VARIAN 70 SERIES

POWER SUPPLY MANUAL

(UNIVERSAL)

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GENERAL DESCRIPTION
SECTION 1

The **Varian 70 Series Power Supply Manual** describes the power supply and its interface with a Varian 70 series computer.

The manual is divided into six sections:

- Introduction to the power supply and its relation to the system
- Installation and interface 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	Manual 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
Semiconductor Memory Manual	98 A 9906 04x
Option Board Manual	98 A 9906 05x
Test Programs Manual	98 A 9952 06x

The Varian 70 series power supply provides all the dc power requirements for the processor board, option board, and 32,768 (32K) words of memory (core, semiconductor, or any combination). The regulated dc outputs of the power supply are:

- +5V dc at 40A (logic)
- +5V dc at 5A (memory)
- -12V dc at 15A
- +22.5V dc at 0.6A
- +20V dc at 10A maximum and +20.6V dc at 8A maximum, where the total current for the two outputs is less than 10A

The power supply contains overcurrent-protection circuits that prevent component damage if one or more outputs is shorted, and which return the outputs to normal automatically when the short is removed. The +5V dc and +20V dc outputs are also protected by an overvoltage circuit that provides a low impedance across the terminals when the outputs rise above +6.2V dc and +23V dc, respectively. One circuit breaker protects the power supply from internal overloads or shorts, while another protects it from an overvoltage condition at one or both of the +5V dc outputs.

The power supply can be turned on or off, or placed on standby (HOLD), from the power switch on the computer front panel.

When the power switch on the computer is in HOLD position, the power supply provides only those voltages required to maintain data in the volatile semiconductor memory (if present). Overheating of the power supply causes a processor power shutdown in which the power supply enters the HOLD status and remains there until sufficient cooling permits an automatic return to normal operation.

At the beginning of a power failure or shutdown, the power supply sends a power-failure alarm signal and a delayed system-reset signal to the processor. Following the alarm, a one millisecond energy storage provides power for an orderly shutdown of the computer.

An optional data-saver provides battery power for the maintenance of data in the semiconductor memory during a loss of ac line power.

Table 1-1 lists the specifications of the power supply.

Table 1-1. Power Supply Specifications

Parameter	Specification
Input line voltage	104-130V ac, or 208-260V ac (one second after the application of line power, the input voltage can drop to 100V ac, or 200V ac, without loss of data)
Input line power	1500W maximum
Input line frequency	48-63Hz, single-phase
Regulated dc outputs	+5V dc at 40A (logic) +5V dc at 5A (memory) -12V dc at 15A +22.5V dc at 0.6A +20V dc at 10A maximum and +20.6V dc maximum, where the total current for the two outputs is less than 10A
Voltage-adjustment range	± 5 percent on all dc outputs
Output ripple	Peak-to-peak 0.05V maximum on all dc outputs
Line regulation	10mV dc maximum deviation
Load regulation	Maximum change at output connector
+5V dc (logic) output	50mV for each 10A load change
+5V dc (memory) output	50mV for each 3A load change
-12V dc output	50mV for each 10A load change
+22.5V dc output	50mV for each 100mA load change
+20 and +20.6V dc outputs	50mV for each 5A load change
Short-circuit current limits	
+5V dc (logic) output	15A
+5V dc (memory) output	3.5A
-12V dc output	5A
+22.5V dc output	1A
+20 and +20.6V dc outputs	4A
Direct-current isolation	Minimum 100 megohms from transformer primary to all other windings and to chassis ground
Electromagnetic interference	Over the range 10kHz to 100MHz, minimum 40 db attenuation of ac input noise
Audible noise	Maximum 40 db at 3 feet
Environment	0 to 50 degrees C, 0 to 90 percent relative humidity without condensation
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 nas been inspected and packed to ensure its arrival in good working order. To prevent damaging the power supply take reasonable care during unpacking and handling. Check the shipping list to ensure that all equipment has been received. Immediately after unpacking, inspect the equipment for shipping damage. If any is found:

a. Notify the transportation company.

b. Notify Varian Data Machines.

c. Save all packing material.

2.2 PHYSICAL DESCRIPTION

The power supply is in a chassis 5.25 by 19 by 19 inches (13.3 by 48.3 by 48.3 cm) that is suitable for rack-mounted or table-top installation. Figure 2-1 is a front view, and figure 2-2 a rear view of the power supply.

Use of the lights, circuit breakers, and adjustment screws on the power supply front and rear panels is explained in section 3.

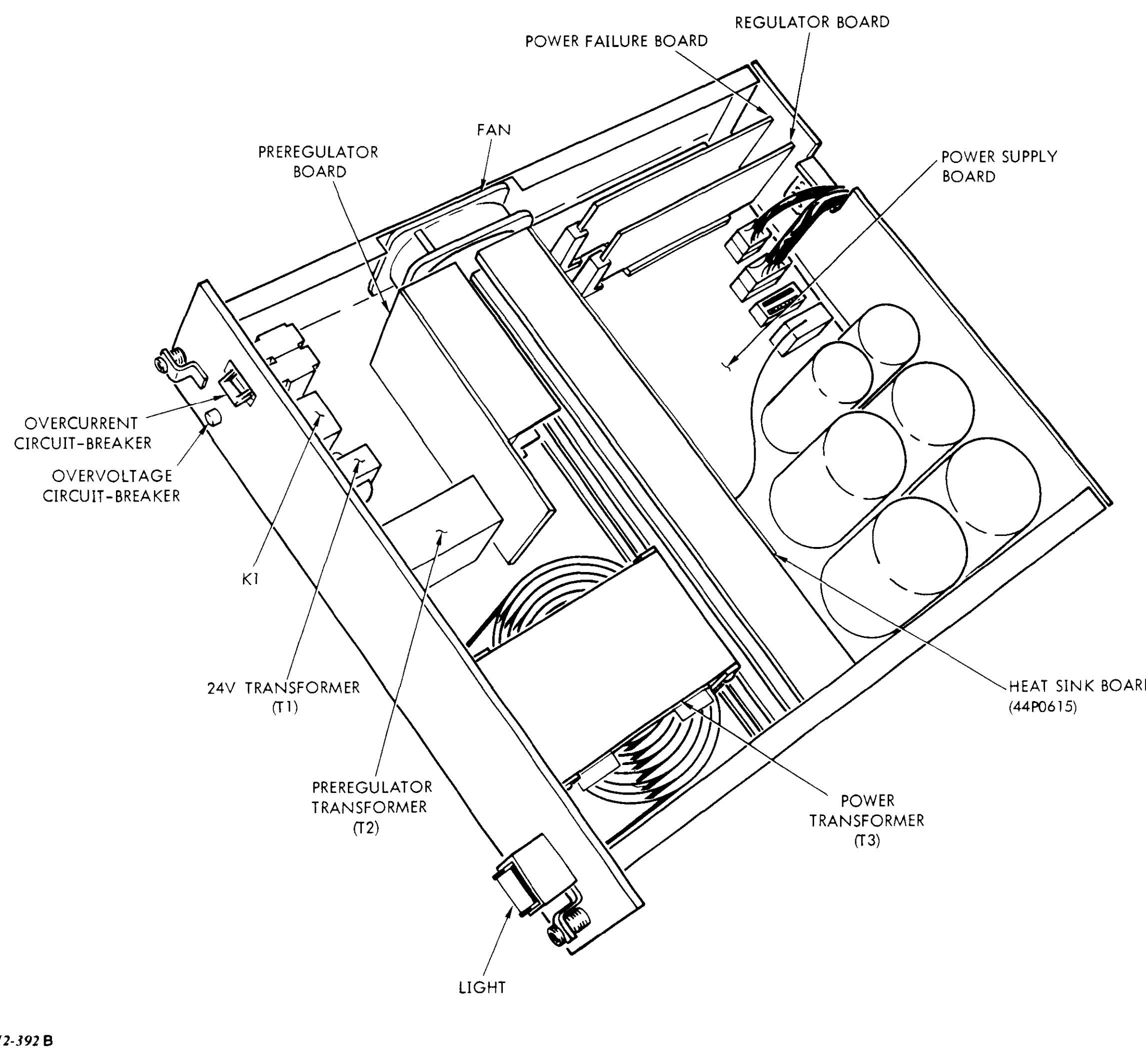

Figure 2-1. Power Supply (Front)

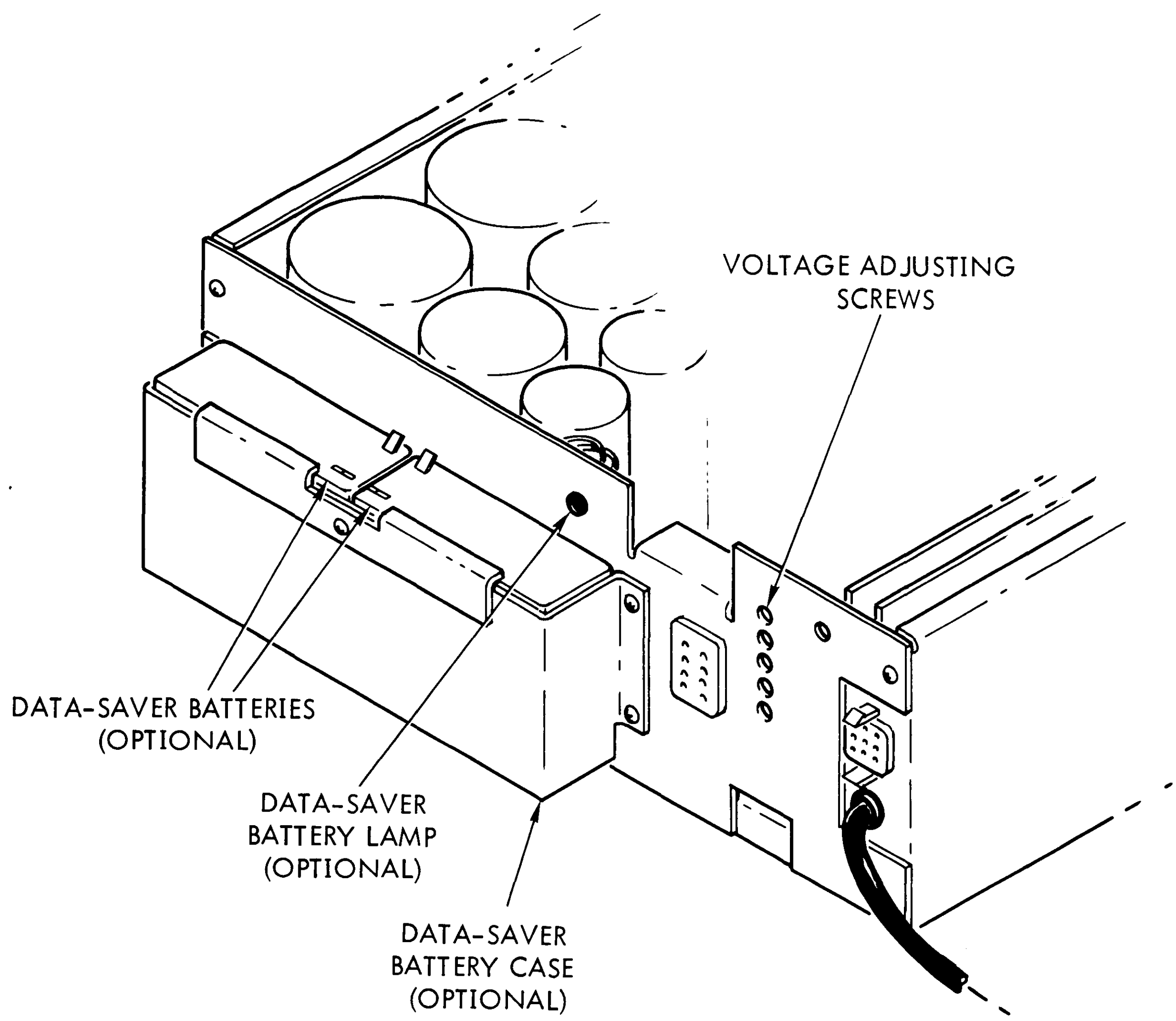

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Figure 2-2. Power Supply (Back)

2.3 LINE VOLTAGE JUMPERS

Figure 2-3 shows the jumper connections required for 115V ac and 230V ac line input operations. These are normally set at the factory for each system, and need be changed only when converting from one voltage to another.

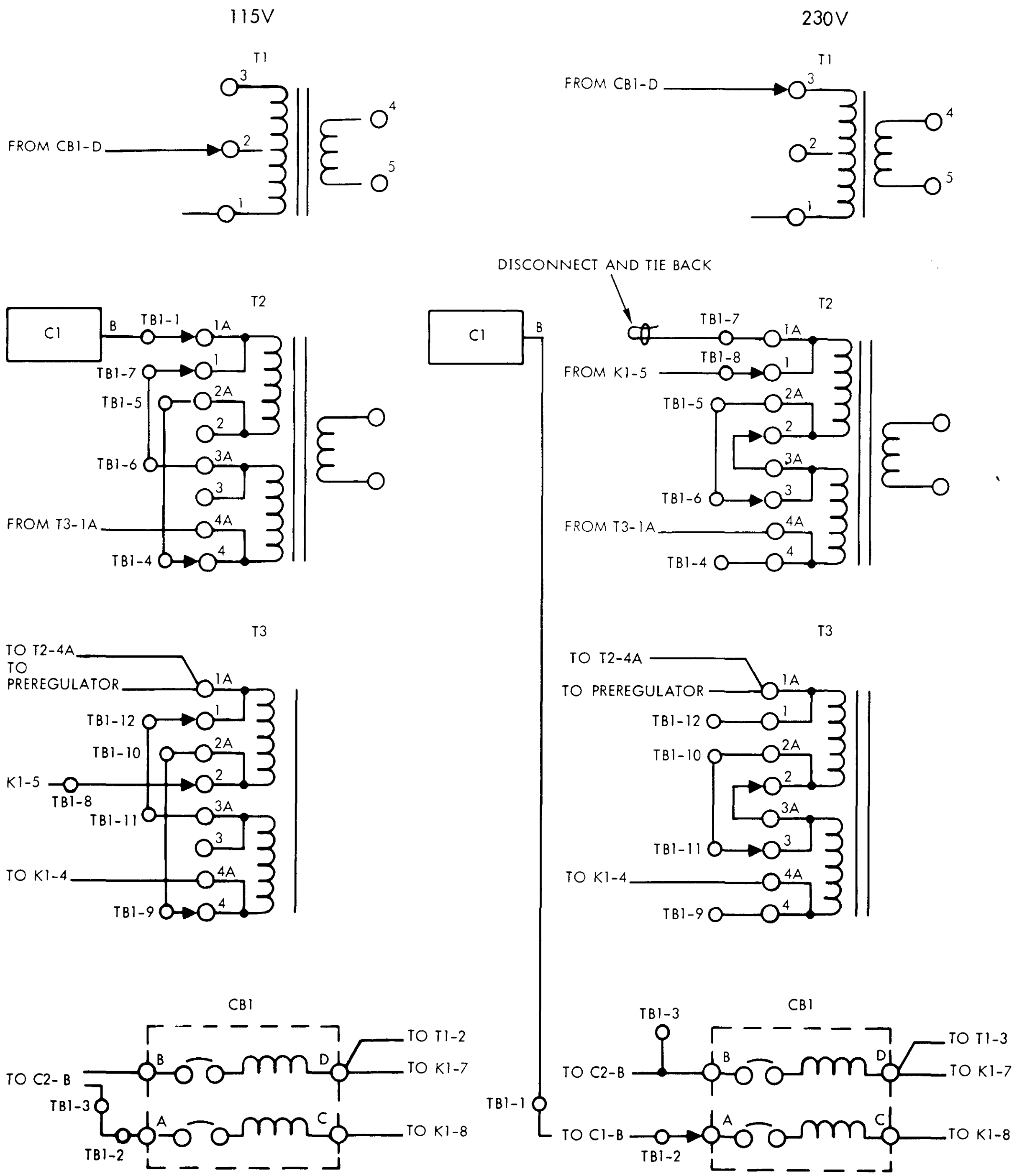

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Figure 2-3. Jumpers for 115V ac and 230V ac Service

2.4 INTERCONNECTION

Figure 2-4 shows typical cable connections. Figure 2-5 shows typical pin assignments for connections between the power supply and the mainframe, between the power supply and an I/O expansion chassis, and between the power supply and a second power supply for additional memory expansion.

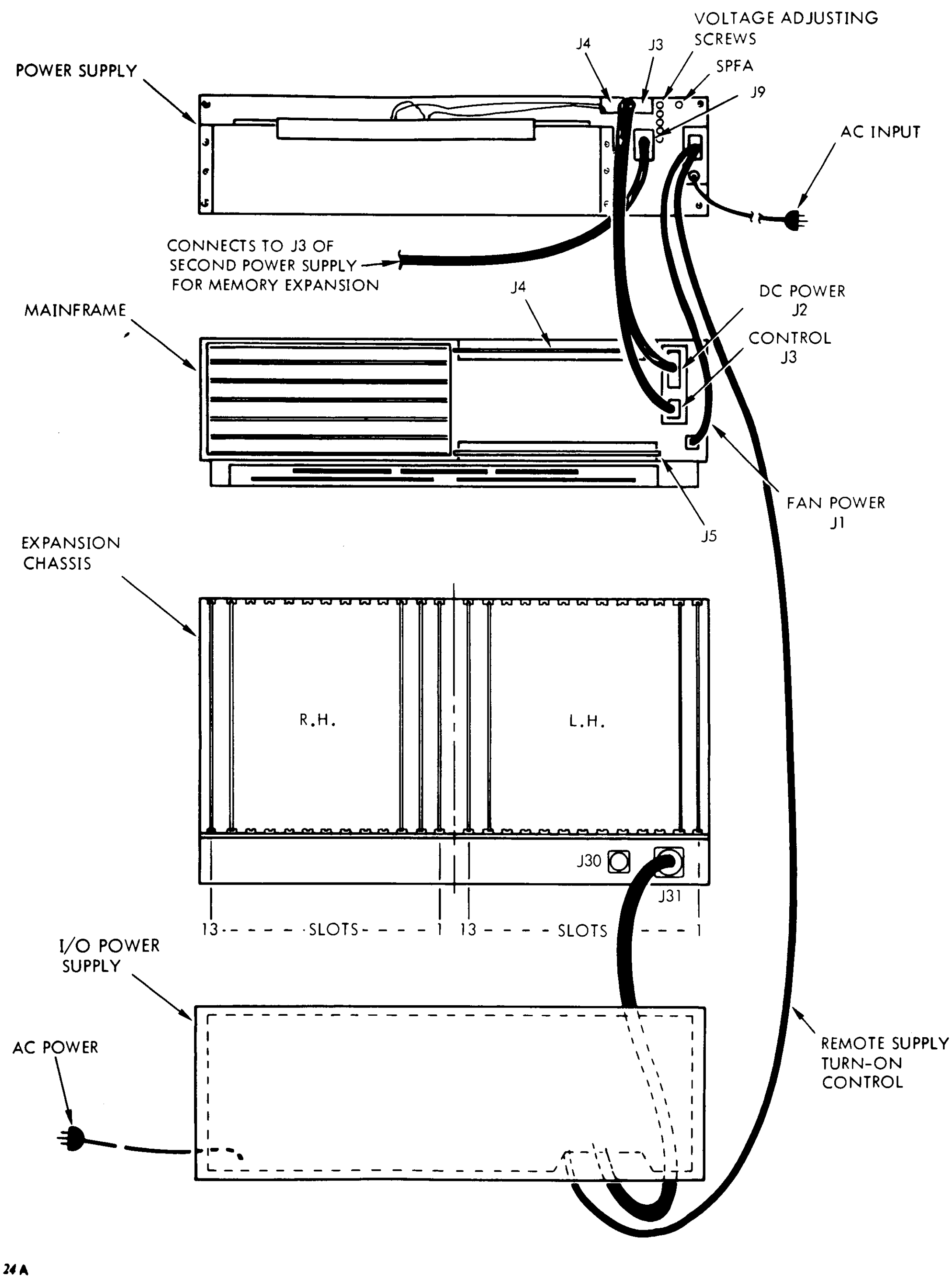

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Figure 2-4. Typical Power-Supply Interconnection

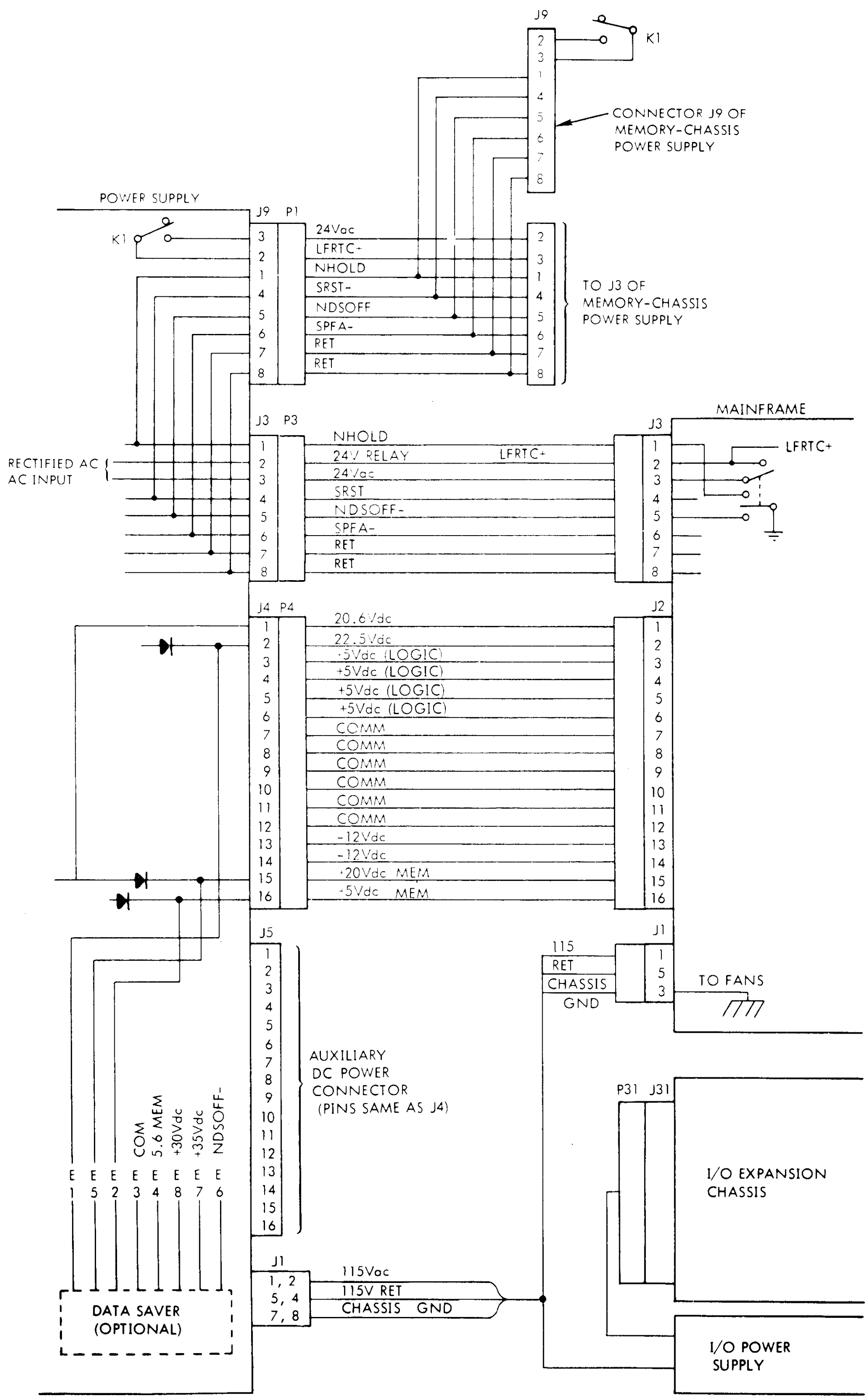

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Figure 2-5. Typical Pin Assignments

2.5 OUTPUT VOLTAGE ADJUSTMENT

The power-supply output voltages are initially factory-adjusted. Subsequent adjustments are made with the potentiometer screws on the rear of the supply (figure 2-2). Voltages are usually set to give the proper readings in the computer mainframe, but can also be read at the power-supply output by using the pins of the power-supply/expansion-chassis connector, J5, permitting readings with the power-supply/mainframe connector J4 under normal system load.

2.6 POWER-FAILURE ALARM ADJUSTMENT

The power-failure alarm is factory adjusted to a threshold of 102V ac input for 115V ac nominal operation, or 204V ac input for 230V ac nominal operation. Because of a two-volt hysteresis, the actual threshold is 100V ac (200V ac). When the input voltage falls below the threshold voltage, the power-failure alarm (section 4.7) activates a routine for shutting down the computer in an orderly manner. The threshold voltage can be adjusted by turning the VOLTAGE SENSE screw on the back of the power supply (figure 2-2).

2.7 DATA SAVER (OPTIONAL)

On a power supply equipped with the optional data-saver there is a light on the rear panel that indicates, when lit, that the data saver is operational and that data in the semiconductor memory will not be lost in case of an ac line-power failure. This light goes out when the data saver cannot provide the necessary voltages to maintain these data, e.g., when the data-saver batteries are discharged.

SECTION 3
OPERATION

There is one light on the front of the power supply. This illuminates when there is power at the output connectors to indicate that the computer is on. It does not indicate ac line input to the power supply.

The front of the power supply also has two circuit breakers. The upper breaker is a toggle switch that trips when there is excessive line current, and that can be used as an ON/OFF switch. The lower breaker is a red button that trips specifically when the silicon-controlled rectifier (SCR, section 4.10) conducts, indicating that one or both of the +5V dc outputs has exceeded +6.2V dc, or that the +20V dc output has exceeded +23V dc.

The back of the power supply has five adjustment screws for setting the output voltages (section 2.5) and one for setting the power-failure threshold voltage (section 2.6). These adjustments are intially made at the factory, but can be changed by following the directions given above.

If the power supply is equipped with the optional data-saver, there is also a light on the back of the supply. This light is on when the data saver is on and functioning. When the data saver is no longer functioning, e.g., because of low batteries, the light goes out, indicating that data in the semiconductor memory has been lost.

SECTION 4
THEORY OF OPERATION

Figure 4-1 illustrates the functional circuits of the power supply.

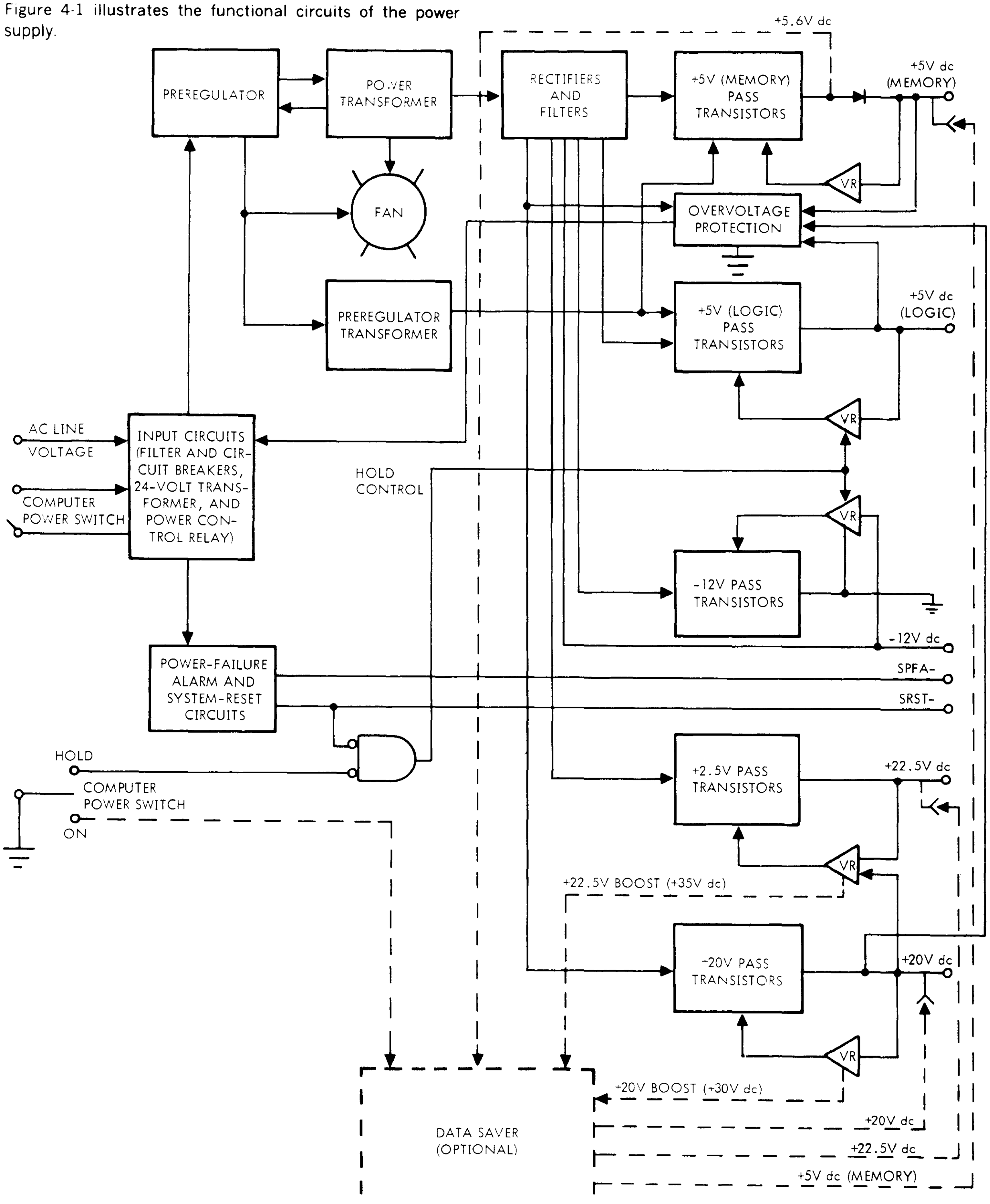

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Figure 4-1. Power Supply Block Diagram

With the power cord plugged in, ac line voltage is applied to the **input circuits** (figure 4-2). When the computer power switch is turned on, the output of the 24V transformer energizes the power control relay, which routes ac line voltage to the **preregulator, preregulator transformer,** and **fan.**

The preregulator increases the efficiency of the power supply by providing the **power transformer** with a uniform, predetermined voltage. The preregulator transformer transfers voltage from the preregulator to the +5V circuits and thus provides a current path to the power transformer when power is first applied. Output voltages from the power transformer pass through **rectifiers and filters** to provide the proper dc voltages for the **pass transistors and regulator circuits**.

Each dc output has its own pass transistors and regulator circuitry. Each regulator monitors the output voltage and provides a control signal to the pass transistors that increases or decreases the controlled current in order to maintain a constant output voltage.

A **power-failure alarm** circuit monitors the voltage of the 24-volt relay coil and generates an alarm signal for the computer if the voltage falls below a certain level. A **system-reset** signal is also generated during a power-up/down sequence. When the computer power switch is in the HOLD position, and the system-reset signal is generated, the **hold control** circuit turns off both the +5V logic output and the -12V output.

The optional **data saver** provides back-up power for the +5V (memory), +20V, and +22.5V outputs during a loss of ac power.

4.1 INPUT CIRCUITS

The input circuits (figure 4-2) consist of **input filters and circuit breakers,** a **24V transformer,** and a **power-control relay** (sheet 1 of schematic 95E0923).

The **ac line voltage** comes to the input circuits through an ac power cable that contains a black wire (hot), a white wire (neutral), and a green wire (chassis ground). Filter capacitors C1 and C2 are connected to the neutral and hot lines to reduce input noise. Resistors R1 and R2 drain the capacitor charge when the power cable is removed from the ac receptacle. Circuit breaker CB1 is connected to the hot line as protection against overloading or shorts within the power supply. As required by Underwriters' Laboratories, for 115V operation, the circuit breaker opens only the black wire; but for 230V operation, the circuit breaker opens both the black and white wires. The circuit breaker actuates when the power supply draws more than 15A ac for 115V operations, or 7.5A ac for 230V operation.

The 24V transformer T1 provides ac line-voltage isolation, allowing the supply to be turned on and off remotely from the computer power switch. The ac is applied to the primary of T1 through CB1. The secondary of T1 produces 24V ac that energizes the power-control relay K1 when the computer power switch is turned on. With the computer power switch turned on, 24V ac are applied across the coil of K1. The energized relay routes the ac line voltage to the preregulator and the primary of power transformer T3 (the transformer primary and the preregulator are in series).

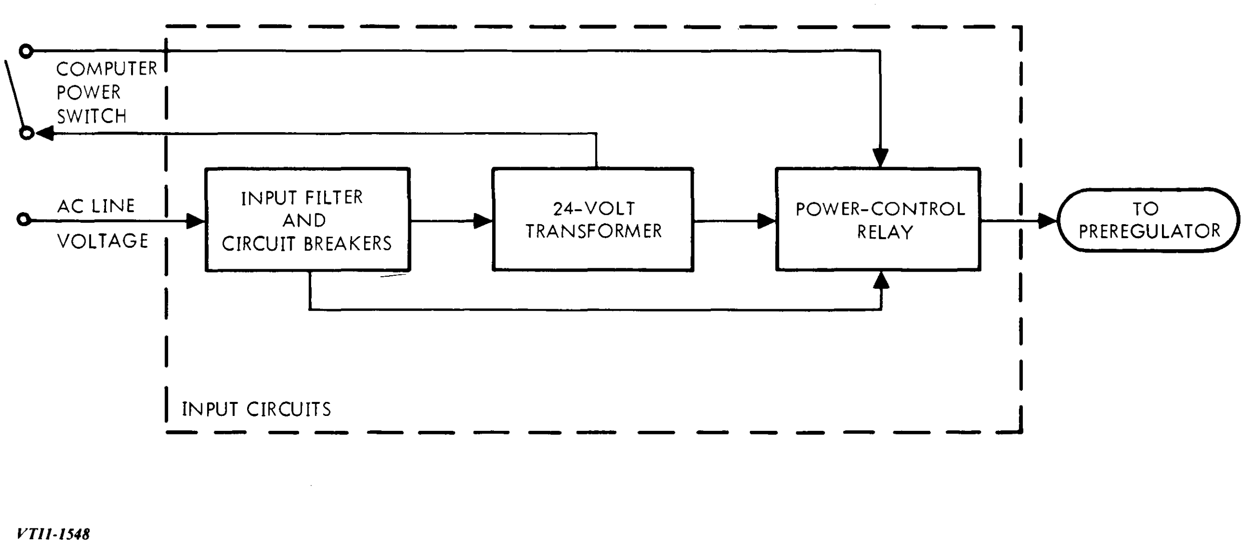

Figure 4-2. Input-Circuit Block Diagram

4.2 PREREGULATOR

The preregulator (figures 4-3 and 4-4) regulates the ac by clipping the positive and negative peaks of the ac line voltage applied to the primary of power transformer T3.

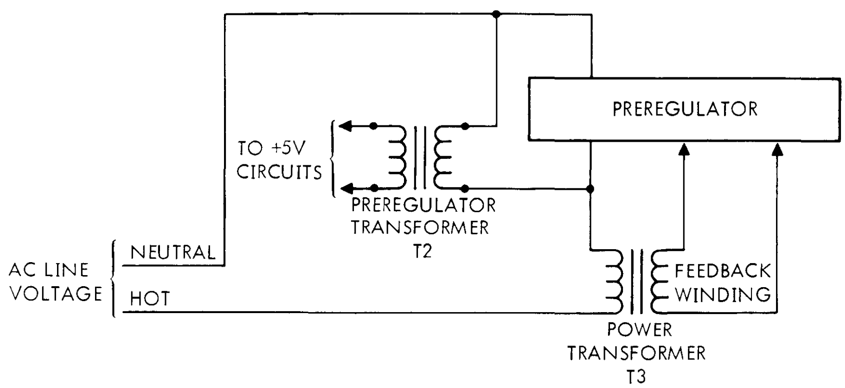

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Figure 4-3. Preregulator Simplified Circuit Diagram

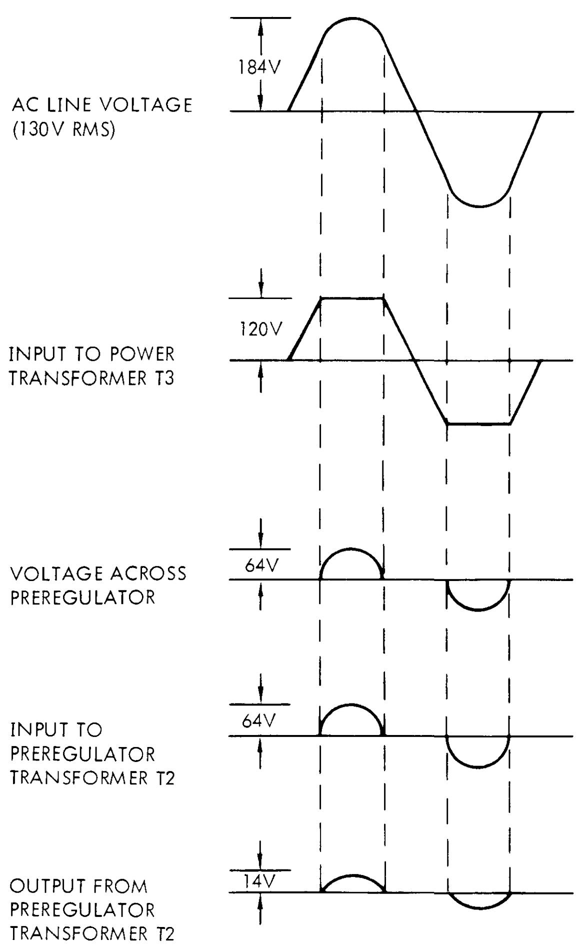

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Figure 4-4. Typical Preregulator Voltage Levels

When the power-control relay is energized, the ac line voltage is connected across the preregulator and power transformer, which are in series. During the unclipped portion of the input sine wave, the preregulator is saturated, causing only a one-volt drop. During the clipped portion, the preregulator impedance varies to maintain a constant voltage across the primary of the power transformer. When the input sine wave has reached its peak, the preregulator impedance is at a maximum, thus providing the necessary voltage drop.

Refer to schematics 95E0923 and 91D0451 during the following circuit descriptions. All current passing through the primary of T3 also passes either through CR9, Q2, Q3, Q6, and Q7 of the preregulator or through preregulator transformer T2. The impedance of Q2, Q3, Q6, and Q7 is controlled by Q4, which in turn is controlled by Q1 and level-detector IC1.

The level-dectector monitors the input line voltage by comparing a rectified voltage with a reference voltage. The rectified voltage comes from a 15V peak signal produced by the feedback windings of T3. This signal is full-wave rectified by CR1, CR3, CR4, and CR5, and divided by R2 and R3. The reference voltage is divided by R5. When the rectified voltage is greater than the reference voltage by a few millivolts, the output of the level-detector conducts, causing Q1 to conduct. With Q1 conducting, the drive current to Q4 is reduced, causing it to conduct less. Then Q2, Q3, Q6, and Q7 provide a higher impedance, causing a higher voltage drop. When the voltage across the preregulator is greater than 22.5V, preregulator transformer T2 begins to supply current to the +5V output, thereby reducing the current through the preregulator.

A delay network consisting of SCR Q5, Zener diode CR7, resistor R15, and capacitor C5 protects transistors Q2, Q3, Q6, and Q7 from heavy current when power is turned on.

The clipping level can be varied by adjusting potentiometer R5.

4.3 PREREGULATOR TRANSFORMER

The preregulator transformer T2 has two functions:

a. Provides a current path to the power transformer when power is first applied.

b. Transfers voltage from the preregulator to the +5V circuits.

When ac power is first applied, the preregulator impedes the flow of ac line current to the primary of power transformer T3. The primary of the preregulator transformer provides a shunt around the preregulator. The preregulator transformer offers a low-impedance path because the discharged +5V filters (C5 through C8 on schematic 95E0941) are a low impedance load for the transformer secondary.

The preregulator transformer produces an output during the clipped portion of the ac line voltage (figure 4-4). The transformer output is full-wave rectified by CR2, and then applied to the +5V filters C5 through C8.

4.4 POWER TRANSFORMER

The energized power-control relay routes the ac line voltage to the primary of the power transformer T3, which is in series with the preregulator (schematic 95E0923). The outputs from the power transformer go to the rectifiers and filters (schematic 95E0941). An additional output provides feedback to the preregulator.

4.5 RECTIFIERS AND FILTERS

The outputs from the power transformer T3 are rectified and filtered to provide the proper dc voltages for the pass transistors and voltage-regulator circuits.

The voltage for the 20V dc circuits originates from pins 10 and 12 of T3, and is full-wave rectified by CR1 (schematic 95D0932). The rectified voltage (approximately 25V peak) is applied to filter capacitor C3 (schematic 95E0941), which reduces the peak-to-peak ripple to 1V at full load.

The voltage for the +5V dc circuits originates from pins 13 through 15 of T3, and is full-wave rectified by CR3 and CR4 (schematic 95D0932). The rectified voltage (approximately 9V peak) is applied to filter capacitors C5 through C8 (schematic 95E0941), which reduces peak-to-peak ripple to 1V at full load.

The voltage for the -12V dc circuits originates from pins 16 and 17 of T3, and is full-wave rectified by CR5 (schematic 95D0932). The rectified voltage (approximately 15V peak) is applied to filter capacitor C9 (schematic 95E0941), which reduces peak-to-peak ripple to 1V at full load.

The +5BOOST signal, which provides operating power for the +5V voltage-regulators, is produced at pin 11 of T3. This is 13.5V dc due to the two diodes of CR1, whose anodes are connected to common. Filter capacitor C4 (schematic 95E0941) reduces peak-to-peak ripple to 0.5V for +5BOOST.

The booster voltages for the +20V and +22.5V regulators originate from pins 7 and 9 of T3. These are full-wave rectified (10V peak) by CR1 through CR4 and filtered by capacitor C1 (schematic 95E0941) producing a 0.5V peak-to-peak ripple.

4.6 PASS TRANSISTORS AND VOLTAGE REGULATORS

A regulator circuit (figure 4-5) is provided for each dc output of the supply. Each regulator circuit contains an integrated circuit (IC) voltage regulator that drives the base of a transistor driver. The driver output is connected to the base of one or more pass transistors on the heat sink board. The pass transistors receive a dc voltage from the rectifier-filter circuits and provide a controlled loss resulting in a regulated output voltage. The loss caused by the pass transistors is controlled by the voltage regulator.

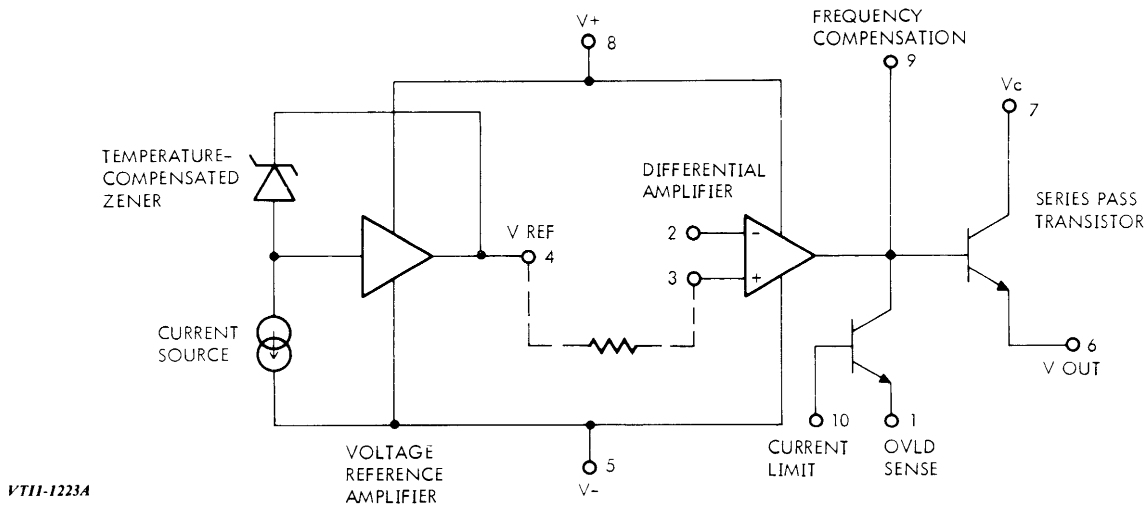

Figure 4-5. IC Voltage-Regulator Block Diagram

The temperature-compensated reference voltage is coupled through an external resistor to the noninverting input at pin 3. The voltage at pin 3 is compared with the regulator output that is fed back to the inverting input at pin 2. The reference voltage is a stable voltage in the range 6.8 to 7.5 dc, depending on the individual IC.

4.6.1 +20V Regulator

The +20V regulator (figure 4-6, and schematic 91D0388) is associated with pass transistors Q1 and Q2 on the heat sink board. The regulator output voltage (20 and/or 20.6V dc) is fed back through an adjustable divider network and is compared with the reference voltage. When the regulator output voltage decreases, current flow increases, causing transistor driver Q2 and pass transistors Q1 and Q2 to conduct more. This results in more output current for the load, causing an increase in output voltage. When the regulator output voltage increases, current flow decreases, causing the transistors to conduct less. This results in less output current for the load, causing a decrease in output voltage.

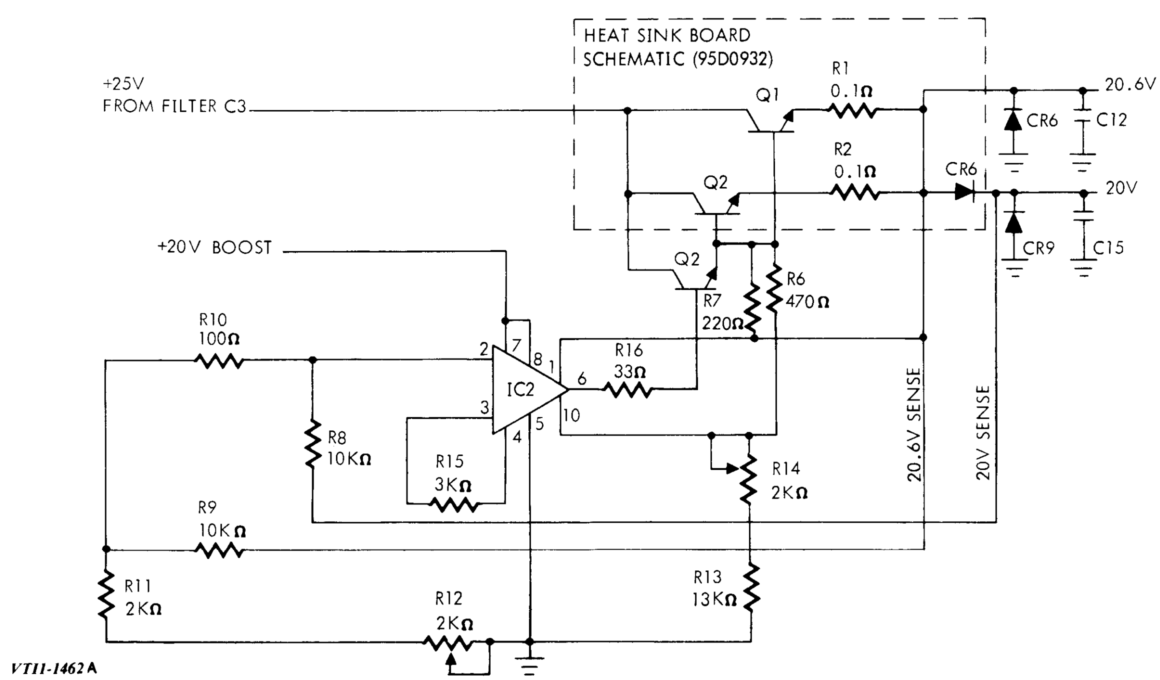

Figure 4-6. +20V dc Regulator

Overcurrent protection is provided by a voltage divider R6, R13, and R14. A portion of the voltage between ground and the base of the pass transistors is tapped off by the divider network. The tapped voltage is subtracted from the output voltage since the current is flowing through the base-emitter junction and emitter resistor of the pass transistors. Under normal loading conditions, the voltage between pins 1 and 10 of IC2 is 0.6V or less. During an overcurrent condition (approximately 12A), +0.7V is produced at IC2-10 with respect to IC2-1, causing a reduction in drive current. When the output terminal is shorted to ground, the pass-transistor base voltage (with respect to ground) is low and very little voltage is tapped off by the divider network. This results in a foldback-current (figure 4-7) that limits the output load current to approximately 4A.

Potentiometer R12 allows adjustment of the regulator output voltage. Potentiometer R14 provides an overcurrent adjustment for control of the amount of load current required to produce an overcurrent condition. Capacitors C12 and C15 provide energy storage for load transients. Diodes CR6 and CR9 provide reverse voltage protection.

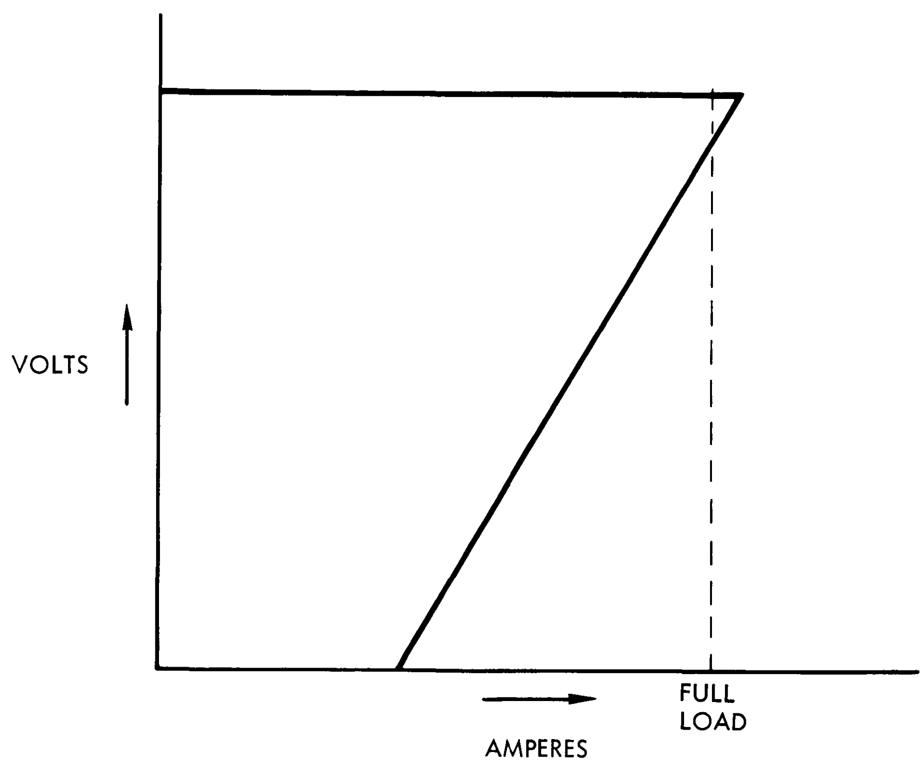

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Figure 4-7. +20V dc Foldback Overcurrent Curve

4.6.2 +5V (Logic) Regulator

The +5V (logic) regulator (figure 4-8, and schematic 91D0388) is associated with pass transistors Q4 through Q7 on the heat sink board. The regulator output voltage (5V OUT) is fed back to IC4-2 and is compared with the reference voltage at IC4-3. The reference voltage is divided down to +5V by the voltage divider R33, R35, and R38. The regulator operates in the same manner as the +20V regulator (section 4.6.1). IC4 monitors the regulator output voltage and provides the appropriate drive current to transistor drivers Q4 and Q3, which in turn drive pass transistors Q4 through Q7.

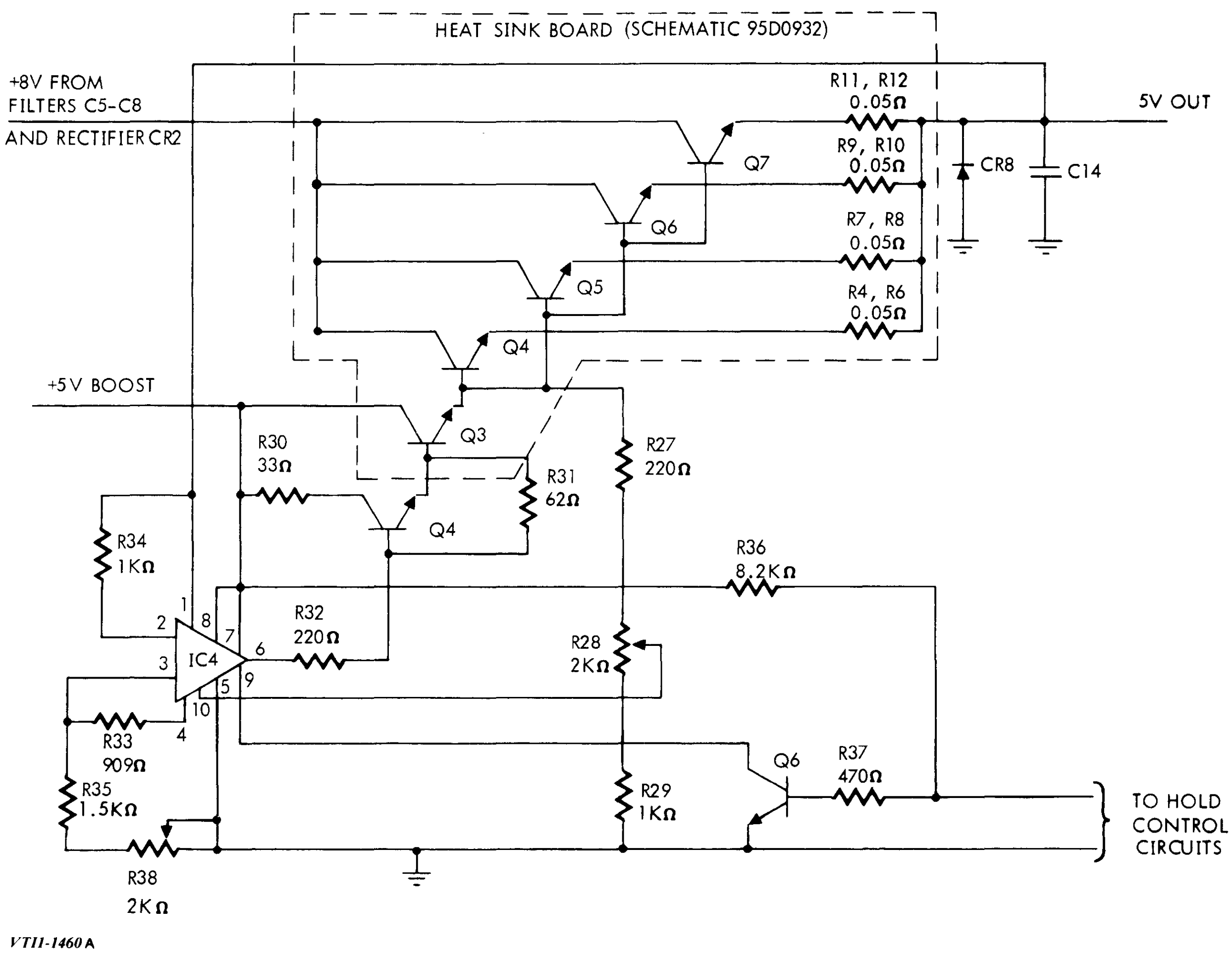

Figure 4-8. +5V (Logic) Regulator

Overcurrent protection is provided by a voltage divider R27, R28, and R29. The voltage between pins 1 and 10 of IC4, under normal loading conditions, is 0.6V or less. During an overcurrent condition (approximately 45A), IC4-10 is 0.7V more positive than IC4-1, causing a reduction in drive current at IC4-6. With a full load (40A) at the output, approximately 1.44V are dropped across the base-emitter junction and emitter resistors of the pass transistors to produce the 0.7V. Of the 1.44V dropped across the base-emitter junction, 0.84V is tapped off by the voltage divider and applied to pin 10 of IC4. This produces 0.6V between pins 1 and 10 of IC4. If the +5V output terminal gets shorted to ground, very little current flows through the voltage divider, resulting in little or no voltage at pin 10 of IC4. This increases the voltage drop between pins 1 and 10 of IC4, causing an overcurrent condition. A short circuit is defined as a flow of approximately 15A through the shorted load.

When the computer power switch is in HOLD, Q6 conducts and turns IC4 off. This gives a regulator output of 0.5V dc.

Potentiometer R38 allows adjustment of the regulator output voltage. Potentiometer R28 provides an overcurrent adjustment for controlling the amount of load current required to produce an overcurrent condition. Capacitor C14 provides energy storage for load transients, and diode CR8 provides reverse voltage protection.

4.6.3 +5V (Memory) Regulator

The +5V (memory) regulator operates in the same manner as the +5V (logic) regulator except it has no transistor for the hold function. The +5V (memory) regulator (schematic 91D0388), which includes IC3 and Q3, drives one pass transistor Q8 on the heat sink board. Potentiometer R26 is the regulator voltage adjustment.

4.6.4 -12-Volt Regulator

The -12V regulator (figure 4-9, and schematic 91D0388) is associated with pass transistors Q9 and Q10 on the heat sink board. The major difference from the positive-voltage regulators is that pin 5 of C5 is connected to the output voltage, and the emitters of the pass transistors are grounded. The -12V dc output is monitored at IC5-2 through a voltage divider consisting of R48, and R49. The monitored voltage should be +5V dc. The reference voltage from IC5-4 is also divided down to +5V dc by voltage R50 and R51, and is applied to IC5-3.

With +5V dc at IC5-2 and IC5-3, the IC regulator produces at pin 6 an output current that allows the pass transistors to pass sufficient current to the load to maintain a -12V dc output.

Overcurrent protection is provided in the same manner as in the +5V (logic) regulator. The overcurrent voltage divider for the -12V regulator consists of R40, R41, and R42.

When the computer power switch is in HOLD position, Q7 conducts. This turns off IC5 resulting in a regulator output of approximately -0.5V dc. Potentiometer R50 allows adjustment of the regulator output voltage. Potentiometer R41 provides an overcurrent adjustment that controls the amount of load current required to produce an overcurrent condition. Capacitor C10 provides energy storage for load transients, and diode CR5 provides protection against reverse voltage.

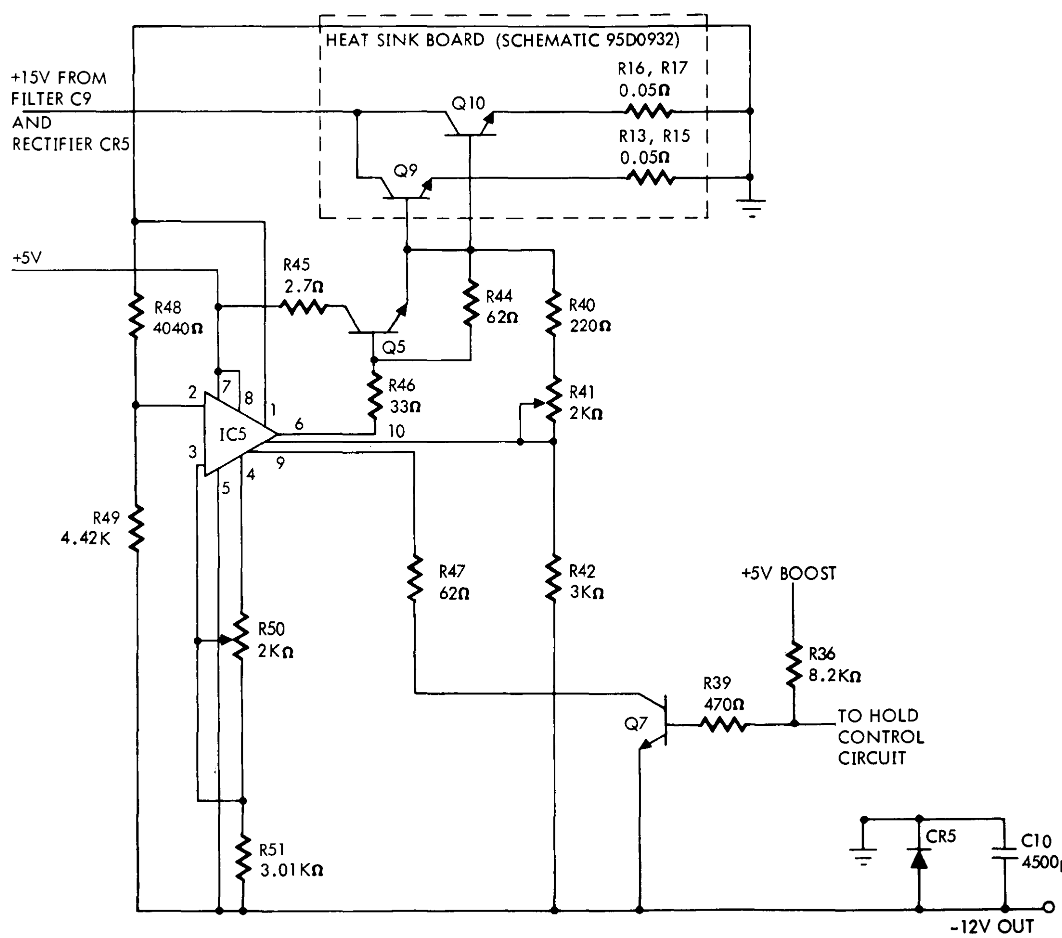

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Figure 4-9. -12V Regulator

4.6.5 +22.5V Regulator Circuit

The +22.5V regulator (figure 4-10, and schematic 91D0388) is associated with pass transistor Q1. The common terminal (IC1-5) of this circuit is connected to +20V dc instead of ground. Thus, the produced voltage is +2.5V dc with respect to +20V dc, resulting in a regulated +22.5V dc output with respect to power-supply ground.

The circuit operates like the +20V regulator except that during an overcurrent condition it enters a constant-current mode. During an overcurrent condition (approximately 0.8A), IC1-10 is 0.7V more positive than IC1-1, causing the +22.5V dc output to drop to +20V dc.

Potentiometer R5 allows adjustment of the regulator output voltage, capacitor C15 provides energy storage for load transients, and diode CR9 prevents reverse voltage.

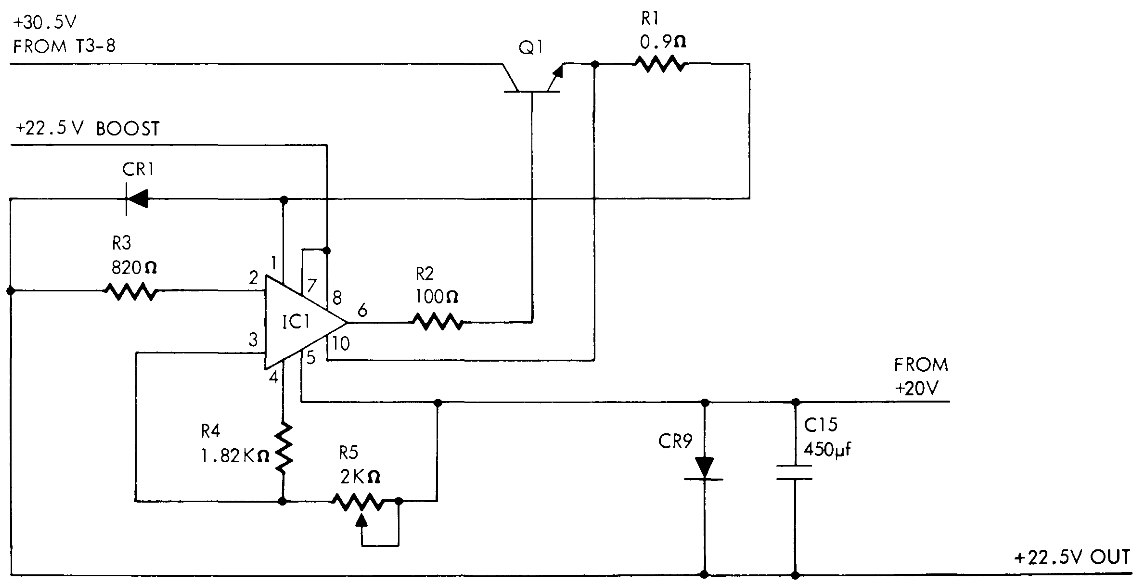

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Figure 4-10. +22.5V Regulator

4.7 POWER-FAILURE ALARM AND SYSTEM RESET

The power-failure alarm circuit (schematic 91D0387) monitors the output of the 24-volt transformer and, if the voltage falls below a certain level, generates SPFA- (system power failure alarm). SPFA- (figure 4-11 and table 4-1) enables a computer power-down sequence to occur when ac power is removed. SPFA- is true (low):

a. During a power-up sequence, SPFA- remains low for approximately 200 milliseconds after the ac line voltage reaches 102V ac (204V ac for nominal 230V ac input).

b. During a power-on condition, if the ac line voltage falls below 100V ac (200V 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 input signals to the power failure alarm circuit are fullwave rectified by CR1 through CR4 and filtered by C1. A portion of this dc voltage is sensed at IC1-3 where it is compared with a reference voltage at IC1-2. When the ac line voltage rises above 102V ac (204V ac), the voltage at IC1-3 is greater than the reference voltage at IC1-2, causing current flow at IC1-6. The current flows through R8 and charges C3. After approximately 200 milliseconds, C3 charges to the breakdown voltage of CR6, causing Q2 to conduct and Q3 to turn off. The 5V at the collector of Q3 is transferred through voltage divider R16 and R17 to the base of Q4. After a delay of 100 microseconds (caused by C4), Q4 turns on and Q5 turns off, resulting in SPFA- high (+5V dc).

When the ac line voltage is removed or falls below 100V ac (or 200V ac for nominal 230V ac input), the voltage at IC1-3 is less than the reference voltage at IC1-2 causing no current to flow at IC1-6. This immediately turns on Q3 and Q5 resulting in SPFA- low.

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 occured (16 milliseconds). When SPFA- is low (IC1-3 more negative than IC1-2), no current flows from 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.

THEORY OF OPERATION

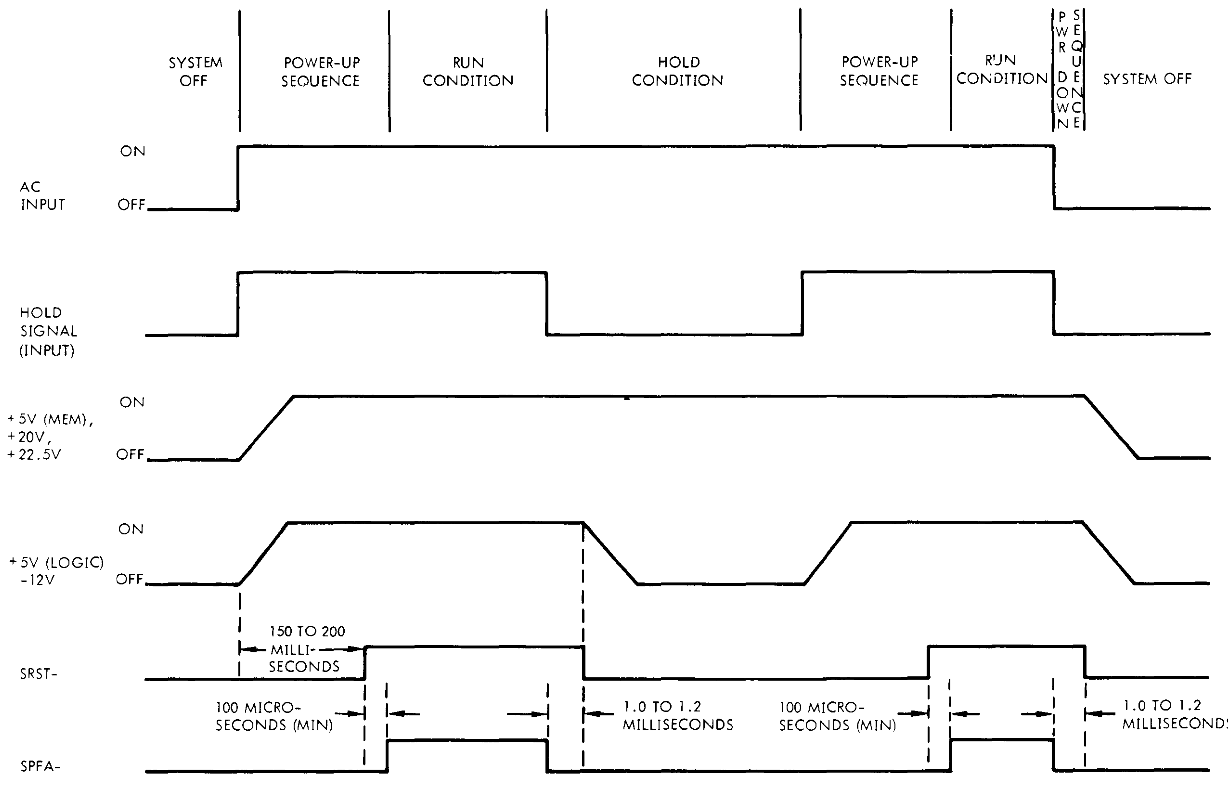

Figure 4-11. Power-On/Off Timing

Table 4-1. Power-Failure Alarm Characteristics

Parameter	Power-Failure Alarm (SPFA –)	System Reset (SRST-)
Power-up sequence	Maximum 0.2V dc until at least 100 micro-seconds after SRST –	Maximum 0.2V dc for 150-200 milliseconds after ac input reaches threshold voltage (normally 102V ac for nominal 115V ac, or 204V ac for nominal 230V ac operation)
Rise time	Maximum 200 nanoseconds	Maximum 200 nanoseconds
RUN mode	Minimum 4.5V dc	Minimum 4.5V dc
HOLD mode	Maximum 0.2V dc	Maximum 0.2V dc (drops from RUN mode value 1.0 to 1.2 milliseconds later than SPFA –)
Power-down sequence	Drops to a maximum of 0.2V dc less than 0.5 microsecond after ac input drops below threshold voltage	Drops to a maximum of 0.2V dc 1.0 to 1.2 milliseconds later than SPFA –
System OFF	Maximum 0.2V dc	Maximum 0.2V dc

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.

During power-down, the collector of Q3 goes low and C5 discharges through CR8 causing Q6 to stay on for approximately one microsecond, allowing the one-shot to assume control. The negative transition produced by Q3 is applied to the one-shot, causing it to generate a one millisecond pulse. This positive pulse is applied through R26, keeping Q6 and Q7 off. After the one-millisecond delay, Q6 turns off and Q7 turns on. This deenergizes relay K2 causing SRST – to go low (SRST – is connected to ground signal RETRST –).

4.8 HOLD CIRCUIT

The hold circuit turns off the +5V (logic) regulator and the -12V regulator one millisecond after the computer power switch is placed in HOLD.

When the computer power switch is placed in HOLD, a low HOLD signal (figure 4-11) is applied through CR11, CR19, and CR13 turning Q9 off. The low HOLD signal is also applied through CR12 to IC1-3, causing SPFA – to go low immediately and SRST – to go low after one millisecond. When SRST – goes low, Q8 turns off. Both Q8 and Q9 are now turned off, (HOLD CONTROL line goes high), which turns on Q6 and Q7 on the regulator board (schematic 91D0388). This turns off the +5V (logic) and -12V regulators.

When the hold signal is removed (HOLD goes high), Q9 turns on immediately, allowing the +5V and -12V to rise to their regulated outputs. SPFA – and SRST – go to the computer after a delay of approximately 200 milliseconds. This ensures that the voltages are within operating tolerances prior to the beginning of data processing.

4.9 OVERVOLTAGE PROTECTION

The overvoltage protection circuit (located on the power failure alarm and heat sink boards) protects the loads of the +5V (logic and memory) and +20V outputs against high voltages. The overvoltage protection circuit (figure 4-12), which is diode coupled to the +5V and +20V outputs, consists of a zener diode (CR17) and transistor circuit that drives a silicon-controlled rectifier (SCR). If one of the +5V or the +20V output exceeds +6.2V dc and +23V dc, respectively, the overvoltage protection circuit provides a low impedance across the outputs (5V MEM, 5V LOGIC, and 20V OUT) thus reducing them to approximately one volt.

Under normal conditions (outputs are +5V and +20V), CR17 operates as a reversed-biased diode to provide a high impedance that prevents Q10 from conducting. If an output voltage exceeds +6.2V dc (or 23V dc), CR17 goes into avalanche mode that allows enough current flow through R35 to start Q10 conducting. With Q10 conducting, the voltage developed at the junction of R36 and R37 triggers the SCR (Q11), which provides a low impedance across the output terminals. When Q11 conducts, current passing through CB2 breaks the contacts at terminals 6 and 7. This interrupts power to relay K1 which, in turn, removes power to the supply. To restore power, it is necessary to activate the red button (of CB2) on the front panel.

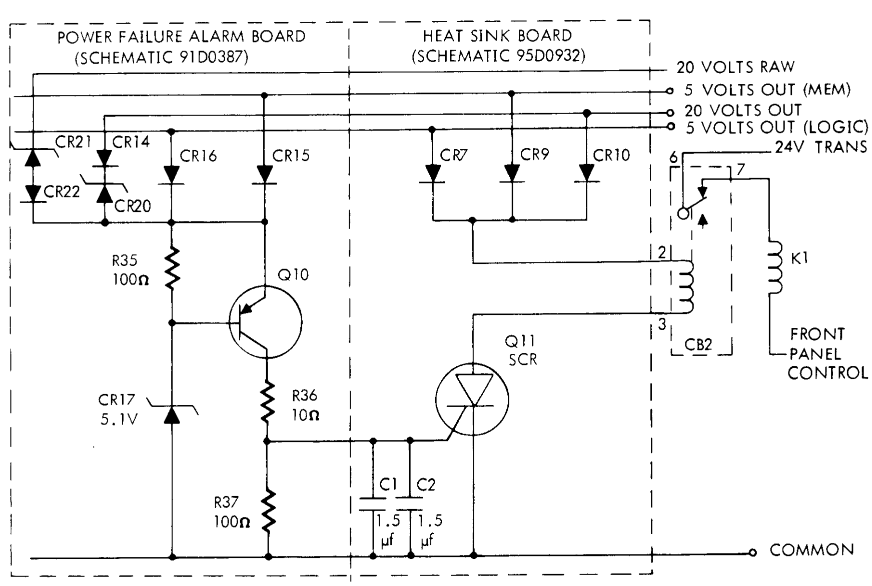

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Figure 4-12. Overvoltage Protection Circuit

4.10 DATA SAVER (OPTIONAL)

A power supply with the optional data-saver has the normal rear panel replaced with a data-saver panel. This panel is the rear panel of the power supply with the data-saver components mounted on the inside and the batteries in their holder mounted on the outside. Table 4-2 gives the specifications of data saver.

The electrical interface between the data saver and the power supply consists of a series of quick-release connectors (E1, E2, etc.) that plug into the supply just inside the rear panel.

The data saver provides the low-current voltages necessary to maintain (refresh) the data in semiconductor memory when the ac line input drops below the predetermined threshold voltage. The batteries are recharged through the circuitry associated with IC1, which provides a constant current until the batteries are fully charged, then acts as a voltage regulator to maintain the batteries with a trickle charge. Inputs to this circuit are +30V (E2, the +20BOOST from the power supply) and +35V (E1, the +22.5BOOST from the power supply).

The lamp (DS1) on the back of the power supply is lit as long as the data-saver batteries have sufficient charge to maintain the semiconductor memory. When the batteries are discharged, the light goes out and data are lost. The light comes on when the batteries reach 24V and remains on until they discharge to less than 21V.

The circuitry associated with IC1 and IC2 produces +5V dc at 0.75A, +20V dc at 0.2A, and +22.5V dc at 0.05A when the ac input drops below the threshold voltage. In this case, the +5.6V dc input from the power supply (at E12) drops, causing a rise in the +5V dc data-saver output at E11, and vice versa. Thus, when the +5.6V dc input is high, pin 2 of IC3 is greater than pin 3 and the data saver is off (low).

The data-saver +5V dc output can be adjusted at R24, and the +20V dc (and +22.5V dc) output can be adjusted at R29. When the computer power switch is OFF, NDSOFF – is at ground and the data saver is inactive.

Table 4-2. Data-Saver Specifications

Parameter	Specifications
Dimensions	3 by 4.5 by 12 inches (7.5 by 11.5 by 30.5 cm)
Adjustable Voltage Range	+5V dc: ±5 percent +20V dc: ±5 percent
Ripple	1.0 percent maximum peak-to-peak
Transient response	Output voltage returns to within dc *load* specification within 50 microseconds for 50 percent load change (maximum deviation 0.150V for a transient of 30 percent change in load/microsecond)
Input voltages	+30± 1V dc at 0.5A +35± 3V dc at 0.1A
Load regulation (50 percent load change)	+5V dc: 50mV maximum, at 0 to .75A +20V dc: 120mV maximum, at 0 to .2A +22.5V dc: 120mV maximum, at 0 to .05A
Total regulation (combined effects of ripple, transient loads, dc loading from 0 to 100 percent, changes in line voltage and frequency, long-term stability and all other sources)	+5V dc: ±5 percent +20V dc: ±10 percent +22.5V dc: ±10 percent

Table 4-2. Data-Saver Specifications *(continued)*

Overvoltage limit (+5V dc only)	+5.7V dc to +7.5V dc
Short-circuit currents	+5V dc: Less than 1A +20V dc: Less than 2A +22.5V dc: Less than 0.1A
Overload protection	Electronic current-limitation with automatic recovery
Ambient temperature (without forced-air cooling)	0 to 55 degrees C

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SECTION 5
MAINTENANCE

Maintenance personnel should be familiar with the contents of this manual before attempting troubleshooting. Maintenance of the power supply consists of preventive and corrective procedures.

5.1 PREVENTIVE MAINTENANCE

Clean the unit by blowing out dust and dirt with an air hose. Remove objects that may have fallen into the power supply. If these are under the power-supply board, they can usually be removed by tilting the unit on end.

With the power supply unplugged and deenergized, remove the top cover and the regulator and power-failure boards. Inspect the boards for oxidized contacts and clean as required with a good contact cleaner. Allow the cleaner to dry before replacing the boards. While the boards are out, inspect the connector contacts, cable connectors, and subassembly plugs and connectors for dirt, corrosion, and proper mating. Clean and straighten as required.

Inspect the power cables to ensure that they are not under abnormal tension in any direction.

The only power-supply devices that should show any symptoms of wear are the power-control relay and the fan.

The relay has a dust cover and does not normally require preventive maintenance. However, if the contacts are blackened, clean them with a good contact cleaner and/or a fine-toothed burnishing tool. **CAUTION:** Ensure that power is removed prior to cleaning the contacts.

The fan is factory-lubricated for life and requires no maintenance. If the fan slows down or stalls due to bearing wear, replace it. However, first ascertain that the abnormal operation is not due to some other cause, such as obstruction of the blades, loose or disconnected fan cable, or lack of ac power.

CAUTION: Do not operate the power supply in RUN mode without the fan. It can be so operated in HOLD mode with proper attention to the presence of high voltages.

5.2 CORRECTIVE MAINTENANCE

Incorrect dc voltage readings do not always indicate a malfunctioning power supply. This condition could be caused by a short in the load (such as in the processor or memory).

As an aid in isolating malfunctions within the power supply, table 5-1 lists resistance checks that can be made at the power cable connector (when disconnected from the mainframe). Refer to section 2 for power cable pin assignments. If the output resistance of a single power-supply regulator is greatly different from the table value, the fault is likely to be in that regulator. If all such resistance readings are correct, examine the portions of the power supply prior to the output section (raw dc).

Table 5-2 indicates symptoms of particular faults and the corrective measures required. Unlisted faults require a good knowledge of the power supply for correction. Become familiar with the theory of operation (section 4) and try to isolate the fault to a particular section, and further reduce the possibilities to the component level by resistance and voltage checks.

Voltage adjustments are performed as described in section 2.

Table 5-1. Power-Supply Plug Resistance Checks

+5V dc (logic) to ground	27 ohms
+5V dc (memory) to ground	150,000 ohms
-12V dc to ground	100 ohms
+20V dc to ground	3,000 ohms
+20.6V dc to ground	3,000 ohms
+22.5V dc to ground	50,000 ohms
+24V ac to ground	1,500 ohms
NHOLD to ground	12,000 or 1,000 ohms
SPFA – to ground	120 ohms
SRST – to ground	120 ohms

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 in the on condition, 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. Overvoltage-protection circuit breaker (CB2) tripped.	Check circuit breakers on power-supply front panel. Disconnect power cable from mainframe. Connect a jumper between pins 2 and 3 of cable connector P3 (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 (T1), power relay (K1), and associated wiring.
As above except that front panel light is on.	Preregulator not operating, or power transformer primary open.	Check voltages across power transformer (T3) primary and across preregulators.
No outputs from +5V dc (logic) or -12V dc regulators. Others OK.	Processor power switch in HOLD, or power supply overheated and the heatsink thermostat therefore closed, or +5V dc (logic) regulator faulty.	Ensure that power switch is not in HOLD. If not, check heat sink temperature. Check fan and air passages. If OK, check +5V dc (logic) regulator.
No outputs from +22.5V dc, +20.6V dc, or +20V dc regulators. Others OK.	+22.5V dc and +20V regulator drive voltages not getting to regulator board.	Rectifiers CR1 through CR4 suspect, therefore check capacitors C1 and C2 for shorts (schematic 95E0941).
+ 5v dc (logic) output is 2-3V dc, +5V dc (memory) output is 1V dc, -12V dc output is low, +20V dc output is either OK or intermittent.	Overvoltage protection SCR Q11 is on due to failure of either +5V dc regulator, or to external intermittent short to +20V dc.	Turn processor power switch OFF, then back ON. If problem remains, replace regulator board. Check SCR Q11 (schematic 95D0932) for short.
Circuit breaker CB1 trips when processor power switch is turned on.	Short in power section, heat sink, or power-supply board (problem not prior to power relay).	SCR Q11 short should trip overvoltage-protection circuit breaker. Remove both heat-sink board (44P0615) connectors and connector between transformer T3 and power-supply

Table 5-2. Fault Isolation Techniques *(continued)*

Symptoms	Fault	Action
		board (44P0617). Turn processor power switch ON. If breaker trips, fault is in input circuits. If breaker does not trip, replace connectors (with power OFF) one at a time starting with heat sink. After each connection, turn processor power switch ON. When circuit breaker trips, fault is in last unit connected.
-12V dc output is low. Others OK.	External jumper not connected on regulator board.	Check resistance between pins 20 and 21 of regulator-board connector P1. If the jumper is properly installed, the resistance should be zero. If jumper is OK, replace the regulator board.
All regulated outputs OK. SPFA – and SRST – both low.	Power-failure alarm threshold (104V ac or 208V ac) not set properly, or low input power.	Check power line and threshold adjustment. If OK, replace power-failure alarm board.
All regulated outputs OK. Only SPFA – low.	External short on SPFA – or faulty power-failure alarm board.	Check SPFA – with ohmmeter. If OK, replace power-failure alarm board.
All regulated outputs OK. SPFA – high, SRST – low.	External short on SRST –, or faulty power-failure alarm board.	Check SRST – with ohmmeter. If OK, replace power-failure alarm board.
Exceptional ripple on any one regulated output, others OK (120Hz or 100Hz).	External load at current limit, or faulty main filter capacitor of affected regulator.	Check current limit by rotating overload potentiometer clockwise. If ripple decreases, external load is too high (return potentiometer to previous setting). If ripple unchanged, check connection to filter capacitor. Replace capacitor if faulty.

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 faulty transistor.
Output of any regulator except +5V dc (logic) and +5V dc (memory) high.	Shorted regulator or pass transistor.	Check regulator output transistor with ohmmeter. Replace regulator board.
Input voltages to all regulator pass transistor higher than normal.	Shorted preregulator.	Remove power first, then check preregulator pass transistors and rectifier bridge. If faulty, replace entire preregulator board.

SECTION 6
MNEMONICS

This section describes the power-supply signal mnemonics.

Mnemonic	Description
AC	Alternating current
CT	Center tap
DC	Direct current
HOLD –	Signal from computer power switch (low HOLD – signal causes the power supply to operate in the hold condition)
NDSOFF –	Goes low when data saver is inactive
LFRTC –	Line-frequency real time clock
OCP	Overcurrent protection
OVP	Overvoltage protection
PFAC	Input signal of power-failure alarm circuit
SPFA –	System power failure alarm (low SPFA – goes to the computer during a power failure or shutdown)
SRST –	System reset (low SRST – goes to the computer during a power failure or shutdown)
24V ac	Line from 24V transformer output to external power switch

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