J8, J6, J4

PIN DESIGNATIONS	
4	1
5	2
6	3

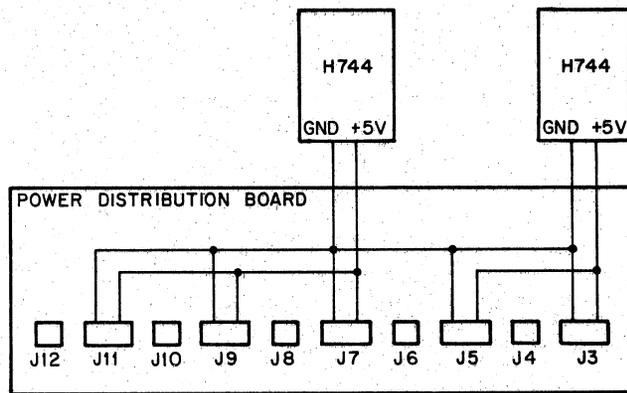
PIN	SIGNAL
1.	LO GND
2.	LTC (Line Clock)
3.	DC LO
4.	AC LO
5.	Not Used
6.	Not Used

3-17



11-2570

Figure 3-9 Power Distribution Board



11-2565

Figure 3-10 H744 Connection Diagram

4. 5409730-YA Regulator, +15 Vdc output, is routed via the power distribution board etch to H745. The +15 Vdc is also routed via the etch to 15-pin Mate-N-Loks J3, J5, J7, J9, and J11. 5409730-YA LTC, AC LO, and DC LO outputs are routed via the etch to six-pin Mate-N-Loks J4, J6, J8, J10, and J12.

The dc and signal outputs of Mate-N-Loks J3 through J12 are routed to the backplane via a power harness. Table 2-2 lists the power harnesses required for the appropriate option.



## **CHAPTER 4**

### **MAINTENANCE**

BA11-K maintenance procedures are divided into two categories: preventive maintenance and corrective maintenance. Corrective maintenance should be performed to isolate a fault or malfunction and to make necessary adjustments and/or replacements. Diagnostic programs that test the functional units of the system and special calibration and test procedures aid in performing corrective maintenance. This chapter describes the equipment and procedures needed for performing corrective and preventive maintenance.

#### **4.1 MAINTENANCE EQUIPMENT REQUIRED**

Maintenance procedures for the BA11-K require the standard equipment (or equivalent) listed in Table 4-1.

#### **4.2 PREVENTIVE MAINTENANCE**

##### **4.2.1 General**

Preventive maintenance consists of specific tasks performed periodically to prevent failures caused by minor damage or progressive deterioration due to aging. A preventive maintenance log book should be established and necessary entries made according to a regular schedule. This data, compiled over an extended period of time, can be very useful in anticipating possible component failure.

Preventive maintenance tasks consist of mechanical and electrical checks. All maintenance schedules should be established according to environmental conditions at the particular installation site. Mechanical checks should be performed as often as required to enable fans and air filters to function efficiently. All other preventive maintenance tasks should be performed on a regular schedule determined by reliability requirements. A recommended schedule is every 1000 operating hours or every three months, whichever occurs first.

##### **4.2.2 Physical Checks**

The following is a list of the steps required for mechanical checks and physical care of the BA11-K.

1. Check all fans to ensure that they are not obstructed in any way.
2. Inspect all wiring and cables for cuts, breaks, frays, deterioration, kinks, strain, and mechanical security. Repair or replace any defective wiring or cable covering.
3. Inspect the following for mechanical security: lamp or LED holder assemblies, jacks, connectors, switches, power supply regulators, fans, capacitors, etc. Tighten or replace as required.
4. Inspect power supply capacitors for leaks, bulges, or discoloration. Replace as required.

**Table 4-1**

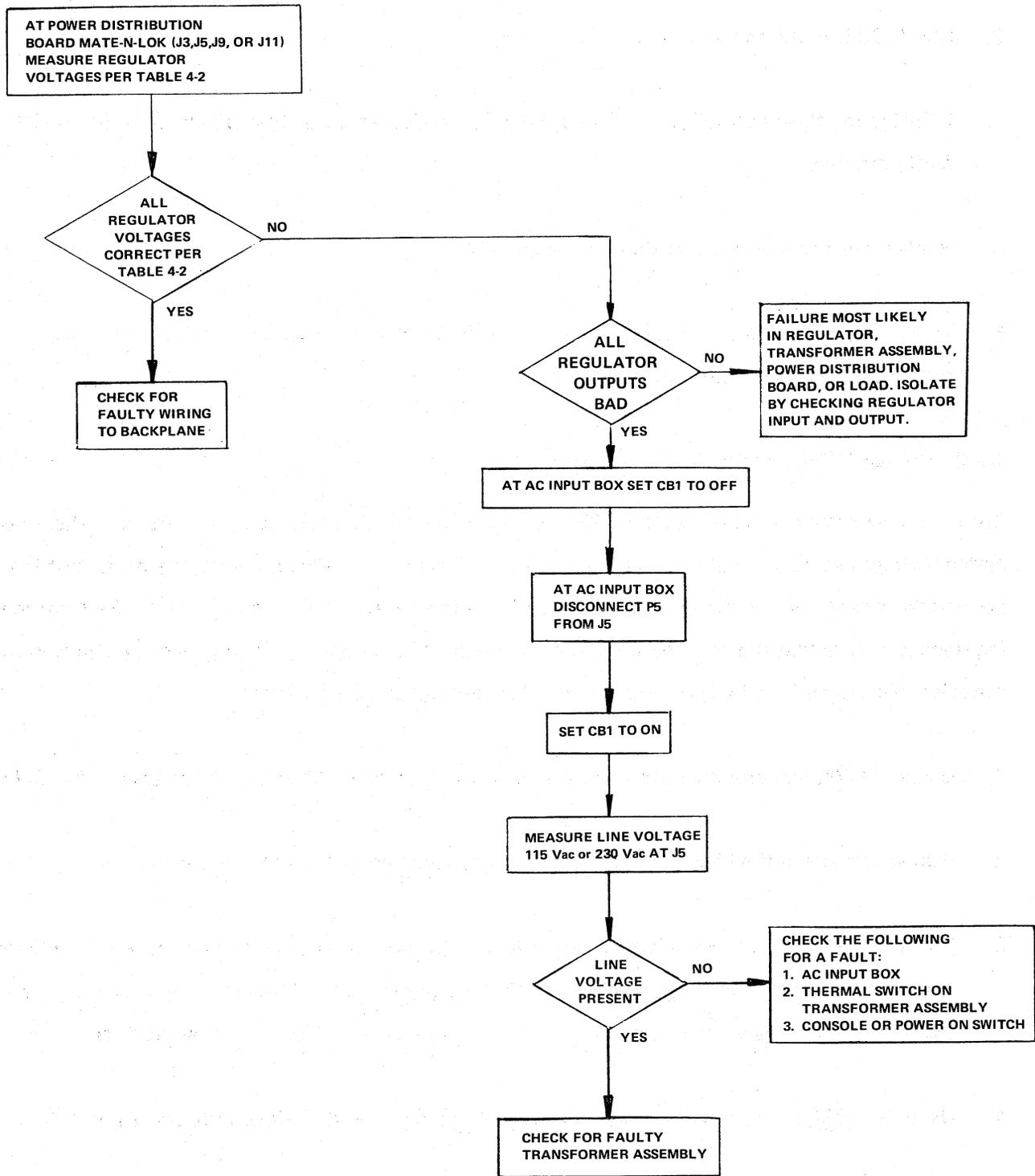
**Maintenance Equipment Required**

Equipment or Tool	Manufacturer	Model, Type, or Part No.	DEC Part No.
Oscilloscope	Tektronix	453 (or equivalent)	29-13510
DVM	—	—	—
Volt/Ohmmeter (VOM)	Triplett	—	29-13510
Diagonal Cutters	Utica	47-4	29-13460
Diagonal Cutters	Utica	466-4 (modified)	29-19551
Miniature Needle-Nose Pliers	Utica	23-4-1/2	29-13462
Wire Strippers	Millers	101S	29-13467
Solder Extractor	Solder Pullit	Standard	29-13451
Soldering Iron (30 W)	Paragon	615	29-13452
Soldering Iron Tip	Paragon	605	29-19333

### 4.3 MAINTENANCE PROCEDURE

#### 4.3.1 H765 Power System Fault Isolation

The H765 Power System (Figure 3-2) consists of field replaceable modules. Once a power system failure is discovered, the following steps and associated flowchart (Figure 4-1) can be utilized to isolate to a faulty module:



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Figure 4-1 H765 Fault Isolation Flowchart

1. Ensure the H765 is plugged in and getting primary ac power (115 Vac/230 Vac).
2. Check CB1 on the ac input box.
3. Utilizing the flowchart (Figure 4-1) and H765 Power System schematic (Figure 3-2), isolate the faulty module.
4. Replace the module as described in Paragraph 4.4.
5. When a fault is isolated to a voltage regulator, refer to Paragraphs 4.3.2 – 4.3.4 for voltage regulator checks and adjustments.

#### **4.3.2 Voltage Regulator Checks and Adjustments**

Correct power system voltages at the backplane are critical to a properly operating system. The power system voltages are supplied by the regulators listed in Table 4-2. Each voltage regulator, except the 5409730-YA, has an adjustment potentiometer (Figure 4-2) which is located next to the output lamp. Perform the following steps to ensure that the voltages are within tolerance. If a voltage regulator cannot be adjusted to meet the tolerance, check for a bad regulator, power distribution board, or wiring.

1. Using a DVM, measure the output voltages under normal load conditions at the backplane (Table 4-2).
2. Adjust voltages at the backplane to the tolerances specified in Table 4-2, as required.
3. Using a DVM, measure the voltage at the regulator (or power distribution board). Ensure that the maximum voltages at the regulator (Table 4-2) are not exceeded. These voltages represent the maximum regulator voltage prior to crowbar. (Do not adjust the regulator to these voltages.)
4. Using an oscilloscope, measure the peak-to-peak ripple content on all dc outputs (Table 4-2).

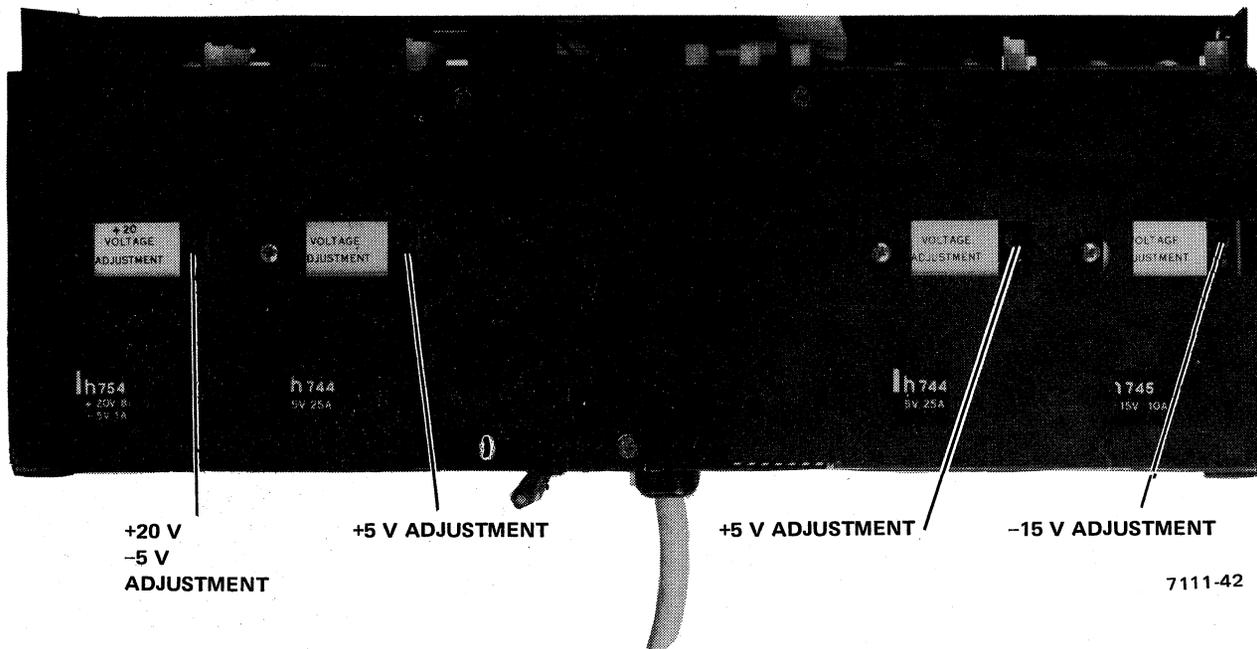


Figure 4-2 Regulator Adjustments

**Table 4-2**  
**Regulator Specifications**

Regulator	Voltage and Tolerance at Backplane	Maximum Voltage at Regulator (Note 1)	Maximum Out- put Current	Maximum Peak- to-Peak Ripple
H744	+5 Vdc $\pm$ 250 mV	5.5 Vdc	25 A	200 mV
H745	-15 Vdc $\pm$ 750 mV	16 Vdc	10 A	450 mV
H754	+20 Vdc $\pm$ 1 V	21.5 Vdc	8 A	5% } (Note 2)
(Note 4)	-5 Vdc $\pm$ 250 mV	5.5 Vdc	1 - 8 A (Note 3)	5% }
5409730-YA	+15 Vdc $\pm$ 10%		1.5 A	

- Notes: 1. Do not adjust the regulator to these voltages. They represent the maximum regulator voltage prior to crowbar.
2. At backplane. Typical ripple  $\approx$   $\pm$ 3%.
3. Maximum -5 V current is dependent upon +20 V current. It is equal to 1 A plus the current of the +20 V supply up to a total of 8 A.
4. When adjusting the output of H754, adjust +20 Vdc first, then -5 Vdc.

### 4.3.3 Voltage Regulator Troubleshooting

The voltage regulators in the H765 Power System are designed to be replaced when a failure is detected. However, there are unique situations when a regulator needs to be repaired in the field. Table 4-3 lists the primary fault indications, the most probable cause, and corrective action required. This table should be used in conjunction with the regulator's theory of operation (Chapter 3) and the print set.

Once the repairs have been accomplished or a new regulator is installed, refer to Paragraph 4.3.2 for voltage regulator checks and adjustments.

**Table 4-3**  
**H744, H745, H754 Voltage Regulator Troubleshooting Chart**

Fault Indication	Most Probable Cause	Corrective Action
No Output Voltage	1. D1 (bottom of D1 will appear burnt)	Replace regulator or D1.
	2. E1 (DEC 723, IC voltage regulator)	Replace regulator or E1 (Figure 3-7).

Table 4-3 (Cont)

H744, H745, H754 Voltage Regulator Troubleshooting Chart

Fault Indication	Most Probable Cause	Corrective Action
(Cont)	3. Misadjusted output voltage	Shut power off and turn voltage adjust fully ccw (below crowbar voltage). Turn power on and slowly increase voltage, per Table 4-2, until correct value is obtained.
Blown fuse	1. Q2 (pass transistor)	Replace voltage regulator or pass transistor and associated components.
	2. Excessive loading of voltage regulator	Replace fuse and check loads.

**4.3.4 Regulator Bench Test Procedures (H744, H745, and H754)**

This paragraph suggests procedures to troubleshoot and test the H744 +5 V Regulator, H745 -5 V Regulator, and H754 +20 V, -5 V Regulator modules. The procedures are intended to aid in locating a fault, provided the fault has not destroyed the etched circuits.

When replacing a faulty voltage regulator, the new voltage regulator may need adjustment to compensate for the load. If the new regulator is initially adjusted too high, it may activate the crowbar circuit and therefore provide no output when initially installed. If this happens, turn power off and rotate the adjustment potentiometer counterclockwise. Then reapply power (regulator should not crowbar) and adjust the regulator output.

**4.3.4.1 Initial Tests** – When a power system fault has been isolated to a voltage regulator (H744, H745, or H754), examine internal fuse F1. A blown fuse usually indicates that the main pass transistor Q2 and/or one of its drivers, Q3 or Q4, has short circuited.

1. Check for damage to base-emitter bleeder resistors and a scorched etched board in the area of Q3 (and Q4 if applicable).
2. If the pass transistor and drivers check OK on a VOM, the fault may be caused by continuous base drive to the first driver, Q4 (Q3 in H754). Check level shifter Q5 for a short circuit.

3. Check the resistance to ground at the input to precision voltage regulator integrated circuit E1 (pins 4 and 5) to determine if an external short circuit is affecting the IC.
4. Use the VOM to check for a short circuit between fuse terminals and ground. Possible short circuits involving mounting TO-3 components to the heat sink may be located by connecting VOM leads between TO-3 cases and a regulator bracket mounting screw on the end of the heat sink.

**4.3.4.2 Output Short Circuit Tests** -- A voltage regulator that provides no output, or low output, without causing fuse F1 to blow is probably working into a short-circuited output.

#### **NOTE**

**An activated crowbar or a short-circuited output in an otherwise properly operating voltage regulator will not cause F1 to blow.**

1. If fuse F1 is not blown, and the area of etched circuit around the ac input to the bridge circuit is not damaged, it is safe to apply an ac input to the voltage regulator to determine if the regulator is overloaded by a short circuit across the output.
2. Connect the voltage regulator to a test bench source and advance the Variac to about 90 V (20 Vac at voltage regulator input). If the output is near 0 V, turn the voltage adjustment fully counterclockwise and repeat the test.
3. If the regulator appears overloaded, check for a short circuit across the output and for a component failure in the crowbar circuit.

**4.3.4.3 Testing a "Dead" Regulator** -- Use the following procedure to test a faulty regulator that does not exhibit the symptoms described above.

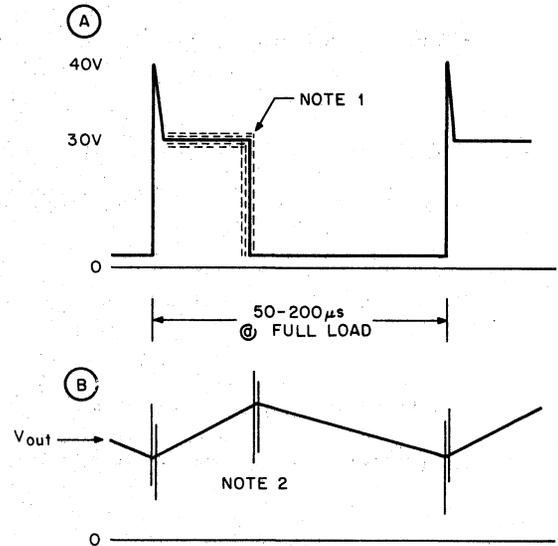
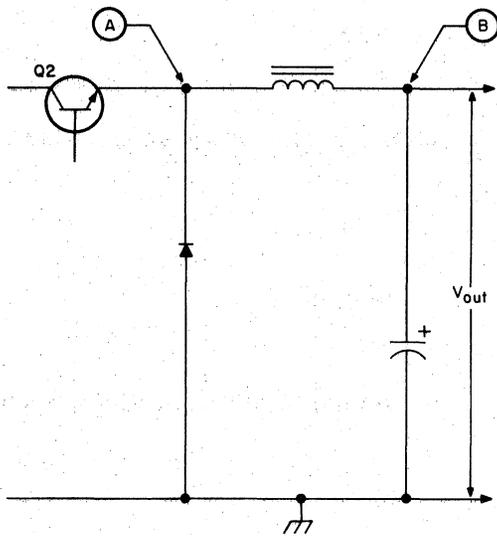
1. Apply 115 Vac to the test bench source (25 Vac at the voltage regulator input), with no load on the regulator output.

2. Check for 30 Vdc across filter capacitor C1 (and C2 if applicable).
3. Check for +15 Vdc at pin 12 of precision voltage regulator E1. No voltage at this point could mean Zener diode D2 (H744) or D3 (H754) has failed.
4. Check for 6.8–7.5 Vdc at pin 6 of E1 with respect to ground, pin 7.
5. If all voltage measurements steps 2, 3, and 4 are OK and there is no output voltage, pin 5 of E1 should be positive with respect to pin 4.

E1, pin 2, should be +0.6 V with respect to pin 3. If it is not, connect the emitter and base of Q5. If a 0.6 V indication is obtained, precision voltage regulator E1 is OK and the fault is probably caused by Q5 or Q4 (Q3 in H754).

**4.3.4.4 Testing a Voltage Regulator After Repairs** -- Before returning a repaired voltage regulator to service, it should be checked as follows:

1. Connect the repaired voltage regulator to the appropriate source connector.
2. Set the voltage adjustment fully counterclockwise and set the load to zero.
3. Close the input circuit breaker and advance the Variac until output voltage is indicated (at approximately 60–80 Vac input). No audible noise should be heard under no-load conditions.
4. Be sure Q2 is connected and soldered before loading the regulator.
5. Advance the Variac to 130 Vac and return to 115 Vac.
6. Apply a 30–50 percent load. The output voltage should remain nearly constant. A clean whistle may be heard. A buzz or a harsh hissing sound indicates possible instability. Check waveforms as indicated in Figure 4-3.



NOTE 1: 30 volt level shifts with AC input voltage.  
Small 120Hz jitter is normal.

NOTE 2: Maximum output ripple is specified in table 4-2  
Peak noise=1% max.

Measure noise with a short 100Ω terminated piece of foil coax. Normal 10:1 scope probe will not give an accurate noise measurement.

11-1075

Figure 4-3 Typical Voltage Regulator Output Waveforms

- Apply 100 percent load and set the voltage adjustment for nominal output, as listed in the following chart:

H744	+5.10 Vdc
H745	-15.10 Vdc
H754	+25 Vdc between +20 and -5 V outputs

- Apply 200 percent load and check for a decrease in the frequency and the output voltage.

#### NOTE

If the output voltage does not decrease noticeably (approximately 1 V on H744, or 1 to 5 V on the H745 and H754), do not attempt the following short circuit test.

9. Short circuit the output. The regulator should continue to operate at a low frequency with a clean, smooth whistle and stable waveforms.
10. Increase the voltage adjustment and observe the output voltage when the crowbar circuit fires. The output voltage should be within the following ranges:

H744	6.00–6.65 V
H745	16.8–20.5 V
H754	25.0–30.0 V and –6.00 to –7.00 V

#### 4.3.4.5 5409730-YA Regulator Test Procedure

To Be Supplied

## 4.4 H765 POWER SYSTEM SUBASSEMBLY REMOVAL PROCEDURE

### 4.4.1 Introduction

The H765 Power System access procedure enables the H765 to be accessed for adjustments and sub-assembly removal. The removal procedures include:

1. H765 Power System access procedure
2. H744, H745, and H754 Regulator removal
3. AC power input box and 5409730-YA regulator removal
4. Fan removal
5. Transformer assembly removal
6. Power distribution board removal.

#### **4.4.2 H765 Power System Access Procedure (Figure 4-4)**

1. Remove ac power by disconnecting the ac line cord from the ac power source.
2. Fully extend the BA11-K from the rack, ensuring cables do not bind.
3. Remove the BA11-K's top cover by removing six screws.
4. Remove the cable clamps by removing four screws.
5. To remove the H765's top cover, loosen the top three screws and remove the back three screws.

#### **4.4.3 H744, H745, and H754 Regulator Removal (Figure 4-5)**

1. Perform the H765 Power System access procedure (Paragraph 4.4.2).
2. Rotate the BA11-K 90 degrees.

#### **CAUTION**

**Hold H765 in place while removing screws.**

3. Tilt the H765 Power System by removing two screws on each side of the H765 (Figure 4-4).
4. Remove the bottom cover of the BA11-K.

#### **WARNING**

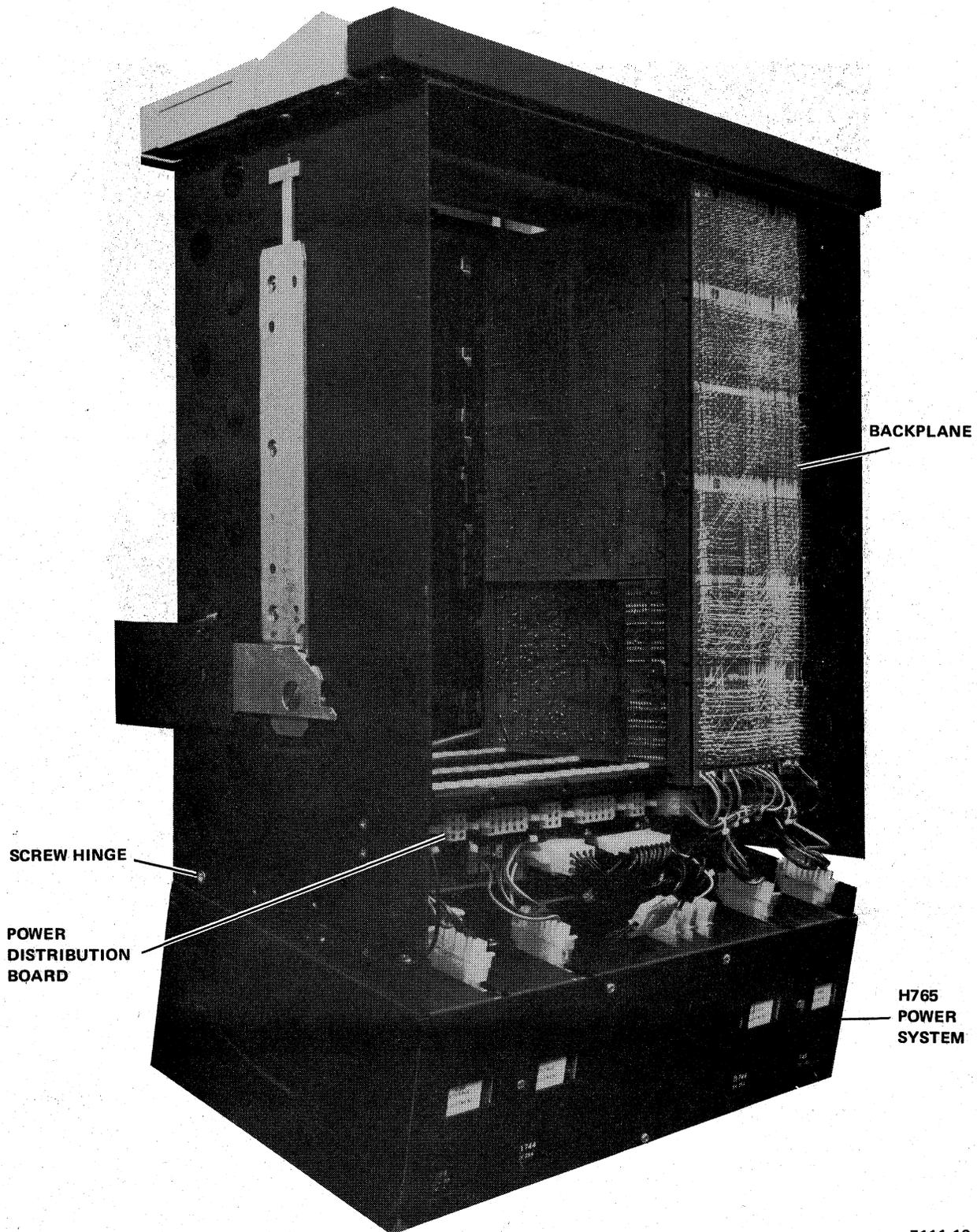
**Power must be removed prior to removing regulators.**

5. Disconnect the Mate-N-Lok from the regulator to be removed.
6. Remove three screws, two on the top and one on the bottom of the regulator (Figure 4-4).
7. Rotate the BA11-K 90 degrees to the horizontal position.

#### **CAUTION**

**Use the correct length screws when installing regulator.**

8. Slide out regulator and install a new regulator.
9. Perform the regulator voltage adjustment procedure (Paragraph 4.3.1).



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Figure 4-4 H765 Power System Access

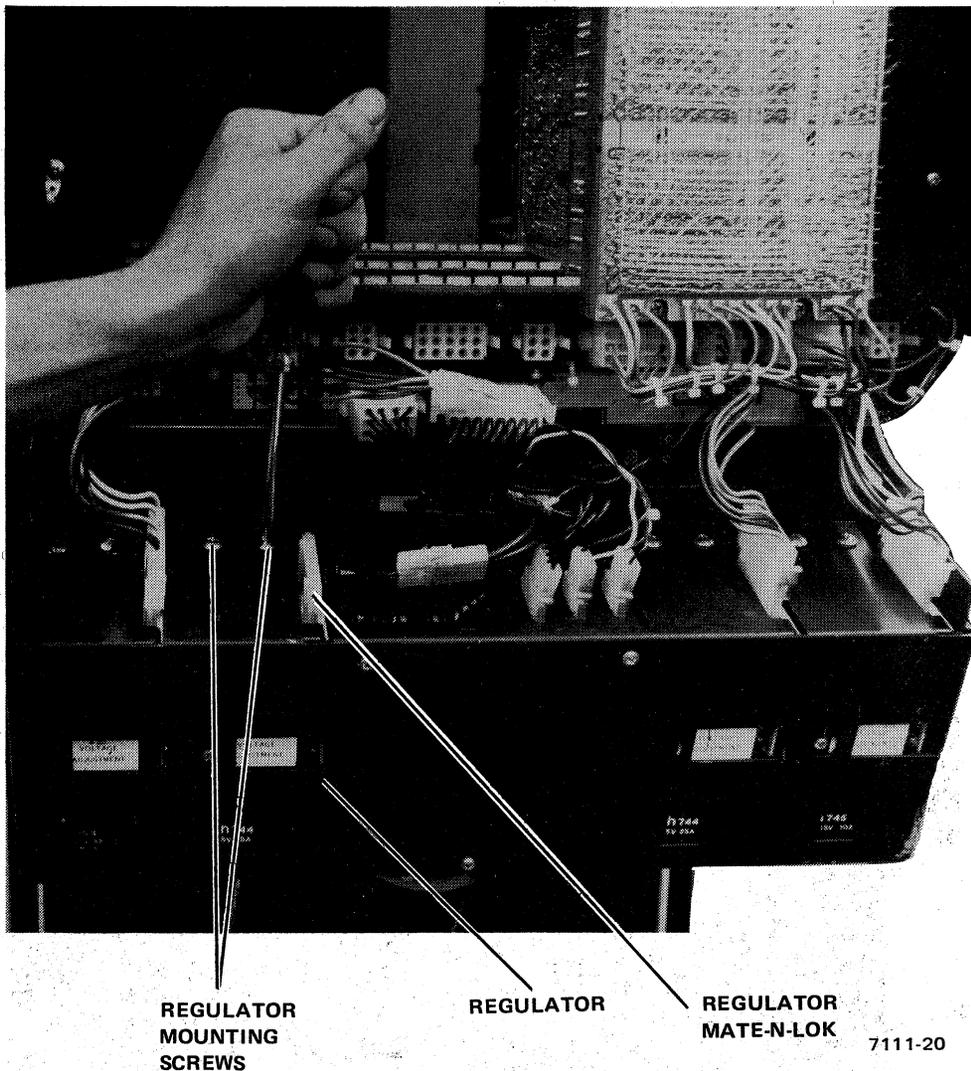


Figure 4-5 Regulator Removal

#### **4.4.4 AC Input Box and 5409730-YA Regulator Removal**

1. Perform the H765 Power System access procedure (Paragraph 4.4.2).
2. Rotate the BA11-K 90 degrees.
3. Tilt the H765 Power System by removing the two screws on each side of the H765 (Figure 4-4).

#### **WARNING**

**Ensure ac power is removed prior to removing the ac input box or 5409730-YA Regulator.**

4. Disconnect the Mate-N-Loks on the top and bottom of the ac input box (Figure 4-6).
5. Disconnect the two Mate-N-Loks from the 5409730-YA Regulator.

#### **CAUTION**

**Hold the ac input box in place while performing the next step.**

6. Remove three screws and slide out the ac input box.
7. Remove 5409730-YA Regulator from the ac input box.

#### **CAUTION**

**When reinstalling the ac input box, carefully check cable connections. Do not connect the 4-wire, 4-pin Mate-N-Lok connector to the flying lead 4-pin Mate-N-Lok.**

#### **4.4.5 Fan Removal**

1. Perform the H765 Power System access procedure (Paragraph 4.4.2).
2. Tilt the BA11-K 90 degrees.
3. Tilt the H765 Power System by removing the two screws on each side of the H765 (Figure 4-4).

#### **WARNING**

**Ensure ac power is removed prior to replacing fans.**

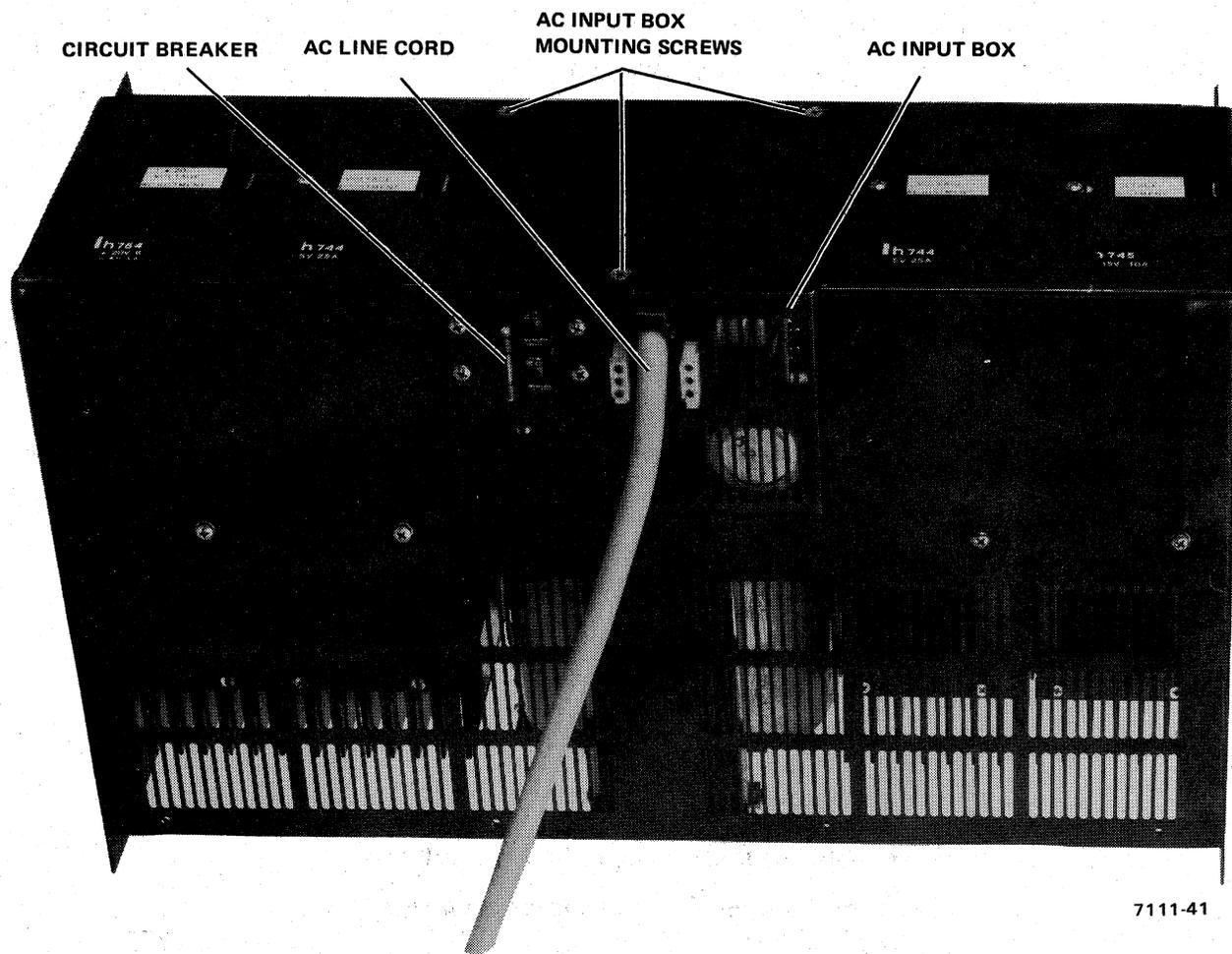


Figure 4-6 AC Input Box

4. Remove all modules.
5. On the module side of the fan, remove the two screws holding the fan (Figure 4-7).
6. Slide the fan out of the H765 and disconnect the jack from the fan.

#### **4.4.6 Transformer Assembly Removal**

##### **WARNING**

**Remove ac power prior to performing this procedure.**

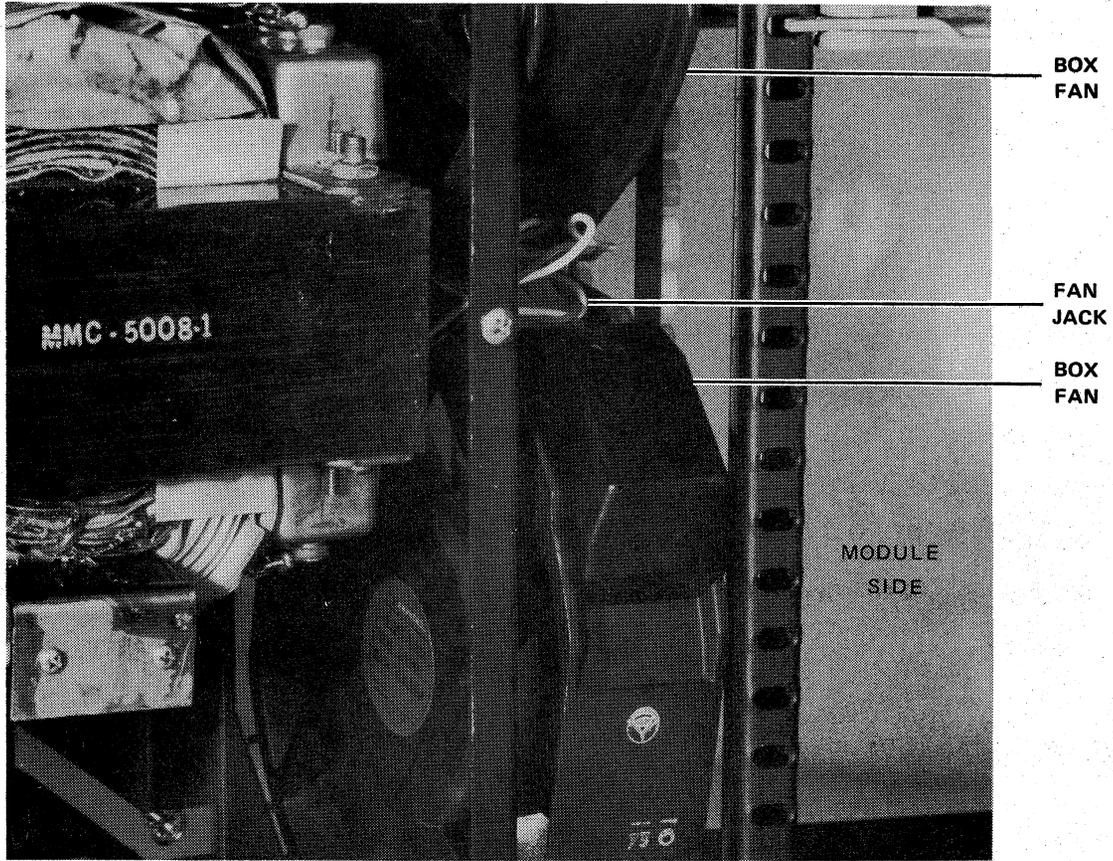
1. Remove the H745, H754, and both H744 Regulators per Paragraph 4.4.3.
2. Remove the ac input box per Paragraph 4.4.4.
3. Remove both fans per Paragraph 4.4.5.
4. Disconnect the transformer assembly's Mate-N-Loks (Figure 4-8).
5. Remove both screws from the transformer assembly's cable clamp (Figure 4-9).
6. Rotate the BA11-K to the horizontal position.
7. Remove the transformer assembly's mounting screws and nuts (Figure 4-9) and lift out the transformer assembly.

#### **4.4.7 Power Distribution Board Removal**

##### **WARNING**

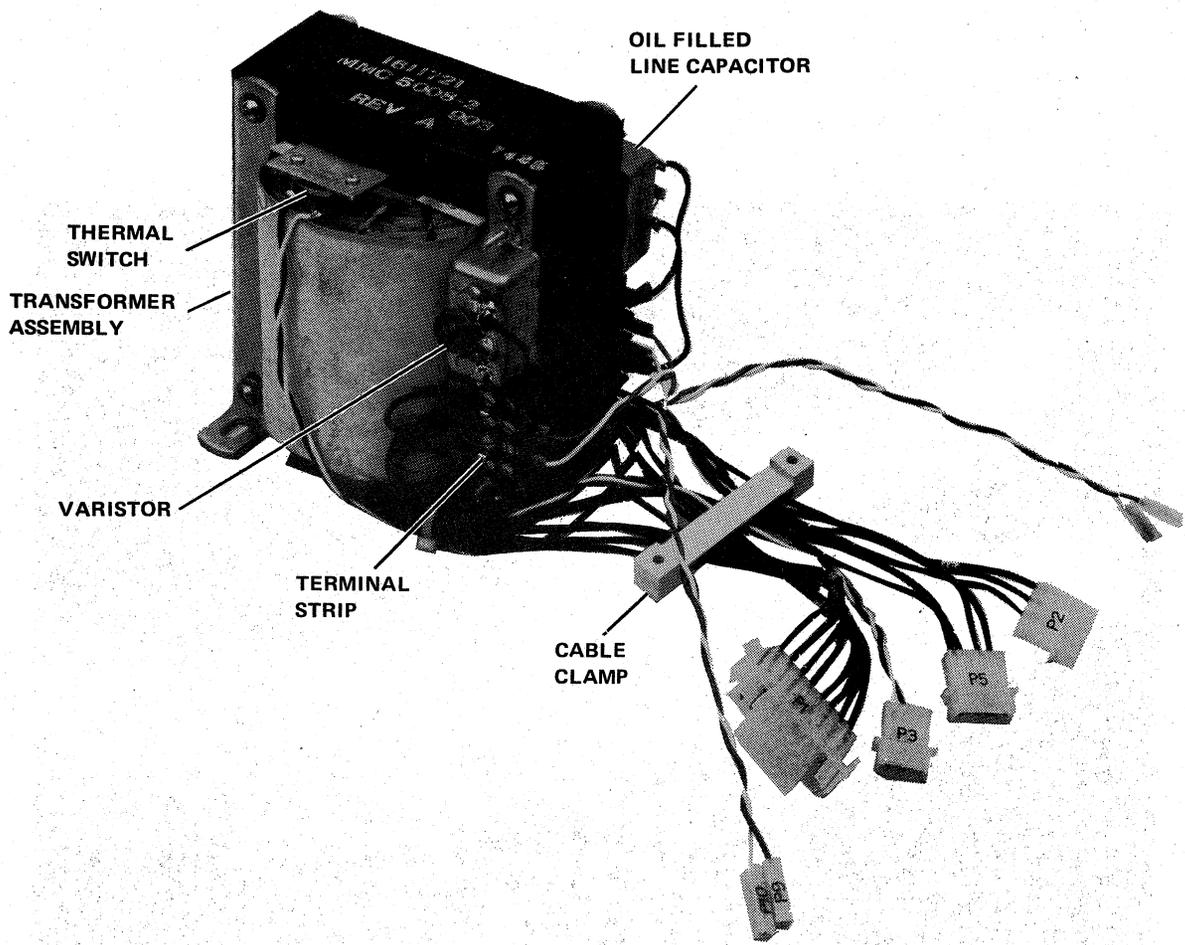
**Remove ac power from the H765 Power System.**

1. Disconnect all Mate-N-Loks and the ground lead from the power distribution board.
2. Remove the four screws from the mounting bracket (Figure 4-10) and remove the power distribution board.



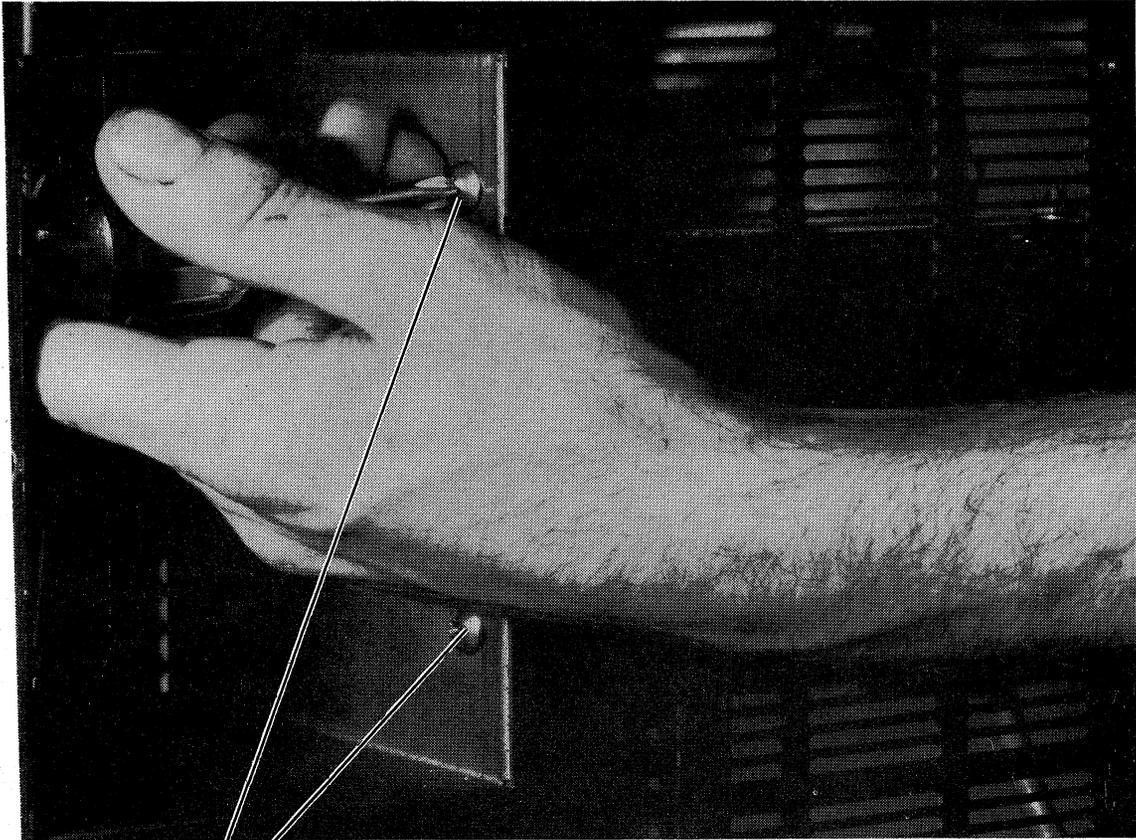
7111-6

Figure 4-7 Fan Removal



7111-4

Figure 4-8 Transformer Assembly



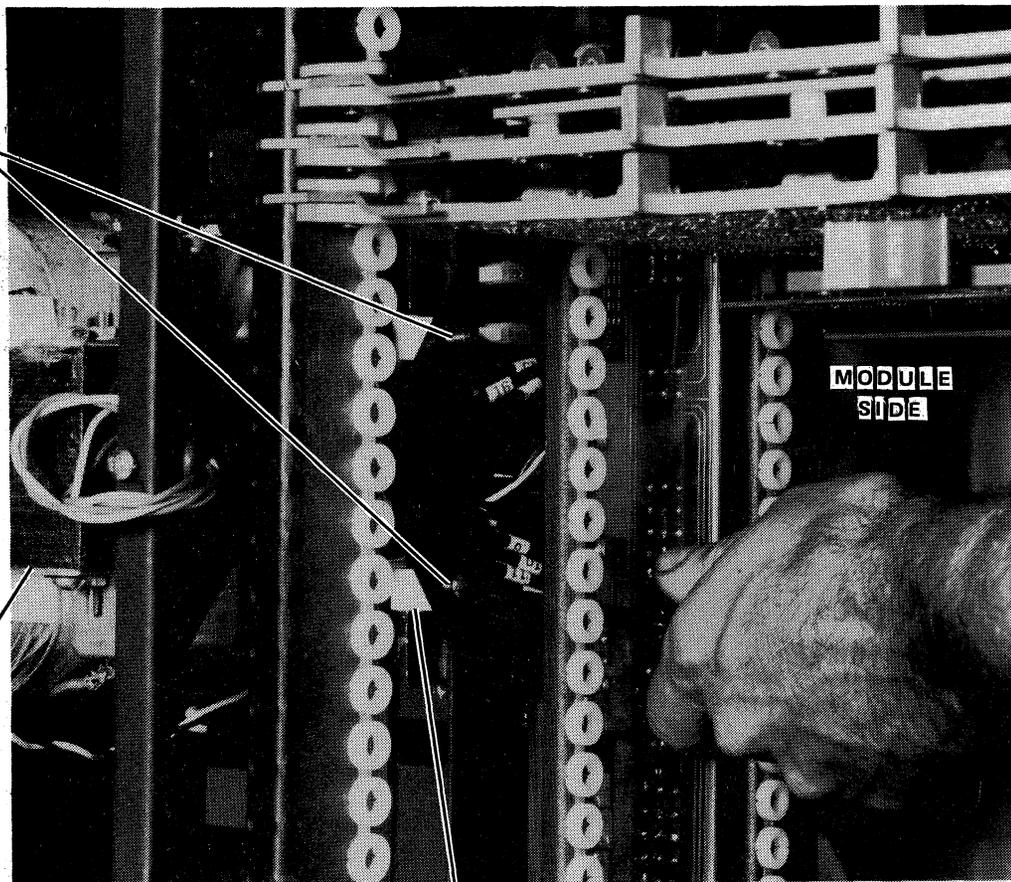
7111-11

**TRANSFORMER ASSEMBLY  
MOUNTING SCREWS**

Figure 4-9 Transformer Assembly Removal (Sheet 1 of 2)

CABLE CLAMP  
MOUNTING  
SCREWS

TRANSFORMER  
ASSEMBLY



TRANSFORMER  
ASSEMBLY  
CABLE CLAMP

7111-10

Figure 4-9 Transformer Assembly Removal (Sheet 2 of 2)

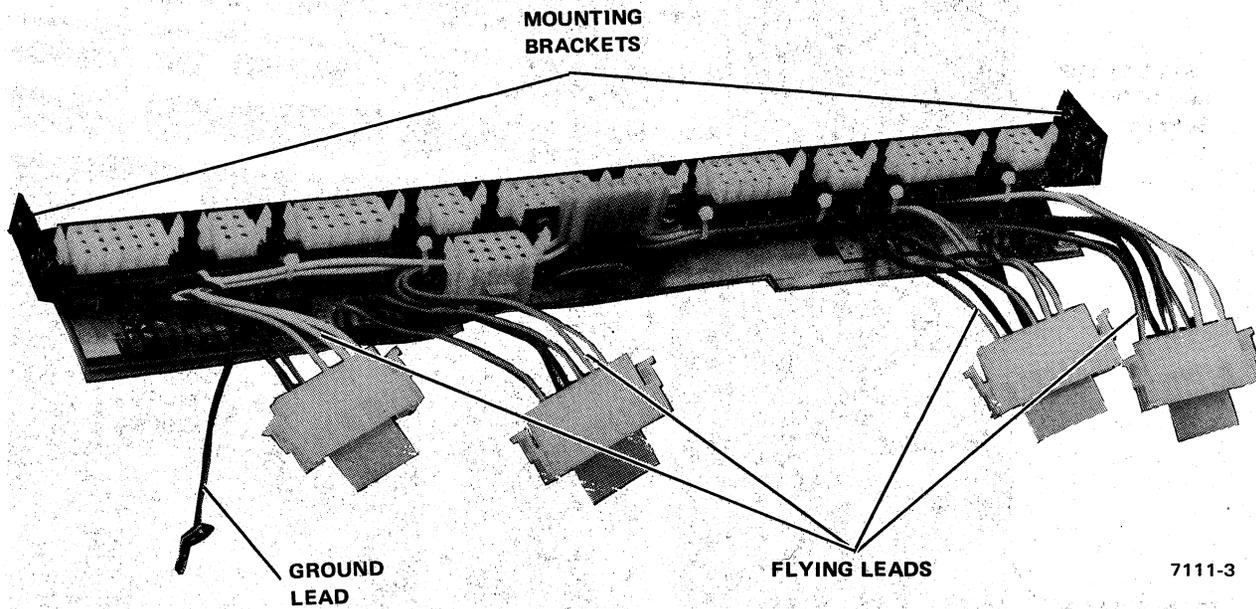


Figure 4-10 Power Distribution Board Removal

## **CHAPTER 5**

### **UNPACKING AND INSTALLATION**

#### **5.1 INTRODUCTION**

This chapter provides information on the unpacking and installation of the BA11-K Mounting Box. Information on installation certification is also included.

#### **5.2 UNPACKING**

The BA11-K is shipped ready to operate in a protective box (Figure 5-1). Remove the BA11-K from the box and visually inspect for damage. Save the shipping cartons and packaging materials in case it is necessary to return the BA11-K for service. The slide mounts are attached to the BA11-K, but the mounting screws are packed in a bag placed in the shipping container.

#### **5.3 INSTALLATION IN A CABINET**

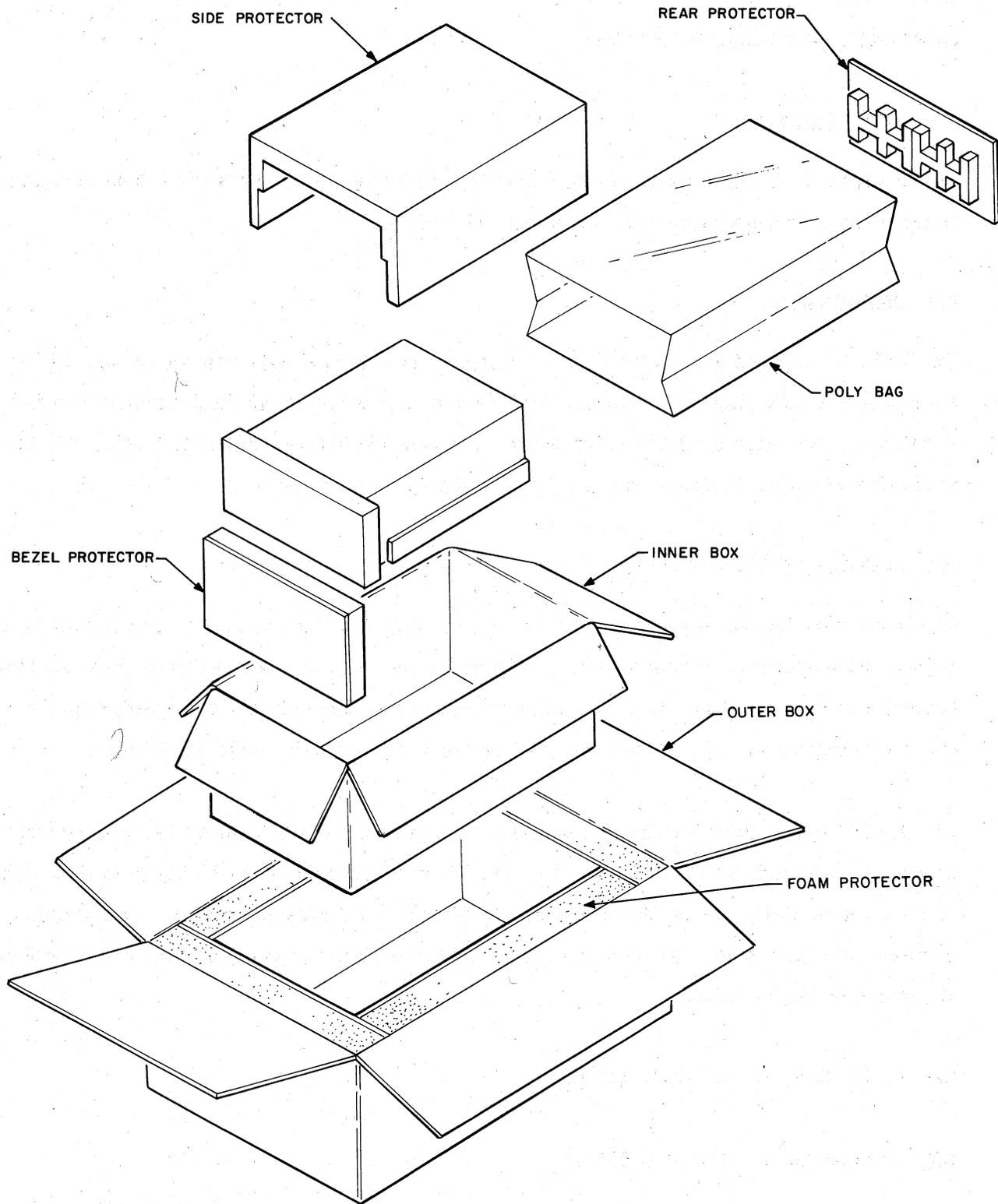
The front of the fixed slide has an integral bracket and is mounted in the cabinet with two screws that are secured with captive (Tinnerman) nuts. The rear of the fixed slide is attached to a separate L-shaped bracket with two screws and nuts. The bracket is attached to the cabinet with two screws that are secured with captive nuts. Mount the fixed slides equidistant from and parallel to the floor.

Lift the BA11-K and slide it carefully into the fixed guides until the slide release engages. Unlock the slide release and push the BA11-K fully into the cabinet. Extend the BA11-K enough to allow access to the front mounting screws. Slightly loosen the front and rear slide mounting screws and slide the computer back and forth. This allows the slides to assume a position that causes minimum binding. Retighten the mounting screws.

#### **5.4 AC POWER SUPPLY CONNECTION**

##### **5.4.1 Connecting to 115 Vac or 230 Vac**

The BA11-KE/KF, designed for use on 115 Vac/230 Vac circuits, is equipped with a three-prong connector, which, when inserted into a properly wired 115 Vac or 230 Vac outlet, grounds the chassis. It



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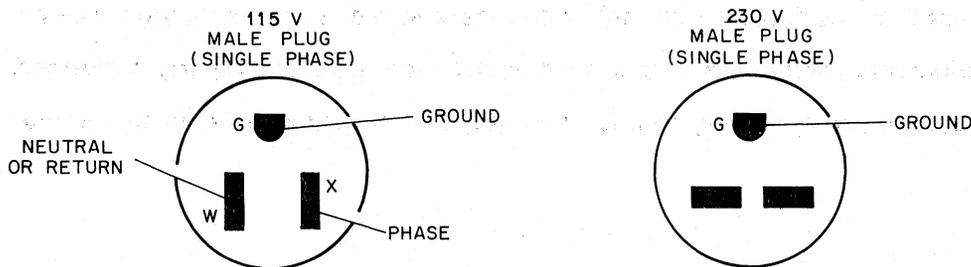
Figure 5-1 BA11-K Packaging

is unsafe to operate the BA11-K unless the chassis is grounded, since normal leakage current from the power supply flows into metal parts of the chassis.

If the integrity of the ground circuit is questionable, the user is advised to measure the potential between the computer case and a known ground with an ac voltmeter.

The BA11-KE/KF operates at voltages ranging from 90 V to 132 V/180 V to 264 V (47 Hz–63 Hz). The plug configuration and specifications are shown in Figure 5-2.

On installation outside of the United States or where the National Electrical Code does not govern building wiring, the user is advised to proceed with caution.



CONNECTOR SPECIFICATIONS

DESCRIPTION	NEMA * CONFIGURATION	POLES	WIRES	PLUG	RECEPTACLE
				DEC PART NO.	DEC PART NO.
115V, 15 AMP	5-15	2	3	90-08938	12-05351
230V, 15 AMP	6-15	2	3	90-08853	12-11204

\* ADD P SUFFIX FOR PLUG  
ADD R SUFFIX FOR RECEPTACLE

Figure 5-2 Connector Specifications

### 5.4.2 Quality of AC Power Source

If the BA11-K is to be installed in an electrically noisy environment, it may be necessary to condition the ac power line. DEC Field Service engineers can assist customers in determining if their ac line is satisfactory.

## **5.5 REMOTE POWER CONTROL**

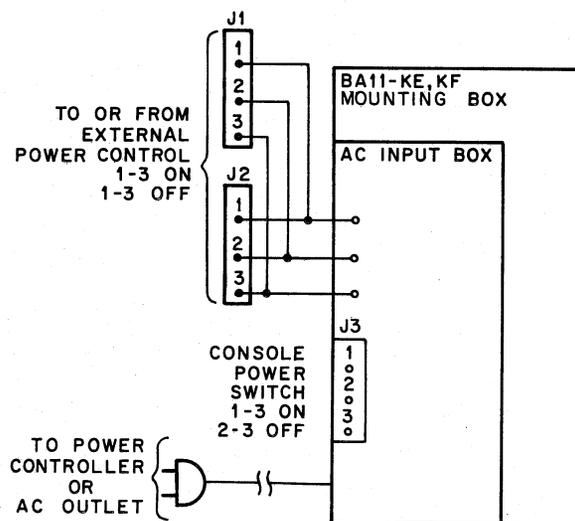
Power control (Figure 5-3) of the BA11-K can be accomplished by the following three methods;

1. A key switch can be utilized to control the BA11-K. This is accomplished by connecting the proper cable to J2 or J3 on the ac input box.
2. Mate-N-Loks J1, J2, or J3 on the ac input box can be configured to enable a power controller to control application of ac power.
3. CB1 on the ac input box can be used as an on/off switch.

## **5.6 INSTALLATION CERTIFICATION**

Once the BA11-K has been installed, it is strongly recommended that a system diagnostic be run to ensure that the equipment operates correctly and that installation has been properly performed. Because system configurations vary widely, no one diagnostic will completely exercise all the attached devices.

The user's manual that comes with the diagnostic package should be consulted for the appropriate diagnostic to be run. The user's manual lists the devices that each diagnostic will exercise. Once the diagnostic is selected, the respective diagnostic write-up should be consulted for specific operating instructions. If the user is not familiar with console operation and/or procedures for loading paper tapes, he or she should read the applicable manual.



11-2563

Figure 5-3 Power Control



**BA11-K MOUNTING BOX  
MANUAL  
DEC-11-HBKEF-A-D**

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