UNIVAC

77 System Power Supply

Model 77-406x

Operation and Service

SPERRY UNIVAC®

77 SYSTEM POWER SUPPLY
MODEL 77-406X; P/N 0102020-000/003/005
OPERATION AND SERVICE MANUAL

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CHANGE RECORD

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When changes occur to this manual, updated pages are issued to replace the obsolete pages. On each updated page, a vertical line is drawn in the margin to flag each change and a letter is added to the page number. When the manual is revised and completely reprinted, the vertical line and page-number letter are removed.

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LIST OF EFFECTIVE PAGES

Page Number	Change in Effect
all	new manual
all	complete revision

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual describes the SPERRY UNIVAC 77 System Power Supply. The manual is comprised of six sections:

- o General Description - An introduction to the manual and an overview of the system, including a list of important features and specifications.
- o Installation - A discussion of general installation considerations, including physical description and interface information.
- o Operation - A discussion of operating controls and indicators.
- o Theory of Operation - A functional description of the memory system with timing and block diagrams.
- o Maintenance - A discussion of general maintenance considerations.
- o Mnemonics - An alphanumeric listing of signal mnemonics with their definitions.

Logic diagrams, schematics, and parts lists pertinent to the system power supply are included in the system documentation package. This documentation is assembled just prior to when a computer system is shipped and reflects the configuration of that particular system.

Reference manuals pertinent to the 77-200/400 memory are listed below with their corresponding document numbers.

Title	Document Number*
77-200 System Reference Manual	98A 9906 42x
77-400 System Reference Manual	98A 9906 41x
77-600 System Reference Manual	98A 9906 40x
V70 Series Architecture Reference Manual	98A 9906 00x

*The character x represents the revision number, which is in the range 0 through 9.

1.2 DESCRIPTION

The 77 System Power Supply provides power and voltage required by the 77 series of computers. The power supply is modular in design and contained in a chassis measuring 5.25 inches high by 19.5 inches wide by 19.5 inches deep and mounts in a standard 19-inch rack. The power supply is designed to supply a wide varity of power requirements. Its flexibility is due to the modular design of the power supply. The basic power supply consists of a chassis, front panel, and an ac power board. Various power modules are added to meet specific system requirements. Available power modules consist of a +5V dc logic supply, a +5.2V dc and +12V dc memory supply, a +12V dc data communications supply, and a data save (battery) supply. The basic power supply chassis contains power control and power failure alarm circuits, RFI filter, and transient suppressors and provides four module spaces into which the power modules are installed.

Two standard preconfigured modules of the system power supply are available. Model 77-4060 contains one 100 ampere logic power module and one memory power module capable of supporting up to 256K words of semiconductor memory. Model 77-4061 contains one 100 ampere logic power module, one memory power module, and one data communications power module which provides power for up to 32-lines. The system designer may utilize one of the preconfigured models or may specify a power supply tailored to his specific applications by installing the individual power modules required. Figure 1-1 shows a typical power supply configuration.

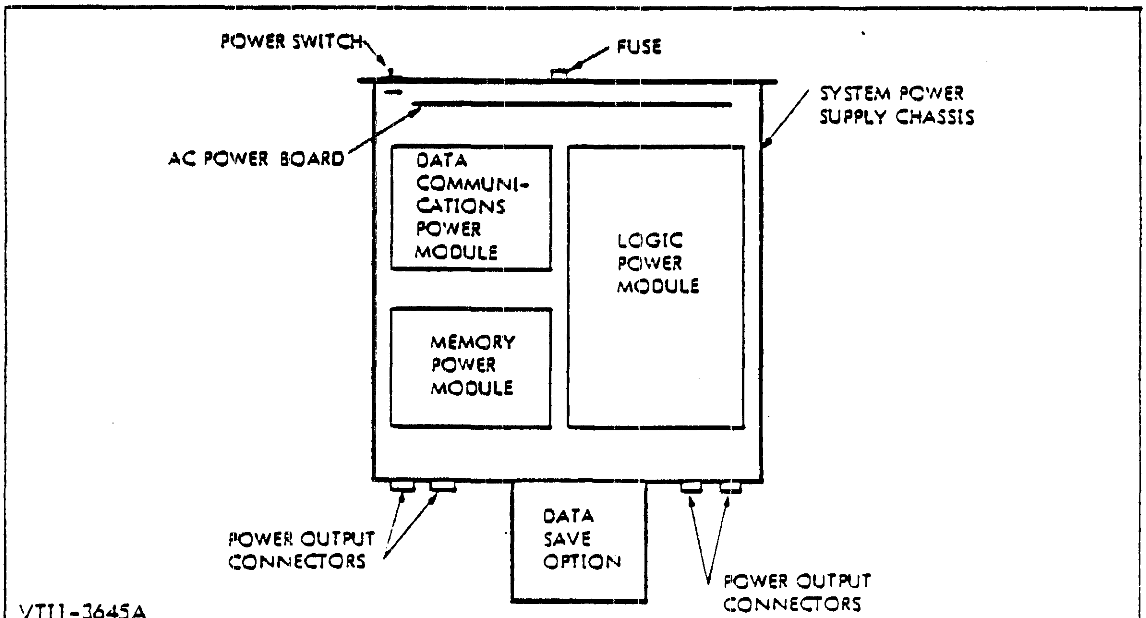

Figure 1-1. System Power Supply Typical Module Configuration

Each of the System Power Supply modules is a self-contained supply which obtains its primary power from the ac power board located at the front of the power supply chassis. Model 77-4066 logic power modules provides +5V dc at 100 amperes for the computer processor and I/O controllers. The logic power modules utilize two module spaces. Model 77-4067 memory power module provides +5.2V dc at 6 amperes and +12V dc at 4 amperes. The memory power module utilizes one module space. Model 77-4068 data communications power modules provides +12V dc at 1.2 amperes and -12V dc at 1.4 amperes. The data communications power module utilizes one module space. In addition to the power modules, a data save option is available. The data save (batteries) mount externally to the rear panel. The data save circuitry provides temporary power to the computer memory if a power failure occures.

The System Power Supply includes the following features:

The power supply chassis includes a RFI filter, power ON-OFF switch, fuse, transient suppressors, and an ac power board. The ac power board includes the ac power control circuit, power fail detection and power failure alarm circuits, and a current loop power supply.

Over-voltage/Overcurrent Protection. Circuits in the individual modules prevent damage to computer circuits and power supply circuits from over-voltage and/or overcurrent. The data communications modules has no over-voltage protection.

Alarm Circuit. An alarm circuit generates a signal when loss of input power or deterioration of input power occurs. This alarm signal enables a computer power fail/restart sequence to occur. After a power failure is detected, the system power failure signal is delayed permitting the computer to prevent loss of currently processed data prior to shutdown. The computer will then utilize this alarm signal to achieve an orderly shutdown.

Remote Control. The power supply employs a remote control feature which allows the power supply to be powered-up or powered-down by computer control. A hold mode allows the logic power to be turned off while memory power is maintained. The power supply provides an output control which can be connected to additional power supplies so that one computer control can remotely control any number of power supplies.

Data Save Option. When installed, the data save feature in conjunction with the power failure alarm feature prevents loss of data by maintaining the memory power. Batteries are switched in, maintaining the memory power output voltage. The batteries will maintain 256K of N-MOS memory for a minimum of 1.5 hours. The batteries are maintained in a charged condition by the memory power supply.

Adjustable Modules. The logic supply module and memory supply module are adjustable by controls located on the rear panel connector plate. The data communications circuits do not require precision power voltages, thus the data communications power module is not adjustable.

Specifications for the System Power Supply are listed in table 1-1. Specifications for the power modules are listed in tables 1-2 through 1-4.

Table 1-1. System Power Supply Specifications

Parameter	Specification
Input voltage	104 to 132V ac.
Input current (max)	15 amperes full load (with two logic power modules installed).
Input frequency	47 to 63 Hz.
Power on/off switch	Turns off all output power, including data save power. Switch is mounted on the front of the power supply chassis and overrides remote turn-on and hold.
Remote turn-on (24V ac, LFRTC)	Remote switch closure turns on power supply. Remote switch contact rating: 24V ac at 2 amperes maximum.
Remote hold (NHOLD)	Remote switch closure to ground turns on memory supply and fans. Remote switch contact rating 30V dc at 25 milliamperes.
Data-save (NDSOFF)	Switch closure to ground turns off battery backup of memory supply. Switch contact rating 30V dc at 100 milliamperes.

Table 1-1. System Power Supply Specifications (continued)

Parameter	Specification
Weight	60 lbs (27.2 Kg) maximum without data save option. 65 lbs (29.5 Kg) maximum with data save option.
Dimensions	5.25 inches high by 19.5 inches wide by 19.5 inches deep (133 by 483 by 495 mm) without data save option. Data-save adds 6.62 inches (168 mm) to depth.
Operational environment	0 to 50 degrees C (32 to 122 degrees F) at sea level; 0 to 35 degrees C (32 to 95 degrees F) at 14,000 feet (4.27 km) altitude; 0 to 90 percent humidity without condensation.

Table 1-2. Logic Power Module (77-4066) Specifications

Parameter	Specification
Type	Off line switching supply.
Input	102 to 132V ac, 47 to 63 Hz, at 7 amperes maximum.
Output	Adjustable from +4.5 to +5.25V dc at 100 amperes maximum.
Regulation (line and load)	20 millivolts from one-half load to full load.
Ripple	50 millivolts peak-to-peak maximum.
Cooling	By internal fan
Energy storage	6 milliseconds minimum at full load and low line.
Dimensions	Two module spaces: 5 inches high by 8 inches wide by 12 inches deep (127 by 203 by 305 mm).

Table 1-3. Memory Power Module (77-4067) Specifications

Parameter	Specification
Type	Transformer and switching regulators.
Input	102 to 132V ac, 47 to 63 Hz, at 1.8 amperes.
Output	+12V dc at 4 amperes, +5.2V dc at 6 amperes.
Regulation (line and load)	20 millivolts no load to full load.
Ripple	100 millivolts peak-to-peak maximum.
Cooling	From chassis fan. 100 fpm minimum.
Dimensions	One module space: 5 inches high by 8 inches wide by 5.25 inches deep (127 by 203 by 133 mm).

Table 1-4. Data Communications Power Module Specifications

Parameter	Specification
Type	Transformer and series regulators.
Input	102 to 132V ac, 47 to 63 Hz, at 3 amperes maximum.
Output	+12V dc ±5% at 1.2 amperes. -12V dc ±5% at 1.4 amperes.
Ripple	10 millivolts peak-to-peak maximum.
Regulation (Line and load)	20 millivolts no load to full load.
Cooling	From chassis fan, 100 fpm minimum.
Dimensions	One module space: 5 inches high by 8 inches wide by 5.25 inches deep (127 by 203 by 133 mm).

SECTION 2
INSTALLATION

2.1 INSPECTION

The 77 System Power Supply has been packed and inspected to ensure its arrival in good working order. To prevent damage, take 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. Ascertain that wires and cables are neither loose nor broken, and that hardware is secure. If damage exists:

a. Notify the transportation company.

b. Notify Sperry Univac.

c. Save all packing material.

2.2 INSTALLATION

The power supply is 5.25 inches high, by 19 inches wide, by 19.5 inches deep and installs into a standard rack. The data save option, when installed, utilizes a battery pack which adds an additional 6.62 inches to the depth of the power supply.

2.2.1 Module Installation

Two standard preconfigured models of the system power supply are available, but a total of 21 configurations are possible utilizing the three power supply modules and the fan modules. The +5V dc logic supply requires two module spaces. The +5.2V dc and +12V dc memory supply, and the ±12V dc data communication supply require one module space each. The basic chassis is designed to accept any combination of modules. The logic supply is installed using holes marked B, the memory supply is installed using holes marked D, and the data communications is installed using holes marked E.

The logic supply contains a built-in fan module, however the memory supply and the data communications supply require the addition of fan modules when installed. Figure 2-1 in conjunction with table 2-1 shows the combinations of module installations possible. Figure 2-1C shows the model 77-4060 preconfiguration and figure 2-1E shows the model 77-4061 preconfiguration.

Table 2-1. System Power Supply Configuration

Figure 2-1 Reference	Model No.	Modules Required				
		LPM 77-4066	DCPM 77-4068	MPM 77-4067	Fan	Blank Pannel
A		1	-	-	-	2
B		2	-	-	-	-
C	77-4060	1	-	1	1	1
D		1	-	2	1	-
E	77-4061	1	1	1	1	-
F		1	1	-	1	1
G		1	2	-	1	-
H		-	-	1	1	3
I		-	-	2	1	2
J		-	-	3	2	1
K		-	-	4	2	-
L		-	1	-	1	3
M		-	2	-	1	2
N		-	3	-	2	1
O		-	4	-	2	-
P		-	1	1	1	2
Q		-	1	2	2	1
R		-	1	3	2	-
S		-	2	1	2	1
T		-	2	2	2	-
U		-	3	1	2	-

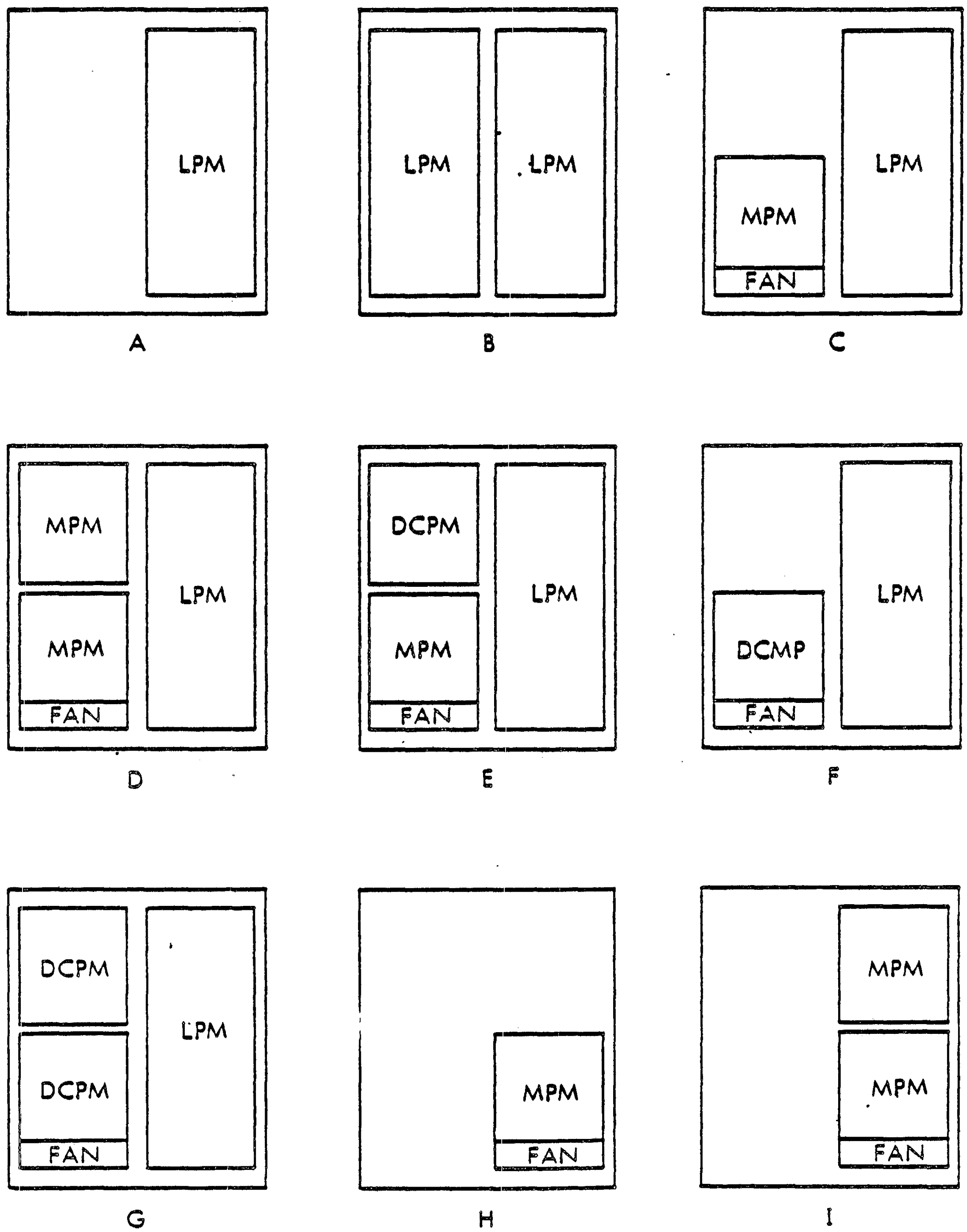

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Figure 2-1. System Power Supply Configuration

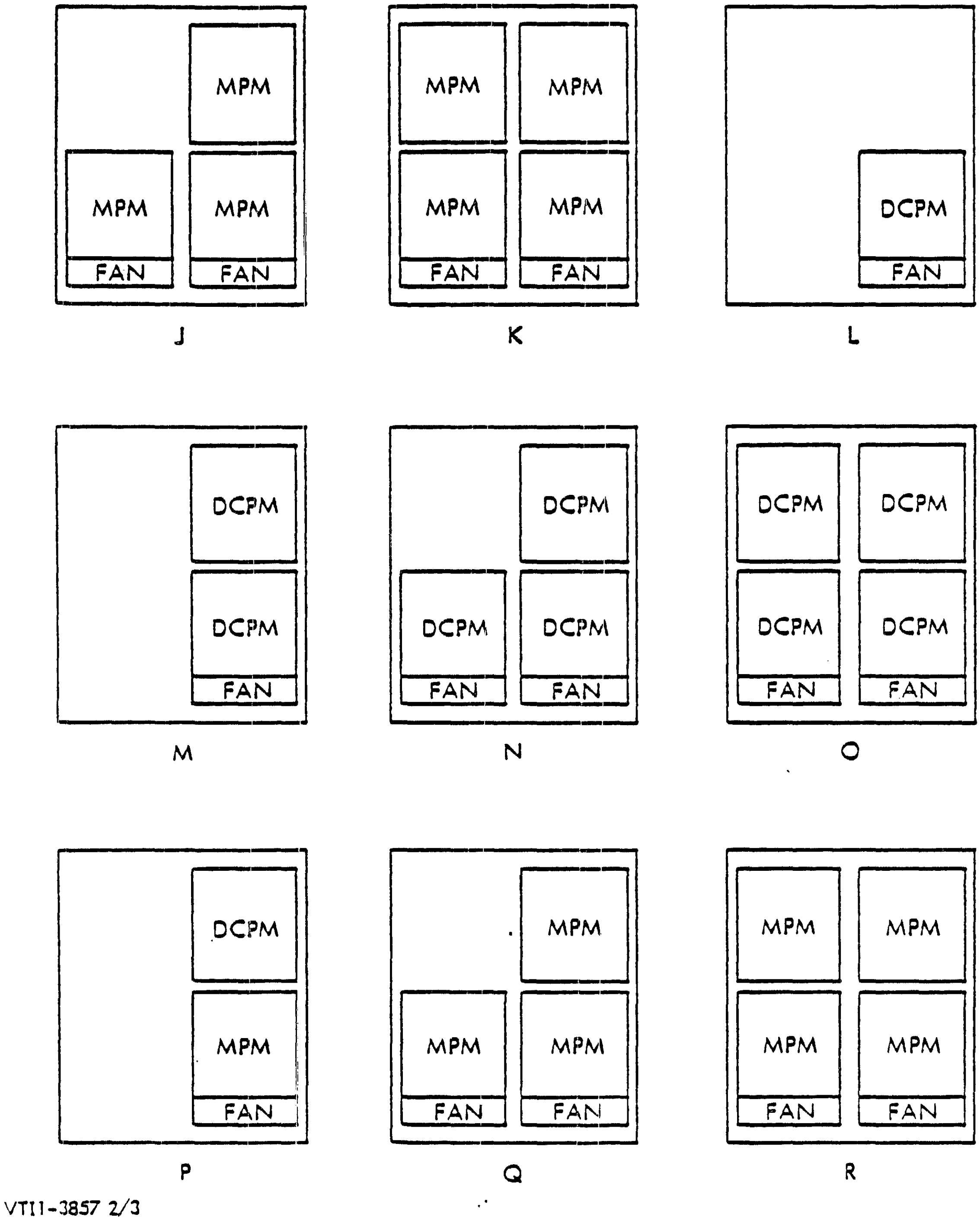

Figure 2-1. System Power Supply Configuration (continued)

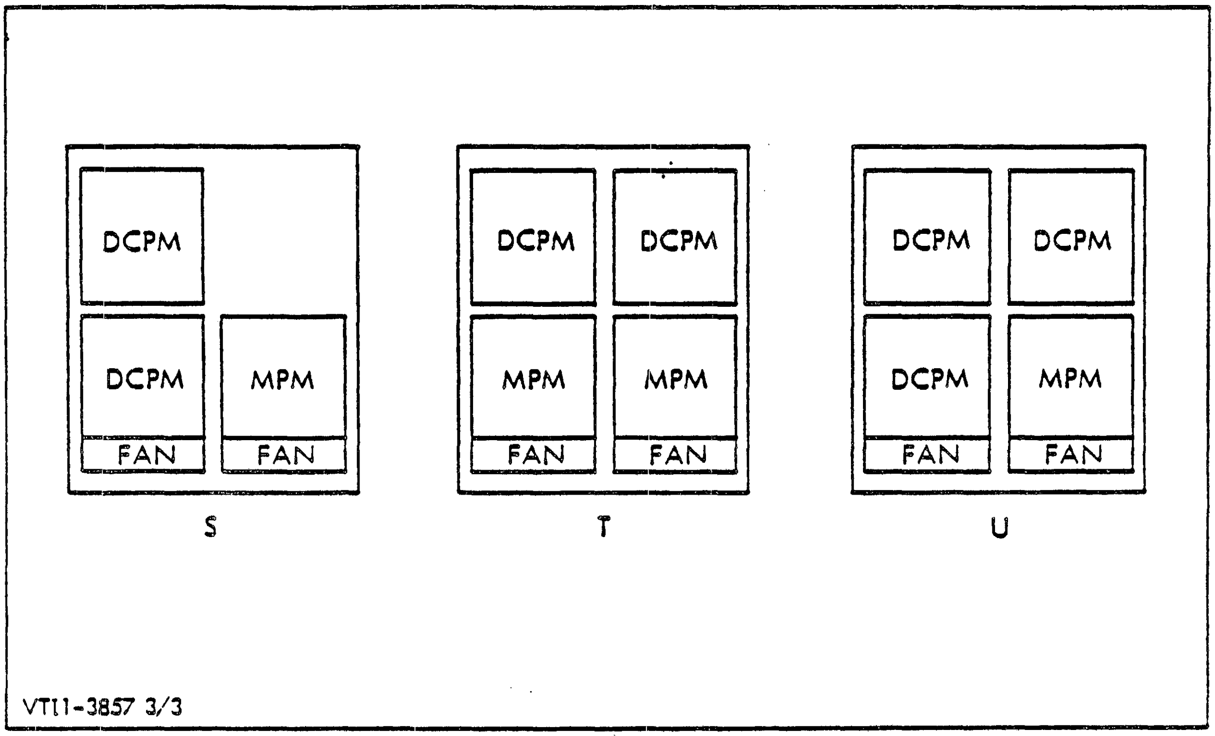

Figure 2-1. System Power Supply Configuration (continued)

2.2.2 Power Interface

Power modules and fan modules receive 117V ac power from J1 through J7 on the ac power board. dc power output are provided on connector plates mounted on the rear panel. Each power module utilizes its own connector plate. In power supply configurations where some connector plate positions are not used, a blank connector plate is installed in the unused position(s). Figure 2-2 shows a typical rear panel configuration.

A power cable connects each power module to its connector plate. Each power module output is terminated in bulkhead mounted connectors. Potentiometers mounted on the connector plates provide adjustment of the output power for the logic power module and the memory power module. The data communications power module is not adjustable. Connectors J8 through J15 are permanently mounted on the rear panel and provide interface as follows: J8, turn-on control for expansion supply; J9, ac power board remote control input; J10 power detect; J11, current source-power fail; J12 through J15, system fan power.

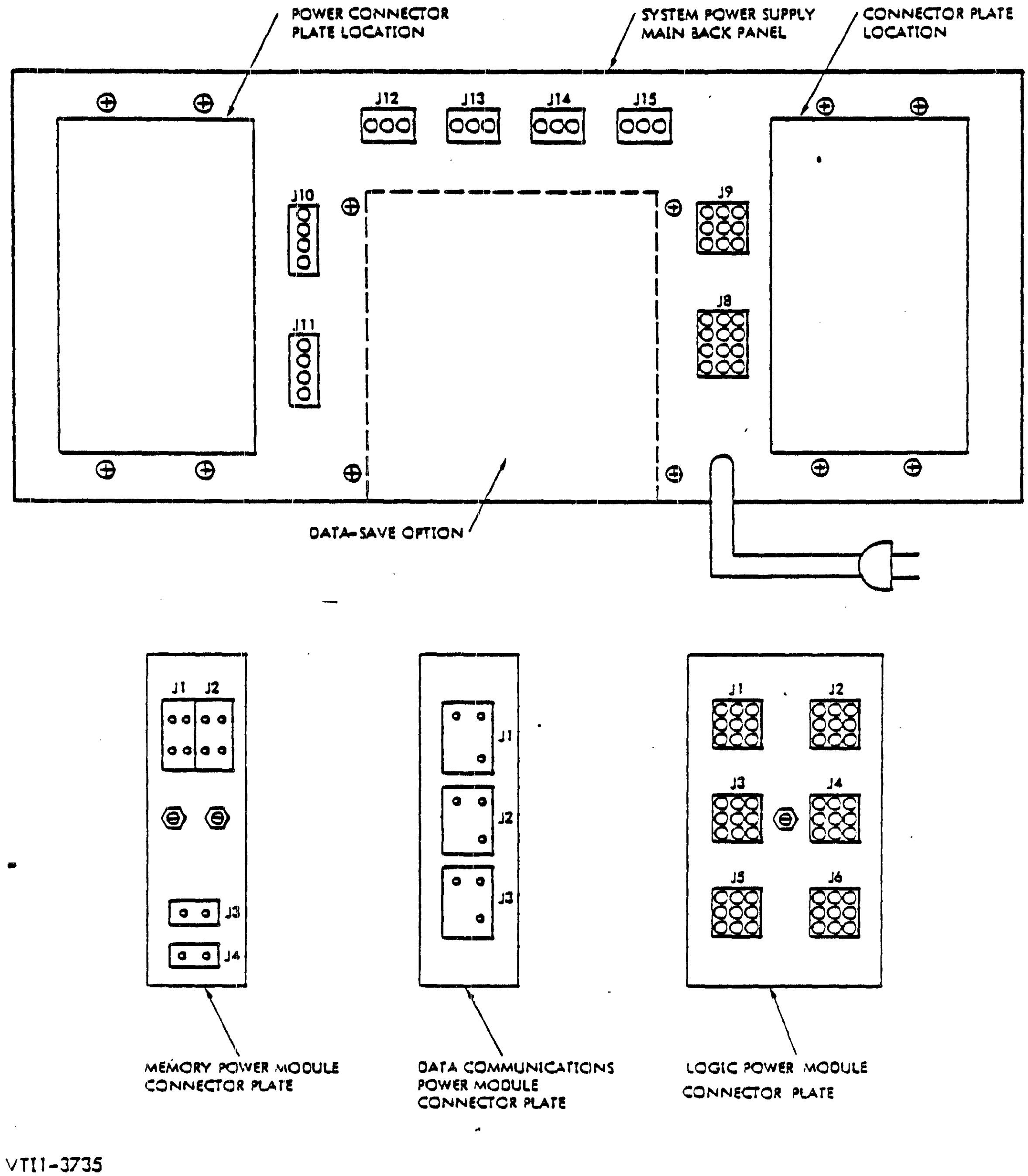

Figure 2-2. Rear Panel Configuration

The memory power module connector plate houses four connectors. Connectors J1 and J2 provide +5V dc (+5.2M) and +12V dc (+12M) and are wired in parallel. Total maximum current from both connectors must not exceed 4 amperes for +12M and 6 amperes for +5.2M. Connector J3 connects the battery (data save option) to the memory power module. Battery charging current is provided. Connector J4 is utilized to provide connection to a remote battery source. Connector J4 does not provide battery charging.

The data communications power module connector plate houses three connectors J1 through J3. Each connector is wired in parallel and provides +12V dc and -12V dc. The maximum total current from all connectors must not exceed 1.2 amperes for +12DC and 1.4 amperes for -12DC.

The logic power module connector plate houses six connectors J1 through J6. Each connector is wired in parallel and provides +5V dc. Each connector is rated at 40 amperes, however the maximum total current from all six connectors must not exceed 100 amperes.

2.2.3 Standard Configurations

Because of the various options of the system power supply and because all of the connectors of the connector plates need not be utilized, many dc power interfaces are possible. Two standard preconfigurations are available, however. Model 77-4060 containing one logic power module and one memory power module is illustrated in figure 2-3. Model 77-4061 containing one logic module, one memory power module with data-save option, and one data communications power module is illustrated in figure 2-4.

To distribute dc power to the 77 system the power supply is connected with the appropriate cable (figure 2-5). The cable is connected between the power supply connector plate to the appropriate power connector on the connector planes that house the printed circuit boards.

2.3 BATTERY INTERFACE

Refer to figure 2-2. J3 and J4 of the memory power module connector plates provide input to the memory power module from the data-save option (battery) and for an external battery (18V) respectively. The external battery connected to J4 is not charged by the system power supply.

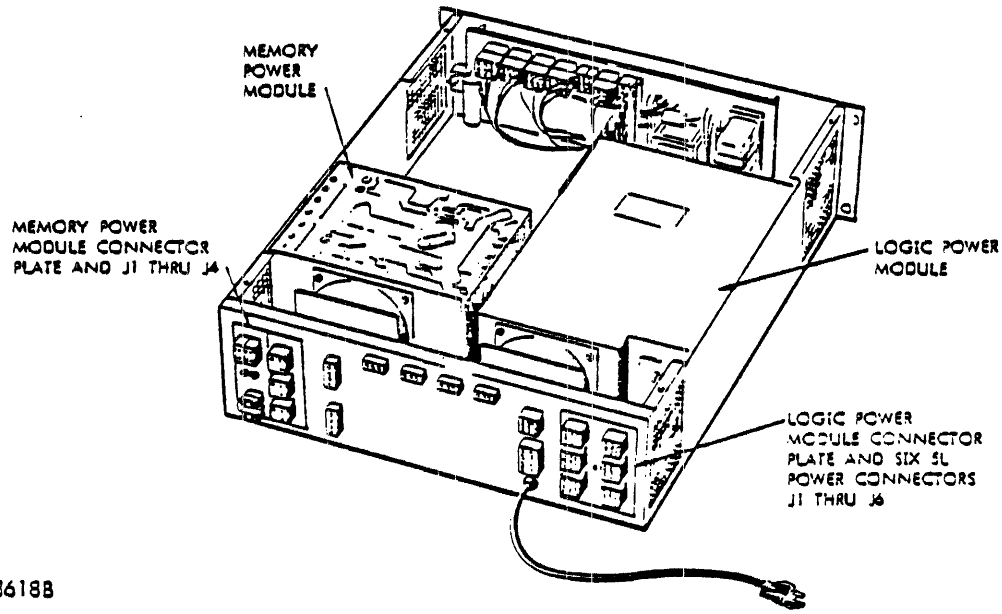

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Figure 2-3. Model 77-4060 System Power Supply

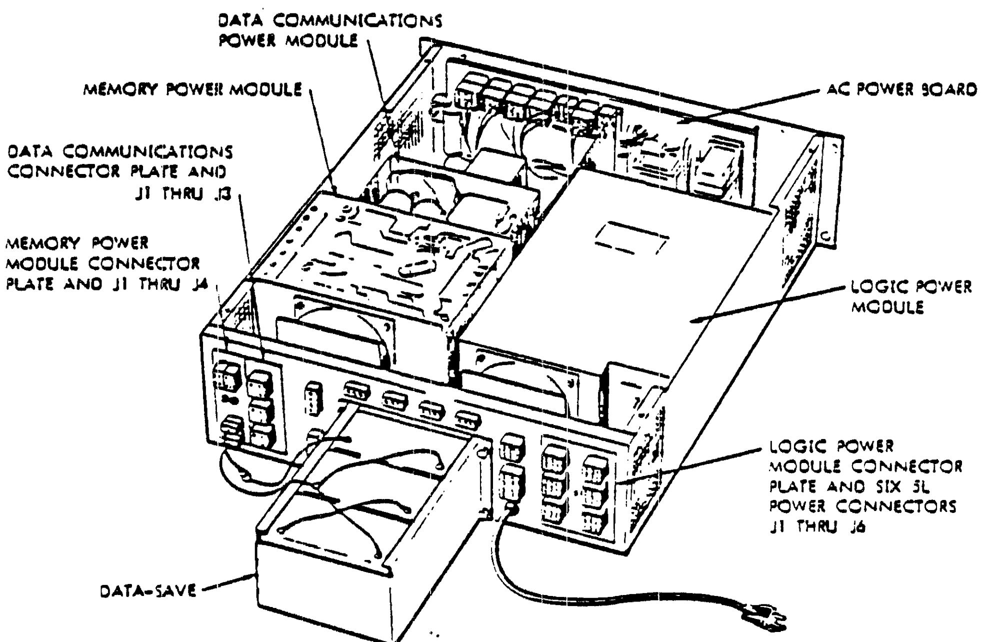

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Figure 2-4. Model 77-4061 System Power Supply

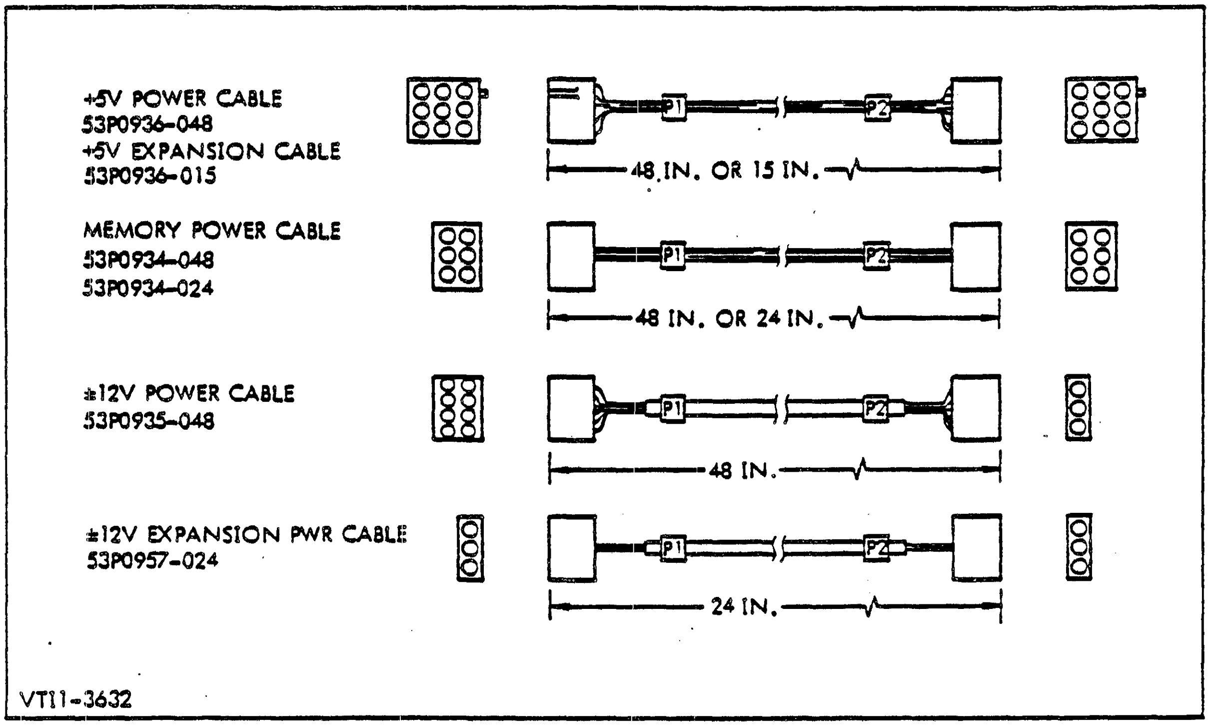

Figure 2-5. DC Power Cables

2.4 FAN POWER INTERFACE

Refer to figure 2-2. Connectors J12 through J15 of the systems power supply provide output for system fans. These connectors are wired in parallel and derive their source power internal to the systems power supply (ac power distribution).

2.5 POWER FAIL INTERFACE

Refer to figure 2-2. Connector J11 provides the current source (NCS) and the power fail detect (NCLSW2) signals. These signals provide a current source (NCS) and a current loop (NCLSW2) which are interfaced to the systems:

a. Data-Save Board of the main cardframe chassis.

b. Memory Controller Board of the main cardframe chassis.

c. Bus Driver Board of the main cardframe chassis.

d. Other power supplies for systems with multiple power supplies (J10 of the system power supply, J3 of the integral power supply).

When the power failure detection cabling is used in the computer system, any mixture of System Power Supplies and Integral Power Supplies may have their power failure detection circuits daisy chained.

Refer to figures 2-6 through 2-8. These figures show various configurations using the System Power Supply output connectors J10 and J11. Connector J11 is the primary current source and must be used in the beginning of the chain as shown in figures 2-6 through 2-8. If an Integral Power Supply is installed in the chain, (figures 2-7 and 2-8) the current source connectors would be J6 and J7 replacing J11 and J10 respectively. Connectors J6 and J7 of the Integral Power Supply provide identical features as the Systems Power Supply connectors J11 and J10.

Two types of cables are used in the power failure detection interface (figure 2-9). These are power fail cable 1 and power fail cable 2. The terminator is a loop to provide continuity. The number 3 power fail cable interconnects the power fail circuitry of either power supply to one power fail bus interface module on the memory timing and control board. The power fail expansion cable is used to connect power failure alarm and system reset signals between connector planes (figure 2-10).

2.6 REMOTE CONTROL POWER INTERFACE

Remote control power cables provide interface connection between the on-off switch on the control panel and the dc power control circuits in the main power supply and between the dc power control circuits in the main supply and the power control circuits in an additional power supply (figure 2-11). One cable configuration connects the control panel to the main supply and another configuration is used to connect the main supply to another supply. Use of these cables permits power supplies in the system to be simultaneously turned on or off by the remote control panel. They also permit the secondary power supply to be controlled by the power switch located on the main supply. This capability is provided by a power interlock (daisy-chain) and if a third supply is used it is controlled by the second supply, etc. Thus the power output of each subsequent power supply added to the system is turned on or off by the remote control panel.

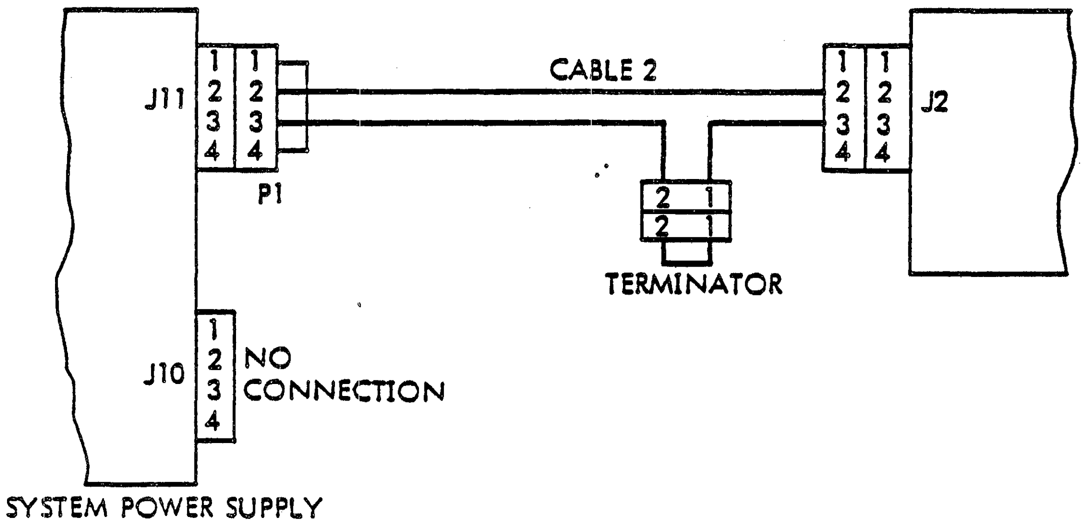

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Figure 2-6. Power Failure Cabling Basic Configuration

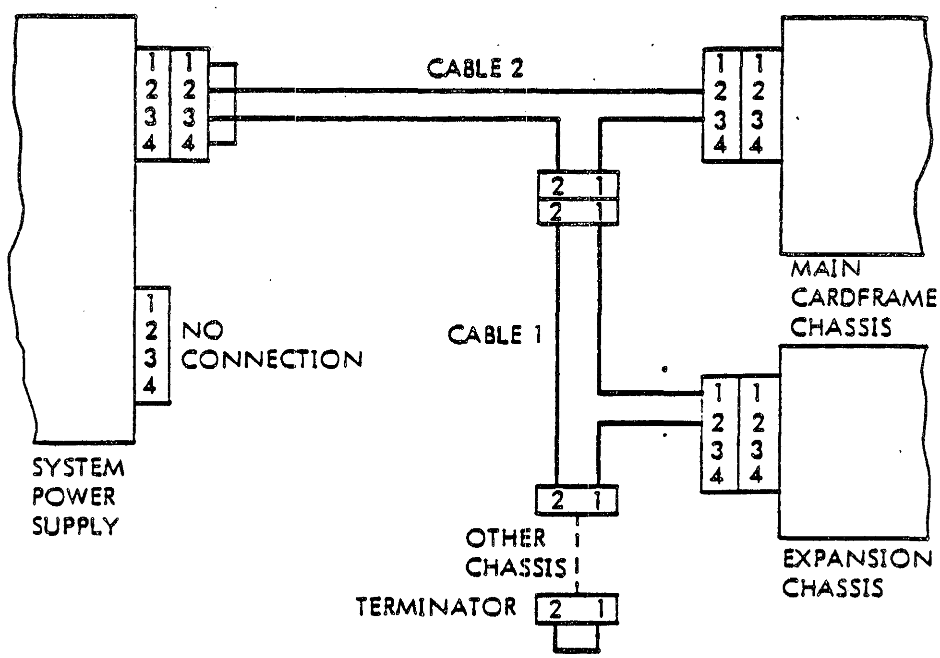

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Figure 2-7. Power Failure Cabling, Expansion Configuration

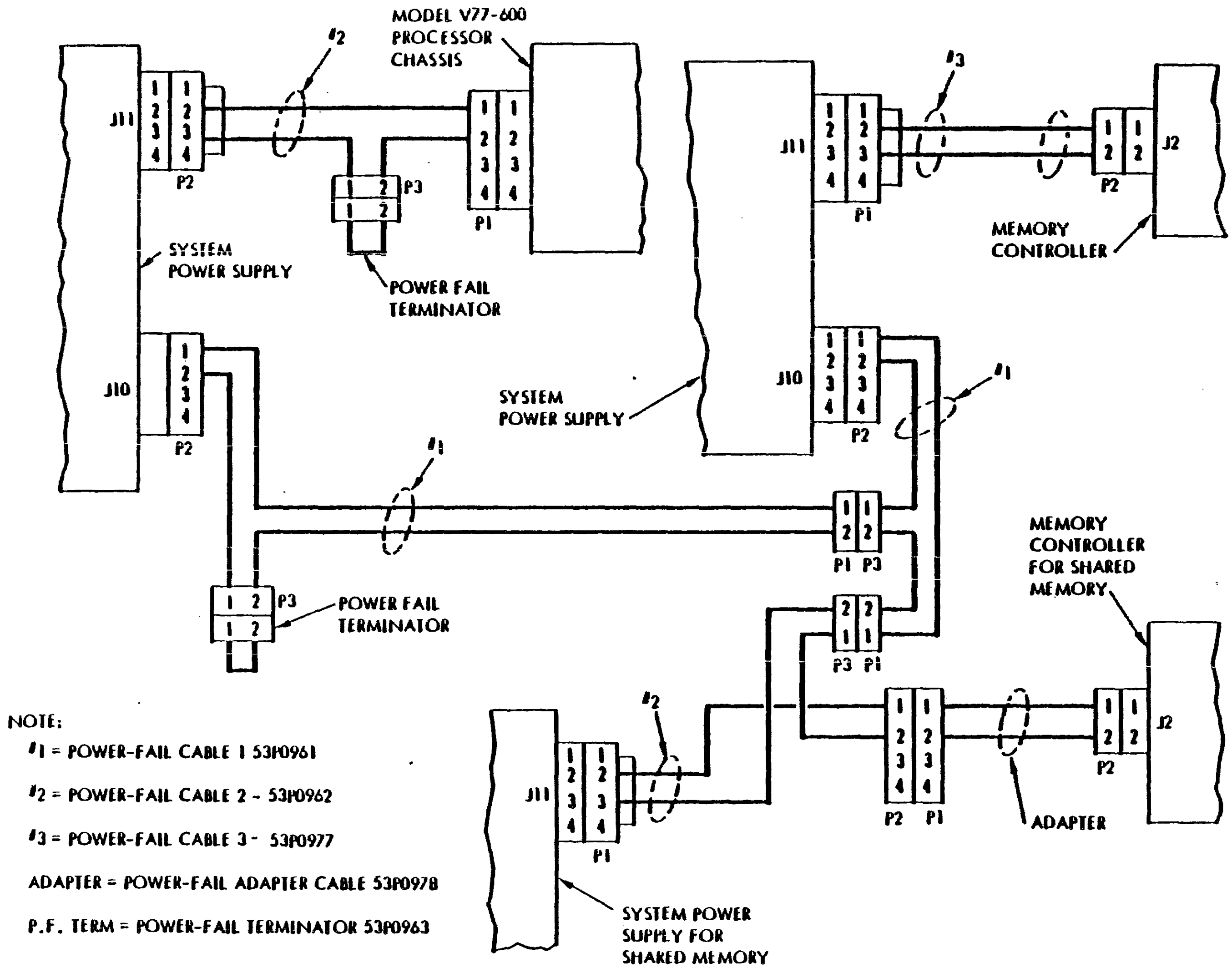

Figure 2-8. Power Failure Cabling, Shared Memory Configuration.

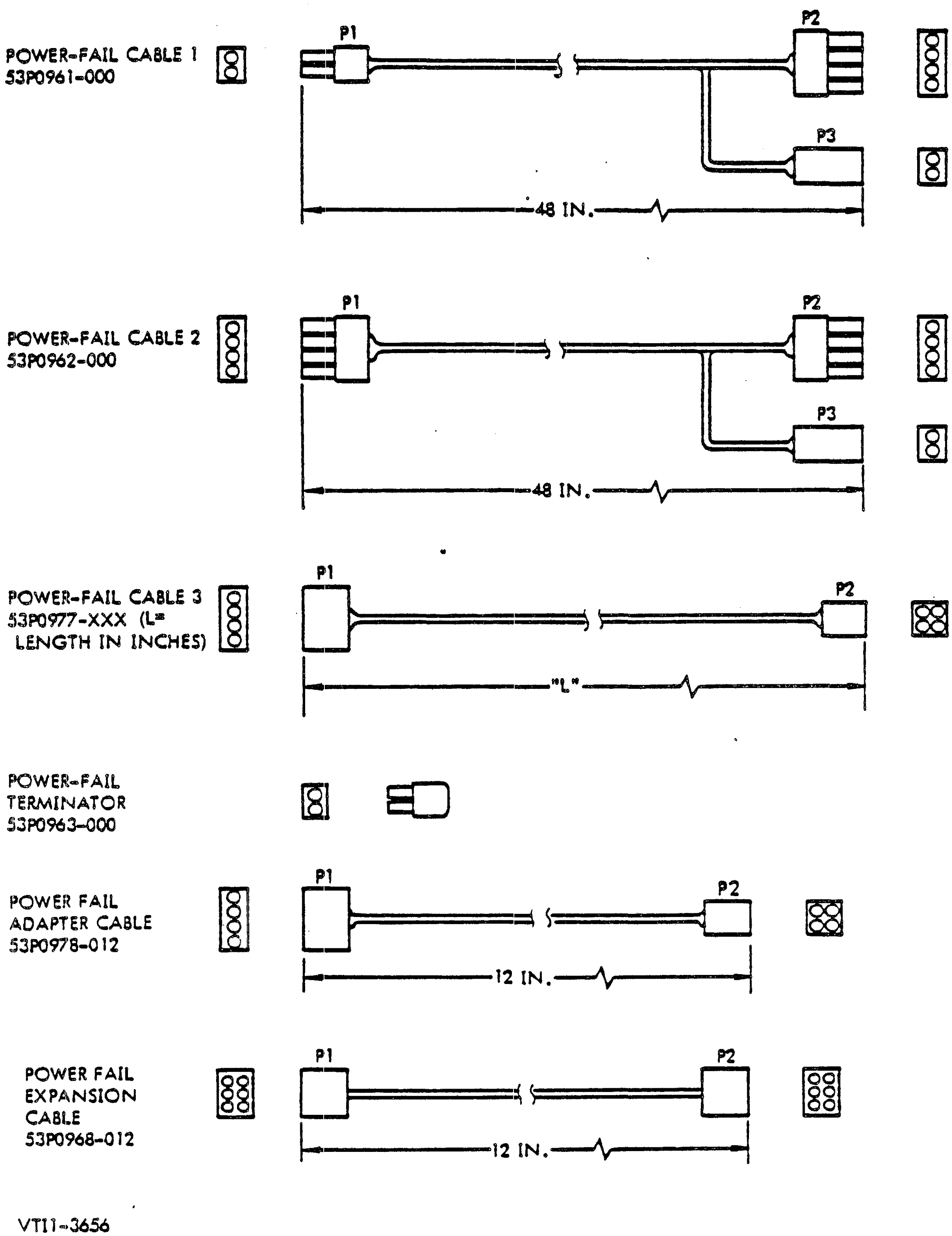

Figure 2-9. Power Failure Cables and Terminator

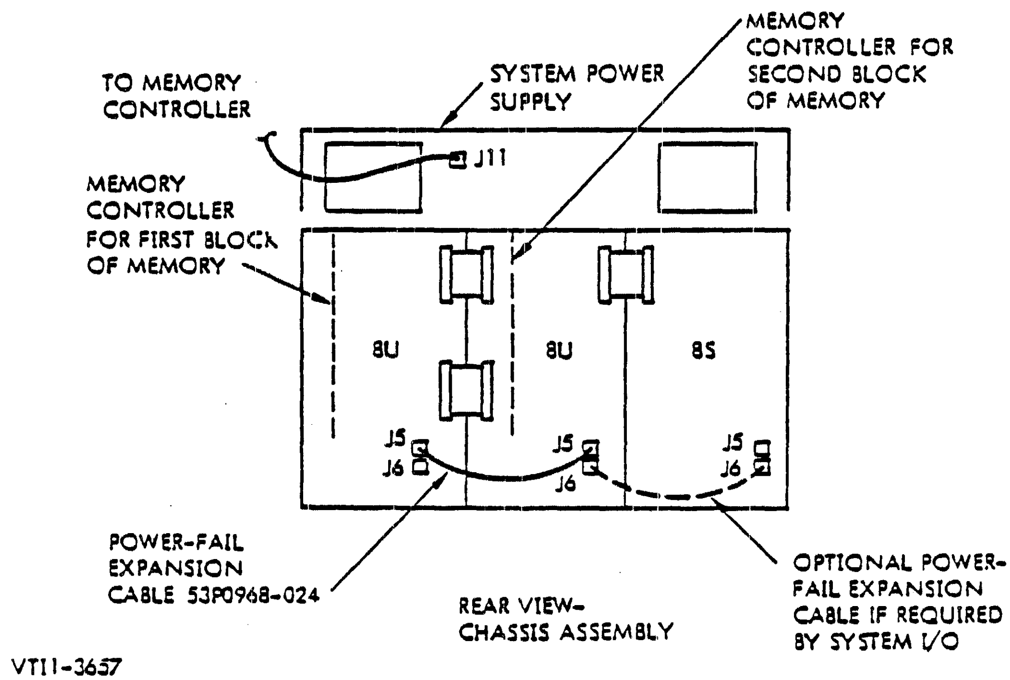

Figure 2-10. Power Failure Expansion Cable Installation 77-400

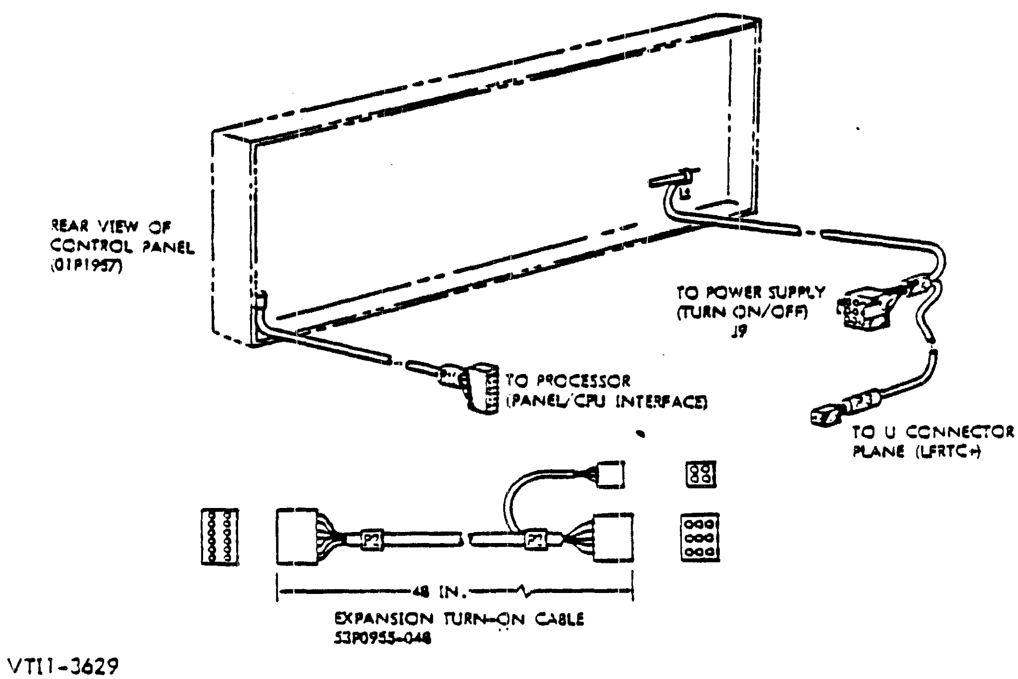

Figure 2-11. Control Panel Cables 77-200/400

2.7 EXPANSION CONTROL INTERFACE

The system power supply power control interface consists of J8 and J9 of the rear panel (figure 2-2).

Connector J9 provides 24V ac output from the secondary of T1 (24VAC and LFRTC+), a ground from the panel on-off switch (NDSOFF), board ground (RETURN) and an input called NHOLD.

Connector J8 provides expansion control. J8 interfaces with additional power supplies' power control input(s) which permit power in the added supply to be enabled/disabled by the on/off condition of the first system (ac expand LFRTC + EXP). Thus the power on/off control is distributed for multiple power supply systems from a single control. Additionally the connector provides a ground via the panel on-off switch (NDSOFF); this signal is paralleled with NDSOFF of connector J9. The NHOLD signal provides a ground when NHOLD power control relay is energized by NHOLD at J9.

2.8 REAR PANEL CONNECTOR PIN ASSIGNMENTS

Tables 2-2 through 2-6 list permanently mounted rear panel connector pin assignments.

Table 2-2. AC Power Distribution Connectors J1 through J7* Pin Assignments

Pin	Assignment	
1	Switched ac (117V)	24V ac tied to LFRTC and NHOLD
2	Switched ac (117V)	24V ac tied to LFRTC
3	Chassis Ground	
4	Data save off	(NDSOFF)
5	ac Neutral	
6	Return (external)	

*The pin assignments of these seven connectors are connected in parallel. The outputs are derived by the AC Power Board, which is powered by primary power.

Table 2-3. Expansion Control Connector J8 Pin Assignments

Pin	Assignment	
1	AC Expansion	(AC EXP)
2	Line frequency Real-Time Clock Expansion	(LFRTC + EXP)
3	Data-Save Off Expansion	(NDSOFF EXP)
4	Return	
5	Return	
6	Hold Expansion	(NHOLD EXP)

Table 2-4. Power On/Off Control Connector J9 Pin Assignments

Pin	Assignment	
1	24V ac	
2	Line Frequency Real-Time Clock	(LFRTC +)
3	Data-Save Off	(NDSOFF -)
4	Hold	(NHOLD)
5	Return	
6	Return	

Table 2-5. Power Fail Control Connector J10 Pin Assignments

Pin	Assignment	
1	Current Loop Switch 1+	(NCLSW+)
2	Current Loop Switch 1-	(NCLSW-)
3	Not used	
4	Not used	

Table 2-6. Power Fail Control Connector J11 Pin Assignments

Pin	Assignment	
1	Current Loop Switch 1+	(NCLSW1+)
2	Current Loop Switch 1-	(NCLSW1-)
3	Current Source -	(NCS-)
4	Current Source +	(NCS+)

2.9 MEMORY POWER MODULE CONNECTOR PIN ASSIGNMENTS

Tables 2-7 through 2-9 list the memory power module connector pin assignments.

Table 2-7. +5.2M and +12M Connectors J1 and J2 Pin Assignments

Pin	Assignment
1	+12V dc (+12M)
2	+5.2V dc (+5.2M)
3	+5.2M return
Note: J1 and J2 are connected in parallel.	

Table 2-7. +5.2M and +12M Connectors J1 and J2 Pin Assignments (continued)

Pin	Assignment
4	+5.2V dc (+5.2M)
5	+5.2M return
6	+12M return
Note: J1 and J2 are connected in parallel.	

Table 2-8. Data-Save (Battery) Connector J3 Pin Assignments

Pin	Assignment
1	Battery +
2	Battery -

Table 2-9. External Battery Connector J4 Pin Assignments

Pin	Assignment
1	Battery +
2	Battery -

2.10 LOGIC POWER MODULE CONNECTOR PIN ASSIGNMENTS

Table 2-10 lists the logic power module connector pin assignments.

Table 2-10. +5L Connectors J1 Through J6 Pin Assignments

Pin	Assignment
1	Common
2	Common
3	Common
4	+5V dc (+5L)
5	+5V dc (+5L)
6	Common
7	+5V dc (+5L)
8	+5V dc (+5L)
9	Common
Note: Connectors J1 through J6 are connected in parallel.	

2.11 DATA COMMUNICATIONS POWER MODULE CONNECTOR PIN ASSIGNMENTS

Table 2-11 lists the data communications power module connector pin assignments.

Table 2-11. Data Communications Connectors J1 Through J3 Pin Assignments

Pin	Assignment
1	+12V dc
2	-12V dc
3	Return
4	Return
5	Not Used

Table 2-11. Data Communications Connectors J1 Through J3 Pin Assignments (continued)

Pin	Assignment
6	Not Used
7	Not Used
8	Not Used
Note: Connectors J1 through J3 are connected in parallel.	

SECTION 3
OPERATION

3.1 GENERAL OPERATION

The power supply has one toggle switch on the front panel. The switch is the only front panel control and it controls primary power (117V ac) on the AC Power Board. The power board in turn provides power to the System Power Supply ac distribution connectors J1 through J7. These connectors in turn provide primary power (117V ac) to the optional power modules (logic-memory-data communications) and fan power. The only other controls are those on the rear panel. The controls on the connector plates, +5L for the logic power module(s), +5.2M and +12M for the memory power module(s) are voltage adjustments and must not be adjusted as an operational procedure. Information on these controls is provided in section 5.

3.2 POWER-UP/POWER-DOWN OPERATION

3.2.1 Remote Turn-On

This feature allows the power supply to be turned on remotely by the computer panel switch or by another power supply.

3.2.2 Remote Hold Control

The remote hold (NHOLD) feature allows power to memory power modules and fans to be retained while logic power is turned off by the panel switch.

3.2.3 Data-Save Remote Control

This feature allows the optional data-save (battery) to be remotely turned off if desired, removing memory voltage from the system.

3.3 DATA-SAVE OPTION

The data-save operation is automatic unless remotely turned-off. If the primary power drops below 102V ac a power fail condition is detected and the data save circuit is actuated. The battery will maintain 256K of N-MOS memory for a minimum of 1.5 hours. During normal operation, the data save batteries are maintained in a charged condition.

SECTION 4
THEORY OF OPERATION

This section consists of an overall functional description followed by detailed circuit descriptions. Functional block diagrams accompany the text to aid the reader in understanding the circuit descriptions. Refer to the list of mnemonics in section 6.

4.1 FUNCTIONAL DESCRIPTION

The System Power Supply is a modularly constructed chassis mounted power supply. The basic power supply consists of a chassis, front panel, and an ac power board. Separate power modules consisting of the memory power module, logic power module and data communications power module may be installed on the chassis of the power supply. Each of the power supply modules is a self-contained supply which obtains its primary power (117V ac) from the ac power board located at the front of the power supply chassis.

4.2 AC POWER BOARD

Figure 4-1 is the functional block diagram of the ac power board. The ac power board distributes primary power (117V ac) to the power modules and fans, includes the expansion control circuits, and power fail detect circuits.

4.2.1 Input Circuits

These circuits consist of the ac power line cord and its three prong connector, panel switch (S1), 20 ampere fuse (F1), RFI filter, surge suppressors and primary winding of the step down transformer (T1).

The line cord accepts input power (104 to 132) volts ac at a frequency of (47-63) Hz. The line cord is color coded to provide the following identification: 117V ac-black; neutral-white; and green-chassis ground. Fuse F1 (20 ampere slow blow) provides overload protection. FL1 is a radio frequency interference (RFI) filter which attenuates noise generated by the systems power supply modules to prevent line interference. The surge suppressors (RV1 through RV4) reduce the amplitude of transients from the line before the transients reach the modules.

The power on-off switch turns off all outputs, including the data-save voltages. Switch S1 is on the systems power supply front panel. The switch overrides the remote turn-on, hold and data-save off controls.

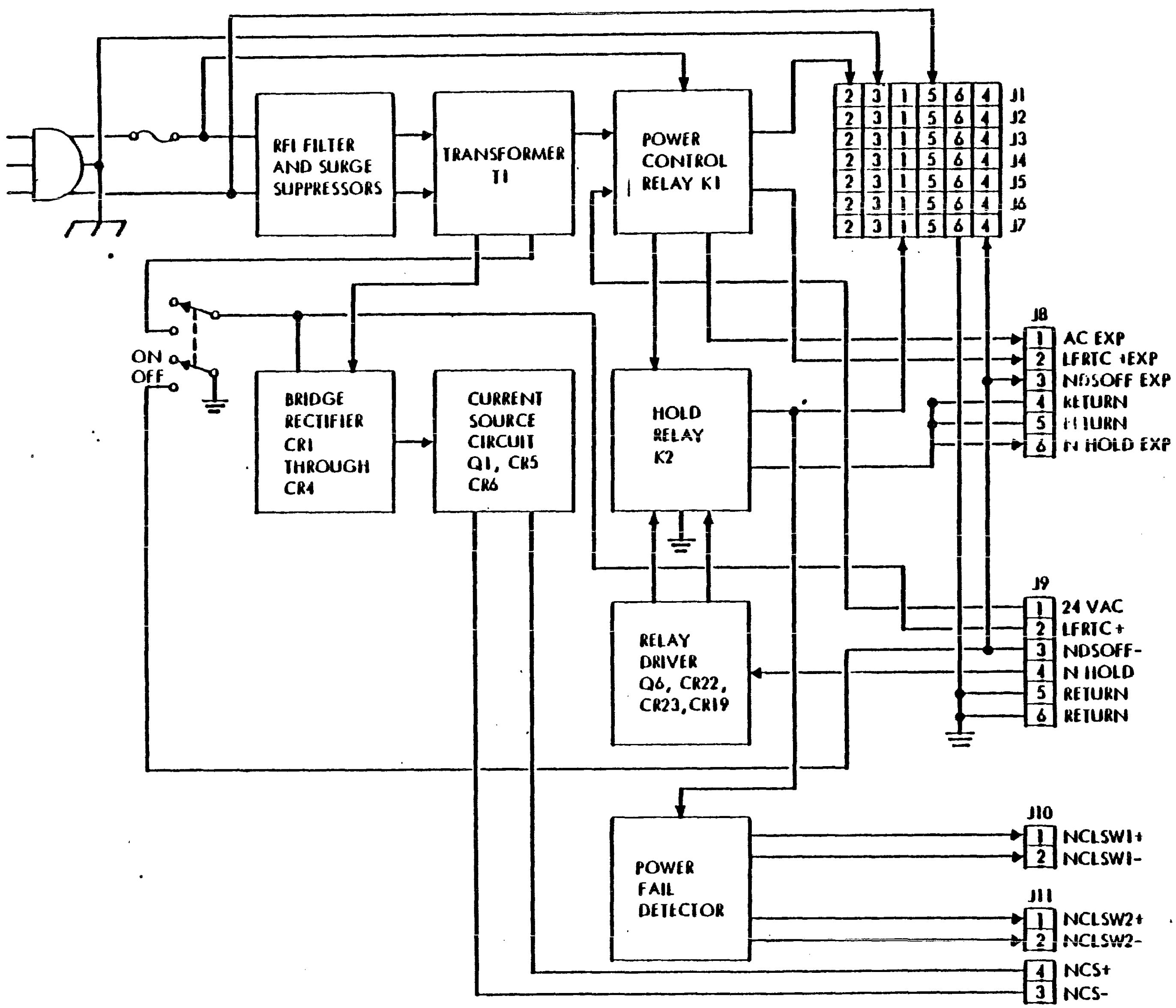

Figure 4-1. AC Power Board Functional Diagram

The secondary of T1 steps down the primary voltage to 28V ac. The 28 volts provides coil power to relays K1 and K2 and the power fail indication circuitry. Fuse F1 protects the supply from damage caused by an overload.

4.2.2 AC Power Distribution

The supply is modular and the modules are optional. Distribution of primary power is provided to the power modules by seven ac outlet connectors (J1 through J7) on the ac power board. Connectors J1 through J7 may also provide external power. The system power supply can house up to four full sized power modules, therefore four of the distribution connectors will be used for this purpose. Depending on the options up to two chassis cooling fans may be required. In this case, two of the distribution connectors will be used for supplying fan power. The remaining connector of the ac power board is then required to interface the 117V ac to the systems power supply rear panel connectors (J12 through J15). These fan power connectors provide power for cooling fans located external to the system power supply. Each (J1 through J7) connector is rated at 10 amperes maximum per connector, total current 15 amperes. Power is applied by the systems power supply front panel switch or by the remote computer panel switch.

The ac hot input line is applied to the input pins of relay K1. When the relay is energized by the panel or by a remote switch the relay energizes and power is applied to pin(s) 2 of J1 through J7. The ac neutral connection is directly connected from the junction of RV2 and RV3 to pin(s) 5 of J1 through J7. Chassis ground is directly interfaced to pin(s) 3 of J1 through J7. Additionally the ac hot output of K1 is applied to pin(s) 1 of J1 through J7 when an external remote hold NHOLD signal is active. This allows for memory power to be turned on independantly. Pins 6 of J1 through J7 provide a remote return and pins 4 provide data-save off (NDSOFF) to the memory power supply module.

4.2.3 Fan Power Distribution

There are four ac connectors (J12 through J15) on the rear of the systems power supply chassis. These connectors derive their input from one of the ac power distribution connectors. The four parallel connectors provide 117V ac to operate the fans on the computer processor expansion and I/O chassis.

> FAN POWER is prohibited from being used if the system power supply houses two logic power modules (77-4065). The line power cord cannot withstand the additional fan current drain.

4.2.4 Expansion Control Circuit

The power supply connector J8 provides connection to an additional power supply's power control input. Connector J8 permits power in the added supply to be enabled/disabled by the on-off condition of the first system. In this manner power on-off control is distributed for multiple supply systems from a single control point. This is accomplished by the ac power board providing a relay closure when the system power supply is on. This 28V ac signal is rated at two amperes maximum.

When relay K1 is energized the lower set of its contacts provide continuity between pins 1 and 2 AC EXP and LFRTC+EXP respectively. NDSOFF EXP pin 3 provides switch closure to ground (closed in the off state). NDSOFF turns off the data-save (battery) power to the memory power modules when the computer key switch is in the OFF position. The key switch is remote to the system power supply. NHOLD EXP pin 6, provides switch closure to ground (closed in the hold mode) which causes only the fans and the memory supply to turn on if remote turn on is closed. In this mode the data-save battery is charged. Remote turn on of the supply is accomplished by the 28V ac and LFRTC+ signals at J9 pins 1 and 2 respectively. Remote hold NHOLD pin 4 of J9 controls the logic and data communications power modules.

4.2.5 Current Source Generation Circuit

CR1 through CR4 form a full wave bridge rectifier to rectify the secondary of T1. R1 limits the short circuit current to ground through LFRTC+. C1 filters the rectified ac which serves as emitter bias for common base transistor Q1.

4.2.6 Power Fail Detect Circuit

The power fail detect circuit is housed on three separate circuit boards, the ac power board, the bus driver board and memory controller. The combined boards monitor the ac line voltage and provide warning when the line voltage falls below a predetermined value. The ac power board provides threshold control and alarm generation. The bus driver board, located at a remote processor or I/O, generates two signals, systems reset (SRST-) and system power fail alarm (SPFA-). These signals in turn are interfaced to the processor and I/O devices. There are two types of the bus driver boards (44P0813-000 and 44P0813-001). Bus driver board 44P0813-000 can input one power failure detect signal. The optional bus driver board 44P0813-001 has connectors and circuitry to handle an additional four power failure detection signals. Each of these NPWROK signals would be from an individual power supply. Additional bus driver boards may be added to the system to provide power failure detection for more than five power supplies.

Refer to figure 4-2. When the line voltage falls below 102V ac, each current loop circuit (NCLSW1 and NCLSW2) output open circuits. This action causes the SRST- and SPFA- signals to be generated at the bus driver board. When the ac line voltage rises to 104V ac, the current loop circuits will close circuit (one second delay) indicating normal power.

Refer to schematic diagram 91E0596. The ac input voltage for the circuit is obtained at pins 5 and 1 of J1 through J7. The voltage is rectified by rectifier CR7 through CR10. Resistor R6 and capacitor C3 filter the rectified voltage. Resistor R7 limits the dc output current to 45 mA.

Integrated circuit IC1 provides a temperature stable reference for the comparator IC2A.

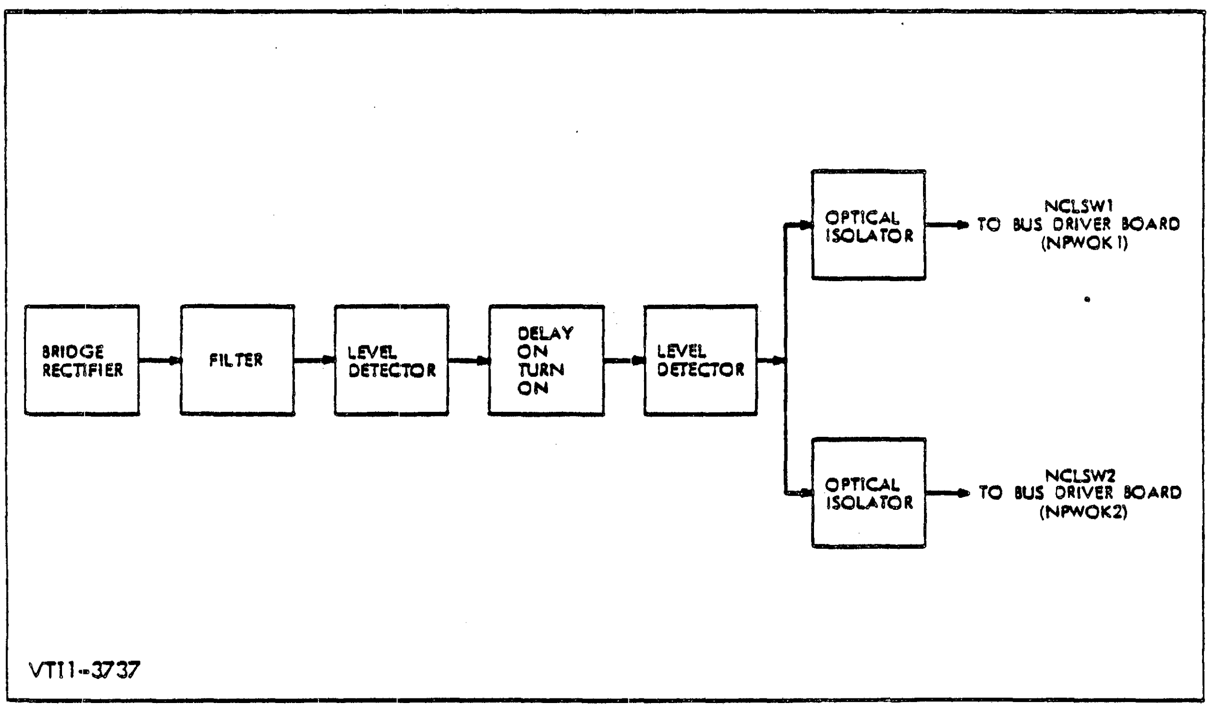

Figure 4-2. Power Failure Detection Functional Diagram

Network C3 and R8, R9, R10 partially filter the full wave rectified output of CR7-CR10. IC2A compares an attenuated version of the output of C3-R8,-R9, and -R10 filter with a 2.0 volt level set by IC2A. When the minimum value of the ripple, which was pre-adjusted by R9, falls below the level of 2.0 volts the output of IC2A goes high. This turns on Q2 and discharges C6 which causes the output of IC2B to go high. With IC2B high transistors Q4 and Q5 turn off. With transistors Q4 and Q5 turned off both current loops are open.

Feedback from the output of IC2B to the non-inverting input of IC2A (CR18 and R20) cause a 2 per cent hysteresis in IC2A comparator.

When the line voltage rises 2 per cent above the level that caused the ac power fail detect to generate an alarm, the output of IC2A goes low and Q3 is turned off. This causes C6 to charge to +22 volts through R21. When the voltage at the inverting input of IC2B is greater than 17.9 volts, set by R16, R7, and R18 ICB2 goes low turning on Q3, thereby enabling both current loop outputs. Capacitors C8 and C9 prevent high frequency transients from inadvertant activation of the photo transistors in IC3 and IC4.

4.3 BUS DRIVER BOARD

This board, not a part of the system power supply, is located in a remote processor or I/O chassis. Because it is a part of the power fail detect function of the ac power board its description is provided in this manual. Refer to figure 4-2. The figure shows independent optical isolators outputting signals NCLSW1 and NCLSW2. These two signals are directly interfaced to one of five optical isolators (inputs) on the bus driver board, part number 44P0813-001. Note that the signals have different names at the output of the ac monitor board and at the input of the bus driver board: NCLSW1 and NCLSW2 and NPWOK 1 through NPWOK 5. These are the signal names that are on the schematic.

Any or all of the five optical isolators accept NCLSW1 or NCLSW2 current loop signals from the ac power board. The power fail signals are interfaced to the board by means of current loop interfaces. The NCLSW1 or the NCLSW2 signal causes the bus driver board to generate the systems power failure (SPFA) and system reset (SRST) signals. With a power failure, SRST occurs 1.3 millisecond, after SPFA. Upon reactification of power, SPFA occurs 130 microseconds after SRST. The time between the two signals allows the CPU and I/O to commence an orderly shut down procedure without the loss of currently processed data. This feature, when configured with the data-save option enables the computer to store register data in memory as the logic power module maintains system power for a short period of time. The reed relay (normally closed contacts) holds SRST and SPFA signals to ground when power is not available to the bus driver module. For single current loop applications only one optical isolator is used, bus driver board part number 44P0813-000.

4.3.1 Bus Driver Board Schematic Description

Refer to schematic 91E0596. The current loop signal (NPWROK+ and NPWROK-) is interfaced at J3. This current loop NCLSW1+ and NCLSW1- or NCLSW2+ or NCLSW2- is in series with NCS at the ac power board. The signal is received by optical isolator IC1. The optical isolator drives transistor Q1 which forms a 300 microsecond delay (C6 and R2). Transistor Q1 drives level detector IC6A. The level detector has a hysteresis characteristic to sense the time out of delay network C6 and R2. The level detector IC6A drives transistor Q2 which generates a 1.4 millisecond delay with network R10 and C8. Transistor Q2 drives level detector IC6B. The level detector has hysteresis characteristics to sense the time out of network R7 and C8. The output of IC6B is amplified by Q3 and A2 transistor pair. The latter circuit (A2) provides a ground to SRST when +5 volt power is available and the inputs and timing require a low signal on the SRST line.

The following description explains the system power failure (SPFA) generating circuits. The function derives its input from the output of level detector IC6A. The level detector drives IC6C which inverts the signal and drives transistor (Q4). Transistor Q4 drives the level detector which has hysteresis characteristics to sense the time out delay network (C9 and R29). Transistor Q4 along with network (C9 and R29) generate a 130 us delay. The IC6D level detector has hysteresis characteristics to sense the time out of network (C9 and R29). The output of IC6D is amplified by transistors Q5 and A2. Transistor A2 provides a ground to SPFA when the +5 volt power is available and when the inputs and timing require a low on the SPFA line.

This paragraph describes the power on relay function. The normally closed contacts of relay K1 hold the SRST and the SPFA signals to ground when power (+5V pin 1 of J1) is not available to the bus driver board. When K1 is activated by the +5 volts the grounds are removed allowing the board to indicate outputs as per normal inputs.

There are four additional inputs to the bus driver board (part number 44P0813-001). The individual inputs accept associated outputs from the ac power boards of other power supplies. The current loops are received by the optical isolators IC2 through IC5. The associated transistor inverts its optical isolator input. The transistor outputs are collector OR'ed with the output of Q1. Any one of the five inverting transistors can activate level detector IC6A.

Unused inputs of the bus driver board must be disabled. This is established by inserting the appropriate jumper as indicated on the schematic. To enable the associated input, J4 through J7, remove the jumper. Five additional power supply inputs may be provided by adding a second bus driver board to the system. When additional boards are implemented connectors J2's are jumpered together with jumper A-A removed on the board and with no input to connector J1.

4.3.2 Bus Driver Expansion Capability

The current source and the power failure detection functions are part of the ac power board. The bus driver board is located in the remote (computer) cardframe chassis. Each cardframe chassis contains its own bus driver board. The limit of expansion is that no more than ten power supplies plus bus driver boards are allowed on the current line.

4.4 MEMORY POWER MODULE

The memory power supply consists of three major assemblies: The chassis, memory power supply board and regulator board. The combined assemblies provide outputs of +12 volts at 4 amperes (+12M) and +5.2 volts at 6 amperes (+5.2M). The supply can run up to four 64K semiconductor memory modules (01A186264K). It incorporates provisions for the data-save options. This option (backup battery power) provides short time data-save capability but does not provide +5 volt logic power (+5L). The data-save option provides power to the various memory modules for the following lengths of time: the 256K module for 1.5 hours, the 64K module for 6 hours and the 32K module for 12 hours.

The memory power module operates on 117V ac, 47 to 63 Hz power in normal operation and on 18-volt power in the data-save mode. Change over from normal to data-save power is automatic on loss of primary power. During normal operation the memory power module supplies 0.9 ampere to charge the battery.

Overvoltage and overcurrent (with foldback) protection is provided. The unit will not energize unless primary power is present but will continue to operate on battery power after the removal of primary power. When a battery voltage of about 16 volts is reached the data-save supply is disabled. The data-save supply can also be disabled by means of data-save off (NDSOFF) switch closure to ground. The battery will continue to be charged when NDSOFF is grounded.

Refer to figure 4-3 for the memory power module functional diagram. The module consists of two boards, the memory power board and regulator board. Additionally, the chassis provides step down and rectification of the line voltage and battery charge for the data-save (battery). Transformer T1 provides selection of the input line voltage and isolation and voltage step down to the rectifier-filter. The bridge rectifier and capacitor convert the transformer secondary voltage to direct current. The capacitor also serves as a charge reservoir at power shutdown. The battery charger is a series pass regulator designed to provide 20.5 volts and is current limited to 0.9 amp to provide the charging current to charge the data-save battery. The threshold detector controls the switch that enables the regulator. Hysteresis is provided so that the switch is on when its input voltage (VS) is greater than 25 volts and off when VS is less than 16 volts. The +12M regulators for the control logic provide +12V to power the control logic clock. The control logic provides the signal processing necessary to control the frequency and pulse width of the signals applied to the +5.2 volt memory (+5.2M) and +12 volt (+12M) switches. The current sense devices are low resistance resistors which provide a signal required to sense and control the load current under overload conditions. The overvoltage protection circuits are SCR's which are triggered on by the output voltage provided the voltages exceed predetermined levels. The diode (D1) automatically connects the data-save battery to the VS when VS is equal to or less than the voltage of the battery, the voltage across the diode. The latch is set when either the 12V or 5V overvoltage protection circuit is actuated. This causes the threshold detector to shut down the switching regulators. To restore power, the primary power must be removed and turned back on after sufficient time has elapsed to discharge the rectifier filter to less than 12V.

4.4.1 Memory Power Board Schematic Description

The memory power board electronics is sub-divided into three major functions. Input power and battery charger; 12 volt regulator and overvoltage SCR; 5 volt regulator and overvoltage SCR. Refer to figure 4-4. The memory power board functional diagram shows the major components into related functions. This functional will assist in understanding and identifying components of the schematic diagram (95E1292) of the system documentation package.

Input ac power is derived from the system power supply ac power board distribution connectors (J1 through J7). The fuse F1 varistor RV1 input capacitor C40 transformer T1, capacitor C1 and the full wave bridge rectifier CR1 are all part of the memory power module chassis. The fuse F1 is rated at 3 ampers, fast blow. Due to the location of F1, it also protects the supply when it is operating on battery or a remote source of dc power (connector J3).

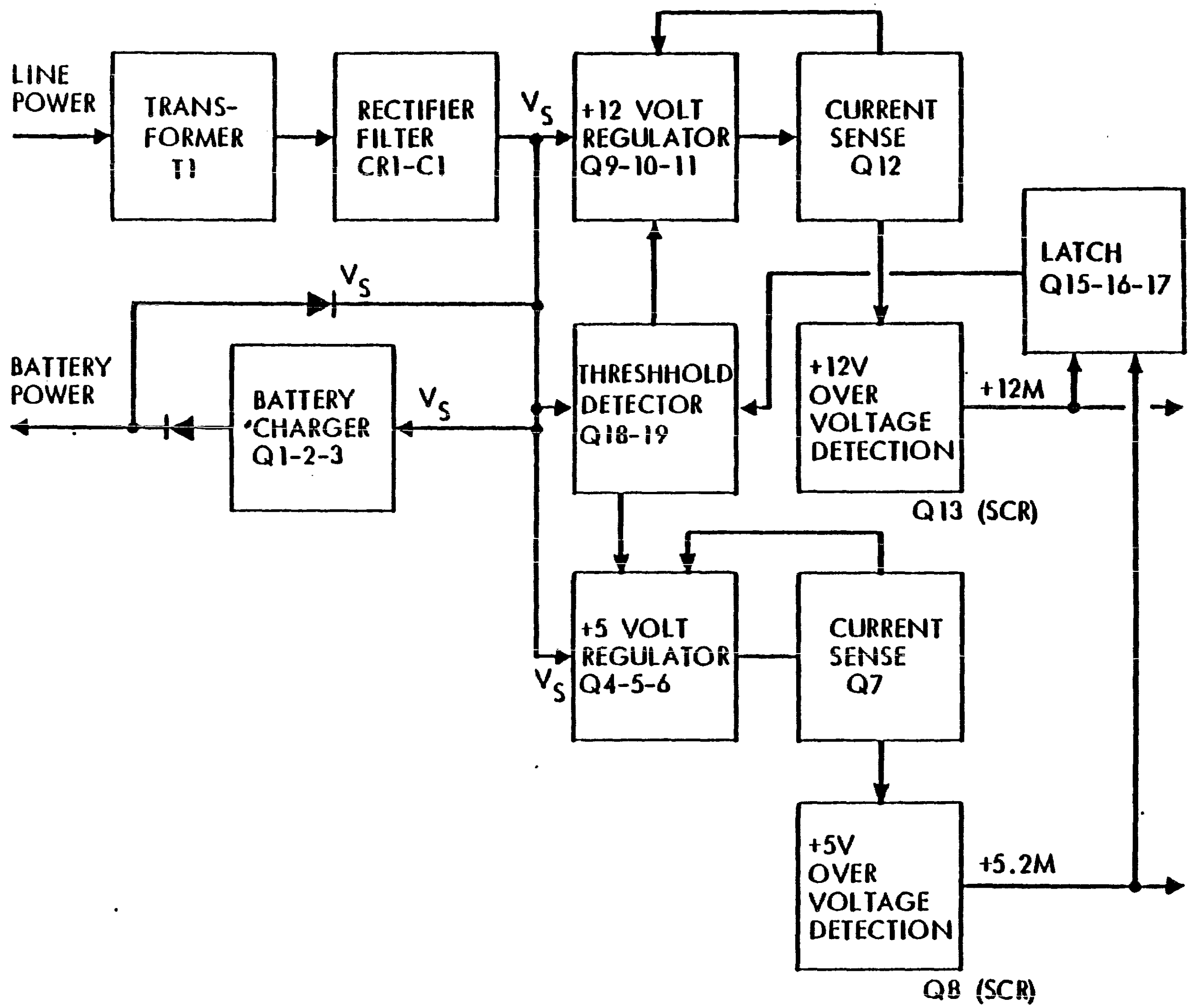

Figure 4-3. Memory Power Module Functional Diagram

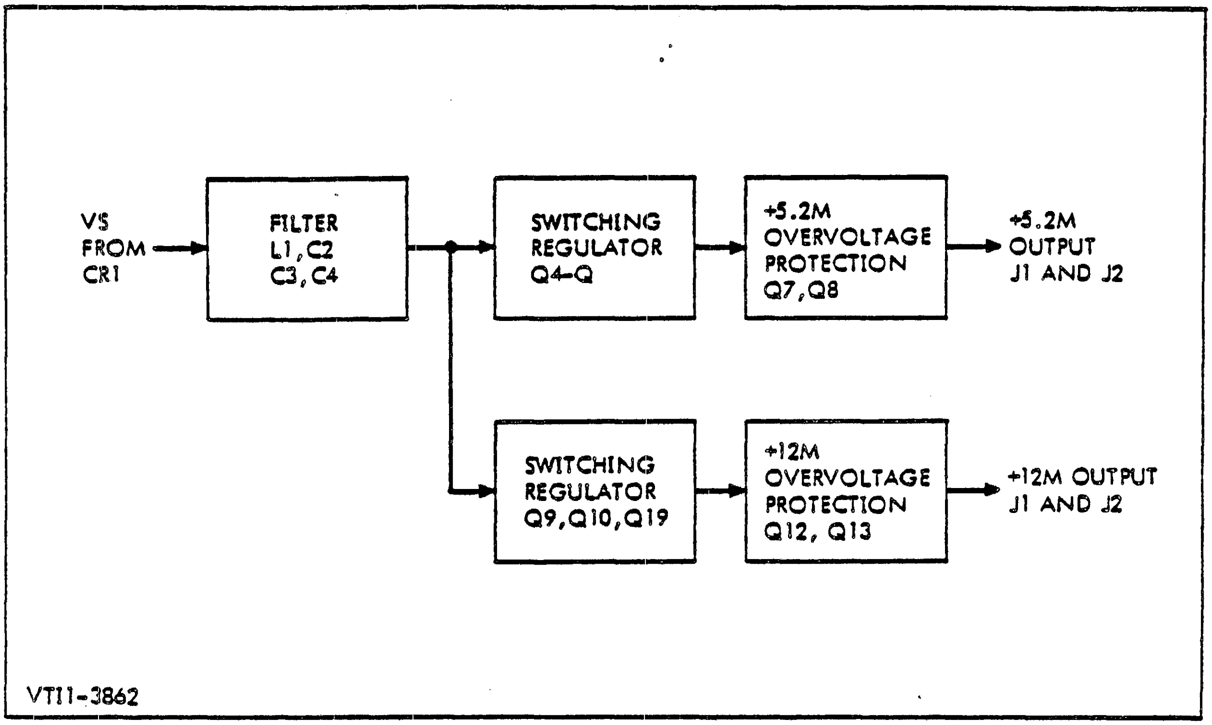

Figure 4-4. Memory Power Board Functional Diagram

RV1 is a voltage limiting varistor. Transformer T1 has a tapped primary to accomodate various values of line power. For 115 volt applications the primary power is applied between pins 1 and 7 of the primary, pins 2 and 6 must be strapped. The transformer secondary has pins 9 and 10 strapped, pin 8 and 11 connect to the full wave bridge rectifier. The peak secondary voltage is rated at 40 volts with 130 volts RMS at the primary. The full wave bridge rectifier converts the input alternating current to direct current. The dc output (VS) of the rectifier is typically 32 volts dc, depending on the line voltage. Capacitor C1 provides transient suppression. L1, C2, and C3 form a T-section filter which is effective at 20Khz and up. Capacitor C4 functions as both a 120hz and 20Khz filter. The filter output VS is applied to the +12 volt and +5.2 volt series switching regulators and the battery charger of this board. VS is also applied to the threshold detector and the control logic of the memory regulator board.

Transistors Q1 and Q2 are series pass devices which supply battery charging current. Q3 drives Q1 and Q2. R3 is the base return for Q1 and Q2, R4 is the base return for Q3. Resistors R1 and R2 force

Q1 and Q2 to share the current. The battery charging function components are located on the regulator board and are discussed there. Diode CR3 is a steering diode that allows the memory power supply to operate from the external data-save battery (18V). During failure of primary power, the battery replaces the output of the rectifier. This feature is only used during the data-save condition. Maximum current is 2.7 amperes. Diode CR2 is a steering diode which allows the memory power supply to operate on an external dc supply. The current through this diode is steady dc when in use and is rated at 3 amperes.

4.4.2 +5.2 Volt Regulator Circuit

This circuit accepts the filtered rectifier voltage from inductor L1 and applies it to the emitter of series switch transistor Q4. The output (collector) of the series switch provides the regulated 5.2 volts dc. Zener diode CR5 and diode CR6 limit the reverse voltage applied to Q4. Inductors L2 and L3 supply turn-off pulses for Q4 and Q5 respectively. Resistor R5 limits the current build-up in L2 and R6 damps the turn-off pulse. Resistor R8 is the base emitter return for driver Q5 and also limits the current through L3, CR7 limits driver Q5's reverse voltage while R7 damps the base turn off pulse. Resistor R9 prevents accidental short circuiting of the base to ground. Driver transistor Q6 provides drive for driver Q5. Its emitter diodes CR8 and CR9 provide a threshold for Q6, R11 is its base return. Inductor L4 of Q4 limits the turn on current through Q4 and Q5, then CR10 discharges L4 when Q4 switches off. Capacitor C5 controls the rate of the fall of the collector of series switch Q4. The capacitor charges through L5 when Q4 switches on and discharges through CR11 when Q4 switches off. Diode CR12 provides a path for the current through L6 when Q4 is switched off. Inductor L6 stores energy while Q4 is on and supplies energy to the load when Q4 is off. Capacitor C6 is a high frequency bypass capacitor and C7 stores energy for the load and works with L6 to form a low pass filter that converts the rectangular pulses of voltage at E18 to an average dc value. Resistor R14 is a preload resistor which maintains a minimum current through L6. Capacitor C28 allows the chassis to function as a shield at high frequencies.

4.4.3 +12 Volt Regulator Circuit

This circuit is nearly identical to the circuit description of section 4.2.2. Refer to section 4.2.2 for a description of the +12 volt regulator.

4.5 REGULATOR BOARD

The functions of this board work in conjunction with the memory power board. The voltage regulator and its associated components form the battery charging function for battery input A. The latch, composed of transistors Q15, Q16 and Q17 with related components form the latch which is set by either voltage sense transistors (Q20 or Q21). This indicates that either SCR has turned on, which indicates overvoltage. The latch subsequently functions to disable both regulators. The threshold detector (Q18 and Q19) sense the value of VS that causes the supply to start up. The 5 volt current sense and the 12 volt current sense functions each consist of two operational amplifiers, one monitors the load voltage and the other the load current. The sawtooth generator provides a reference for the +5.2 and +12 volt comparators. The comparators compare the outputs of the current sense to the sawtooth reference. The output of the comparators are applied to the overvoltage protection transistors and SCR's. When either overvoltage protection SCR's are triggered the latch is set and threshold detector shuts down the series regulator switches.

4.5.1 Regulator Board Schematic Description

Refer to schematic 95E1292. A description of each major function of the board follows.

4.5.2 Battery Charger Circuit

The major components of this function are the voltage regulator IC1, current limiting transistor Q7 and thermister RT1. The voltage regulator (IC1-pin 11) drives transistors Q1, Q2, and Q3 of the memory power module. The output provides approximately one ampere at 20.5 volts to charge the data-save batteries. Transistor (Q7) limits the charging current to one ampere. Thermistor RT1 and resistors R31, R32, R34 and R36 form a temperature sensitive voltage divider which determines the output voltage of the battery charger. Diode CR4 is an isolation diode that protects the charger.

4.5.3 Overvoltage Shut Down Latch Circuit

The major components of this circuit are transistors Q15, Q16 and Q17. The latch is set by either of the overvoltage sensors Q20 or Q21. The positive OVP signal is developed when either Q20 or Q21 senses the OVP condition. When transistor Q17 of the latch detects

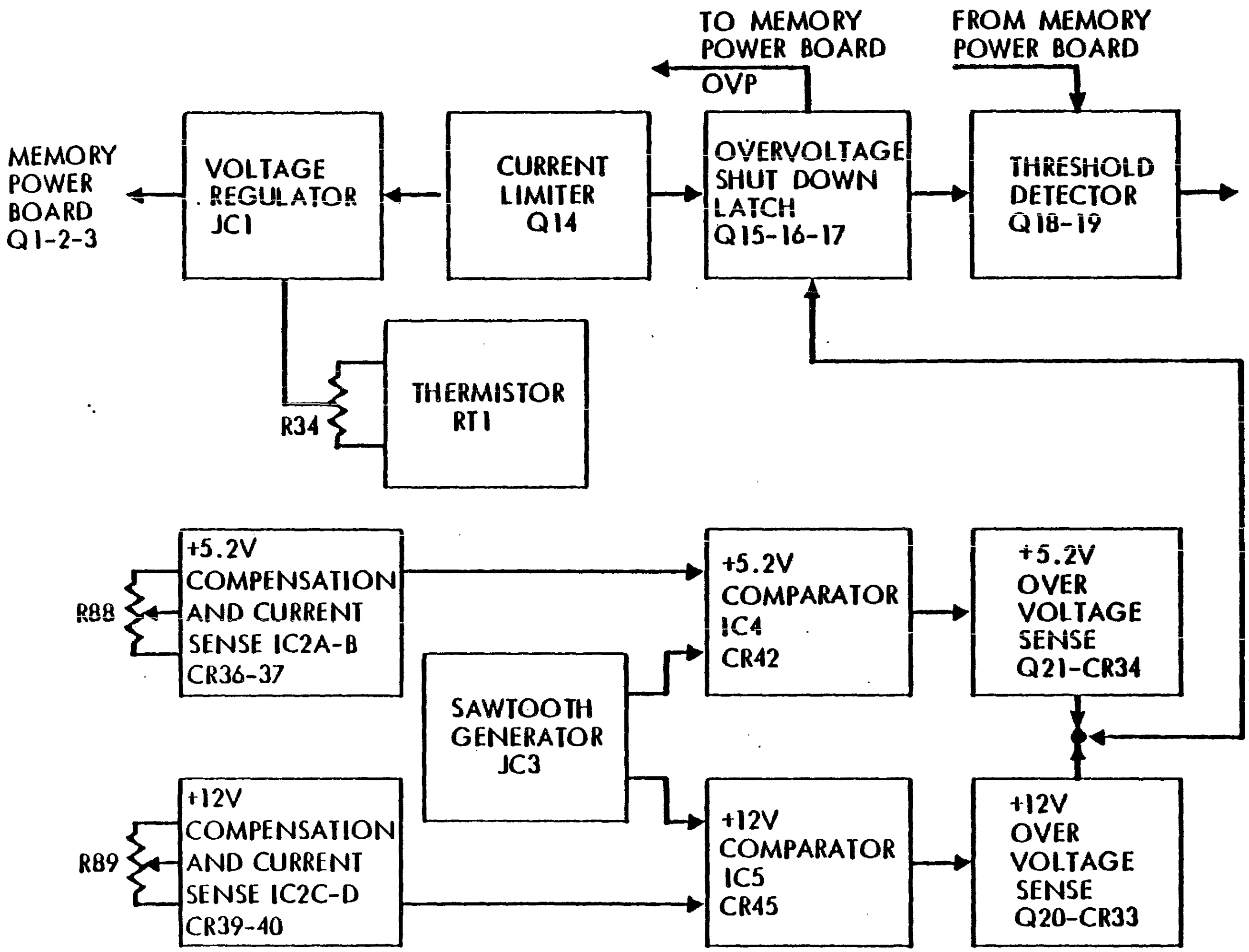

Figure 4-5. Regulator Board Functional Diagram

the OVP signal it conducts and Q16 latches Q17. Transistor Q16 also forces Q19 to conduct which pulls the cathodes of CR43 and CR44 low. With both CR43 and CR44 low output signals 12D and 5D go low respectively. Each of these signals shut down the associated switching regulator of the memory power board.

Diode CR27 isolates the sense bleeder (R44, 45, 46, 47) from the latch circuits. Resistor R43 furnishes base current for Q16 on power turn-on. CR29 biases Q16. Resistors R39 and R40 are current limiting resistors and CR26 isolates R37 and R38 from R40. Resistors R41 and C16 provide a time delay for Q15, transistor Q15 is a current source that delays the availability of current to the base of Q17 on power-up. Transistor Q16 must turn on first when power is applied. Detector CR28 isolates R45 and R46 from R42 when the NDSOFF signal goes high (regulators enabled). Resistor R22 is the pull up for the NDSOFF line, capacitor C18 attenuates noise on the line. The VS supply must exceed about 26 volts for operation to commence, but when Q19 is off, R50 shunts R45, 46, 47 and the memory power module will not shut down until VS drops to about 15VDC.

Capacitor C20 is a decoupling capacitor. Resistor R55, zener diodes CR34 and CR35 act as a voltage divider to provide bias for Q20 and Q21. R52 and R56 are current limiting resistors. R51 is the base return for Q20. Diode CR33 prevents the Q20 base emitter junction from being back biased.

4.5.4 Threshold Detector Circuit

The major components of this function are transistors Q18 and Q19. Transistors Q18 and Q19 are the threshold detector. Resistors R44, R45, R46, R47 comprise a voltage divider that determines the value of VS that will cause the supply to start. When the voltage at the cathode of CR30 exceeds 8.2 volts, Q18 will conduct and Q19 turns off. At this time, CR43 and CR44 become reverse biased and operation starts. Transistor Q20 senses the 12 volt supply overvoltage condition by monitoring the 12M line from the memory power board. Likewise Q21 senses the 5 volt supply overvoltage condition by monitoring 5M line. The collector resistors, R53 and R57 of Q20 and Q21, limit the gate currents of SCR's Q8 and Q13 of the memory power board. Resistors R54 and R55 are Q8 and Q13 gate returns.

4.5.5 5.2I Current and 5.2V Voltage Sense Circuit

The major components of this function are IC2-4 and IC2-8 which are part of four independent operational amplifiers. Two amplifiers are associated with each regulator. The circuit inputs are the 5I and 5M (outputs of the regulator) from the memory power board and the wiper arm of the potentiometer R88. The outputs of IC2-8 and IC2-14 are wire OR'ed and input the comparator IC4-3. This output is compared with a reference from a sawtooth generator IC3. Amplifier IC2-8 serves as an integrator with its negative input terminal, the arm of potentiometer R88, set at +5.2 volts by means of the voltage divider string R63, R88, R64. Since only the operational amplifier input current flows through the input resistor the integrator does not load the voltage divider. The output of IC2-8 is the integral of the error signal sensed between the +5.2M voltage and the reference voltage (arm of R88). When the error signal (+5.2M-VR) increases, the voltage at IC2-8 increases, causing the average value of the voltage applied to L6 (memory power board) to decrease. Capacitor C25 and resistor R65 form the integration time constant, while C23, C24 and R66 form the remainder of the loop compensation parameters. When the current through sense wire A-A develops (5L regulator board) 60 millivolts across A-A, the voltage at IC2-14 will exceed that at IC2-8. Then the voltage at IC2-8 will decrease attempting to maintain control. Because of CR37, IC2-8 decouples from IC4-3. On this occurance IC2-14 has control. Operational Amplifier IC2-14 and resistors R59, 60, 61, 62 with the drop across A-A determine the value of the current maintained at R60. Because R60 also senses output voltage, foldback occurs. C21 stabilizes the current loop.

4.5.6 12I and 12V Sense Circuit

This function is nearly identical to the circuit description of the 5.2I and 5.2V sense function of section 4.4.5. Refer to section 4.4.5 for a description of the 12I and 12V sense function.

4.5.7 Sawtooth Generator Circuit

This function generates a sawtooth voltage which is used as a reference at the 12 volt and 5 volt comparator functions.

Integrated circuit (IC3) is the sawtooth generator. Transistor Q23 functions to charge capacitor C30, the capacitor discharges through the IC. Resistor R70 and diode CR41 determine the current through Q23. Resistor R74 sets the current through CR41. Transistor Q22 supplies 11 volts to IC3. Resistor R67 sets the current through CR38 and CR38 applies +12 volts to the base of Q22, R68 and R69 are current limiting resistors. R72 provides positive feedback for the comparator IC4-7. Finally R13 couples the sawtooth to IC4-2.

4.5.8 5.2 Volt Comparator Circuit

The major component of this function is the comparator IC4. It accepts the output of the wire OR'ed diodes CR36 and CR37. This input is compared with the output of the sawtooth generator. The generator generates a pulse whenever the sawtooth voltage on IC4 pin 2 exceeds the dc level on IC4 pin 3. R92 is the base return for IC4-3. The voltage on pin 3 is determined by either the output of IC2-14 or IC2-8 depending on the magnitude of the current through the sense wire A-A of the 5L regulator board. When the voltage on IC2-8 is greater than the voltage at IC2-14 the +5.2M output voltage is being controlled. If IC2-14 is more positive, the +5.2M current is being controlled.

4.5.9 12 Volt Comparator Circuit

This function is nearly identical to the circuit description of section 4.3.8. Refer to section 4.3.8 for a description of the 12 volt comparator.

SECTION 5
MAINTENANCE

It is essential that maintenance personnel be familiar with the contents of this manual (especially section 4) before attempting power supply troubleshooting. The power supply maintenance information includes a list of test equipment, circuit board repair, preventative maintenance, and corrective maintenance.

5.1 TEST EQUIPMENT

The following is a list of test equipment and tools recommended for power supply maintenance:

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

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

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

4. Soldering iron, 15-watt pencil type.

5.2 CIRCUIT BOARD REPAIR

The power supply contain standard 2-layer PC boards. The boards contain electronic components and conducting paths located on both sides.

After it has been determined that circuit board repair is required, it is recommended that the nearest Sperry Univac customer service office be contacted to install a new circuit board in the power supply and return the faulty one to the factory for repair. However, if the user decides to perform on-site repair, extreme caution must be taken to avoid causing permanent damage to the circuit board. Approved repair procedures should be followed such as those described in document IPC-R-700A prepared by the Institute of Printed Circuits.

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 on the logic diagram for that board at a location within or adjacent to the associated component symbol. The reference designator for a chassis-mounted component is stamped on the chassis near the associated component and appears on the associated schematic diagram within or adjacent to the component symbol. For integrated circuit (IC) components, the IC reference designator appears on the PC board next to the IC package and within each associated logic symbol on the logic diagrams. The individual logic circuits of a multi-circuit IC can be identified on the logic diagrams and located on the PC board by the IC pin numbers. The numeral 1 or a mark designating pin 1 appears on the PC board adjacent to pin 1 of each IC package.

5.4 ADJUSTMENTS

The +5L, +5.2M, +12M output voltages and power failure threshold voltages can be adjusted in the field if required. All are initially adjusted at the factory, and thus should be re-adjusted in the field only after assurance that adjustment is required. These adjustments are included in section 5.8. The +12L and -12L output voltages are not adjustable.

5.5 PREVENTATIVE MAINTENANCE

Preventive maintenance of the power supply consists of visual inspection and cleaning, and should be performed at periodic intervals to prevent unnecessary failures and repairs.

5.5.1 Inspection

With the power supply unplugged and deenergized, remove the cover and visually inspect the power supply for accumulated dust, dirt, loose or unattached hardware, and foreign debris. Remove all plug-in PC boards and inspect contacts for oxidation and proper mating. With the plug-in boards removed, inspect all other PC boards for corroded solder connections, oxidized and bent connector pins, and loose or unattached components. Inspect the power supply cables to ensure that they are not under abnormal tension in any direction and inspect the cable connectors for oxidation and proper mating of connector pins.

5.5.2 Cleaning

Clean the interior of the power supply by blowing out accumulated dust and dirt with an air hose. Remove loose hardware and foreign debris that may have fallen into the power supply by tilting the unit on end and shaking gently.

Clean all PC board contacts with a good contact cleaner and allow the cleaner to dry before replacing the board. Also clean cable connector pins and PC board connector pins with contact cleaner and straighten any bent pins.

5.6 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 corrective maintenance sections. If adjustments do not correct the malfunction, refer to corrective maintenance sections.

Due to the system power supply being modular and the types of modules being optional the remainder of this section will be treated on a modular basis. Because the optional modules derive their primary power from the ac power board of the system power supply these circuits will be covered first. The memory power module, logic power module, and data communications power modules will follow.

5.7 ADJUSTMENTS

The procedure consists of monitoring test points, adjusting the ac power fail threshold and power module voltage adjustments.

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

Name	Voltage	Tolerance	Test Point	Return
Input ac	117 ac	±2.34V	E3	E1
Distribution	117 ac	±2.34V	J1 - J7 pin 2	E1
Distribution	117 ac	±2.34V	J1 - J7 pin 1	E1

Power Failure Threshold. Use the variable ac power source (section 5.1) to provide the input voltage at the ac power board. Use the digital multimeter to monitor the input voltage at TP-E3 and TP-E1 (return). Check the power-fail alarm threshold voltage as follows:

1. Before applying power to the variable ac power transformer set the dial for a 117V ac output. Jumper J11-1 to J11-4. Line frequency shall be normal system power line frequency.

2. Apply power to the variable ac power transformer and observe that the multimeter reads 117±2V ac.

3. Use the oscilloscope dual trace to monitor the NCLSW2 signal at J11-2 to J11-3 respectively. Observe that the signal is high.

4. Slowly turn the dial on the variable ac power source until the multimeter reads 98.0V ac and observe that the NCLSW2 signal is low.

Voltage Adjustments. After setting up the equipment, perform the following procedures depending upon the optional power modules installed in the systems power supply.

a. Logic Power Module(s). Adjust the logic power, adjust control(s) for 5.2±0.05 dc. These control(s) are located on the connector plates of the system power supply. The voltage should be measured at the power supply.

b. Memory Power Module(s). Adjust the memory power, adjust control(s) +5.2M and +12M for +5.2±0.05V dc and +12±0.1V dc respectively. The voltages should be measure at the load.

c. Data Communications Power Module. Because the supply generates non-critical tolerance voltage, the module has no external adjustment. Should the +12 volts or -12 volts be in excess of 0.6 volts out of tolerance. Check the module's internal voltage adjustment or replace the supply.

After setting up the equipment and performing the procedures for checking the power-failure-alarm threshold voltage previously described adjust this voltage to the required threshold amplitude by setting potentiometer R9 (ac power board) until NCLSW2 signal goes low when the input voltage is set at 102.00V ac.

5.8 CORRECTIVE MAINTENANCE

Corrective maintenance of the power supply consists of checking voltage and control outputs, troubleshooting hints and fault isolation techniques. Corrective maintenance of the system power supply is performed when a failure occurs within the system power supply/optional power modules.

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 remain incorrect, the malfunction is likely in the power supply. Cycle ac power to determine if the over-voltage protection circuitry was activated.

Troubleshooting Hints. When troubleshooting the system power supply, remember that the optional power modules derive their input power from the ac power board. Each optional module (logic-memory-Data communications) must be plugged into one of the ac power distribution connectors (J1 through J7) of the ac power board. Each of the optional power modules contains a line fuse. The ac power board is thereby protected by an inadvertant shorted power module.

If none of the power modules are generating output voltages the trouble is in the ac power board its input circuits (line cord-fuse-surge supressor-RFI filter), or output circuits (ac power distribution connectors/harness).

If only one of the power modules has no output, the module is probably faulty, its line voltage connector is not connected/malfunctioning or the line fuse is blown or missing. In this case (only one power module faulty) the ac power board (power fail detect excepted) and its interfaces are good. To turn the power supply on or off by the front panel switch, J9-1 must be jumpered to J9-2 to simulate a remote control switch closure.

Procedures for isolating the major causes of power supply failures are listed by the following tables: Table 5-1 includes troubleshooting the ac power board, the memory power board and the memory power regulator board. Table 5-2 is the troubleshooting procedure for the bus driver board. Faults not listed in the table require a good understanding of power supply theory of operation before they can be corrected. Maintenance personnel should become familiar with the theory of operation (section 4) before attempting to

Table 5-1. Fault Isolation Techniques

Symptoms	Fault	Action
All of the dc outputs, expansion ac outputs, expansion control outputs, and power fail outputs are missing with the following conditions existing: ac power cord is plugged into a proper power source, fuse (F1) is inserted and not blown, panel switch S1 is on, remote on/off is on.	Power relay K1 of the ac power board is not energizing. Cooling fans are not operating. No voltage at the primary (pins 1 and 2) of transformer T1.	Check RFI filter FL1, and cable harness.
	Power relay K1 of the ac power board is not energizing. Cooling fans are not operating. The appropriate line voltage and frequency are present at the primary (pins 1 and 2) of transformer T1.	Check transformer T1 primary, panel switch SW1, transformer T1 secondary capacitors C2, and surge suppressor RV5, remote input 28V ac and LFRTC.
	Power relay K1 of the ac power board is not energizing. Cooling fans are not operating. 28V ac is present at pins A & B of relay K1.	Replace relay K1.
	Power relay K1 of the ac power board energized. Cooling fans not operating.	Check wiring between relay K1 and connectors J1 through J7.
All of the dc outputs of the systems power modules are available and are the proper voltages.	The current switch output (NCS+) of the power fail detect circuit (J11-3) is malfunctioning. The system power	Check bridge rectifier CR1 through CR4, transistor Q1, zener diodes CR5, CR6 with associated resistors and capacitors.

Table 5-1. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
	fail detect function is inoperative.	When the faulty component has been replaced, the 19 vdc (unloaded) signal will be restored. The power fail detect function will be restored.
All of the dc outputs of the system power modules are available and they are the proper voltages. The power fail threshold adjustment does not control the threshold.	Both of the power fail detect signals NCLSW1 and NCLSW2 fail when the system power supply line voltage is above 102V ac. The power fail detect current loop signal (NCS) is good.	Check bridge rectifier, CR7 through CR10, CR11, zener diodes CR12, and CR13, CR14 through CR17, IC1, IC2, Q2 and associated resistors and capacitors.
	Only one of the power fail signals NCLSW1 or NCLSW2 fail when the system power supply line voltage is above 102V ac. The power fail detect current loop signal (NCS) is good.	If NCLSW1 is bad, check transistor Q5, CR20, IC3 with associated resistors and capacitors. If NCLSW2 is bad check transistor Q4, CR21, or IC4 and associated components. When the power fail detect circuits have been returned to normal and the ac line voltage falls below 102V ac, transistor switches Q4 and Q5 open sending a power fail

Table 5-1. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
		indication to the bus driver board(s) of the processor chassis which generate system power fail (SPFA) and system reset (SRST) signals.
There is no remote turn-on function (no current path for signal ac EXP and LFRTC of J8 pins 1 and 2). All other functions normal.	Relay contacts 4 and 7 not providing continuity when relay energized.	Replace relay K1.
The data-save off function is malfunctioning. The battery back-up of the memory supply modules remains on when the computer key switch is in the off position. NDSOFF signal at J8 and J9 bad.	The ground connection provided by tie point E7, S1 contacts 2 and 3 to connectors J8 and J9 are lacking continuity.	Replace panel switch SW1 or repair the faulty connection.
All of the dc outputs are available except the +5.2M and +12M outputs of only one memory power module. Because of options more than one memory power module may be installed in a system power supply. All of the ac power outputs are good.	The malfunction is limited to the memory power module in question. Both the +5.2M and +12M voltages are bad at the output of the memory power board.	Replace or troubleshoot and repair the memory power module.

Table 5-1. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
	There is no dc input voltage at the input terminals E4 and E5 of the memory power board. There is no ac input to transformer T1.	Ensure that the memory power modules input cable is connected to one of the ac distribution connectors of the ac power board. Check fuse F1 for proper rating and continuity.
	There is no dc input voltage at the input terminals E4 and E5 of the memory power board. The proper input voltage and frequency is applied to transformer T1, pins 1 and 6.	Check transformer T1, capacitor C1 and full wave bridge rectifier CR1. When the trouble is corrected a nominal +28V dc will appear at terminal E4 of the memory power board.
	A nominal 28V dc appears at the input terminals E4 and E5 of the memory power board. There is no emitter bias on either of the switching transistors Q4 and Q9.	Check RF choke L1, and filter capacitors C1, C2 and C3.
All of the dc outputs are available except the +5.2M outputs of only one memory power module. A nominal +28V dc is available at the output of the filter L1-C4 of the memory power board.	The +5.2M switching regulator (transistors Q4, Q5, Q6) or an associated diode, zener diode, resistor or capacitor is bad.	Isolate and replace the faulty component. The +5V dc will return to terminal E18.

Table 5-1. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
All of the dc outputs are available except the +12M outputs of only one memory power module. A nominal +28V dc is available at the output of filter L1-C4 of the memory power board.	The +12M switching regulator (transistors Q9, Q10, Q11) or an associated diode, zener diode resistor or capacitor is bad.	Isolate and replace the faulty component. The +12V dc will return to terminal E19.
All of the dc outputs are available. There is no voltage regulation of the +12M or +5.2M outputs of only one memory power module.	The +12M and the +5.2M voltage adjustment potentiometers have no control of adjusting the memory power module.	Check the following regulator board components. Voltage regulator (IC3), transistors Q22 - Q23, diodes CR38 - CR41 and associated resistors and capacitors.
	The +5.2M voltage adjustment potentiometer has no control over adjusting the +5.2M output. The +12M output is regulated and adjustable.	Check integrated circuits IC2-14, IC2-8 diodes CR-36, CR-37, and IC4 with zener diode CR42.
	The +12M voltage adjustment potentiometer has no control over adjusting the +12M output. The +5.2M output is regulated and adjustable.	Check integrated circuits IC2-1, IC2-7, diodes CR39, CR40, IC5 and zener diode CR45.
All of the dc outputs are normal with the exception of one memory power module.	The threshold detector circuits are malfunctioning. The supply	Check threshold detector transistors Q18 and Q19, zener diode CR30, diodes

Table 5-1. Fault Isolation Techniques (continued)

Symptoms	Fault	Action
The outputs are abnormally low or the supply shut down and cannot be restarted.	should shut down when the supplies internal voltage (VS) falls below +15V dc. It should not start up until VS. reaches 8 volts.	CR31, 32 and CR43, 44. When an overvoltage condition exists Q19 conducts pulling the cathodes low. When the circuit is restored to proper action this will turn off both regulators and prevent overvoltage. The latch Q15, Q16, and Q17 with related components can cause the same symptoms.
All of the dc outputs are normal with the exception of either the +5.2M or +12M output from one memory power module. Either the +5.2 or +12M output has an overvoltage condition.	The memory power module fuse has blown. A replacement fuse also blows. Either the +5.2M or +12M overvoltage protection circuits have failed.	Check transistors Q7, zener diode Q8 and diodes CR13, CR44 for lack of overvoltage protection for the +5.2 volt circuits. Check transistor Q12, zener diode Q13, and diodes CR22, CR43 for lack of overvoltage protection for the 12 volt circuits. Should the supply lack overvoltage protection for both the +5.2M and +12M circuits, additionally check the latch transistors Q15, Q16 and Q17. Diodes CR31, CR32 and zener diode CR30.

Table 5-2. Bus Driver Board Troubleshooting Techniques

Symptoms	Fault	Action
The ac power board of the systems power supply is generating a power fail detect signal due to an actual power failure. The bus driver board is not generating systems reset (SRST) or systems power fail (SPFA) at J1 pins 5 and 3 respectively.	Relay K1 does not energize SRST and SPFA are held to ground.	Measure the source of the voltage for the board if the source is available ensure that the same +5V dc is available at pin 1 of J2.
	Relay K1 does not energize with +5V present at pin 1 of J2.	Measure voltage at pins 1 and 2 of relay K1. If +5V dc is present change the relay. If +5V dc is not present at the relay check transistor Q1, diode CR8 zener diode CR7 and associated components.
	Relay K1 energizes and the power fail signal is present at the boards input (pins 1 and 2 of J3) but there is no signal at test point 1 (TP1).	Check transistor Q1, photo transistor IC2, and diode CR1 along with related components.
	The signal is present at TP1 but it is not present at the output of integrated circuit IC6-13.	Troubleshoot IC6-13 and IC6-2 along with its related components.
The ac power board is generating a power fail detect signal due to an actual power failure.	The bus driver board is generating the SRST signal but it is not generating SPFA.	Check transistor A2, Q4, Q5 integrated circuits IC6-1, IC6-2 and related components.

perform corrective maintenance. After a failure has been isolated to a particular chassis circuit the faulty component(s) must be replaced. If a faulty circuit has been located to a particular board repair the circuit or replace the board.

5.9 LOGIC POWER MODULE CORRECTIVE MAINTENANCE

Should the module voltage outputs fail, first check the fuse and ensure that the module is connected to one of the connectors (J1 through J7) of the ac power board. If the 5 volt 5L voltages are out of tolerance, try adjusting the voltage at the appropriate connector plate of the system power supply rear panel. If none of the foregoing correct the problem, replace the logic power module. Field repair of this module is not recommended due to the dangerous voltages within this module.

5.10 DATA COMMUNICATIONS POWER MODULE CORRECTIVE MAINTENANCE

Should the module voltage outputs fail, first check the fuse and ensure that the module is connected to one of the connectors (J1 through J7) of the ac power board. If the foregoing does not correct the problem, replace the data communications power module.

5.11 DATA-SAVE OPTION MAINTENANCE

Maintenance of the data-save option consists of visual inspection, cleaning, checking performance, making an adjustment and isolating faults.

With power supply cover removed from the system power supply; and the cover removed from the memory power module inspect the data-save circuits of the memory module chassis, memory power board, and the memory regulator board. Check for accumulated dust, dirt, loose or unattached hardware and corroded terminals and terminal contacts. Replace any leaking batteries.

Remove the battery retaining plate from the battery case on the power supply back panel, remove the data-save batteries, and inspect the inside of the case for accumulated dust, dirt, corrosion, and terminal contacts for corrosion.

5.11.1 Cleaning

The data-save circuit board and the inside of the battery case may be cleaned by blowing out accumulated dust and dirt with an air hose. Corrosion may be removed with a contact and terminal cleaner (liquid) or a burnishing tool. Corroded terminals and terminal contacts should be cleaned with liquid terminal cleaner and burnishing tool. To prevent further corrosion, terminals and terminal contacts can be coated with a thin film of silicone grease, as required.

5.11.2 Performance Check/Adjustments/Troubleshooting

To ensure that the data-save option is in satisfactory working condition, check its performance at regular intervals. This check includes test, adjustment, and troubleshooting of the battery charge circuit and the input and output voltage circuits of the data-save board located in the power supply.

5.11.3 Battery Charge Circuit

Remove the cover from the supply and remove the data-save connector from the J3 at the system power supply rear panel. With the memory module operating, VS at terminal (E8 through E11), use the digital voltmeter to monitor the dc output voltages at the indicated data-save circuits of the memory power and memory regulator board. See table 5-3.

Table 5-3. Battery Charge Circuit Adjustments and Troubleshooting

Step	Test Point	Return	Voltage	Adjustments and Troubleshooting
1	E8	E5	+29±3.5V dc	If the voltage is not present check the output of the voltage regulator or (IC1 pin 11) and zener diode CR23 of the memory regulator board. Replace the faulty component.
2	E8	E5	+20±2.4V dc at 1ma	If the voltage and current is present, but out of tolerance adjust potentiometer R34 at the voltage regulator on the memory regulator board.
3	E1	E5	+20.5±2.4V dc	If no voltage is present check pin 12 of the voltage regulator, diode CR25 and the circuits associated components.

Table 5-3. Battery Charge Circuit Adjustments and Troubleshooting (continued)

Step	Test Point	Return	Voltage	Adjustments and Troubleshooting
4	E8 E1	E5 E5	29±3.5V dc 20±2.4V dc	If the voltage is present within tolerance check the battery charging transistors Q1, Q2 and Q3 and associated components of the memory power board.

SECTION 6
MNEMONICS

Mnemonic	Description
A-A	Memory Power Module Sense Wire
AC EXP	AC Expansion
CPU	Central Processing Unit
I/O	Input/Output Unit
LFRTC	Line Frequency Real Time Clock
LFRTC+EXP	Line Frequency Real Time Clock Expansion
NCS	Current Source
NCLSW	Current Loop Switch
NDSOFF	Data-Save Off
NDSOFF EXP	Data-Save Off Expansion
NHOLD	Hold
NHOLD EXP	Hold Expansion
NPWROK	Power OK
OVP	Overvoltage Protection
SPFA	System Power Failure
SPFD	System Power Failure Detect
SRST	System Reset
+5L	Logic Power Module +5V dc Output
+5.2M	Memory Power Module +5.2V dc output
+12L	Data Communications Power Module +12V dc Output
-12L	Data Communications Power Module -12V dc Output
+12M	Memory Power Module +12V dc output
Vs	Memory Power Module Filtered output