VARIAN 72

POWER SUPPLY MANUAL

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SECTION 1
GENERAL DESCRIPTION

The Varian 72 Power Supply Manual describes the V72 power supply and its use within a Varian 70 series computer system.

The manual is divided into six sections:

- Introduction to the power supply and its relation to the system
- Installation and interconnection information
- Operation
- Theory of operation
- Maintenance
- Mnemonics list

Documents such as logic diagrams, schematics, and parts lists are supplied in a System Maintenance Manual. This manual is assembled when the equipment is shipped, and reflects the configuration of a specific system.

The following list contains the part numbers of other manuals pertinent to the Varian 70 series computers (the x at the end of each document number is the revision number and can be any digit 0 through 9):

Title	Number
72 System Handbook	98 A 9906 20x
73 System Handbook	98 A 9906 01x
74 System Handbook	98 A 9906 21x
Processor Manual	98 A 9906 02x
Core Memory Manual	98 A 9906 03x
16K Core Memory Manual (1.2 Microseconds)	98 A 9906 24x
16K Core Memory Manual (990 Nanoseconds)	98 A 9906 25x
Option Board Manual	98 A 9906 05x
MAINTAIN III Manual	98 A 9952 07x

The Varian 72 power supply provides all the dc power required by the computer processor board, option board, and 65,536 (64K) words of core memory. However, with a 64K system a memory map option is needed which requires additional power. The regulated dc outputs of the V72 power supply are:

Table 1-1. Power Supply Specifications

Parameter	Specification
Input line voltage	103.5 to 126.5V ac or 207 to 253V ac
Input line current	12 amperes ac, full load
Input line frequency	47 to 63 Hz, single-phase
Line regulation	10 mV dc maximum for 103.5 to 126.5V ac or 207 to 253V ac line change at one-half full load
Regulated dc outputs	+5V at 42 amperes, maximum load
	-12V at 12 amperes, maximum load
	+20.6V at 3 amperes, maximum load
Adjustable dc voltage range	±5 percent on all dc outputs
Output ripple	100 mV maximum, peak-to-peak
Load regulation of all dc outputs:	Maximum change at output connector:
+5V output	135 mV for 50-percent change at 115V ac or 230V ac input
-12V output	135 mV for 50-percent change at 115V ac or 230V ac input
+20.6V	135 mV for 50-percent change at 115V ac or 230V ac input
Short-circuit current limits for all dc outputs:	
+5V output	15 amperes
-12V output	5 amperes
+20.6V output	2 amperes

Table 1-1. Power Supply Specifications (continued)

Parameter	Specification
Dimensions	5.25 by 19 by 19 inches (13.3 by 48.3 by 48.3 cm)
Weight	70 pounds (31.8 kg)

SECTION 2
INSTALLATION

2.1 INSPECTION

The power supply has been inspected and packed to ensure its arrival in good working order. To prevent damaging the power supply, avoid rough handling during unpacking and installation. Immediately after unpacking, check the shipping list to ensure that all equipment has been received and inspect the equipment for shipping damage. If damage is found:

a. Notify the transportation company.

b. Notify Varian Data Machines.

c. Save all packing material.

2.2 PHYSICAL DESCRIPTION

The power supply contained within a 5.25 by 19 by 19 inch chassis is suitable for rack mounting or table-top installation. A toggle-type circuit breaker and ac power indicator are mounted to the front panel and are the only external controls of the power supply. Figure 2-1 is a top view of the power supply with all major components listed by name and part number. Three power supply cables exit from one side of the rear panel through a special cable supporting bracket. The input power cable exits from the other side of the rear panel and is supported by a standard rubber grommet. All of these cable are connected at one end to terminals located on PC boards inside the power supply.

Use of controls and indicators are explained in section 3.

2.3 MAJOR ELECTRONIC COMPONENTS

The major electronic components of the power supply are illustrated in figure 2-1 and include six different printed circuit boards, six identical heat sink boards, and a single heat sink module listed below:

a. AC Power Board (part number 44C0586). This printed circuit card contains terminal boards, a 24V transformer, and a power control relay.

b. AC Filter Board (part number 44P0721). This printed circuit card contains ac filters and a solid state relay control voltage circuit.

c. Capacitor Board (part number 44P0715). This card contains ac filtering networks.

d. Power Supply Board (part number 44P0716). This card contains connectors for the six heat sink cards (plug-in modules), connectors for the regulator card and power fail card, a terminal board, and electronic components associated with the regulator and power fail circuits.

e. Regulator Board (part number 44P0528-001). This card contains voltage regulator circuits for the +5V, +20.6V, and -12V outputs.

f. Power Fail Board (part number 44P0623). This card contains the power failure alarm circuit.

g. Heat Sink Board (part number 44P0518). This plug-in module contains two power transistors mounted on a heat sink.

h. Heat Sink Module (part number 17A0022-001). This module is mounted on the chassis and contains four power rectifiers, one silicon-controlled rectifier, and a thermal switch (figure 2-2).

The six heat sink boards plug into circuit board connectors which are mounted on the component side of the power supply board as shown in figure 2-1. The rear panel and cables are shown in figure 2-3.

2.4 LINE VOLTAGE JUMPERS

Figure 2-4 shows the jumper connections required for 115V ac and 230V ac operation. These connections, normally made at the factory for each individual system, must be changed according to the illustration when converting from one input voltage source to the other.

2.5 INTERCONNECTION

Typical cable connection between the power supply and other units of a computer system are shown in figure 2-5. Pin assignments for power supply connectors are listed in table 2-1; pins that are not used are designated N/U; other pins are listed with corresponding signal nomenclature.

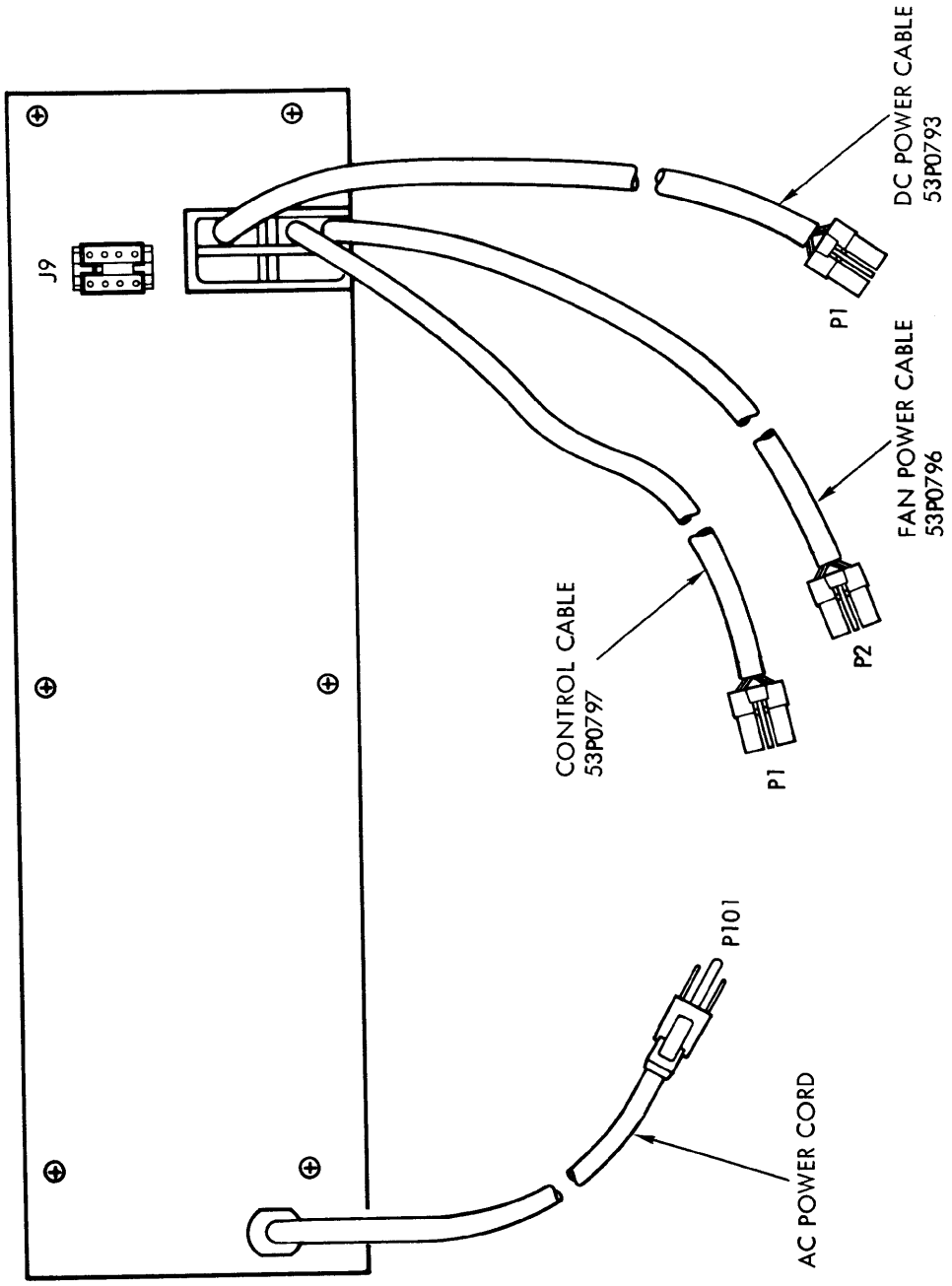

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Figure 2-3. Power Supply (Rear Panel)

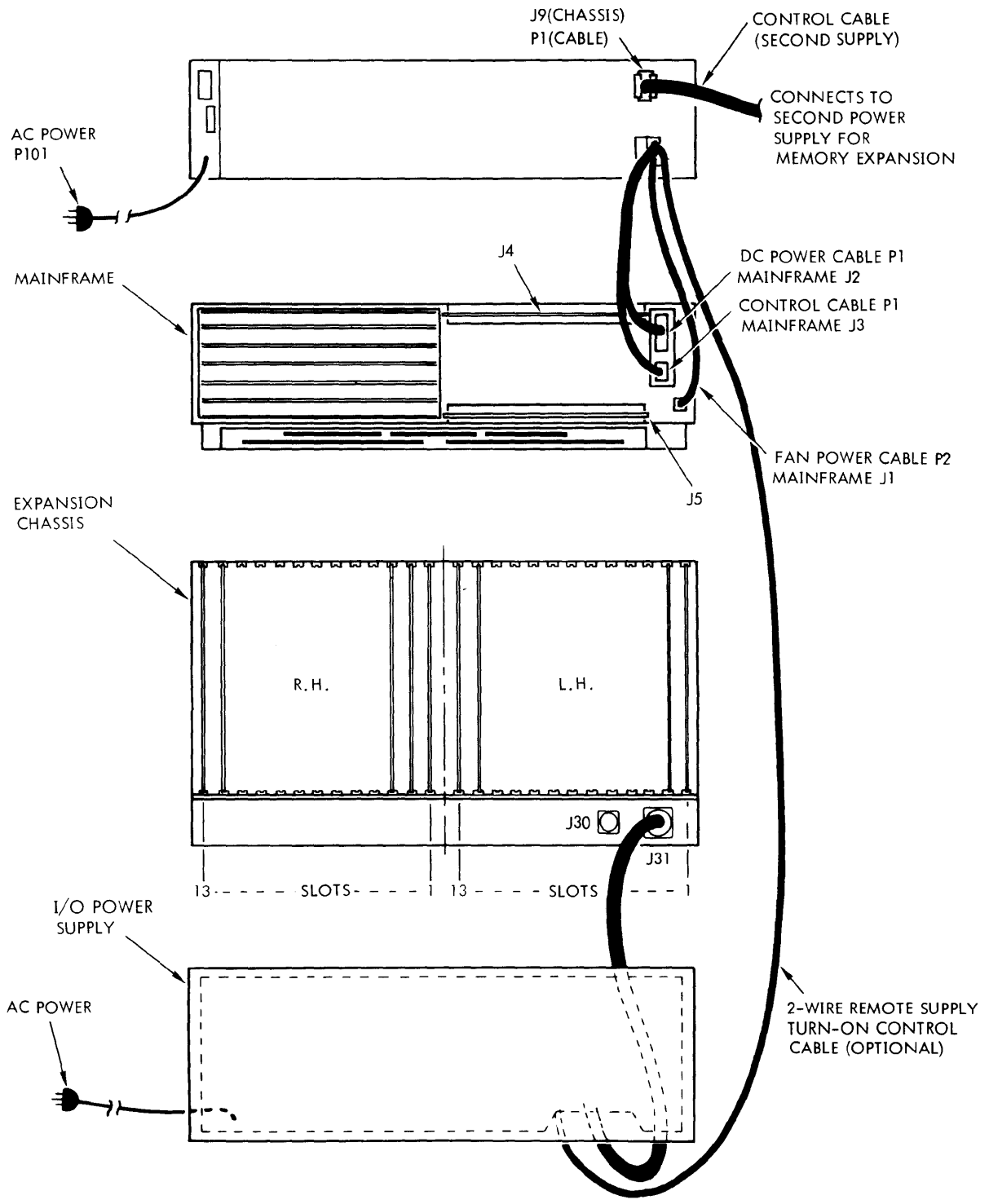

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Figure 2-5. Typical Power Cable Connections

Table 2-1. Pin Assignments for Connectors (continued)

CONTROL CABLE CONNECTOR P1

Pin	Signal
1	N HOLD
2	LFRTC+
3	24V ac
4	SRST-
5	N/U
6	SPFA-
7	RETRST-
8	N/U

CONTROL CABLE CONNECTOR P9

Pin	Signal
1	N HOLD
2	N/U
3	N/U
4	SRST-
5	N/U
6	SPFA-
7	RETRST-
8	N/U

SECTION 3
OPERATION

3.1 CONTROLS AND INDICATORS

The power supply has one toggle-type circuit breaker (CB1) and one ac power indicator (DS1) located on the front panel. The circuit breaker can be used as a power switch for the power supply but is primarily an overcurrent protection device. The ac indicator illuminates when the power supply provides the proper output voltages to the computer.

3.2 POWER-UP/POWER-DOWN FUNCTIONS

A power-up sequence is initiated during system operation when toggle circuit breaker CB1 is used as the power supply ON/OFF switch and is set to the ON position. When the computer POWER switch is turned on, or other power-on switching action occurs, power indicator DS1 on the power supply illuminates indicating that output power is being supplied to the computer system.

A power-down sequence occurs during system operation when the ambient temperature in the power supply exceeds +140 degrees centigrade, when the ac input voltage drops below the required amplitude, when the line current exceeds 15 amperes, when CB1 is set in the OFF position, or when the remote turn-on contacts open. If the ambient temperature exceeds +140 degrees centigrade, thermal switch S1 opens the input voltage line by deenergizing the K1 relay located on the ac power card and the K2 relay on the back of the front panel. If the line current exceeds 15 amperes during system operation, CB1 trips removing the input line voltage from other power supply circuits. In each case, power indicator DS1 on the power supply front panel goes off indicating that output power has been removed from the computer system.

SECTION 4
THEORY OF OPERATION

This section describes the operation of power supply circuits shown on schematic diagram 95E1060. The circuit descriptions in this section are related to the power supply block diagram, figure 4-1. Mnemonics referenced in text and shown on figure 4-1 are described in section 6.

4.1 INPUT CIRCUITS

Input circuits (figure 4-1) consist of the ac power cable, ac filter card, solid state relay, ac circuit breaker, ac power indicator, ac power card, and power transformer T1. Refer to schematics 95C1167 and 95C1077 for circuit details of the ac power card and ac filter card, respectively.

As shown in the simplified input circuit schematic, figure 4-2, the power cord consists of a standard three-wire cable and ac power plug. AC line voltage is applied to the input circuits through the black conductor of the power cable; the white conductor is the input line voltage return (neutral); the green conductor is connected to chassis ground.

The power supply can be wired for either a 115V or a 230V ac input by changing jumper wire connections between specific terminals of TB1 and TB2 located on the ac power card. As shown in figure 4-2 and schematic diagram 95E1060, jumper wires are represented by solid lines for 115V operation and by dotted lines for 230V operation.

Circuit breaker CB1, used to protect the power supply from overloads and shorts, is connected between an ac line voltage filter located on the ac filter card and power control circuits located on the ac power card. CB1 is actuated when power supply circuits draw more than 15A ac for 115V operation or 7.5A ac for 230V operation. As required by Underwriters' Laboratories, CB1 opens only the input voltage line when conducting 115V ac; for 230V ac, CB1 opens both the input voltage line and the return line.

With CB1 closed and the computer power switch ON, input line voltage is conducted through the ac power cable to an RC filter located on the ac filter card. This filtering circuit removes transient voltages from the input line voltage before applying this voltage to power-control circuits of the ac power card. With transients removed, the ac line voltage is conducted through CB1 to contact terminal 7 of power-control relay K1 and

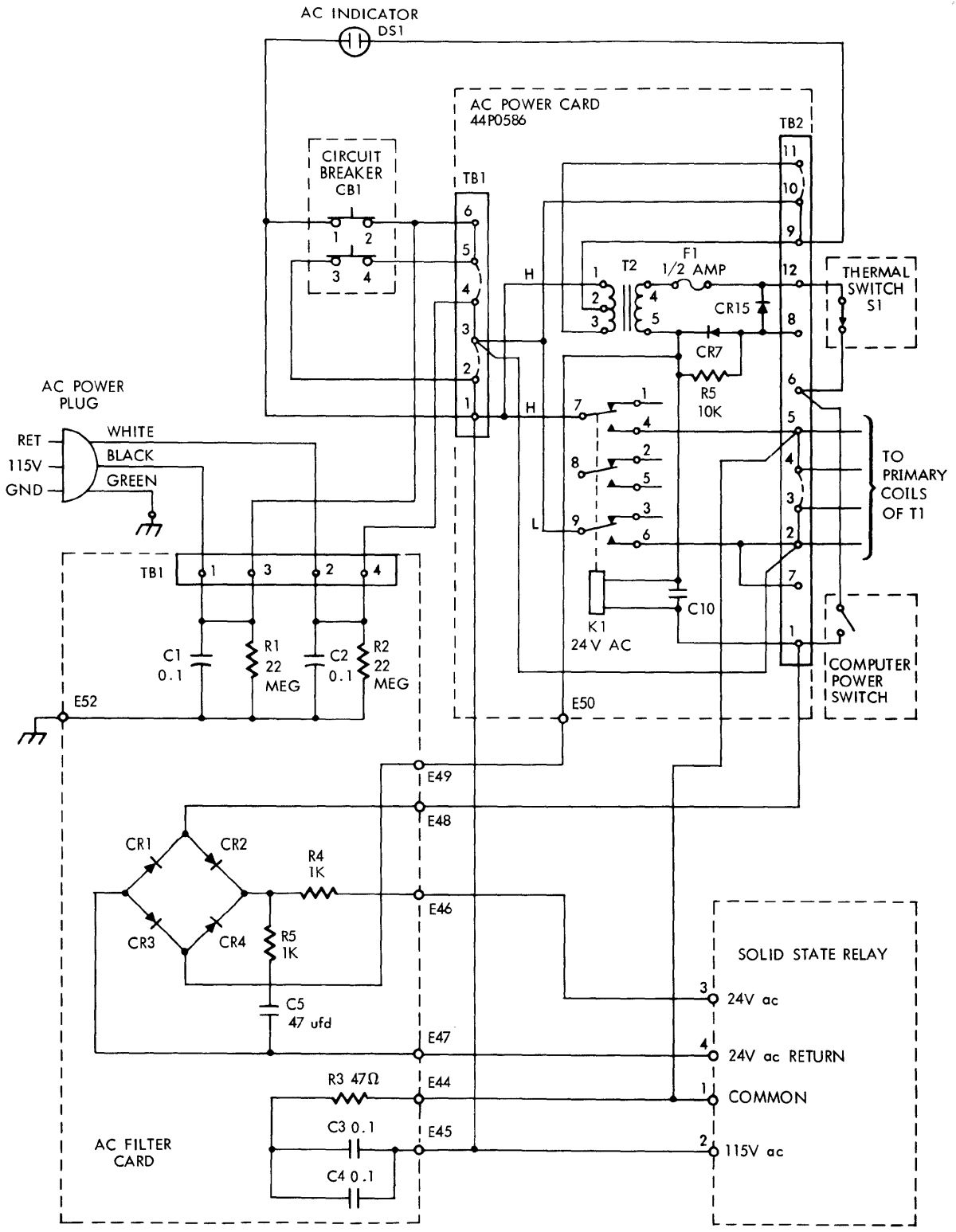

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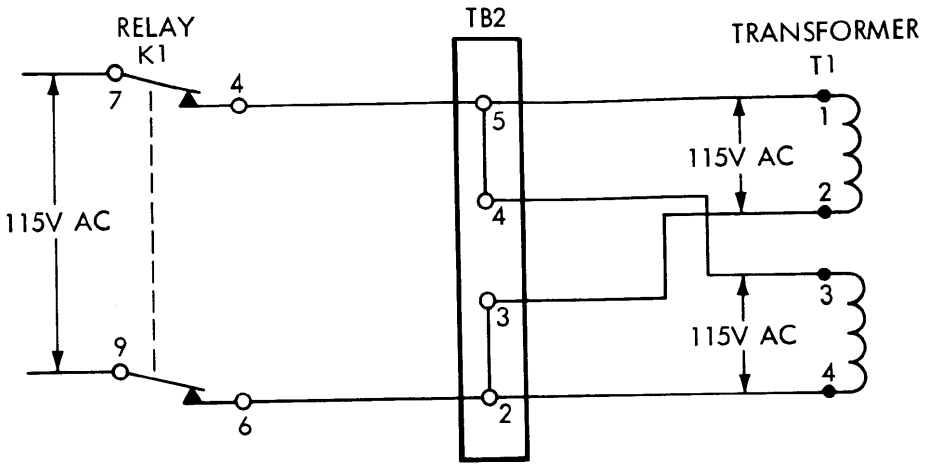
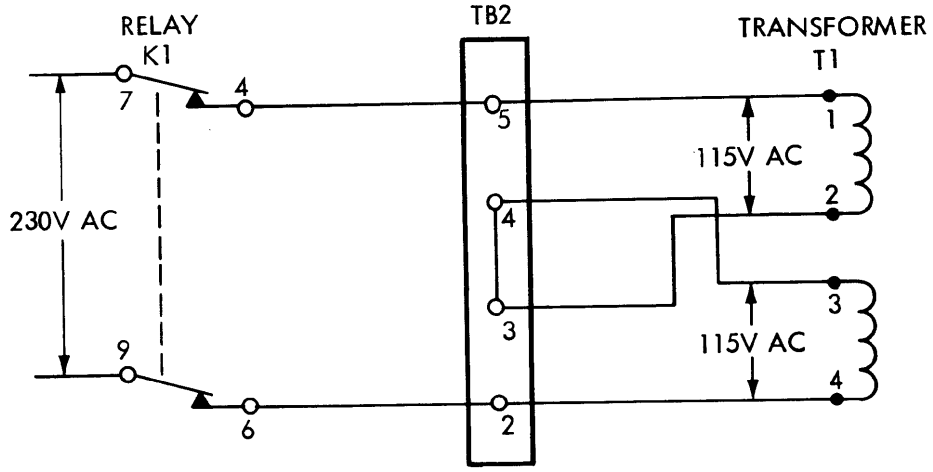
Figure 4-2. Input Circuits Simplified Schematic



A. 115-VOLT OPERATION



B. 230-VOLT OPERATION

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Figure 4-3. Power Transformer Primary Connections

Table 4-1. T1 Secondary Voltages

AC Voltage Developed	Measured Across Terminal	Terminal	Center Tap
12V	T1-5		T1-6
12V	T1-7		T1-6
24V	T1-5	T1-7	
9V	T1-8		T1-9
9V	T1-10		T1-9
14.5V	T1-11		T1-12
14.5V	T1-13		T1-12
27V	T1-14		T1-15
27V	T1-16		T1-15

circuits convert the unregulated ac voltages from the T1 secondary to full-wave rectifiled voltages containing less than 2V peak-to-peak ripple at full load. In addition, the filter capacitors on the capacitor card provide 2-milliseconds of stored energy which is required during a power-down sequence (section 4.6).

The boost voltage developed across terminals 5 and 7 of T1 provides operating power for the +20.6V regulator. The regulated voltage output from the +20.6V regulator provides operating power for the +5V regulator and the regulated output from the +5V regulator, in turn, provides power for the -12V regulator.

Because high currents are developed at the +5V and -12V output terminals of the T1 secondary, rectifiers for these voltages (CR8, CR9, CR10, and CR11) are mounted to the heat sink module. On the other hand, the low currents developed at the +20.6V and +20.6V (boost) output terminals of T1 do not require a heat transfer mounting. Associated power rectifiers, CR1 and CR2, for the +20.6V dc output and reverse-voltage protection diode CR3 are mounted on the capacitor card; power rectifiers for the boost voltage (CR4 and CR5) are mounted on the regulator card.

4.3 REGULATOR CIRCUITS

Regulator circuits receive low-ripple unregulated dc voltage inputs from the rectifier and filter circuits (section 4.2) and supply regulated dc voltage outputs used by the computer and other equipments.

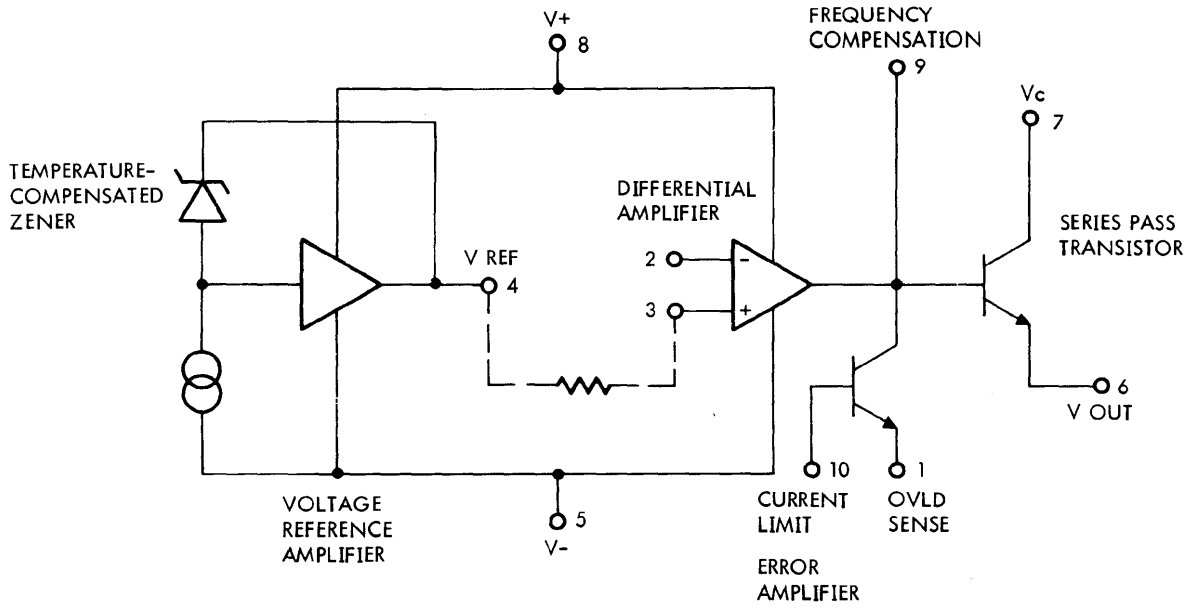

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Figure 4-5. IC Voltage Regulator Block Diagram

For the +20.6V and -12V regulator circuits, the feedback voltage at the inverting input of the IC differential amplifier is adjusted to the required voltage by an external series-connected potentiometer instead of the reference voltage. With the inverting input of the IC differential amplifier adjusted to the same voltage as the noninverting input, the gain of the regulator amplifiers decrease until the output current through the load is of sufficient flow to develop the required voltage (+20.6V or -12V) at the corresponding regulator circuit output.

When the IC voltage regulator is used to develop a positive regulated voltage output, pin 5 of the IC is connected to ground (common) and the positive voltage is measured at the emitters of the pass transistors. When the regulated voltage is negative, the emitters of the pass transistors are connected through resistors to ground (common) and the negative voltage is measured at pin 5 of the IC.

4.3.1 Overcurrent Protection

An overcurrent condition occurs in each output voltage regulator circuit when the output current exceeds the load limitations or short circuit limitations shown in table 1-1 of Section 1.

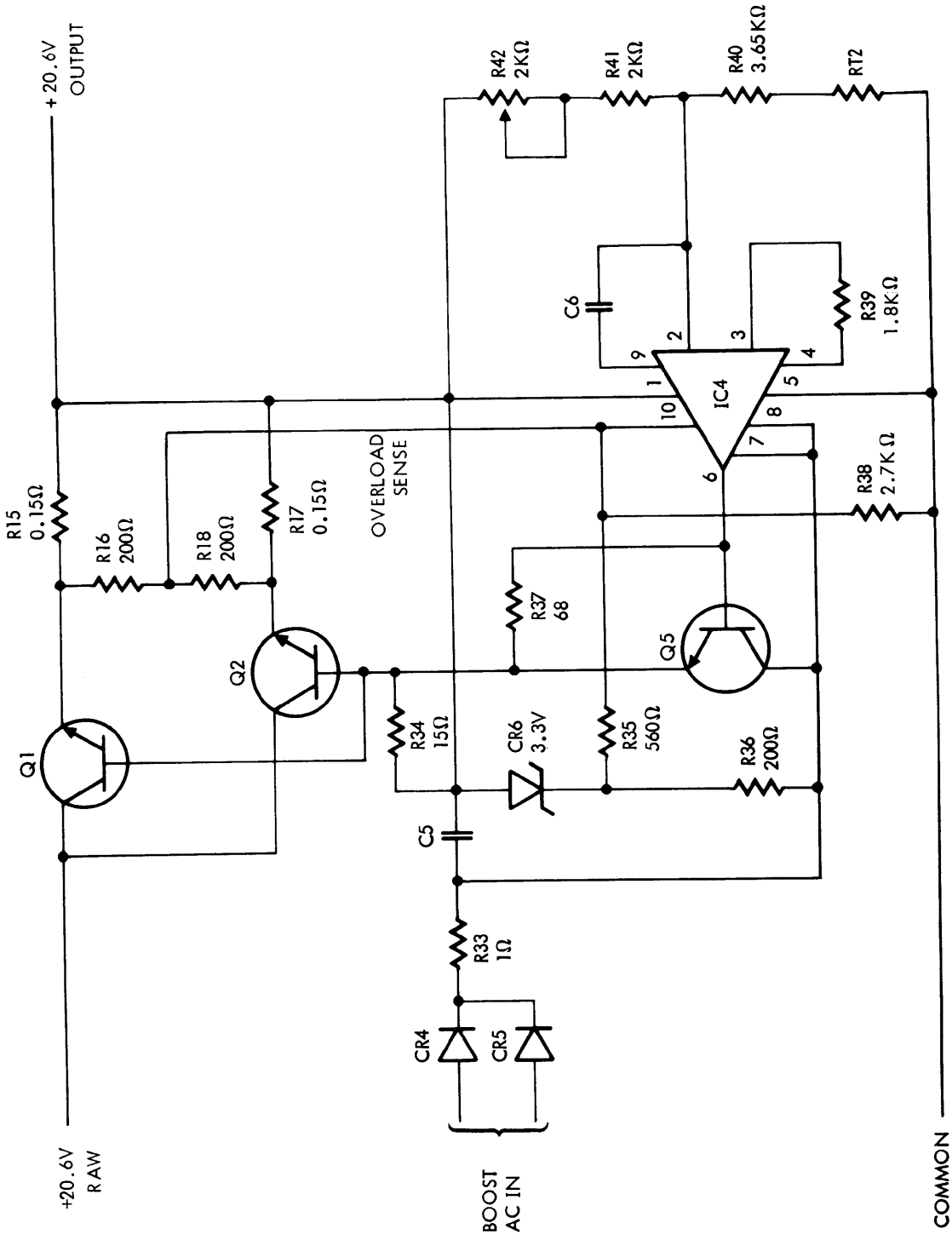

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Figure 4-6. Simplified Schematic of +20.6V Regulator Circuit

With a normal +5V output, CR3 operates as a reversed-biased diode to provide a high impedance that prevents Q4 from conducting. However, if the output voltage exceeds +6.2V, CR3 goes into avalanche mode allowing enough current flow (6 milliamperes) through R23 and R24 to start Q4 conducting. When Q4 conducts, the voltage developed at the junction of R25 and R26 triggers the SCR (Q1), which provides a low impedance across the output terminals. This low impedance reduces the output voltage to approximately 0.3V dc.

4.4 POWER-FAILURE-ALARM CIRCUIT

The power-failure alarm circuit monitors the output of the 24-volt transformer and, if the voltage falls below a certain level, generates an SPFA- signal (system power failure alarm). This SPFA- signal enables the computer power-down sequence when ac input power falls below a 102V ac level or is removed from the power supply. With normal ac input power applied to the power supply, this circuit generates a high-going SRST- signal (system reset) when computer power is turned on. This SRST- signal resets the computer registers and enables computer operation. Characteristics of the power-failure alarm circuit are listed in table 4-2. Timing waveforms associated with power-failure alarm circuit operations are illustrated by figure 4-9.

The power-failure alarm circuit (figure 4-1) is located on the power fail card (schematic diagram 91D0387) and includes a full-wave rectifier, a voltage comparator, switching transistors, capacitors, and relays that are associated with the power-up, power-on, and power-down functions of the power supply. The relationship between these power supply functions and the active state of the SPFA- signal are as follows:

a. During a power-up sequence, SPFA- remains low for approximately 200 milliseconds after the ac line voltage reaches 105V ac (207V ac for nominal 230V ac input).

b. During a power-on condition, if the ac line voltage falls below 103V ac (206V ac for nominal 230V ac input), SPFA- goes low for at least 16 milliseconds.

c. During a power-down sequence, SPFA- goes low at least one millisecond before dc power is removed from the computer.

The power-failure alarm circuit also has an anti-toggling feature that prevents SPFA- from returning to its high state before at least one full cycle of line voltage has occurred (16 milliseconds). When SPFA- is low (IC1-3 more negative than IC1-2), no current flows for IC1-6, causing Q1 to discharge C3. The negative-going signal on IC1-6 is also applied to IC1-3 through C8. Discharging C3 and driving IC1-3 more negative holds SPFA- low for at least one full cycle of line voltage

During a power-up sequence SRST- (system reset) goes high 100 microseconds before SPFA- and, during a power-down sequence, it goes low one millisecond after SPFA- (figure 4-11).

During power-up, the collector of Q3 goes high (+5V dc) causing a positive voltage to be transferred through R22 and R23, which immediately turns Q6 on and Q7 off. With Q7 turned off, relay K2 is energized causing SRST- to go high.

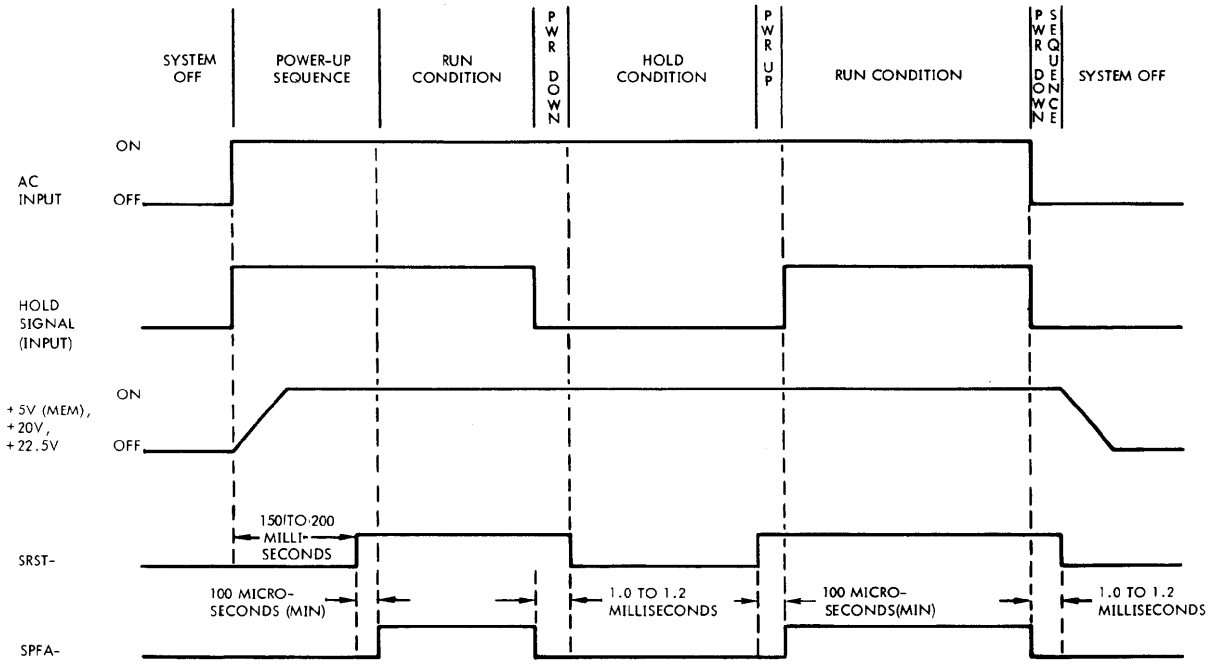

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Figure 4-11. Power-On/Off Timing

SECTION 5
MAINTENANCE

Maintenance personnel should be familiar with the contents of this manual before attempting corrective-maintenance trouble-shooting contained in this section. Power supply maintenance information includes a list of special tools and test equipment, information on circuit board repair, preventative maintenance data, and corrective maintenance data.

5.1 TEST EQUIPMENT

The following test equipment and special tools are recommended for power supply maintenance:

a. Oscilloscope, Tektronix type 547 with dual-trace plug-in unit and high current probe, or equivalent.

b. Digital Multimeter, Hewlett-Packard type 3469B, or equivalent.

c. Variable, AC Power Transformer, Superior Electric type 116B, or equivalent.

d. Soldering iron, 15-watt pencil type.

5.2 CIRCUIT BOARD REPAIR

The power supply contains two-sided PC boards with components and conducting paths located on both sides.

If it is determined that a circuit board requires repair, Varian Data Machines recommends that the user contact the VDM customer service department so that a new board can be installed in the user's system and the faulty one returned to the factory for repairs. However, if the user decides to repair the faulty board, extreme care should be used in making such repairs to prevent permanent damage to the board. Approved repair procedures, such as those described in document IPC-R-700A prepared by the Institute of Printed Circuits, should be followed.

5.3 CIRCUIT-COMPONENT IDENTIFICATION

Each discrete component of the power supply is identified by a reference designator which appears on the associated power supply assembly and on the assembly schematic diagram. The reference designator for each component mounted on a PC board appears on the board adjacent to the associated component and

Clean all PC card contacts with a good contact cleaner and allow the cleaner to dry before replacing the boards in the mating connectors. Also clean cable connector pins and PC board connector pins with the same contact cleaner and straighten the pins as required before mating.

The power-control relay has a dust cover and does not normally require cleaning. However, if the relay contacts have become blackened because of arcing, clean them with a good contact cleaner or a fine contact-burnishing tool. CAUTION: Be sure to remove the ac input power from the power supply before cleaning the relay contacts.

5.4.3 Performance Check

CAUTION: Do not attempt to operate the power supply without cooling fans.

To ensure that power supply components are in satisfactory operating condition, a performance check of the power supply should be made at regular intervals. The performance check consists of checking input and output voltages at specified test points in the power supply and of checking the power-failure threshold voltage. If a failure occurs during the performance check, make the necessary adjustments as described in section 5.4.4. If adjustments do not correct the malfunction, refer to section 5.5 for corrective maintenance.

5.4.3.1 Test Point Voltages

Use the digital multimeter (section 5.1) to monitor the ac input voltage and the dc output voltages at the indicated test points shown below:

Voltage	Test Point	Return	Board
115±11.5V ac	TB2-5	TB2-3	AC Power
-12.0	TP1	TP5	Regulator
+5.0	TP3	TP5	Regulator
+20.60	TP4	TP5	Regulator

5.4.3.2 Power Failure Threshold

Use the variable ac power source (section 5.1) to provide the input voltage to the power supply; use the digital multimeter to monitor the input voltage at TB2-5 and TB2-2 (return) on the ac power card; and use the oscilloscope to monitor the 24V ac at T1-11 or T1-13 with respect to T1-12 (return). Check the power-failure-alarm threshold voltage as follows:

System troubleshooting usually consists of isolating a malfunction to the processor, memory, or power supply. Incorrect dc voltage readings do not always indicate a power supply failure but may be caused by a short circuit in the processor or memory. To determine if the cause of trouble is a power supply failure, disconnect the power cables from the computer chassis. If the dc voltages are then incorrect, the power supply is malfunctioning.

5.5.1 Resistance Check

With the power supply disconnected from the system and ac power removed, resistance checks can be made at pins of dc power cable connector P1 and chassis connector J9 (section 2) that will help isolate faults indicated by incorrect outputs. Table 5-1 lists the approximate resistance values measured between each indicated output connector pin and ground for the associated circuit being checked. Because of slight differences in component tolerances within a given power supply, the measured value may be slightly different from the corresponding value listed in the table. If this is so or if the values are the same, troubleshoot the circuits ahead of the output circuit to isolate the fault. However, if the measured value is greatly different from the table value, the fault is likely to be present within the output circuit being checked.

Table 5-1. Resistance Checks

DC Cable P1 Pin	Associated Circuit	Resistance Ohms
1	+20.6V Reg.	3K
2	+5V Reg.	27
13	-12V Reg.	100
Chassis J9 Pin		
3	24V ac to K1 and K2 Relays	100 Megs
4	SRST- to Computer	120
6	SPFA- to Computer	120

Table 5-2. Fault Isolation Techniques

Symptoms	Fault	Action
All of the dc outputs are missing with the following conditions existing: the front panel light is not on, circuit breaker CB1 is closed, the ac power cord is plugged in, and ac power is present.	Power relay not energizing. Power control plug to processor not attached. Front panel switch not making contact.	Check circuit breakers on power-supply front panel. Disconnect power cable from mainframe. Connect a jumper between pins 2 and 3 of chassis connector J9 (pins 2 and 3 are signal lines LFRTC+ and 24VAC). This applies 24V ac across the coil of relay K1. If power supply starts, problem is in processor control. If it does not start, check 24V ac transformer (T2), power relay (K1), and associated wiring.
As above except that front panel light is on.	Power transformer primary open.	Check voltages across power transformer (T1) primary.
No outputs from dc regulators.	Power supply overheated and the heatsink thermostat therefore open, +20.6V regulator drive voltage not getting to regulator board.	Check heat sink temperature. Check fan and air passages. If OK, check +20.6V regulator. Rectifiers CR4 and CR5 suspect therefore check capacitor C5 for shorts (schematic 91D0318).
+5V dc output is 2-3V dc, -12V dc output is low, +20.6V dc output is either OK or intermittent.	Overvoltage protection SCR Q1 is on due to failure of either +5V dc regulator, or to external intermittent short to +20.6V dc.	Turn processor power switch OFF, then back ON. If problem remains, replace regulator board. Check SCR, Q1 (schematic 95E1060) for short.

Table 5-2. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
Exceptional ripple on any one regulated output, others OK (60Hz or 50Hz, half-wave only).	Main rectifier for affected regulator open on one leg.	Check rectifiers with ohmmeter, replacing as required.
Exceptional voltage deviation on any one regulator for transient load change. Others OK.	Output capacitor for the affected regulator open.	Check capacitor by connecting another of equivalent value in parallel. If transient returns to normal, replace capacitor.
Output of any regulator correct at no-load but low for 50 percent load.	Open driver or pass transistor in affected regulator (transistor acts only as diode).	Check regulator output transistor with ohmmeter. Replace fault transistor.
Output of any regulator except +5V regulator is high.	Shorted regulator or pass transistor.	Check regulator output transistors with ohmmeter. Replace regulator board.

SECTION 6
MNEMONICS

This section describes the power-supply signal mnemonics.

Mnemonic	Description
AC	Alternating current
DC	Direct current
LFRTC+	Line-frequency real time clock
OCS	Overcurrent sense
OVP	Overvoltage protection
RETRST-	System reset return
SPFA-	System power failure alarm
SRST-	System reset
24V ac	24-volt transformer output to external power switch