HEWLETT-PACKARD

Portable PLUS Service Manual

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HEWLETT PACKARD

Portable PLUS Service Manual

(Including A, B, C, D, E, and F Versions)

For all A, B, C, and D versions of the Portable PLUS and for all E and F versions with serial numbers before 2713A———, the service information in this manual must be revised according to chapter 11. For memory and software drawers with serial numbers before 2547A———, service information must be revised according to chapter 11.

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General Information

1.1 Description

The Portable PLUS Computer is a battery-powered computer with a full-sized keyboard and a liquid-crystal display (LCD). The display shows 25 80-character lines of alphanumeric information or 480-by-200 dots of graphics. The display viewing angle can be adjusted by tilting the hinged top case. Display contrast is adjustable by pressing the contrast key.

System memory/Electronic disc consists of 512K bytes of random-access memory (RAM), 192K bytes of read-only memory (ROM); and 8K bytes (expandable to 16K) of configuration EPROM (eraseable, programmable read-only memory) containing specialized system information. The partition of system memory and electronic disc is configurable.

The central processing unit (CPU) is an 80C86 microprocessor.

Real-time clock with alarm, time zone, adjustable accuracy, and audio beeper functions are provided for by the 146805G2 peripheral processing unit (PPU).

The computer is powered by a sealed rechargeable 6-volt lead-acid battery and can be used while the battery is being recharged by the ac adapter.

The computer provides two external connectors for input/output (I/O) operations: an HP-IL (Hewlett-Packard Interface Loop) interface, and an RS-232-C/CCITT V.24, V.28 compatible serial interface. (CCITT stands for Comite Consultatif Internationale de Telegraphie et Telephonie).

The Portable PLUS has several language, memory, and modem configurations. The model number marked on the bottom label indicates the version. Refer to table 1-1.

Table 1-1. Portable PLUS Configurations

Model Number	Meaning	
HP 45711*xy*	Language (and Keyboard)	
	(blank):	U.S. (U.S.).
	A:	South African (U.S.).
	B:	English-European (U.S.).*
	D:	German (German).*
	F:	French (French).
	H:	Dutch (Dutch).
	K:	English-International (U.S.).*
	N:	Norwegian (Norwegian).*
	P:	Swiss-German (Swiss-German).*
	Q:	Swiss-French (Swiss-French).*
	S:	Swedish (Swedish).*
	U:	U.K. (U.K.).
	W:	Belgian (Belgian).*
	Y:	Danish (Danish).*
	Z:	Italian (Italian).*
	Version (Memory and Modem Configuration)§	
	A:	128K, with modem.†
	B:	128K, no modem.
	C:	256K, with modem.‡
	D:	256K, no modem.
	E:	512K, with modem.‡
	F:	512K, no modem.

* Available only without modem.

† Available only with HP 82983A 300/1200 BPS Modem.

‡ Actual modem depends upon language of the computer. For example, the HP 45711C (a U.S. version) has an HP 82983A 300/1200 BPS Modem installed.

§ A, B, C, and D versions and early E and F versions are covered in chapter 11.

The following extensions are available for the Portable PLUS: HP 82981A Memory Drawer (128K bytes of RAM), HP 82992A 1M-Byte Memory Drawer, HP 82982A Software Drawer (for installing ROMs), HP 82983A 300/1200 BPS Modem (installed internally), HP 82984A Expansion Card (128K bytes of RAM; one or two can be installed in a memory drawer), and HP 50922A SNALink/3270 Software Drawer. The modem is to be installed by a dealer or at a Field Repair Center; the other extensions can be installed by the customer.

1.2 Specifications

Specifications for the Portable PLUS are listed in table 1-2:

Table 1-2. Portable PLUS Specifications

Physical Properties

- Dimensions: 33.0 × 25.4 × 7.3 cm (13.0 × 10.0 × 2.9 inches) closed.
- Weight: 4 kilograms (8½ pounds) with battery.

Power Requirements

- Battery type: 6-volt, sealed, three-cell, lead-acid battery.
- Battery voltage: 5.6 to 7.5 volts.
- Battery capacity: 2½ ampere-hours.
- Recharging time: 10 hours if computer is turned off, 18 hours if computer is turned on.
- Power consumption: 125 mA typical on.
  285 μA typical off (sleep mode).

Environmental Limits

- Operating temperature: 0 to 50°C (32 to 122°F).
- Storage temperature: −25 to 55°C (−13 to 131°F).
- Humidity: 5 to 95 percent relative humidity (including condensing).
- Altitude (unpressurized conditions):

  4600 meters (15,000 feet) operating.
  15,000 meters (50,000 feet) storage.
- Vibration: 3g, 5 to 500 Hz.
- Drop: 100g all sides.
- ESD: 10 kV without loss of data.
  10 kV without hard failures.

Display

- Type: high-contrast, wide view angle, liquid-crystal display (LCD).
- Area: 23 × 9.6 cm (9.06 × 3.8 inches).
- Refresh rate: 52.1 Hz.
- Contrast: adjustable via keyboard.
- Alpha formats: 25 lines by 80 characters.
- Graphic format: 480 by 200 dots.

Keyboard

- Design standard: Hewlett-Packard ITF (Integrated Terminal Family).
- Style: full-sized, low-profile keyboard.
- Keys: 76 short-stroke keys.
- Functionality: alphanumeric, display control, edit, special function, function control, terminal control, and embedded numeric keypad.

Table 1-2. Portable PLUS Specifications (Continued)

Memory

- ROM: 192K bytes.
- RAM: 512K bytes (versions E and F).
  256K bytes (versions C and D).
  128K bytes (versions A and B).
- Display RAM: 16K bytes.
- Configuration EPROM: 8K bytes, expandable to 16K.

HP-IL Interface

- Default status: controller.
- Cables: refer to section 1.4.
- Uses: disc drive, printer, plotter, modem, etc.

Serial Interface

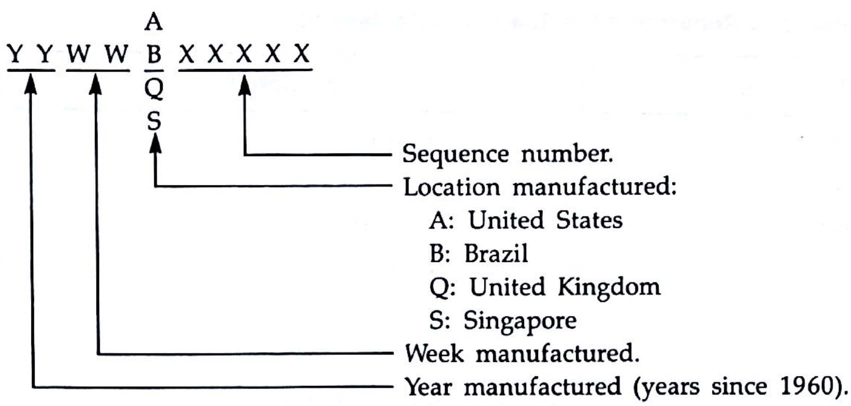
- Compatability: RS-232-C/CCITT V.24, V.28 standards.
- Selections: baud, parity, word length, handshake, and stop bits.
- Baud rates: 110, 135, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600, and 19200.
- Connector: Female 9-pin D-subminiature.
- Cables: refer to section 1.5.
- Uses: printer, modem, etc.

Optional Modem (HP 82983A)

- Compatability: Bell 212A protocol.
- Operation: full-duplex and asynchronous.
- Baud rates: 110, 150, 300, and 1200 bps
- Modes: Originate and Answer.
- Dialing: pulse and tone.
- Answering: automatic and manual.

1.3 Identification

The serial number of the Portable PLUS is used for identification and determination of warranty status. It is located on either the bottom of the case or on the bottom label. Its format is described as follows:



1.4 Accessories

The following accessories are available for the Portable PLUS:

- HP-IL cables:

  ½ meter (1 ½ feet) model HP 82167A.
  1 meter (3 feet) model HP 82167B.
  5 meters (16 feet) model HP 82167D.

- Serial interface cables (with 25-pin D-subminiature connector):

  Modem (DCE) cable (male connector) model HP 92221M.
  Printer (DTE) cable (male connector) model HP 92221P.

- Serial interface adapters (25-pin D-subminiature connectors):
  Female adapter (for converting interface cable) model HP 92222F.
  Custom wiring kit (male and female connectors for customizing interface cables) model HP 92222W.

- Rechargers: refer to table 8-13.

1.5 Test Equipment

Table 1-3 lists tools and equipment needed to repair the Portable PLUS. The list includes the tools you'll use for troubleshooting and for removing and replacing assemblies and components, as described in chapters 8 and 6.

Table 1-3. Recommended Tools and Equipment

HP Part/Model Number	Description
45711-60910*	Diagnostic module.
45711-60907*	Keyboard extension cable.
45711-60908*	LCD extension cable.
1420-0346	Service battery.
45711-60985‡	Service disc.
HP 9114A	Disc drive.
00090-60914*	RS-232-C test connector.
82986-60902	SNALink test board.
82167-60001*	HP-IL cable, ½ meter.
HP 6216B†	Power supply, 25 Vdc, 50 mA.
HP 180C/1801A/1820C†	Oscilloscope.
HP 10004†	Oscilloscope probe.
8710-1560	Torx driver, T-6 bit.
8710-1422	Torx driver, T-8 bit.
8710-1413	Handle for Torx bits.
8710-1425	Extension for hex bits (optional).
8710-1431	Hex driver, 4 mm.
8710-1220	Hex driver, 5.5 mm.
8710-1590	Hex driver, 10 mm.
8690-0129	Soldering tool.
8690-0132	Soldering tool stand.
8690-0344	IC desoldering tool (optional).
8700-0003	X-acto knife.
8700-0006	X-acto knife blade.

* Included in expensed tool package (45711-67801).
† Or equivalent.
‡ Included in service documentation package (45711-60920).

Chapter 2
Site Preparation Requirements

There are no site preparation requirements for the Portable PLUS Computer.

Chapter 3
Installation and Configuration

3.1 Preparation

The Portable PLUS is a truly portable computer: it can be used at a fixed work station, and it can be carried to practically any location.

A typical work station might require space for peripheral devices, such as a disc drive and a printer. A power outlet is needed for recharging the computer's battery and for recharging or plugging in peripheral devices.

For portable use, the computer can be used almost anywhere, since it contains its own battery power. (Refer to the environmental specifications in table 1-2.) Battery-powered peripheral devices might also be used. However, the computer provides an internal "electronic disc" (mass storage memory), which reduces the need for a peripheral mass storage device during remote operation.

3.2 Installation

Installation isn't required to operate the Portable PLUS. However, the battery jumper (located in the battery compartment) must be installed in the "ON" position for the unit to operate. If the computer's battery is sufficiently charged, (at least 20% battery charge shows in the main PAM screen) the unit is ready to operate as a stand-alone computer. If the battery is insufficiently charged, connect the recharger to the computer (figure 3-1)—the computer can be used while its battery is recharging.

Note: If the battery fuse is blown, the unit will not operate unless a recharger is connected. Replace the fuse before proceeding.

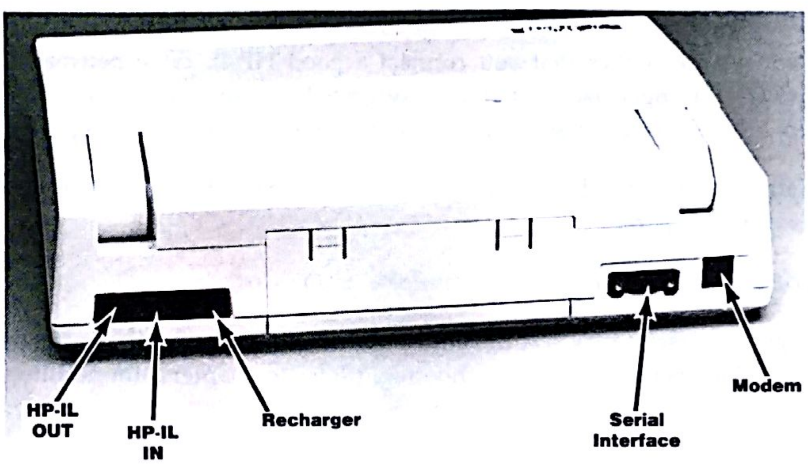


Figure 3-1. Recharger and I/O Receptacles

Peripheral devices are installed by connecting them to one of the I/O receptacles at the back of the computer (figure 3-1):

- HP-IL devices are connected in series between the computer's IN and OUT receptacles using HP-IL cables. Cables are keyed to ensure correct polarity. All HP-IL devices must be turned on for the HP-IL interface to operate.
- One serial device can be connected to the serial interface receptacle using a serial interface cable.
- A phone line can be connected to the (optional) HP 82983A direct-connect modem receptacle using a cable with a standard modular telephone plug. (The Federal Communications Commission requires specific procedures for installing and operating equipment that uses public communications lines. These procedures are described in the modem owner's manual.)

Cables for connecting HP-IL and serial devices to the computer are listed in section 1.4.

3.3 Functional Verification

The built-in diagnostic tests verify proper operation of the computer's basic functions.

> **Note:** Be sure you back up Electronic disc RAM (drive "A") before running the RAM test or the Software/Memory Drawer test; these tests destroy some of the contents of drive "A", even though the directory and files appear to be intact. Later, format drive "A" and reload its contents.

Perform the tests as follows:

1. Turn off the computer by pressing (f8) in the main PAM screen, if present; otherwise, press and hold the contrast key (◐) for approximately 12 seconds.
2. Start the built-in diagnostic test by holding down the (Shift) and (Extend char) keys, then press and hold (f8) for 1 second, then release all three keys. It is sometimes necessary to press the contrast key (◐) in addition, to turn on the computer. (If the test menu doesn't appear, the system isn't operating properly.)
3. Perform all of the built-in tests by pressing the (f1) special-function key.

   The HP-IL test requires either that you connect a good HP-IL cable between the computer's HP-IL IN and OUT receptacles, or that you connect the computer and one or more devices (all turned on) in a loop. (Refer to section 3.2 for information on connecting HP-IL devices.)

For a good unit, all tests should indicate "ok". An error message or failure code indicates a test didn't pass and that service is required.

The built-in diagnostic tests are the only tests available to the customer.

These built-in diagnostic tests do *not* test the entire unit. More extensive diagnostic tests are provided on the service disc, which is used for troubleshooting. (Refer to chapter 8 for additional information.)

3.4 Configuration

The Portable PLUS uses software for configuring its settings, rather than using hardware (such as switch settings).

To turn on the computer, press any key; it is sometimes necessary to press the contrast key (◑) to turn on the computer. The PAM (Personal Applications Manager) screen should appear in the display.

To adjust the contrast of the display, press (◑) to increase contrast, or press (Shift)(◑) to decrease contrast. Press several times for a larger increase or decrease in the contrast.

> **Note:** If you press and hold (◑) for more than 15 seconds, the computer will turn off and the system will be reset. This affects *active* operations but does not affect stored files.

To change the time or date settings, press (f3) (Time & Date) in the main PAM screen. From the time and date menu, use the tab or cursor keys to select the fields to edit, and use the "Next Choice" and "Previous Choice" function keys to select the desired choice. Press the (f8) (Exit) function key to return to the main PAM screen.

The system configuration defines memory allocation, timeout operation, and display options; and selects a peripheral communications device (a serial RS-232-C interace or the optional direct-connect modem). To change the system configuration, press (f6) (System Config) in the main PAM screen. From the system configuration menu, use the tab or cursor keys to select the fields to edit, and use the "Next Choice" and "Previous Choice" function keys to select the desired choice. Use the (f8) (Exit) function key to return to the main PAM screen. (Choosing a *serial* peripheral may require changes in the datacom configuration, discussed next.)

The datacom configuration defines interaction between the computer and I/O devices: those connected to the serial interface, the optional built-in modem, and those connected to the HP-IL interface via an interface device such as the HP 82164A HP-IL/RS-232-C Interface. The datacom configuration also defines baud rate, word length, number of stop bits, and parity. To change the datacom configuration, press the (f5) (Datacom Config) function key in the main PAM screen. From the datacom configuration menu, use the tab or cursor keys to select the fields to edit, and use the "Next Choice" and "Previous Choice" function keys to select the desired choice. Use the (f8) (Exit) function key to return to the main PAM screen.

Refer to the Portable PLUS owner's manual for more information about the configuration menus.

Chapter 4
Preventive Maintenance

No preventive maintenance procedures are required for the Portable PLUS Computer.

Chapter 5
Functional Description

5.1 Introduction

The Portable PLUS consists of the following circuits:

Motherboard PCA (Assembly A2)

- Central processing unit (CPU) circuit.
- Peripheral processing unit (PPU) circuit.
- Address/control circuit.
- Keyboard interface.
- Liquid-crystal display (LCD) interface.
- HP-IL interface.
- Serial (RS-232-C) circuit.
- Video interface circuit.
- Modem interface circuit.
- Clock/ready circuit.
- Power supply.

Memory PCA (Assembly A1)

- System ROM and built-in RAM.
- Configuration EPROM.
- Plug-in ports.

Optional Modem PCA (Assembly A3)

- Direct-connect modem.

The reference designation for each individual component contains a prefix that indicates its associated PCA. For example, (A2U1) indicates component U1 on assembly A2 (the motherboard PCA). Refer to the schematic diagrams in chapter 12 for details of the components within each circuit.

The circuits are connected according to the block diagram in figure 5-1 and are described in this chapter.

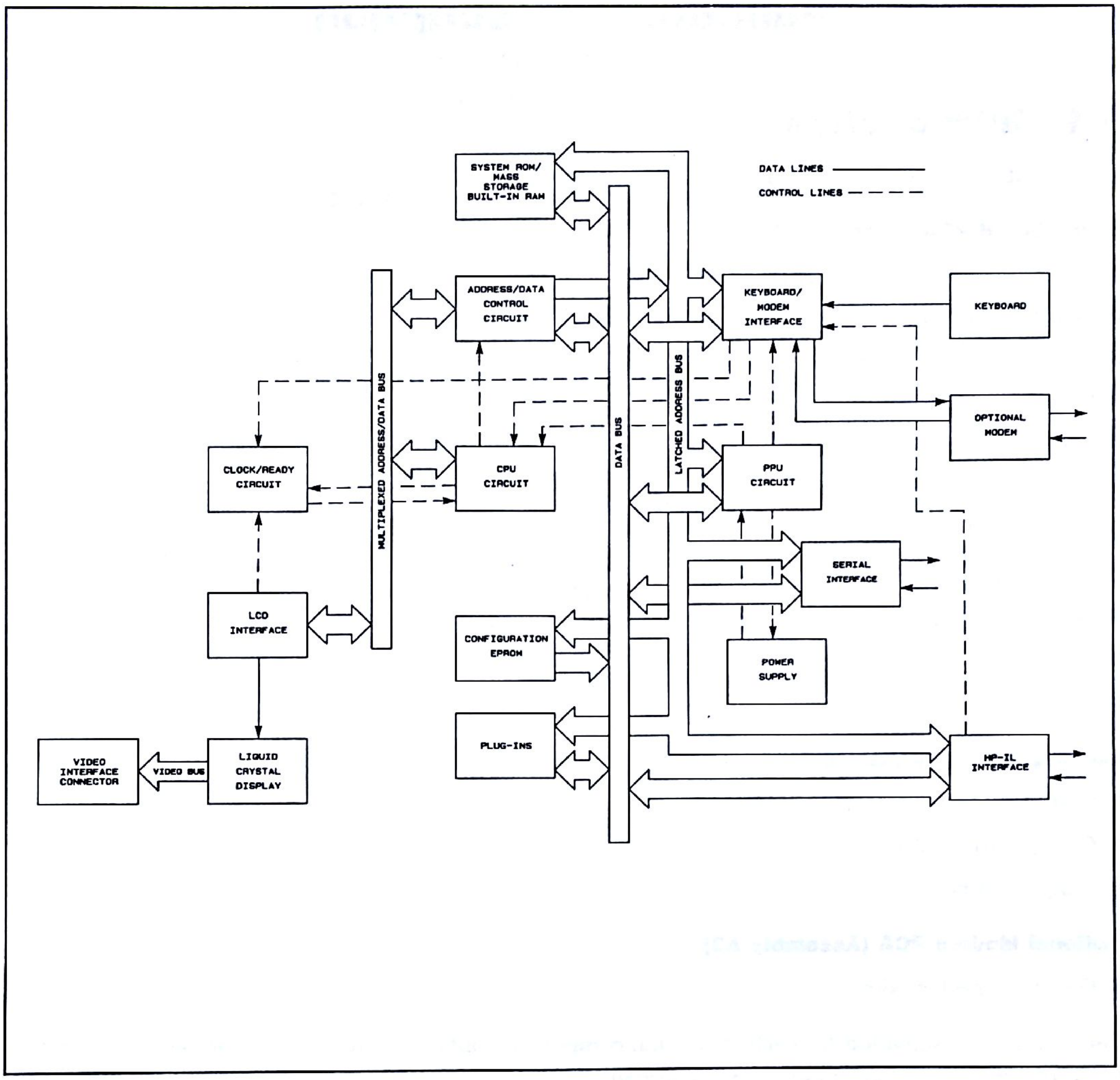


Figure 5-1. Portable PLUS Block Diagram

Note: To access the built-in diagnostics, the computer must be in its *sleep* mode (power supply line VccDS is set to 3.25 volts, and VccS is set to 0V, shutting down the CPU, RS-232-C and HP-IL interfaces, LCD, and modem). Press function key (f8) in the main PAM screen to put the computer to sleep.

To exit the built-in diagnostics, press and hold (Shift) then press function key (f8) in the self-test (built-in diagnostics) screen.

5.2 Central Processing Unit (CPU)

The CPU (A2U1) is a CMOS 16-bit 80C86 microprocessor which performs three primary functions:

- Controls the operation of circuits according to programs and data stored in system RAM/ROM, mass storage RAM, and the configuration EPROM.
- Directs the transfer of data on the CPU address/data bus and on the data bus.
- Responds to interrupts from the PPU and keyboard interface circuits.

The CPU operates at 5.33 MHz using a clock signal (CLK) provided by the clock/ready circuit (described in section 5.14).

The CPU communicates via a multiplexed 16–line address/data bus (AD0–AD15). These lines carry address information and data during separate portions of the bus cycle. Four additional address lines (A16–A19) provide the CPU with 20 address lines in all. Output line M/IO∗ selects either 20-bit addresses in main memory or 16-bit addresses in I/O memory. The only devices on this bus are the LCD controller (A2U10), a buffer (A2U8) providing the interrupt acknowledge vector, three address latches (A2U3, A2U4, and A2U5), and a pair of data bus transceivers (A2U11, and A2U12). The latches create a latched address bus and the transceivers create a data bus. The address and data buses connect to all internal devices and to the two plug-in ports.

The CPU is strapped into *minimum* mode and produces its own bus control signals. Non-maskable interrupts (NMI) can't occur because the NMI pin is grounded. A wait instruction will act as a NOP because the TEST∗ pin is grounded. During interrupt cycles, buffer (A2U8) always provides the CPU with a vector of FF hex. (Software must poll to determine which device caused the interrupt.) The two data bus transceivers do not turn on during interrupt acknowledge cycles, so an addressed plug-in card is free to drive its data bus at these times.

Power is removed from the CPU during the sleep state. When power is applied at power-up, the CPU initializes itself internally.

Figure 5-2 is the memory map addressed by the CPU:

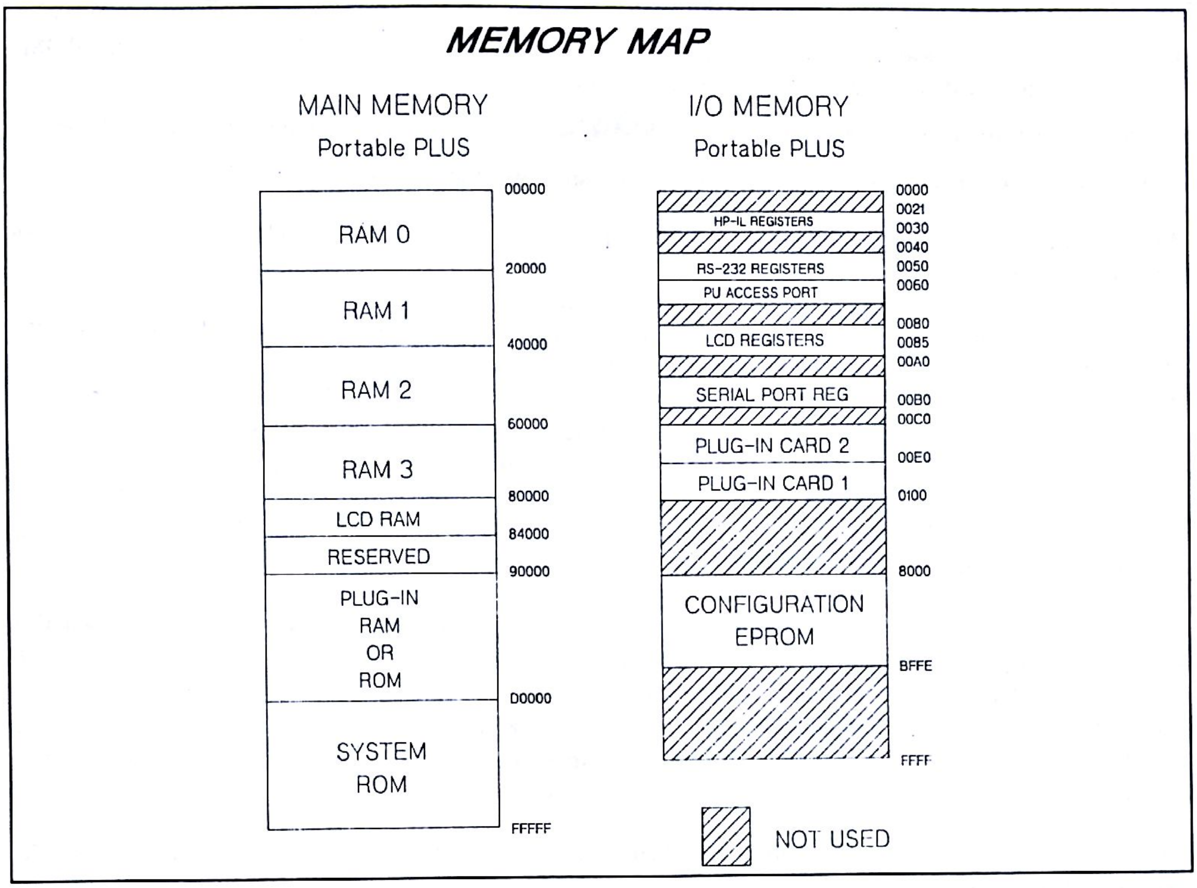


Figure 5-2. CPU Memory Map

5.3 Peripheral Processing Unit (PPU)

The PPU (A2U17) is a single-chip microcomputer of the 6805 family containing 112 bytes of RAM and 2106 bytes of ROM. It controls the computer's power supplies, modes of operation, and beeper, and provides the real-time clock. The PPU continues to run when the computer is asleep.

Pressing and holding down the (◑) key for approximately 15 seconds (or pressing (f8) in the main PAM screen) puts the computer in *sleep* mode; pressing any key should wake up the computer.

Pressing the RESET button (located at the rear of the battery compartment) resets the PPU, causing it to reboot MSDOS.

The CPU/PPU interface is an eight-bit port (at I/O address 0060 hex) integrated onto the LCD controller (A2U10). This interface consists of an eight-bit write only shift register, an eight-bit read-only shift register, and a flag bit. When the CPU writes to the shift register, the flag bit is set. The PPU then shifts out a "0" and eight data bits, and then shifts in the eight data bits written by the CPU. A busy flag is used to signal the end of the data transfer which takes a minimum of 2.3 ms to complete.

The PPU has six open drain inputs (PC0, PC1, PC3, PC4, PC5, and PC7). Every 128 ms it pulls PA3 (pin 8) low, waits 56 μs (for the input lines to stabilize), and then takes its sample. PA3 then goes high to shut off A2Q1 and save battery power.

5.4 Address/Control Circuit

The address/control circuit connects the CPU to the I/O and memory circuits located on the address and data buses. This circuit consists of latches A2U3, A2U4, and A2U5; transceivers A2U11 and A2U12; decoders A2U7, A2U9, and A2U13.

The address/control circuit interfaces the multiplexed CPU address/data bus (AD0–AD15) with the latched address bus (LA0–LA15) and the latched data bus (D0–D15). These latched buses are standard (non-multiplexed) buses. All addresses placed on the latched address bus come from the CPU.

The two latches transfer address information from the CPU address/data bus to the latched bus. When ALE is high, the signals are transferred to the CPU circuits. On the falling edge of ALE, the address signals are latched at the output.

The two transceivers buffer data between the CPU address/data bus and the latched data bus. The direction of transfer is set by the DT/R* signal from the CPU buffer (high indicates transfer from the CPU). A low DEN* signal from the CPU bus select circuit enables the transceivers. Data is transferred when a write or read signal activates the selected IC.

Decoder A2U7 selects individual circuits to transfer data on the latched data bus. When the ALE signal is low, this 3-to-8 decoder uses address lines A5, A6, and A7 to select the HP-IL interface LB3C5*, the PPU circuit PPUCS*, the keyboard interface LK5CS*, or the LCD interface registers LCDRCS*.

When signals ALE and LM/IO* are low, decoder A2U13 uses address lines A14 and A15 to select the configuration EPROM (27C64CS*) to transfer data on the latched data bus.

Buffer A2U8 provides the interrupt byte to the CPU. When the CPU sets INTA* low, the buffer pulls data bus lines D0 thru D7 high. The CPU then reads the interrupt byte (and uses only the lower byte).

A1U4 and A1U5 are 3-to-8 decoders that select one of eight 64K-byte pairs of RAM ICs. RAM is divided into four 128K-byte blocks (0, 1, 2, and 3). Decoder A1U3 provides select signals for ROM and display RAM accesses. Buffers A1U6 amd A1U7 reduce capacitive loading on the address bus to the RAM ICs. Buffer A1U1 buffers CPU control signals for the memory PCA and plug-in devices.

5.5 Keyboard Interface

Multicontroller A2U16 and the SIP resistors A2R12, A2R13, and A2R14 provide the electrical interface to the keyboard. The keyboard assembly contains the 76 key mechanisms, but no electronic components. Hardware supplies the key locations, and software maps these locations into unique key codes.

The keyboard is organized into an eight by nine matrix with three additional function-modifier keys. A matrix key connects a row to a column. The matrix uses the following precharge/discharge scheme: *columns* precharge *high*, *rows* precharge *low*.

The 1LK5 (A2U16) row drivers are tristated, and the columns are precharged. Bleeder resistor A2R14 keeps the floating rows at ground potential and the rows are read at this time. If a row goes high, a key has been pressed. Transceiver (A2U16) then switches to tristate the column precharge drivers, turn on its row drivers, and sample the column lines. Resistors A2R12 and R13 keep floating columns at the positive supply potential. If a column goes low, then a key has been pressed. A closed key will cause a square wave on the connected row and column (high pulse width is 12 μsec nominal; low pulse width is 11.25 μs nominal). When no keys are pressed, all columns are at the positive supply potential, and all rows are at ground potential.

The three function-modifier keys each have their own pull-up resistor to the +5V power supply. A closed key pulls its resistor to ground.

5.6 Keyboard Assembly

The keyboard assembly contains 76 full-travel, ¾-throw keys; it contains no active circuitry. When a key is pressed, the corresponding row and column lines are connected; this is detected by the keyboard interface circuit. Connections between the keyboard and motherboard PCA are made via the 26-pin connector A2J5. (Refer to the schematic diagram in figure 12-5 for the A2J5 connector pin assignments.)

5.7 Liquid-Crystal (LCD) Interface

The LCDC II hybrid (A2U10) functions as a single chip interface to the liquid-crystal display (LCD). The 48-pin hybrid contains two 8K-by-8 static RAMs and the LCD controller.

The LCDC II is connected to the CPU address/data bus and operates at 5 MHz. It latches the CPU's address on the falling edge of ALE and is accessed only when one of its three chip-selects goes active (low). The LCDMCS* line signals an access to the display RAM, and the LCDRCS* signals an access to the LCDC II's internal registers. The third chip-select line signals a CPU access to the PPU's byte-wide port (I/O address 0060 hex).

The LCDC II uses its open drain READY output to control CPU accesses: access cycle times vary with synchronization to its internal clock phases and with display refresh accesses.

The LCDC II control registers and the display RAM remain powered when the computer is asleep.

The LCD connects to the motherboard PCA via 12-pin connector A2J9. (Refer to the schematic diagram in figure 12-4 for pin assignments.)

5.8 Liquid-Crystal Display

A 480-by-200 dot liquid-crystal display provides the computer's visual output. Alpha output is displayed as 25 lines of 80 characters. Graphics output is displayed as a 480-by-200 dot pattern. Connections between the LCD module and the motherboard PCA are made via 12-pin connector A2J9. (Refer to the schematic diagram in figure 12-4 for the A2J9 connector pin assignments.)

5.9 HP-IL Interface

A 1LB3 (A2U15) is used for the HP-IL interface and uses the high byte of the internal data bus. Its 2-MHz clock (supplied by the clock/ready circuit to TSCLK∗, pin 22) is running when the computer is awake. The interface is powered on when the computer is awake, powered down in the sleep mode, and in its reset state as the computer wakes up.

> **Note:** The oscillator disable bit (I/O address 002F bit 0) can be used to reduce power consumption when the HP-IL loop isn't being used.

HP-IL protocol is described in *The HP-IL Interface Specification* (HP part number 82166-90017) and in *The HP-IL Integrated Circuit User's Manual* (HP part number 82166-90016).

The HP-IL interface connects to external HP-IL devices via connector A2J6. (Refer to the schematic diagram in figure 12-5 for connector pin assignments.)

5.10 Serial (RS-232-C) Interface

The serial interface (figure 12-5, center) is compatible with RS-232-C and CCITT V.24 and V.28 specifications. The serial interface performs the following functions:

- Links the mainframe and the serial port.
- Provides part of the link between the mainframe and the modem circuits.

The computer is configured as a data terminal equipment device at the serial interface connector A2J7 (nine-pin female subminiature D). The connector pin assignments are shown in table 5-1.

Table 5-1. Serial Interface Connector Pin Assignments

Pin Number	Signal Name	Description	25-Pin Connector Equivalent
1	DTR	Data terminal ready	20
2	TxD	Transmitted data out	2
3	RxD	Recieved data in	3
4	RTS	Request to send	4
5	CTS	Clear to send	5
6	DSR	Data set ready	6
7	GND	Ground reference	7
8	RLSD	Rec'd line signal detect	8
9	RING	Ring detect	22

The serial interface is split between a 1LK5 serial port (A2U18) and the PPU (A2U17). Multicontroller A2U18 controls frame formatting and receiver/transmitter status.

When the interface is open-circuited, its signal status is as follows: RING reads as a "0"; RLSD, CTS, DSR, and the operation status register serial "data in" bit (I/O address 0048 hex, bit 6) read as a "1".

In sleep mode, A2U18 is powered and is then in its own sleep mode, and serial port control registers remain in their programmed state.

Power control for the interface's line drivers is provided by the PPU (A2U17) at PC2, pin 26. The PPU also controls the serial interface's RTS and DTR lines: PA6 and PA7, pins 5 and 4 on the PPU.

5.11 Video Interface

The video interface (A2J10) is made up of six of the LCD's signals shown in table 5-2.

Table 5-2. Video Interface Connector Pin Assignments

Pin Number	Signal Name	Description	Frequency
1	DI2	Upper right quadrant data line	625 KHz max.
2	DI1	Upper left quadrant data line	625 KHz max.
3	DI4	Lower right quadrant data line	625 KHz max.
4	DI3	Lower left quadrant data line	625 KHz max.
5	FLM	Frame clock	52 Hz
7	CL2	Dot clock	1.25 MHz
6, 8	GND	Ground reference	-

The optional HP 82985A Video Interface connects to A2J10. Refer to section 5.19.3 for additional information.

5.12 Modem Interface

The computer-to-modem interface is contained in 12-pin connector A2J8 with pin assignment listed in table 5-3. (The mating 12-pin connector on the optional modem is designated A3J2.)

Table 5-3. Modem Interface Connector Pin Assignments

Pin Number	Signal Name	Description
1	MRESET*	Modem reset output (active low).
2	MRING*	Ring indicate input from modem (active low).
3, 5, 7, 11	GND	Logic ground
4	MSOUT	Data transmit output (Mark = 5.0V).
6	MSIN	Data received input (Mark = 0.0V).
8	MCARRIER	Carrier detect input (active high).
9	VBAT	Battery supply voltage (approximately +6.5V).
10	MODEMON	Power on enable output to modem (active high).
12	RCM	Return-to-command mode output (active high).

The modem's return-to-command mode is directly controlled by output PA4 on the PPU (A2U17, pin 7). Modem power and reset (MODEMON and MRESET*) are controlled by PPU outputs PD4 and PA2 (A2U17, pins 33 and 9). When MODEMON (PD4) goes high, the modem's power supply turns on; when MODEMON goes low, the modem power turns off. When the modem is off, MRESET* can be either high or low: MRESET* (PA2) should be taken low at the same time as MODEMON (PD4) to conserve battery power.

> **Note:** Since the modem can be off when the computer is on, the modem and computer power supplies are isolated from each other.

5.13 Direct-Connect Modem (Dealer-Installed Option)

The modem PCA (HP 82983A) is a Bell 212A-compatible intelligent modem with auto-answer and auto-dial capabilities using either DTMF (touch-tone) or pulse dialing. It can transmit 1200 bps Di-bit Phase Shift Keyed (DPSK) and Bell 103J (0 thru 300 bps) Frequency Shift Keyed (FSK) messages.

Commands and appropriate responses for the most common modem functions are built-in. These commands are a superset of the Hayes Smartmodem command set. The Portable PLUS can run many of the software packages which use the Smartmodem standard, thus taking full advantage of the modem's capabilities.

Connections are made to the motherboard PCA via 12-pin connector A3J2 on the modem PCA (A2J8 on the motherboard PCA). (Refer to table 5-3 for connector pin assignments.)

Modem Power Supply. The modem PCA contains its own power supply which is isolated from the computer's power supply (because the modem's power can be off while the computer's power is on). The modem power supply is turned on and off by the MODEMON input from the computer. The modem power supply voltages (+5V and −5 Vdc) must track one another closely: the power supply is designed so that the −5V supply tracks within 2% of the +5V supply. The positive supply is a standard dc-to-dc converter using voltage regulator A3VR1 to provide the reference voltage. The negative supply is a switching regulator controlled by microprocessor A3U16.

System Interface Buffer Logic. A3U1, A3Q1, A3Q2, and A3Q11 interface the modem to the computer. When the modem's power supply is turned off, these components protect both the computer and the modem from damage due to component latch-up, and any adverse affects of drawing power through the input protection structures of the ICs on the modem PCA. When the modem's power is on, these components overcome any mismatch between the power supplies of the two systems.

Controller. A3U14 is the controlling microprocessor for the modem. Its on-board ROM contains the code that governs the modem operation. The main system clock A3U11 drives a counter A3U13 which provides the other two frequencies needed by the system.

The modem's operation modes (FSK, DPSK, originate, answer, command, data, and dial) are controlled by a combination of outputs of the microprocessor. These outputs drive analog switches A3U6 and A3U9, inputs to the filter IC A3U12 and the hook-switch A3U17, and software-controlled registers in the modulator and demodulator ICs A3U2 and A3U3.

Transmit and Receive Fiters. The transmit and receive filters provide post-modulation and pre-demodulation filtering required for the modem to function properly. Both filters make use of a switched-capacitor filter IC A3U12 as well as some discrete active and passive filters.

The Transmit Path. The normal transmit path is as follows: TC1 (A3U3, pin 10) is the transmit data output of the modulator. It is passed through an active filter composed of A3U8A, A3R37, and A3C20; then ac coupled to the transmit path by A3C19. That signal is fed to the switched-capacitor filter "transmit in" input TI (A3U12, pin 1). The filtered signal is output from the "transmit out" pin A3U12, pin 8, fed through an analog switch (A3U9B), which selects between normal data mode and tone dial mode through the final amplifier/filter stage (A3U8B, A3R7, and A3C12), and on out through the phone line interface transformer A3T1.

Local analog loopback capability is provided by the two resistors (A3R17 and A3R19), which feed the transmit signal into the recieve path via the analog switch A3U9A.

> **Note:** The values of A3R17 and A3R19 have been chosen to simulate a receive signal level of −42 dBm, optimizing the testing condition for the demodulation circuits during local analog loopback.

The tone dialing path requires two frequencies simultaneously: both the TC1 and TC2 outputs of the modulator (A3U3, pins 10 and 9) are used. These two frequencies are mixed at the appropriate ratio (determined by A3R38, A3R39, and A3R40), fed through the first filter (A3U8A, A3R37, and A3C20), then ac coupled to the next stage. Here the path deviates from the normal data path and goes through the two filters (A3R22/A3C18 and A3R21/A3C17) and to the analog switch A3U9B, which selects between normal data mode and tone dial mode. The final stages of the tone dialing path are then identical to the normal data transmission path.

> **Note:** The transmitted signal is also fed back into the first stage receive filter (via A3R8, A3R9, and A3C13). This allows the transmitted signal to be "subtracted" out of the receive signal, allowing the determination of the true receive data.

The Receive Path. The signal present at the phone interface transformer A3T1 contains both transmit and receive components. This signal is summed with the transmit signal by the receive summer circuit (A3U10A, A3R11 and A3R12, and A3C14) to remove the transmit signal, leaving only the true received signal. The true received signal is then ac coupled via A3C15 to the analog switch A3U9A, which selects between normal and local analog loopback modes.

The output of A3U9A is fed directly to the switched-capacitor filter's "receive input" RI (A3U12, pin 16). Note that A3U12 can be configured to sample four different "bands" of frequencies, as selected by the clock rate fed into the OSCIN input (A3U12, pin 5) and the state of the MODE input (A3U12, pin 13). This allows dial tone detection, remote ring detection, and voice detection, as well as normal modem operation.

Following the filtering, the receive signal is output on A3U12, pin 7 to the ac coupling capacitor A3C16. Note that A3C16 and A3R24 combine to form a high-pass filter. This is necessary because of some low frequency oscillations present at the RO output of A3U12.

The receive signal is then passed through an amplifier/filter (A3U10B, A3R25, A3R23, A3C21, A3CR4, and A3CR5) called the soft-limiter. The soft-limiter is designed to amplify the signal by a factor of 145, clip it into a pseudo-square wave, and maintain an exact 50% zero-crossing duty cycle. (This 50% duty cycle is critical for 300-bps FSK operation.) The output of this stage is fed to two different circuits.

The first is an energy-detect circuit. It is designed to provide the active high signal NRG whenever the input signal to the receive filters exceeds a pre-determined level (−42 dBm). This controls the "carrier detect threshold" of the modem. The energy detect circuit consists of A3CR1, A3CR3, A3R26–A3R31, A3C22, and A3U15B.

> **Note:** Approximately 3 dB of hysteresis is built into this circuit by A3R30. Once the connection is established, the signal level must drop below −45 dBm before the connection is lost.

The other circuit being fed by the soft-limiter is a zero-crossing detector consisting of A3R32–A3R36, A3CR2, and A3U15A. The output of this zero-crossing detector circuit is a true square-wave signal. This signal is the received data that is fed to the demodulator as the "slicer" input (A3U2, pin 1).

> **Note:** The square-wave signal should be an exact 50% duty cycle for proper FSK operation.

The Demodulator. The demodulator circuit consists of the demodulator IC (A3U2), the base-band sine/FSK filter (A3U6A/B/C, A3U5A, A3U7A/B, A3C4–A3C7, and A3R2), and the base-band cosine filter (A3UA/B, A3U5B, A3C1–A3C3, and A3R1). Working together, these circuits recover the modulated data and provide both the receive data (RCVDATA) and a receive data clock RCVCLK (A3U2, pins 3 and 2) to the modulator IC (A3U3, pins 7 and 8).

Note that all transmitted and received data passes through the modulator IC on their way to or from the computer's motherboard PCA.

The Base-Band Sine/FSK Filter. This filter switches between DPSK mode and FSK mode via A3U6A, A3U6B, and A3U6C. In FSK mode, it performs the FSK demodulation. In DPSK mode, it filters out the sine component of the signal. The demodulator IC then combines this sine component with the cosine component to do the DPSK demodulation.

The Base-Band Cosine Filter. This filter is only used to isolate the cosine component of the received data signal. The demodulator IC combines this with the sine component to determine the phase shift of the receive data signal, and thus be able to demodulate the DPSK signals.

The Phone Line Interface. The phone interface is designed to meet all the FCC and Canadian DOC regulations governing direct-connect modems. The "hook-switch" A3U17 controls whether the phone is on-hook or off-hook. Transformer A3T1 provides dc isolation between the phone system and the modem. The metal-oxide varistor A3RV1 provides voltage-surge protection.

A3R4 and A3C9 provide an ac path to allow for ring detection. A3CR7–A3CR11, A3R5, and A3U18 combine to provide both a ring detect function and a valid phone line detect function. When the phone is on-hook (no dc current flowing), an ac signal with sufficient amplitude (such as a ring signal) will cause the opto-isolator A3U18 to activate, pulling the MRING signal low, indicating that a ring signal is being received. When the modem is off-hook and a valid phone line is connected, dc current will flow, forcing U18 to be always on and MRING to be a constant low, indicating that a valid phone line is present. A3R5 and A3CR11 combine to limit the amount of current which flows through A3U18 to a "safe" level.

5.14 Clock/Ready Circuit

The clock/ready circuit consists of an 82C84 clock IC (A2U6), a 74HC393 counter IC (A2U2), a NAND logic gate (A2U14, pins 11, 12, and 13), and a 16-MHz crystal (A2Y1).

> **Note:** This circuit does *not* provide the real-time clock; the PPU performs that function.

The clock/ready circuit generates several clock frequencies.

A 5.33-MHz, 33% duty cycle clock is fed from A2U6, pin 8 to CLK (pin 19 of the CPU), and to the "wait state" counter A2U2, pin 1. A 2.67-MHz, 50% duty cycle clock is fed from PCLK (A2U6 pin 2) to the MCLK (pins 23 of the two 1LK5 multi-controllers A2U16 and A2U18). A 16-MHz, 50% duty cycle clock is sent from the 82C84A oscillator output (A2U6, pin 12) to a binary counter at A2U2, pin 13. This clock is then divided down to 2 MHz, 50% duty cycle and fed to TSCLK of the HP-IL interface IC (A2U15, pin 22).

The LCDC II controller A2U10 has its own 5-MHz oscillator (with internal decoupling).

The 6805 PPU (A2U17) contains a 1-MHz crystal and an on-board oscillator that always operates, even when the computer is asleep.

The computer's bus cycle length varies depending on the address of the device being accessed. This is provided by the CPU's READY input.

The lower 512K bytes of memory space run with no wait states, and cycle times of 748 ns. There is no way to extend cycle times in this region. The upper 512K bytes of memory space and all I/O cycles operate with a minimum of one wait state and a minimum cycle time of 935 ns. These cycles can be extended by pulling the CPU's READY line low, and are extended indefinitely until the READY signal goes high.

5.15 Power Supply

The power supply contains four circuits that operate under control of the PPU. These circuits perform the following functions:

- Provide the regulated supply voltages (VccDS and VccS).
- Recharge the battery (and indicate state of charge).
- Provide the selectable LCD supply voltage (VLCD).
- Provide supply voltages for the RS-232-C serial interface.

5.15.1 VCC Voltage Regulator

The VCC regulator has two supply outputs: VccDS and VccS. Its input (provided by the battery voltage VBAT) is constrained to be in the range 5.6V to 8V. SLEEP is the main control input to the VCC regulator provided by the PPU. SLEEP affects the two supply output voltages.

When SLEEP is at logic 1, the computer is in sleep mode (which appears as "off" to the user). In this mode, the product draws the least battery current—less than 300 μA. Only the circuitry required to maintain clock operation and the user's data is powered. VccDS is regulated to 3.25 Vdc, logic 1 levels are roughly 3.25V, and logic 0 levels are roughly 0V. The PPU, its associated circuitry, and the memory circuitry is powered by VccDS, so these functions are maintained in sleep mode. VccS powers circuitry that does not need to operate while in sleep mode, so VccS becomes a high impedance node and eventually discharges to 0V when SLEEP is at logic 1.

When SLEEP is set to logic 0 by the PPU, the computer is in awake mode ("on" to the user). VccDS and VccS are regulated to 5 Vdc $\pm$ 5% with up to 300 mA total load on both supplies. Logic 1 levels are roughly 5V, and logic 0 levels are roughly 0V.

PLUGIN1* and PLUGIN2* are the two other inputs provided to the VCC regulator. These inputs are grounded when cards are plugged into slot 1 or slot 2, respectively. If either of these lines becomes ungrounded while the computer is awake, the regulator enters a shut-down state—VccDS is driven to 0V and VccS becomes high impedance (turns off). All processor activity, clock operation, and memory retention cease. The reason for this state is to prevent latch-up of the CMOS digital circuitry in the event that the user removes a card while it is being accessed. The VCC regulator stays in this state until both PLUGIN1* and PLUGIN2* are grounded. If PLUGIN1* or PLUGIN2* becomes ungrounded while the computer is in sleep mode, the VCC regulator operates normally and maintains sleep mode.

There are three open-drain logic outputs from the VCC regulator: they pull down to 0V to represent logic 0 and are open circuits to represent logic 1. Their function is to feed status information to the PPU circuitry. CARDSIN* pulls down to 0V to indicate that both PLUGIN1* and PLUGIN2* are grounded, meaning that cards are plugged into both slots. A high impedance at CARDSIN* indicates to the PPU that at least one card has been removed, and that the PPU should not allow the user to turn the computer on. LOW BATTERY pulls down to 0V to indicate that the battery voltage is above 5.8V. When the battery voltage goes below 5.8V, LOW BATTERY becomes a high impedance, indicating to the PPU that a low-battery message should be presented to the user. SHUTDOWN is low to indicate that the battery voltage is above 5.6V, and is high impedance to indicate that the battery voltage is below 5.6V. When the PPU sees SHUTDOWN become a high impedance, it forces the computer into sleep mode to avoid battery damage from over-discharging.

Two other signals connect the VCC regulator with other circuits. VREF is a 1.235V ± 1% reference voltage provided by the VCC regulator for the LCD negative supply circuit. VFETBIAS is a negative voltage provided by the LCD negative supply for the VCC regulator while the computer is awake. When in sleep mode, VFETBIAS is set to 0V.

One regulator circuit provides both supply output voltages. The output of this circuit is VccDS. The regulator is a linear design: a single pass transistor (A2Q63, connected between VBAT and VccDS) is controlled by a differential amplifier which turns on the proper amount to maintain VccDS at 5V in awake mode (or 3.25V in sleep mode). As the current required by the load increases, the differential amplifier provides more base current to A2Q63. This circuit is current-efficient: at high current loads, the only battery current not delivered to the load is the A2Q63 base current.

The differential amplifier consists of A2Q59, A2Q60, A2Q61, A2Q62, and associated resistors. VREF, a 1.235V reference voltage, is provided to the base of A2Q61. Note that the current in A2R71 is essentially zero, so there is no voltage across the resistor. When the circuit is stable, the voltage at the base of A2Q62 is also VREF.

Resistors A2R79, A2R80, and A2R81 form a voltage divider that determines the output voltage of the VccDS regulator. When the computer is in sleep mode, SLEEP is at logic 1, A2R80 is effectively in parallel with A2R81, and VccDS is regulated to 3.25V. When the computer is awake, SLEEP is at logic 0, A2R80 is effectivly in parallel with A2R79, and VccDS is regulated to 5V. (Note that the base current of A2Q62 is not zero, and this affects the operation of the voltage divider.)

The other supply output, VccS, is merely the output of a transistor switch connected to VccDS. When SLEEP is high (3.25V), A2Q70 is turned off. The Vgs of −1.62V (determined by the voltage divider between SLEEP and VFETBIAS) is not negative enough to turn on the transistor. When SLEEP is low, VFETBIAS is in the range −7V to −13V as provided by the LCD negative supply circuit. The voltage at A2Q70 gate is −3.5V or lower. This with a source voltage of +5V at A2Q70 gives a Vgs of −8.5V or lower, sufficient to turn on A2Q70.

If PLUGIN1* or PLUGIN2* is not grounded, A2Q55 or A2Q54, respectively, turn on. If either transistor turns on while the computer is in awake mode, A2Q56 turns on, putting the VCC regulator into the shutdown state. The voltage at the emitters of A2Q61 and A2Q62 is pulled above VREF through A2R121, which clamps off both transistors. This turns off the differential amplifier and A2Q63, the pass transistor. Within the computer circuitry there are current paths between VBAT and VccDS other than the VCC regulator. These current paths would hold VccDS up at about 1V in the shutdown state if it weren't for A2Q88. Bias current is provided through A2R121 and A2R78 to turn on A2Q88 when the VCC regulator is in the shutdown state, which holds VccDS down to less than 0.1V.

When the computer is in sleep mode, the operation of the VCC regulator shutdown circuitry must be disabled. When SLEEP is high, A2Q52 turns on, which turns on A2Q53, which in turn clamps off A2Q56. Even if PLUGIN1* or PLUGIN2* become ungrounded, A2Q56 will not turn on while A2Q53 is on, so VCC regulator shutdown does not occur.

Transistor A2Q83 provides the CARDSIN* output to the PPU circuitry. When there are cards installed in both plug-in slots, the gate of A2Q83 is pulled up to VBAT by A2R66 (pins 7 and 8) and A2R65 (or A2Q53, if on). This turns on A2Q83, which pulls CARDSIN* to ground, which can be detected by the PPU.

If a card is removed from either plug-in slot, A2Q54 or A2Q55 turns on, grounding the gate of A2Q83 and turning it off. CARDSIN* then becomes a high impedance, which is also detectable by the PPU.

A2Q64 is biased on by resistors A2R63 (pins 7 and 8) and A2R66 (pins 5 and 6) if the difference in voltage between VBAT and VCCDS is 0.8V or more. When A2Q64 is on it turns on A2Q84, which grounds LOW BATTERY, indicating to the PPU that the battery is not low.

When the difference between VBAT and VccDS is less than 0.8V, A2Q64 turns off, allowing A2R66 (pins 3 and 4) to turn off A2Q84, making LOW BATTERY a high impedance.

The LOW BATTERY output indicates that the battery is low when VBAT is less than 5.8V. The circuit compares VBAT to VccDS, so it works properly only while the computer is in awake mode.

The SHUTDOWN output circuit is comprised of A2Q65, A2R117, A2R86, A2R66 (pins 1 and 2), and A2Q85. It works in the same fashion as the LOW BATTERY ouput circuit, except it is designed to switch at a voltage difference of 0.6V between VBAT and VccDS.

The reference voltage VREF is provided by A2VR50. Bias current is provided by A2R69 from VBAT. When the computer is awake, the LCD negative supply circuitry loads VREF, so additional bias current is provided through A2CR63 and A2R70.

5.15.2 Battery

The 6-volt (nominal), three-cell, lead-acid battery has its electrolyte completely enclosed in the battery case, eliminating leakage under normal conditions. When fully charged, the battery has 2½ ampere-hours of stored power and a *large short-circuit capacity.*

5.15.3 Battery Charger

The function of the battery charger circuit is to convert the ac output of the recharger to a temperature-compensated dc charge voltage for the battery. The battery charger circuit can actually regulate at two different voltage levels. One level is float voltage, which is the voltage which is applied to the battery after it is fully charged. This voltage is selected to maximize the life of the battery and varies with temperature. At 25°C it is 7.05V ± 2%. The other voltage level is overcharge voltage, higher than float voltage, and applied to the battery for a limited time during each charge cycle to reduce overall charge time. This voltage level is about 7.5V at 25°C.

When the logic input FLOAT, provided by the PPU, is set to logic 1, the battery charger regulates at float voltage. A logic 0 at FLOAT causes the battery charger to regulate at overcharge voltage.

The battery charger circuit has a low-current charge mode. In the event that the three-cell battery has one or more shorted cells, it is unsafe to charge the battery to the full float or overcharge voltage. To avoid over-charging such a battery, the low-current mode is enabled and the voltage regulation mode disabled when VBAT is less than about 5V. Approximately 10 mA of charge current is provided when the battery charger is in the low-current charge mode.

Two outputs are provided by the battery charger to the PPU circuitry. POWER* is driven to logic 0 to indicate that a recharger is plugged in and providing adaquate power to operate the battery charger. POWER* becomes a high impedance to indicate that the battery charger is not operating. The HIGH CURRENT* output is driven to logic 0 to indicate that the battery charger is providing a fairly high load current, roughly 200 mA or more. HIGH CURRENT* becomes a high impedance to indicate that the battery charger load current has dropped below 200 mA.

The battery charger regulator is a linear design and operates in a similar fashion as the VCC regulator. A2Q50 is the pass transistor that is turned on the proper amount to maintain VBAT at the regulated voltage level. The input power is provided from the recharger, which produces 11.6 Vrms when open circuited. A2CR64, A2CR65, A2CR66, A2CR67, and A2C50 form a full-wave rectifier which converts the recharger ac output voltage to dc voltage, which is provided to the emitter of the pass transistor, A2Q50.

A2U50, a lead-acid battery charger integrated circuit, provides base current to control the pass transistor. A resistor divider string made up of A2R54, A2R55, A2R56, A2R57, and A2CR53 generate a voltage that is input at pin 13 and compared with a reference voltage internal to A2U50 (assume that A2Q51 is turned fully on). The internal reference voltage is 2.3V ± 1% at 25°C. A2U50 passes the appropriate amount of base current for the pass transistor through pins 16 and 15 to maintain a voltage at pin 13 equal to the internal reference voltage. When FLOAT is driven to logic 1 by the PPU, A2CR53 is reversed-biased, no current flows through A2R57, and the regulated voltage is determined by A2R54, A2R55, and A2R56 only. This results in the battery charger operating in "float" mode: 7.05V at VBAT when the internal reference is 2.3V. When FLOAT is grounded, current flows through A2R57, and the battery charger regulates at the overcharge voltage.

The resistor divider string made up of A2R54, A2R55, A2R56, A2R57, and A2CR53 also provide voltage to pin 12 of A2U50, except at a different tap-off point. When the voltage at pin 12 is above the internal reference voltage, the voltage regulation mode is enabled; otherwise the battery charger operates in the low-current charge mode. In the low-current charge mode, charge current is sourced by pin 11 of A2U50 through A2R53, and no base current is provided for A2Q50, so it shuts off.

The POWER* output is supplied by a voltage detector circuit in A2U50. When an input voltage of 4.8V or more is supplied to pin 5 of A2U50, the voltage detector circuit pulls the POWER* output down to logic 0 (A2U50, pin 7). When the input voltage supplied to A2U50, pin 5 is less than 4.2V, POWER* becomes a high impedance. The PPU circuitry is able to detect whether POWER* is a logic 0 or a high impedance, and hence whether the battery charger is charging the battery.

The HIGHCURRENT* output is provided by A2Q86. Base current for the main pass transistor of the battery charger regulator flows through A2R51. When there is little current through A2R51, the voltage at the gate of A2Q86 is too small to turn it on. HIGHCURRENT* remains a high impedance, indicating to the PPU that the battery charger regulator is supplying relatively little current. When the regulator is providing a large amount of current, the base current through A2R51 is also large, and the voltage at the gate of A2Q86 is high enough to turn it on, pulling HIGHCURRENT* to logic 0.

A2CR51, A2CR52, and A2C51 form a dc rectifier for A2U50. This prevents A2U50 from being powered by the battery when a recharger is not connected to the computer. If A2U50 were powered from the main dc rectifier and the recharger disconnected, A2Q50 would stay on—operating in reverse mode. Current would flow from VBAT through A2Q50 to the main dc rectifier, powering A2U50, which would keep A2Q50 turned on.

A2Q51 is in series with the resistor-divider string, which provides the feedback for the battery charger regulator. When a recharger is connected and providing power, the voltage at A2C51 turns on A2Q51 after being divided by A2R118 and A2R60. When the recharger is disconnected, A2Q51 turns off so that the feedback resistor divider string does not load the battery.

A2F1 is connected in series with the battery for safety. If shorted, the battery can provide a current of more than 100A, but the fuse limits this to a safe value. A2CR68 is included in the circuit to protect the computer circuitry if the battery is connected backwards. If this happens, current flows for a short time through A2CR68, and VBAT is clamped to the forward diode voltage below ground. Eventually the fuse A2F1 blows.

Jumper A2J11 acts as a switch for the battery. When a shunt is placed between pins 1 and 2, the battery is connected. If the shunt is moved to pins 2 and 3, the battery is disconnected and VBAT is shorted to ground. If a recharger is connected when VBAT is shorted to ground, the battery charger circuit enters the low-current charge mode, and power dissipation is minimized.

Constant-voltage charging provides the fastest battery recharge. A battery charged this way accepts the most charge current when its voltage is low. During battery recharging, charge current tapers off exponentially until 100% charge is reached.

The computer's battery charger regulator attempts to constant-voltage charge the battery, but this does not occur during much of the charge cycle. The computer's recharger has an output impedance of about 11 ohms, so as its output current goes up, its output voltage goes down. A low battery accepts much more current at the desired charge voltage than the recharger is able to supply under normal line conditions. The net effect is that the recharger is unable to pull up the battery voltage to the desired point until the battery is about 80% charged. Thus, during most of the charge cycle, the operation of the system is more like constant-current charging than constant-voltage charging. The battery voltage starts out below the target charge voltage and gradually increases as the charge level increases.

When the 80% charge level is reached, the charge current has tapered off to the point where the recharger can provide enough current at the desired battery voltage. From this point on the battery is constant-voltage charged by the battery charger regulator.

The PPU maintains a "fuel gauge" variable that estimates the state of the battery charge at any time. This variable is displayed for the user in the main PAM screen. A displayed value of 100% represents 2.5 ampere-hours, the full capacity of the battery. No actual measurement of battery capacity is made by the PPU in the maintenance of this variable, however. When no recharger is connected, the PPU decrements the fuel gauge value at various rates that correspond to the currents that the computer is drawing from the battery. A series of constants is provided which represent battery current drain for the computer when it is in sleep mode, awake mode, when the serial interface is in use, and so forth. When a recharger is connected, the PPU continues to decrement the fuel gauge according to battery current drain, but it also adds a constant that corresponds to charge current provided by the battery charger. Battery charger current is usually more than the battery drain current, so the fuel gauge increments when a recharger is connected.

The PPU takes an active part in the charge cycle of the battery. It uses the fuel gauge variable in the execution of this contol. When a recharger is plugged in and the fuel gauge is less than 100%, the PPU sets FLOAT to logic 0, which causes the battery charger regulator to try to regulate at overcharge voltage. If the battery is low, the recharger is not be able to provide enough current for the regulator to develop overcharge voltage across the battery. The HIGHCURRENT* output will be at logic 0, since the regulator will be supplying its maximum current. Every 30 seconds, the PPU sets FLOAT to logic 1 for ⅛ second. This causes the battery charger regulator to try to regulate at float voltage (lower than overcharge voltage) during this period. The PPU then samples the HIGHCURRENT* output from the battery charger circuit. If HIGHCURRENT* is still at logic 0 during the ⅛-second interval, then the PPU continues updating the fuel gauge as described above, using a value of 280 mA for the charger current. As the charge cycle progresses, the battery voltage gradually increases.

If during the ⅛-second interval the PPU reads HIGHCURRENT* as a high impedance, then the battery voltage has reached the float voltage level. This means that the battery is about 80% charged. If the fuel gauge value is less than 80%, the PPU sets it to 80%. For the rest of the charge cycle, the PPU uses 250 mA for charger current in the updating of the fuel gauge.

When the fuel gauge finally reaches 100% (or 4 hours later, whichever comes first), the PPU sets FLOAT to logic 1 and holds it there as long as the recharger is connected. In the updating of the fuel gauge, the PPU uses a value for charger current which is equal to the load current, so the fuel gauge stays at 100%. Once 100% charged, the battery charger maintains the battery voltage at the float voltage, which maximizes battery life and keeps it fully charged.

5.15.4 Power-Up Routine

The following list describes the power-up sequence shown in figure 5-3.

1. When the computer is in *sleep* mode, VccDS is 3.25V nominal, VccS is floating, and SLEEP* is at 0V. When the reset button is pressed, the PPU is reset and all its outputs are tristated.
2. When the reset button is released, PWON* rises to VccDS in 700 to 800 ms. The PPU begins running as the logic 1 threshold of its "reset" input is reached. Then the PPU waits about 1.5 seconds for PWON* to reach the VccDS voltage level. (This provides noise immunity on the slow-rising PWON*.)
3. The PPU now initializes its pins to the following states:

SLEEP*	0V
DSLEEP	VccDS
LCDON*	VccDS
RS-232ON	0V
SLEEP	VccDS
MODEMON	0V

4. The PPU checks various internal variables. If they are invalid, it assumes that true "power on" occurred, waits until *both* cards are plugged-in *and* the ◑ (contrast) key pressed, and then proceeds to step 5.

   If the variables are valid, the PPU assumes that the reset button has been pressed, and then waits until *both* cards are plugged-in before proceeding to step 5. (You don't need to press the ◑ (contrast) key in this case.)

5. The PPU now waits for 50 ms while DSLEEP* and SLEEP* are driven to 0V. DSLEEP* is then driven to the VccDS voltage level approximately 50 ms later.
6. The PPU now begins the process of awakening the computer: SLEEP is driven to 0V which causes VccS to go from 0V to +5V and VccDS to go from 3.25V to 5V. SLEEP* is driven to +5V and the 80C86 CPU starts running about 200 ms after SLEEP has fallen to 0V. Several milliseconds later, LCDON* is driven to 0V and the LCD contrast level is initialized. The PPU then begins looking for commands from the CPU: the computer is now awake.

   RS232ON and MODEMON stay at 0V until the CPU sends appropriate commands causing them to switch.

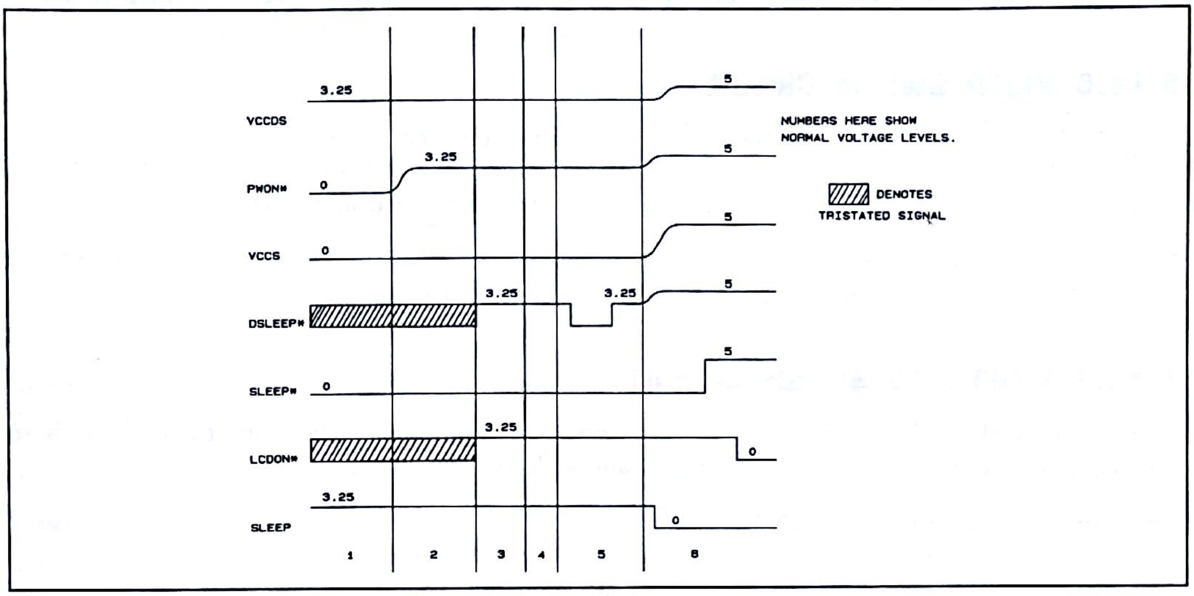


Figure 5-3. Power-Up Sequence

5.15.5 LCD Negative Supply

The computer's LCD requires a negative supply voltage in the range −7V to −13.5V. This voltage affects overall contrast of the LCD for *all* pixels (both on and off). As the voltage goes more negative, the display gets darker.

VLCD is the main output of the LCD negative supply. This output is actually supplied from another node, VFETBIAS, through a transistor switch. This switch provides *delayed* turn-on of the negative voltage to the LCD. VFETBIAS is an output for the VCC regulator circuit, where it is used to bias a P-channel FET fully on.

Input power to the LCD negative supply is provided by VBAT. The PPU provides two main control inputs to turn the supply on or off: SLEEP turns on VFETBIAS when set at logic 0 (awake mode) and turns VFETBIAS off when set at logic 1 (sleep mode). LCDON* closes the transistor switch between VLCD and VFETBIAS when set to logic 0. When LCDON* is set to logic 1, the transistor switch is opened, and VLCD becomes a high impedance node.

STEP1, STEP2, STEP4, and STEP8 are the four digital inputs to the LCD negative supply and determine its output voltage. These four inputs are provided by the PPU circuitry. Each input represents a logic 0 when pulled down to ground, or a logic 1 when high impedance. The four inputs form a binary value ranging from 0 to 15, with STEP8 the most significant bit. A value of 0 for the four inputs causes the LCD negative supply to produce −13V (dark LCD). As the value of the four inputs increments to 15, the output voltage changes in evenly-spaced steps up to −8V (light LCD). The overall function is that of a D/A converter that ranges from −13 to −8 Vdc.

Two miscellaneous connections to other circuitry are VREF and VccS. VREF is a 1.235V ± 1% reference voltage provided by the VCC regulator circuitry. VccS is the switched supply voltage described above in the VCC regulator section. VccS is used in on-off control of the LCD negative supply.

5.15.6 VLCD Switch Circuit

When LCDON* is driven low by the PPU, current flows through A2R108 pins 7 and 8 to turn on A2Q76. A2Q76 then passes current from VccS through A2R108, pins 5 and 6 to turn on A2Q77. With A2Q77 on, VLCD is pulled down to the negative voltage generated at VFETBIAS.

When the PPU drives LCDON* high, A2Q76 is turned off. This interrupts the base current to A2Q77, so that A2Q77 turns off and VLCD is disconnected from VFETBIAS.

5.15.7 VFETBIAS Supply Circuit

The circuit which produces VFETBIAS is a switching dc-to-dc converter, the basic parts of which are an oscillator, a transistor switch, an inductor, and a dc rectifier.

The output of the oscillator is A2U52, pin 7. When this output goes low, it turns on the transistor switch A2Q75. While the switch is on, current from VBAT flows into inductor A2L50, storing energy. As long as A2Q75 is turned on, the current and stored energy in A2L50 increase. The oscillator output eventually goes high, turning A2Q75 off, interrupting the current flow from VBAT through A2L50. Because current flow cannot stop instantaneously in an inductor, current begins to flow through A2CR54 in the *forward* direction. This current discharges A2C62, so the voltage at VFETBIAS is negative. While A2Q75 is turned off, the current in A2L50 decreases, and energy stored in A2L50 is transferred to A2C62. Assume that the VLCD switch is on, so the LCD loads the circuit: during the off-time of A2Q75, A2L50 supplies the load current as well as the current to charge A2C62 (negatively). During the on-time of A2Q75, all the load current is supplied by A2C62. No current flows from A2Q75 to the load because during the on-time A2CR54 is reverse-biased. A2CR54 and A2C62 form the dc rectifier of the dc-to-dc converter. The frequency of oscillation and capacitance of A2C62 are selected so that there is little ac ripple voltage across the load during each cycle.

5.15.8 Variable Control of the VFETBIAS Supply

VFETBIAS is approximately equal to $-\text{VBAT} \times (ton/toff)$ under proper loading conditions (where *ton* is the "on" time of A2Q75 and *toff* is the "off" time). The function of the A2U52 oscillator is to provide control of *ton* and *toff* according to this formula, given the STEP8 through STEP1 inputs.

A2U52 is a low-power comparator. It has an open-collector output (pin 7) that pulls to ground when the voltage at the "+" input (pin 2) is less than the voltage at the "−" input (pin 3). When the "+" input is at a higher voltage than the "−" input, the output becomes a high impedance and is pulled up to VBAT by A2R110 and A2R109.

During *ton*, the comparator output is low. This means that A2Q72 and A2Q73 are off. The voltage at the comparator "−" input is VREF (A2Q74 is on). Assume that the voltage across A2R105 is zero, so the voltage at the "+" input of the comparator is equal to the voltage at A2C60. Since the comparator output is low, the "+" input voltage must be lower than the "−" input voltage. With A2Q72 off, the voltage at the node common to A2R102, A2R103, and A2R104 is more than VREF, and A2C60 is charged through A2R104. When the voltage at A2C60 climbs just above VREF, the comparator output switches high, and *toff* begins.

During *toff*, A2Q73 is turned on. This pulls down the voltage at the "−" input of the comparator to ½VREF. A2Q72 is also turned on, so the voltage at the node common to A2R102, A2R103, and A2R104 is less than ½VREF. This discharges A2C60 through A2R104. When the voltage at A2C60 falls below ½VREF, *toff* ends and *ton* begins again.

Thus, *ton* is the time that it takes A2C60 to be charged from ½VREF to VREF. *toff* is the discharge time of A2C60 from VREF to ½VREF. Since A2R103 is small in comparison with the other resistors in the circuit, *toff* is relatively constant. It is determined predominately by A2R104 and A2C60. *ton* is the key parameter that is varied to control the voltage at VFETBIAS. When STEP8 through STEP1 are set to logic 1 (open circuit), maximum charge current is supplied to charge A2C60 during *ton*, so *ton* is at its minimum for a given VBAT. This makes VFETBIAS at its minimum magnitude, −8V. When STEP8 through STEP1 are set to logic 0 (ground), charge current is shunted away from A2C60. The net charge current for A2C60 is at a minimum for a given VBAT, so *ton* is at a maximum. This makes VFETBIAS at its maximum magnitude of −13 V. The 14 voltage levels of VFETBIAS between these two extremes are achieved by varying the charge current shunted away from A2C60 through A2R97, A2R98, A2R99, and A2R100.

For a given state of STEP8 through STEP1, VFETBIAS remains constant as VBAT varies. Since VFETBIAS is given by −VBAT × (*ton*/*toff*), as VBAT increases, *ton* decreases to keep VFETBIAS constant. This is accomplished by sourcing the A2C60 charge current from VBAT through A2R101. As VBAT increases, the charge current increases, which makes *ton* decrease.

5.15.9 Miscellaneous LCD Negative Supply Circuitry

A2C61 provides positive feedback for the A2U52 oscillator, which prevents spurious high-frequency oscillation at the switch times of the output. When the output switches, A2C61 couples the transition back to the "+" input, and A2R105 allows it to decay to the A2C60 voltage.

When SLEEP is at logic 0 (awake mode), power is provided to the A2U52 oscillator through A2Q71 from VBAT. SLEEP at logic 0 turns off A2Q87. This allows VccS to pull up the gate voltage of A2Q82, turning A2Q82 on. A2Q82 in turn allows current to flow through A2R108, pins 1 and 2, and the base of A2Q71, turning on A2Q71.

When SLEEP is driven to logic 1 (sleep mode), A2Q87 turns on, turning off A2Q82. The base current to A2Q71 is interrupted and A2R108, pins 3 and 4. This ensures that A2Q71 stays off. Power to A2U52 is interrupted, although its open collector output at pin 7 is held at VBAT.

A2Q74 is turned on and off along with A2Q82. When on in awake mode, it passes VREF to the A2U52 oscillator. A2Q74 turns off in sleep mode so that, when not operating, the A2U52 oscillator circuit does not load VREF.

5.15.10 RS-232-C Supply Voltages

The RS-232-C interface standard requires two output voltage levels: one above +5V and one below −5V. The LT1032 driver chip used in the Portable PLUS requires at least +5.3V and −5.9V supplies at worst-case load currents to guarantee meeting the standard's voltage limits. The worst-case load currents at minimum supply levels are 6 mA for both the positive and negative supplies.

The function of the RS-232-C supplies circuitry is to convert the battery voltage VBAT to +5.3 Vdc minimum at 6 mA minimum and −5.9 Vdc maximum at 6 mA minimum. The "conversion" process for the positive supply is trivial, since VBAT itself meets the power requirements. This supply output is called V+232, and is provided to the RS-232-C driver chip through a simple jumper wire from VBAT. The negative supply output is called V−232, and it requires more circuitry.

SLEEP and RS232ON are the two control inputs provided by the PPU for the RS-232 supplies. When SLEEP is set to logic 1 (sleep mode), the RS-232 supplies draw practically zero battery current; if SLEEP is set to logic 0 (awake mode), operation of the RS-232 supplies depends on the other control input, RS232ON. When RS232ON is set to logic 0, the RS-232 supplies draw zero battery current. If RS232ON is set to logic 1 at the same time that SLEEP set is to logic 0, the RS-232 supplies turn on, supplying current to the RS-232-C driver chip and drawing current from VBAT.

The motherboard PCA contains holes for optional circuitry within the RS-232 supplies. These components allow for substitution of a 1488-type RS-232-C driver for the LT1032. The 1488 driver requires positive and negative supplies of higher voltage than those required by the LT1032; the positive supply voltage required for the 1488 is greater than VBAT. The optional components enable the RS-232 supplies circuitry to generate the higher positive voltage.

5.15.11 Voltage Doublers

A voltage doubler circuit is used to generate V−232. When the optional components are loaded, V+232 is also generated by a voltage doubler circuit. (Normally, V+232 is provided by a jumper wire to VBAT.) The voltage doublers are a series of diodes and capacitors that convert the output of an 11-kHz oscillator to the required supply voltages. In the following descriptions of the voltage doublers' operations it is assumed that the forward voltage drop for standard diodes is 0.7V and for schottky diodes 0.2V.

The oscillator output is the tied-together drains of A2Q79 and A2Q80. This oscillator swings between VBAT and 0V. The oscillator output waveform is ac coupled through A2C67 and clamped to 0.7V maximum by A2CR58. The resulting waveform at A2CR58 anode swings between 0.7V and (−VBAT+0.7V). A2CR59 and and A2C69 form a dc rectifier which produces a dc voltage of (−VBAT+0.9V) from the waveform at A2CR58 anode. A2C68 ac couples the waveform at A2CR58 anode to the A2CR60 anode, which clamps the voltage to (−VBAT+1.1V) maximum. Thus, the waveform at A2CR60 anode swings between (−VBAT+1.1V) and (−2VBAT+1.1V). A2CR61 and A2C70 form a dc rectifier that produces a dc voltage of (−2VBAT+1.3V) from the A2CR60 anode waveform. This dc rectified voltage is V−232.

The voltage doubler for V+232 operates in a similar fashion when it is loaded in the printed circuit board. The output of the oscillator is connected to a dc rectifier formed by A2CR55 and A2C65, producing a dc voltage of (VBAT−0.7V). A2C64 ac couples the oscillator output waveform to the cathode of A2CR56, which clamps the voltage to (VBAT−1.4V) minimum. The resulting waveform at the cathode of A2CR56 swings between (2VBAT−1.4V) and (VBAT−1.4V). A2CR57 and A2C66 rectify this waveform to produce (2VBAT−2.1V), which is V+232.

5.15.12 11-kHz Oscillator

A2U53, a quad-NOR integrated circuit, forms the heart of this oscillator. On-off control of the oscillator is provided by A2Q78. If SLEEP is at logic 1 (sleep mode) or RS232ON is at logic 0, A2Q78 is guaranteed to be off. This allows A2R114 to pull up input pins 2 and 13 of A2U53. Output pins 3 and 11 are therefore at logic 0. Input pins 1, 12, 8, and 6 are driven to logic 0. A2C63 is discharged so that both terminals are at 0V. Output pins 10 and 4 are at logic 1, a voltage of VBAT. This turns on A2Q80 and turns off A2Q79. The voltage doublers have 0V as their input voltage, so they transfer no power to the RS-232-C driver chip.

To turn on the oscillator, SLEEP is set to logic 0 (awake mode) and RS232ON is set to logic 1. A2Q78 turns on and sets input pins 2 and 13 to logic 0. This allows the pin 3 and pin 11 NOR-gates to operate as inverters, and they start to oscillate. Each time that pin 11 switches to logic 1, A2C63 ac couples the transition through to input pin 1. Pin 11 is logically the double inversion of pin 1, so there is a positive feedback situation—pin 11 stays at logic 1. Eventually capacitor A2C63 discharges through A2R116, and pin 1 becomes a logic 0. This causes pin 11 to switch to logic 0. Again, A2C63 provides ac coupled positive feedback, so pin 11 stays at logic 0 for a time. Eventually A2C63 is charged through A2R116; pin 1 becomes a logic 1 and pin 11 switches back to logic 1. The period of the oscillator is determined by the charge and discharge times of A2C63.

A2R115 is required in the circuit to limit the input current of pin 1. The voltage transistions that are coupled through A2C63 go above VBAT and below ground, and A2R115 prevents the internal input protection diodes of pin 1 from being over-stressed. The pin 10 and pin 4 NOR-gates buffer the pin 11 output and drive the gates of A2Q79 and A2Q80. A2Q79 and A2Q80 in turn act as an inverter buffer and drive the voltage doublers.

5.16 System ROM and Built-In RAM

On the memory PCA, A1U8 through A1U15 and A1U19 through A1U26 are 16 32K-byte RAM ICs (RAM blocks 0 through 3). A1U16 and A1U27 are 128K-byte ROM ICs. A1U30 is the 8K-byte configuration EPROM, which is described in section 5.17. The ROM and EPROM ICs are mounted in sockets.

RAM can have 16-bit and 8-bit accesses. If LBHE* is low, an upper-byte RAM IC is selected. If LA0 is low (even address), a lower-byte RAM IC is selected. If both conditions exist, a 16-bit word access is performed.

ROM is always accessed in 16-bit words, even though the CPU may need only one byte.

The BALE signal pulses high at the start of each CPU cycle, turning off all RAM and ROM select signals from A1U3, A1U4 and A1U5 while the address bus stabilizes.

5.17 Configuration EPROM

The configuration EPROM (erasable/programmable read-only memory, designated A1U30 on the memory PCA) can be configured as an 8K-byte device (standard) or as a 16K-byte device. A 32K-byte device can be used, but only the upper 16K bytes are addressable, since PGM (pin 27) is connected to VccS. The EPROM is connected to the I/O address and data buses.

Typically, a configuration EPROM contains the computer's unique serial number and information about keyboard mapping, display fonts, and hardware configuration, including the amount of built-in RAM. The CPU uses this information to determine system operation. The configuration EPROM is programmed differently for each language, but all versions use the same unprogrammed EPROM as a replacement.

5.18 Plug-In Ports

Plug-in drawers interface to the memory PCA via 62-pin connectors A1J1 and A1J2. Pins 1 and 2 of these connectors must be shorted for the computer to turn on. Each plug-in drawer shorts these two pins. While servicing the computer, you can install port jumpers (HP part number 45711-60918) instead. The two plug-in port connectors have identical pin configurations. Address, data, and miscellaneous control signals are brought out to these connectors. Address and data line buffers in the plug-in drawers are used to reduce system bus loading.

5.19 System Extensions

The following sections briefly describe available extensions of the computer's capabilities.

5.19.1 Memory (RAM) Drawer

The HP 82981A Memory Drawer provides 128K bytes of additional RAM. One or two HP 82984A Memory Cards can be installed in the memory drawer to provide 256K bytes or 384K bytes of total plug-in RAM. The memory cards are identical to the piggyback PCAs used internally for early E and F versions of the mainframe. The memory drawer PCA buffers the address bus, data bus, and control bus lines from the mainframe. It provides two connectors (J2 and J3) for connecting piggyback PCAs. Logic contained on the memory drawer PCA selects the appropriate RAM ICs, including those on the piggyback PCAs.

The HP 82992A 1M-Byte Memory Drawer provides 1M bytes of additional RAM. The memory drawer PCA buffers the address bus, data bus, and control lines from the mainframe. Logic contained on the memory drawer PCA enables one of eight 128K-byte blocks of RAM according to information on the address and data buses. Logic also selects individual RAM ICs within the enabled block according to the address on the address bus.

5.19.2 Software (ROM) Drawer

The HP 82982A Software Drawer provides sockets for installing up to 1.5M bytes of ROM-based software. Using an alternative configuration, the software drawer can accomodate EPROMs, including a bank of four EPROM pairs emulating a single ROM pair.

The software drawer PCA (figures 12-9 and 12-10) buffers the address bus, data bus, and control bus lines from the mainframe. It provides 12 sockets for installing the ROM or EPROM ICs. Six jumper sockets (XW1 through XW6) define the configuration of the installed ICs. Logic contained on the PCA selects the appropriate ROMs or EPROMs.

5.19.3 Video Interface

The HP 82985A Video Interface provides a connection for duplicating the computer display on an external monitor. The video interface consists of a modified battery door for the computer that connects to the motherboard PCA in the computer, a video cable that connects to the the battery-door connector, a separate interface module that connects to the video cable, and a monitor cable that connects the interface module to a monitor. An ac adapter provides power to the interface module. A description of the interface and complete service information are contained in the *HP 82985A Video Interface Assembly-Level Service Manual* (part number 82985-90003).

5.19.4 SNALink/3270 Software Drawer

The HP 50922A SNALink/3270 Software Drawer provides two capabilities for the Portable PLUS:

- Synchronous RS-232 communication in an IBM Systems Network Architecture (SNA) environment. The computer emulates an IBM 3270 display station, enabling a remote connection to an IBM host computer. Two socketed ROM ICs provide the supporting software.
- Sockets for installing up to 1M bytes of ROM-based software. A jumper selects between "ROMs" and "EPROMs". The "ROM" configuration accomodates mixtures of 32K-byte ROM ICs, 128K-byte ROM ICs, and 64K-byte EPROM ICs. The "EPROM" configuration accommodates only 32K-byte EPROM ICs. (The SNALink/3270 code is provided in two ROM ICs that can be installed in two sockets.)

The PCA (figures 12-24 and 12-25) buffers the address bus (U9 and U10) and data bus (U11 and U12) from the mainframe. The PCA uses several "ZHAL" (zero-power hard-array logic) ICs to implement its functionality. U7 contains the control registers for the drawer's two functions. U6 contains the ID registers.

For the serial function, serial decoder U14 provides the control signals for the Z80 SIO controller IC U2. The controller transfers data between the serial port and the data bus according to the control signals from U14 and from the serial port. Voltage converters U5 and U6 produce the +10V and −10V supplies for the serial port. Oscillator U13 provides the reference clock for the synchronous serial port. Table 5-4 lists the pin assignments for the serial cable used with the SNALink/3270 drawer.

For the ROM function, address decoder U1 selects the appropriate ROM or EPROM ICs. The PCA contains eight sockets for installing the ROM or EPROM ICs. Jumper J2 selects the "ROM" or "EPROM" configuration (in the 1-2 position it selects the "ROM" configuration).

Table 5-4. SNALink/3270 Cable Pin Assignments

10-Pin Connector Pin Number	Signal Name	25-Pin Connector Pin Number
1	Signal Ground	7
2	CTS	5
3	RxD	3
4	DCD (RLSD)	8
5	DSR	6
6	RxDCE	17
7	TxDCE	15
8	RTS	4
9	TxD	2
10	DTR	20
Shield	Protective Ground	1

Chapter 6
Removal and Replacement

6.1 Introduction

This chapter describes the procedures for removal and installation of assemblies during repair of the Portable PLUS Computer. Use these procedures to access assemblies and components you must test or replace.

- Disconnecting the battery (section 6.2)
- Removing the battery (section 6.3).
- Separating the case (section 6.4).
- Replacing the PCAs (section 6.5).
- Removing the keyboard module (section 6.6).
- Removing a keyswitch (section 6.7).
- Removing the display module (section 6.8).
- Removing the clutches and display cable (section 6.9).
- Removing ICs (section 6.10).
- Replacing plug-in drawer PCAs (section 6.11).

Installation procedures are the reverse of removal procedures.

Special "reassembly notes" provide additional information for proper installation of a part or assembly.

Recommended tools for removal and replacement of assemblies and components are listed in table 1-3.

CAUTION

Be sure to wear a grounded wrist strap and that your workbench is electrostatically protected. Many components (especially the display module) are susceptible to damage by electrostatic discharge.

6.2 Disconnecting the Battery

WARNING

A fully charged battery has an enormous short-circuit current capacity. Be careful not to short its terminals. A short-circuit can cause sparks and melt metal, leading to burns or other injuries.

After unplugging the recharger from the computer:

1. Remove the battery cover by pressing on the ribbed latches and sliding the cover down (figure 6-1).

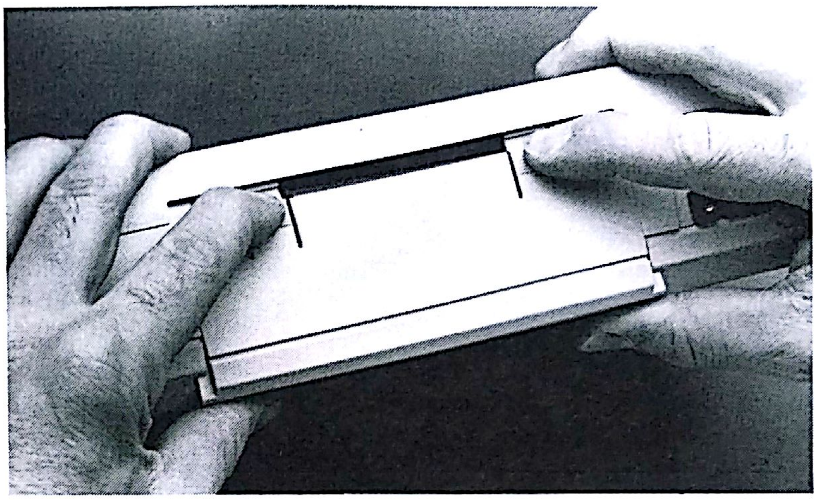


Figure 6-1. Removing the Battery Cover

2. Remove the battery terminal cover by removing the two screws and washers (figure 6-2).

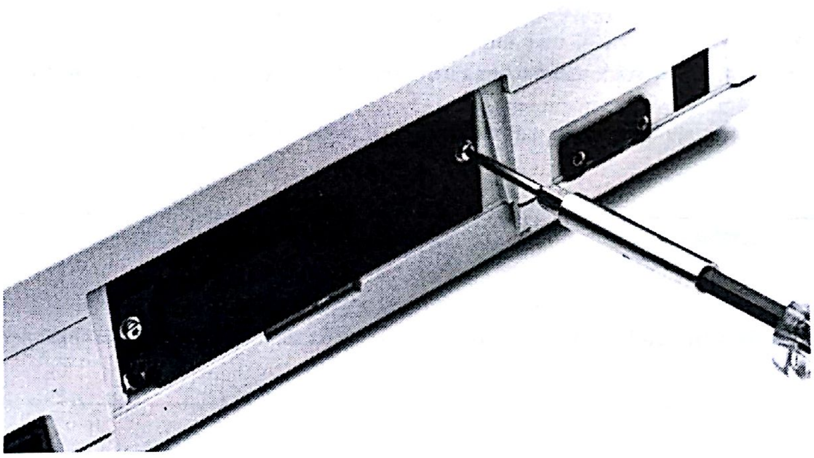


Figure 6-2. Removing the Battery Terminal Cover

3. Disconnect the battery by moving the battery jumper to its OFF position (figure 6-3).

Figure 6-3. Moving the Battery Jumper to Off

> **CAUTION**
>
> Turn the computer upside down before disconnecting the battery straps. If you don't do this, metal filings may fall onto the motherboard PCA and cause intermittent shorts.

4. Turn the unit over. Remove the two flanged hex nuts and disengage the connector straps from the battery's threaded terminal studs. (You might need to use tweezers for this.) Be careful to bend the battery terminal straps just enough to clear the terminal studs to avoid overflexing the straps. Remove any metal filings with a vacuum or a piece of tape.

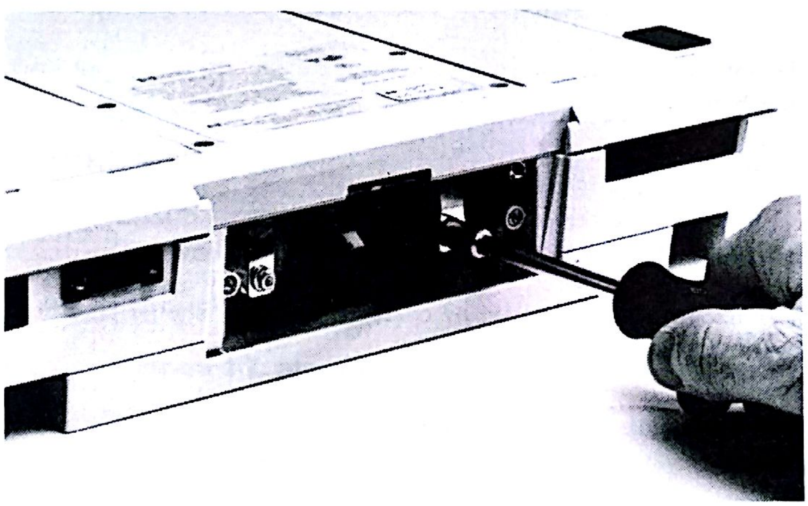


Figure 6-4. Disconnecting the Battery

6.3 Removing the Battery

Note: *The battery should be removed from the unit only if the battery requires service or replacement.* For non-battery-related service, only *disconnect* the battery according to section 6.2 above.

> **WARNING**
>
> The battery contains an acid electrolyte that is sealed in; therefore, avoid damaging the battery case. *Handle a damaged battery with care because the acid can cause burns.*

After disconnecting the battery (section 6.2):

1. Remove the battery and the battery cushion.

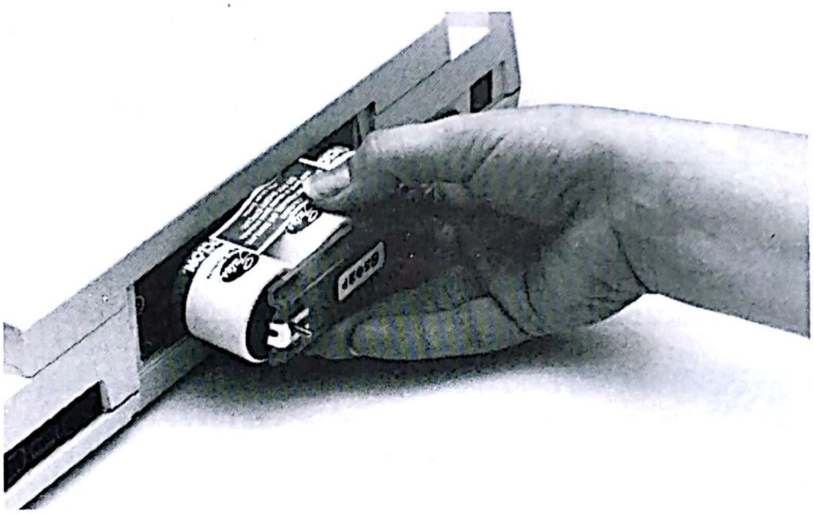


Figure 6-5. Removing the Battery

Reassembly Notes: Fold the battery cushion around the battery before inserting both of them into the battery compartment:

Be sure that the battery's positive (+) terminal is closest to the I/O plate. (See figure 6-4.)

The (new) battery terminal straps must be *carefully* bent out of the way when inserting the battery and cushion into the unit's battery compartment.

The battery straps are easily damaged by overbending. They should both be replaced whenever the battery is removed from the unit.

6.4 Separating the Case

After disconnecting or removing the battery (sections 6.2 or 6.3):

1. Remove the two plug-in drawers by removing the two (short) screws securing each drawer, and then sliding each drawer toward its side of the computer:

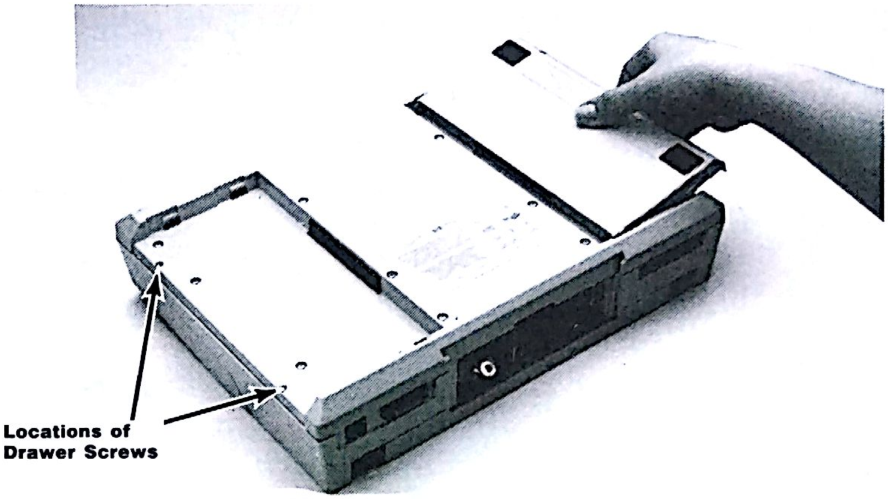


Figure 6-6. Removing the Plug-In Drawers

2. Remove all 12 screws (and washers) from the bottom case.

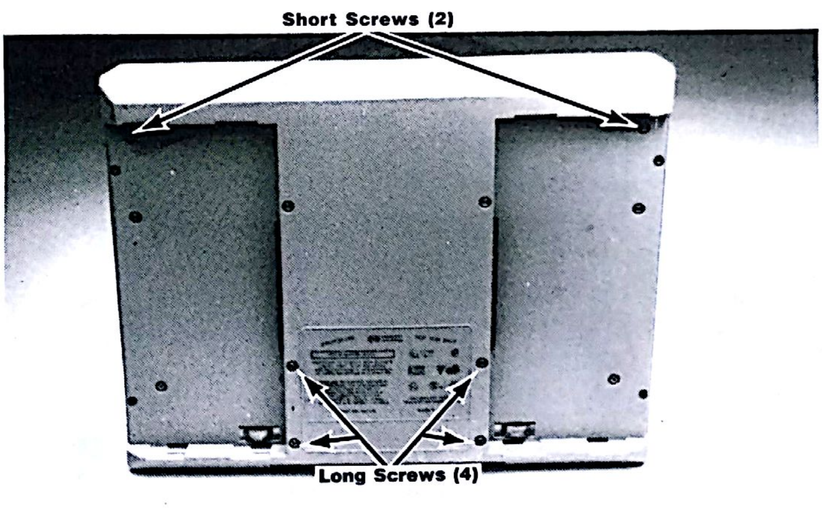


Figure 6-7. Removing the Bottom Screws

Reassembly Note: Use the four *long* screws at the indicated locations and the two *short* screws at the front corners of the unit.

3. Partly open the case, then unplug the keyboard cable and the display cable. Do this by lifting the rear of the top case just enough to reach and unplug the two connectors. To unplug the smaller connector, pull it parallel to the PCAs. To avoid damaging the wires, grasp the connectors by the plastic connector housings. The front edges of the case halves will not separate until these cables are unplugged.

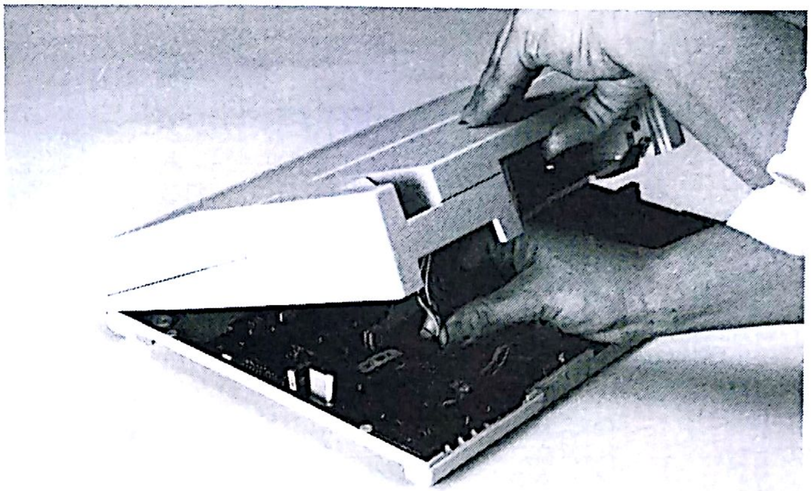


Figure 6-8. Unplugging the Top Case Cables

4. Separate the case by swinging the top case until it disengages from the bottom case.

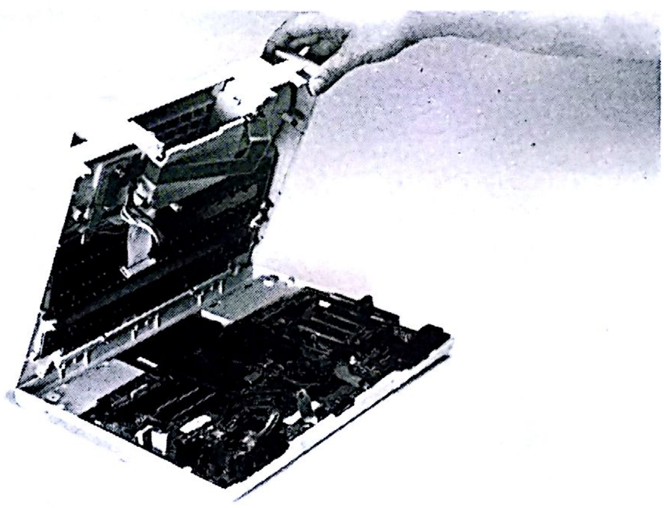


Figure 6-9. Separating the Case

Reassembly Note: Engage the case halves by holding the top case vertically with its front edge placed along the front of the bottom case, then hinge the top case onto the bottom case. *Be careful not to trap or bend the battery straps under the top case.*

6.5 Replacing the PCAs

After disconnecting the battery and separating the case (sections 6.2 and 6.4):

1. If the optional modem has been installed, disconnect the modem ground strap from the modem PCA by removing the flanged hex nut. Then lift the motherboard PCA slightly using the ground (−) battery terminal strap, and unplug the modem PCA from the motherboard PCA.

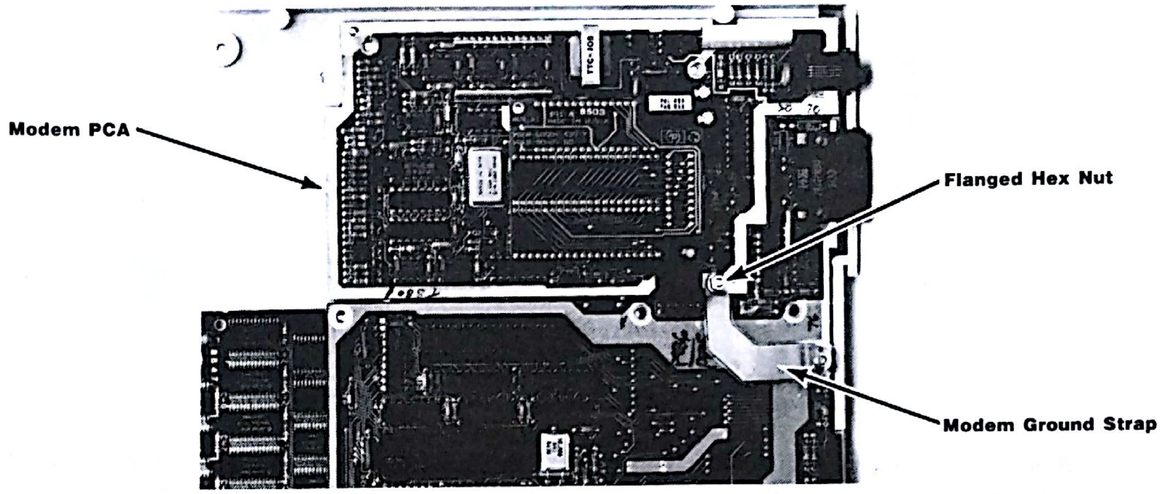


Figure 6-10. Unplugging the Modem PCA

2. Lift the motherboard and memory PCAs away from the bottom case.

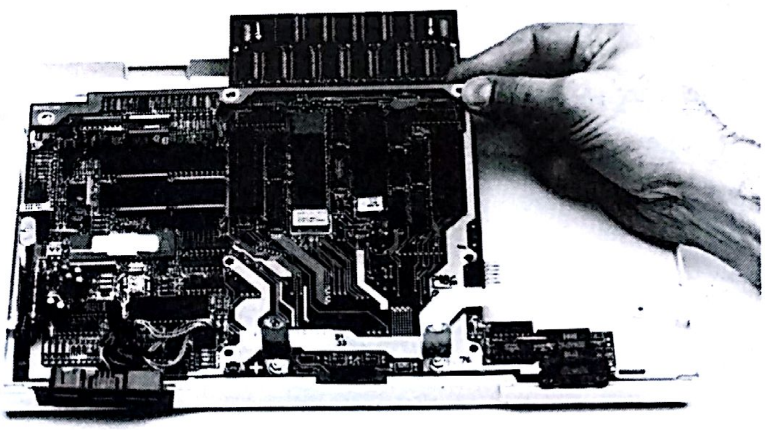


Figure 6-11. Removing the Motherboard and Memory PCAs

3. Separate the memory PCA from the motherboard PCA by carefully prying them apart with your fingers.

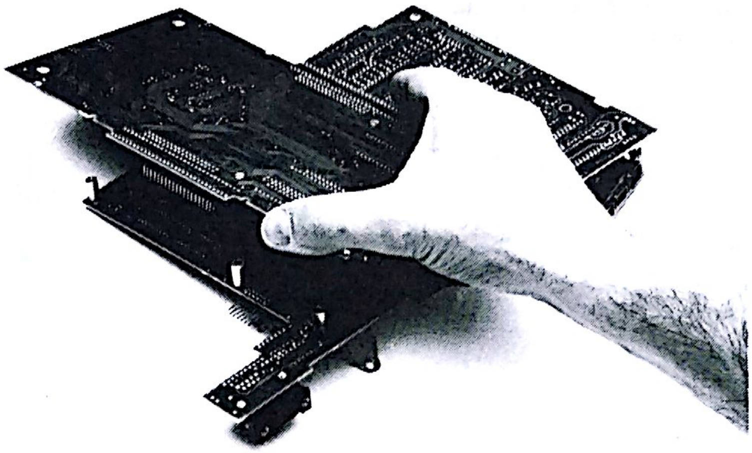


Figure 6-12. Separating the Motherboard and Memory PCAs

Reassembly Note: Be sure that the six mounting slots on the memory PCA are properly oriented with the studs on the motherboard PCA. Then *carefully align the two sets of connector posts* on the memory PCA with the corresponding sets of holes in the motherboard PCA and gently press the PCAs together, one connector set at a time.

Secure the new battery terminal straps to the motherboard PCA with the two flanged hex nuts: *be sure to position the straps correctly.*

6.6 Removing the Keyboard Module

After removing the battery and separating the case (sections 6.3 and 6.4):

1. Remove the hinge cover by removing the four long screws and upper ground strap on the underside of the top case assembly. The ground plate remains fastened to the keyboard PCA. (You will have to open the hinged display in order to remove the hinge cover.)

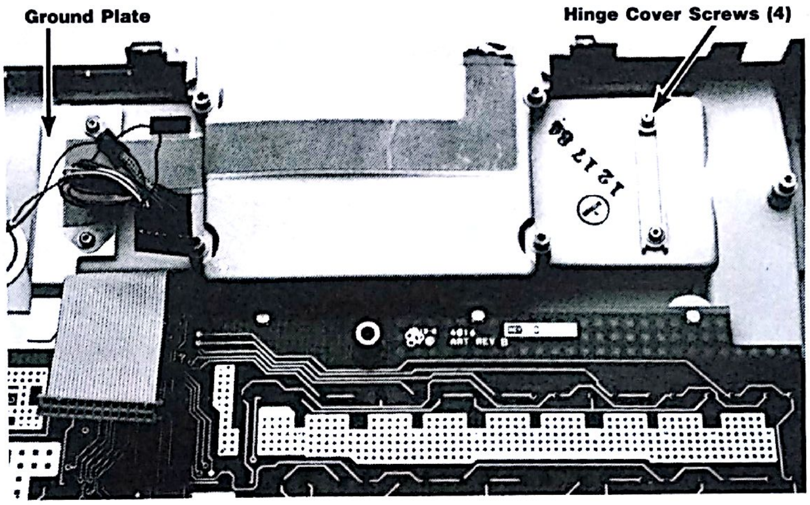


Figure 6-13. Removing the Hinge Cover

Reassembly Note: Be sure that the (upper) ground strap is held by the two screws (with washers) near the I/O opening, and that the groung lug on the display cable is held by the one screw nearest the I/O opening.

2. Remove the four nuts along the top edge of the keyboard; remove the ground plate (figure 6-14).

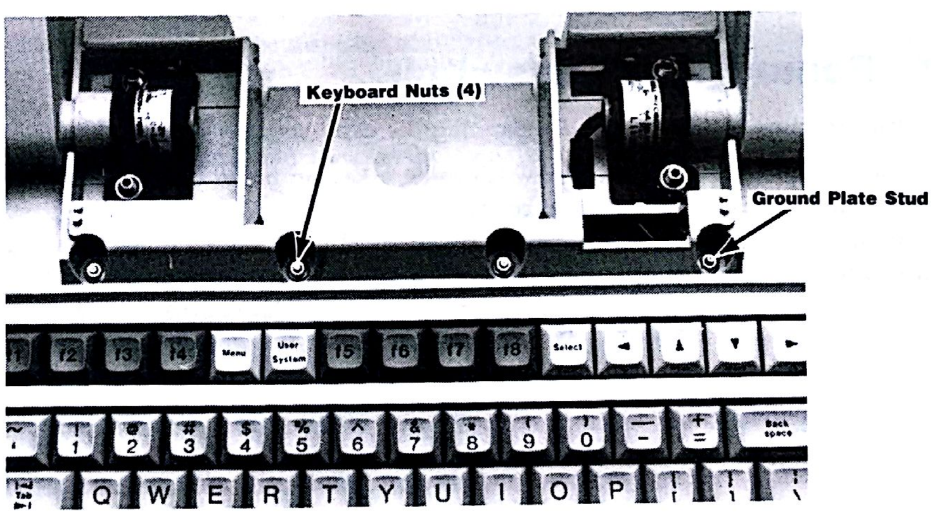


Figure 6-14. Removing the Keyboard Top Nuts

Reassembly Note: First install nuts on the three studs on the keyboard PCA. Then insert the ground plate stud through the fourth hole in the keyboard PCA and loosely install the fourth nut. After positioning the ground plate over the holes for the hinge cover screws, tighten the fourth nut at the top edge of the keyboard PCA.

3. Remove the four nuts on the underside of the keyboard PCA. Do this with the display open and the assembly tipped back on the display case.
4. Pivot and remove the keyboard module. The rear edge of the keyboard pivots out the bottom of the case. The keyboard module then slides out of the bottom of the case.

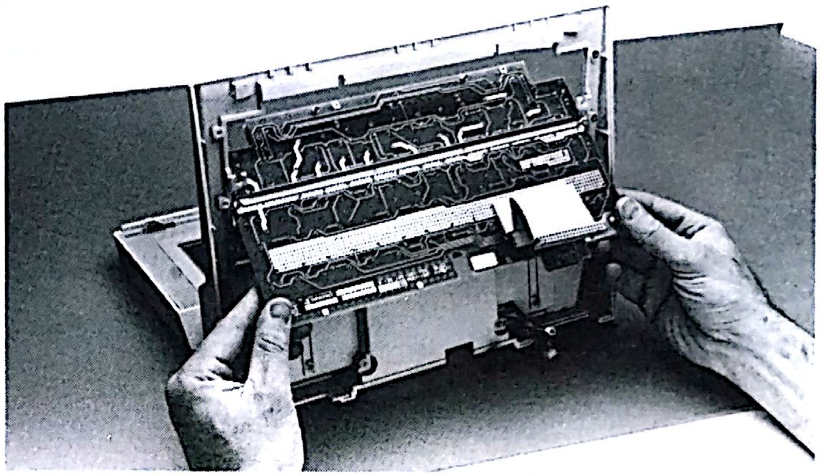


Figure 6-15. Removing the Keyboard Module

Reassembly Note: Insert the front edge of the keyboard just below and behind the tabs at the sides of the main opening.

6.7 Removing a Keyswitch

After disconnecting the battery and separating the case (sections 6.2 and 6.4):

1. Remove the keycap from the keyswitch using a keycap puller or a bent paperclip. (For the four widest keys, the keycaps are also connected to a stabilizer bar underneath; unhook the keycap from the bar by sliding the keycap to one side and unhooking the opposite end, then repeat for the other end. You may have to remove the adjacent keycap(s) to do this.)

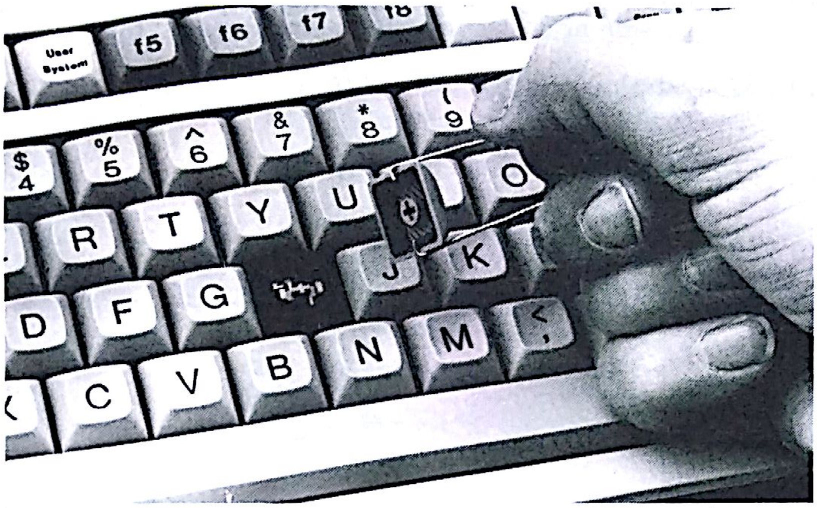


Figure 6-16. Removing a Keycap

Reassembly Note: For a wide key with a stabilizer bar, hook its two pivot clips onto the stabilizer bar, then press the keycap onto the switch.

2. Unsolder the two pins from the underside of the PCA and remove the keyswitch.

6.8 Removing the Display Module

WARNING

Avoid touching, swallowing, or breathing material from a broken display module. The liquid-crystal material is mildly toxic. If the material gets on your skin, rinse it off immediately with alcohol, then wash with water.

Discarded display modules should be disposed of by approved handlers of hazardous chemicals.

CAUTION

Take precautions against physical and electroststic damage to the display module.

Be sure that you are wearing a grounded wrist strap and working at a bench that is electrostatically protected. The display module is extremely sensitive to damage from electrostatic discharge (ESD).

Be careful to *not* to exert pressure on the display module. The LCD display and its PCA can become misaligned, causing irreparable damage.

1. Remove the cap from the display bezel by gently prying out the two ends at the latch slots; discard the cap and the strip of double-sided foam tape that held the cap in place.

   Reassembly Note: Install a new cap/tape assembly (part number 45711-60917) along the top recess with the two notches towards the latches.

2. Remove the two screws at the top of the bezel.

   Reassembly Note: If a new display was installed, remove the protective film before installing the bezel. Avoid over-tightening the two screws—tighten them until they are just snug. (Over-tightening could damage the threads or cause the latches to bind.)

3. Lift off the bezel.

   Reassembly Note: Before installing the bezel, clean the glass on the display module with freon or petroleum benzene (*using only light pressure*), and clean both sides of the bezel window with mild detergent or plastic cleaner.

4. Remove the four screws along the top of the display module, and loosen the four screws along the bottom. Be careful when loosening and tightening the four *lower* screws—the screwdriver must be held at an angle to avoid damaging the plastic display front.

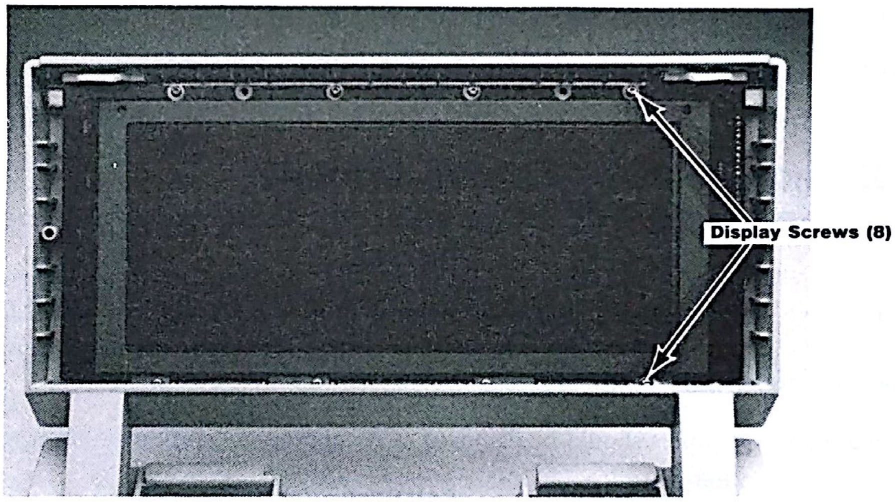


Figure 6-17. Removing the Display Screws

Reassembly Note: Before tightening the screws, slide the display module down toward the keyboard so that all play in the mounting holes is taken up in one direction. Tighten the *top* screws first, then tighten the bottom screws. (Be sure that the braided ground wire from the keyboard is secured by the bottom right screw.)

At the top, tighten the two center screws before tightening the corner screws. While tightening each upper center screw, press the top bracket toward the latch, checking that the latch can snap freely into its closed position (that it's not pinched between the bracket and the display back, but doesn't have excessive play).

5. Lift out the display module and unplug the cable at the back of the module.

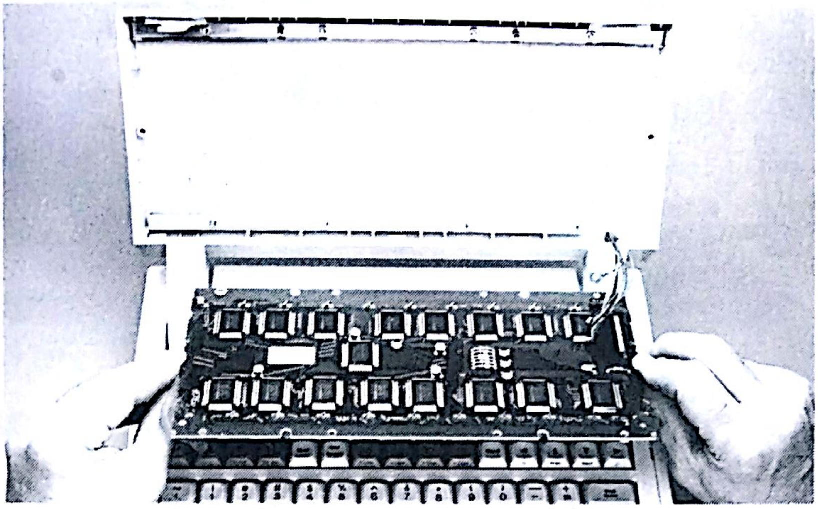


Figure Figure 6-18. Removing the Display Module

Reassembly Note: Before installing the display module, make sure that the top bracket is installed along the top of the display back with its mounting posts facing out. The bottom bracket should be installed with its retaining tabs facing upwards.

6.9 Removing the Clutches and Display Cable

To replace only the *left* clutch, remove the battery and separate the case (sections 6.3 and 6.4), then perform steps 1 through 5 below.

To replace the *right* clutch and display cable, remove the battery, separate the case, and remove the display module (sections 6.3, 6.4, and 6.8), then perform *all* of the following steps.

1. Remove the hinge cover by removing the four long screws (and washers) and the upper ground strap on the underside of the top case assembly. The ground plate remains fastened to the keyboard PCA.

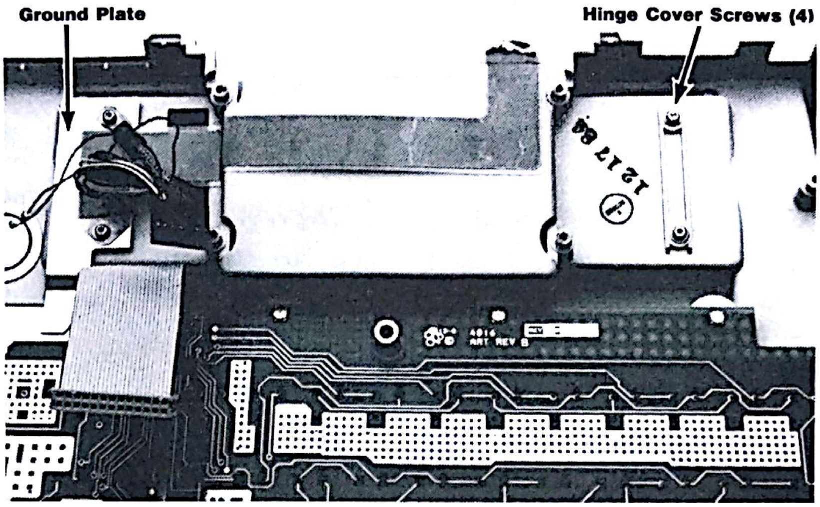


Figure 6-19. Removing the Hinge Cover

Reassembly Note: Be sure the upper ground strap is held by the two screws (with washers) near the I/O opening, and that the ground lug on the display cable is held by the one screw nearest the I/O opening.

2. If necessary, remove the piezoelectric transducer wires from the connector. Do this by carefully lifting the plastic tab on the connector body while pulling on the wire. (This step is necessary only if you are replacing the cable and the *right* clutch.)

   Reassembly Note: The two transducer wires have no polarity. Insert each contact into either hole in the connector.

3. Remove the four nuts holding the clutches.

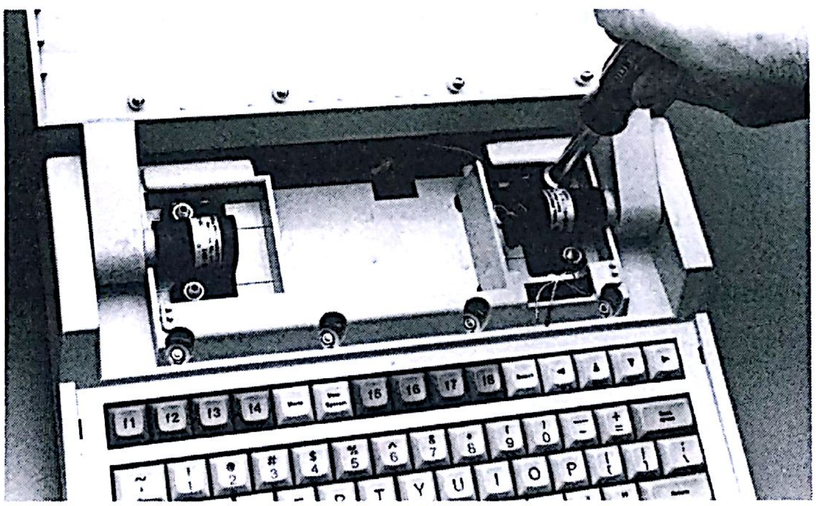


Figure 6-20. Removing the Clutch Nuts

Reassembly Note: Before tightening the four clutch nuts, position the display assembly so that it aligns with the main case along the two sides. Tighten the two nuts nearest the keyboard first. Recheck the alignment after tightening all four nuts.

4. Lift the display assembly off the top case. If you didn't separate the transducer wires, invert the display on the rear of the main case.

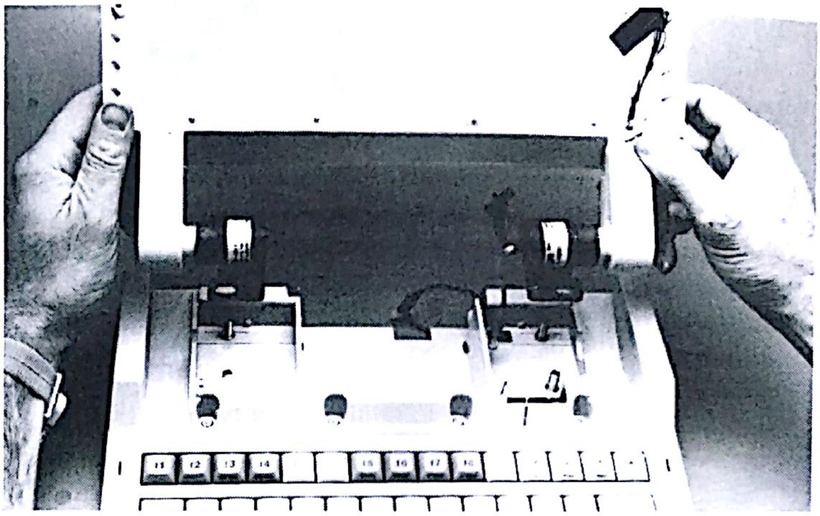


Figure 6-21. Removing the Display Assembly

Reassembly Note: Before installing the display assembly, twist the clutches so that the assembly will lay over the keyboard in its closed position.

5. Pull the left clutch off the spline. (Stop here if you're replacing only the left clutch.)
6. Pull the right clutch off the spline.

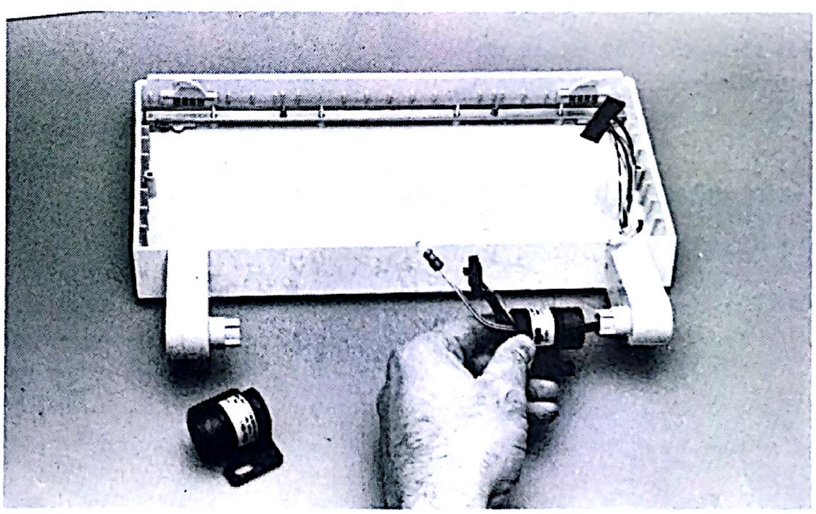


Figure 6-22. Removing the Clutch

7. Unlatch the display front. Do this by pulling out the front piece at one end while depressing the end plastic latch inside until it disengages. (Use a small screwdriver.) While keeping tension on the front piece, disengage other latches toward the oposite side.

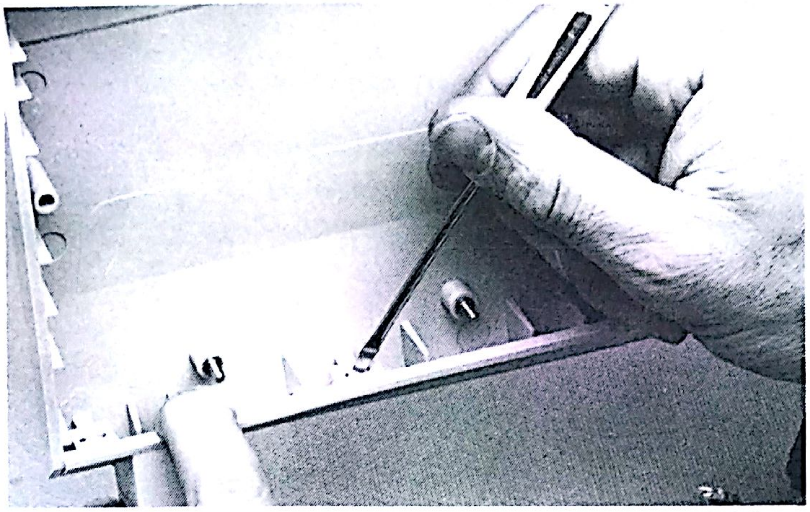


Figure 6-23. Unlatching the Display Front

8. Remove the display front by tipping it out until it disengages near the hinges.

Reassembly Note: Hold the display front at about 30° from the display back while engaging the hinge. Then lower the top of the display front and press along the top until all of the latches engage.

9. Lift out the clutch and display cable. The ferrite bead is held by a piece of tape.

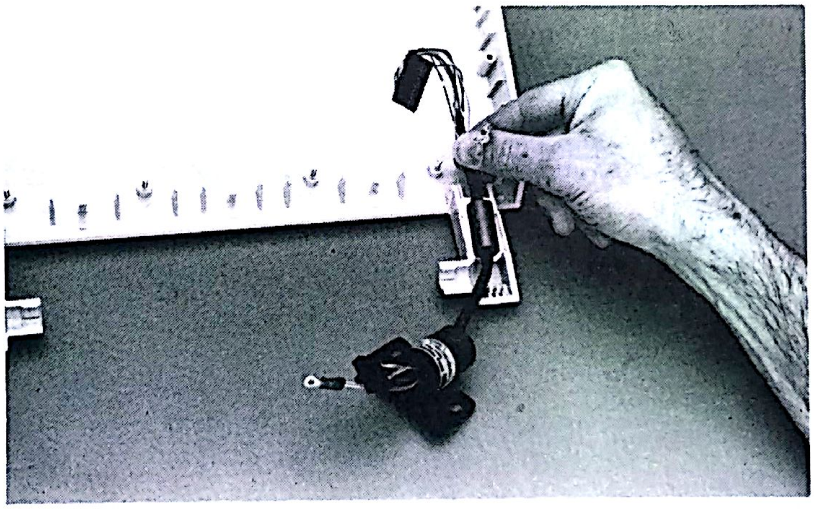


Figure 6-24. Removing the Clutch and Display Cable

Reassembly Note: When installing a new cable, ensure that approximately 10 cm (4 inches) of the display cable extend out of the spline. Place the end of the heat-shrink tubing at the top of the angle on the two ribs. Secure the ferrite bead with a piece of tape (part number 0460-1797).

6.10 Removing ICs

The following steps describe the proper procedure for using the optional desolderer (extractor) to remove a "through-hole" 28-pin IC from a PCA. (This procedure *doesn't* apply to surface-mounted ICs.)

After removing the battery, separating the case, and removing the PCAs (sections 6.3, 6.4, and 6.5):

1. Straighten any bent pins on the underside of the PCA.
2. Premelt the solder at all pins for about 4 seconds. Do this by placing the IC desolderer across all of the IC pins on the underside of the PCA.

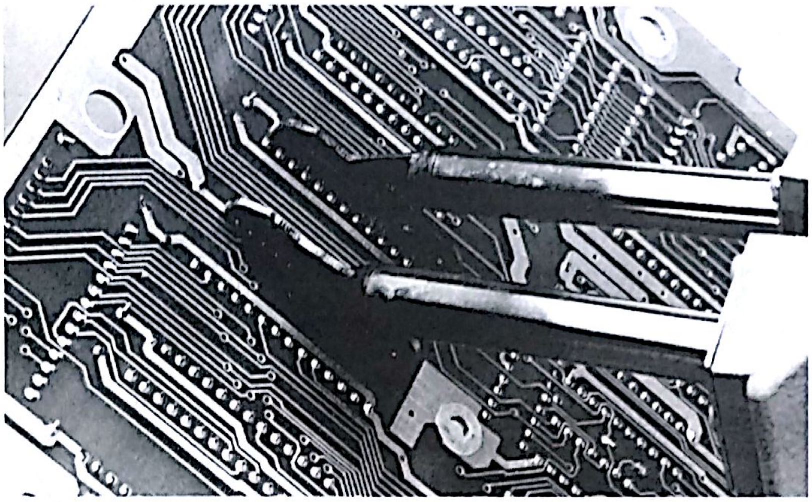


Figure 6-25. Premelting the Solder

3. Desolder and extract the IC by placing the desolderer across all IC pins on the *top* side of the PCA. Lift out the IC with the desolderer when the solder melts. Excessive force shouldn't be required. (If you want to salvage the IC, desolder it from the *underside* of the PCA instead.)

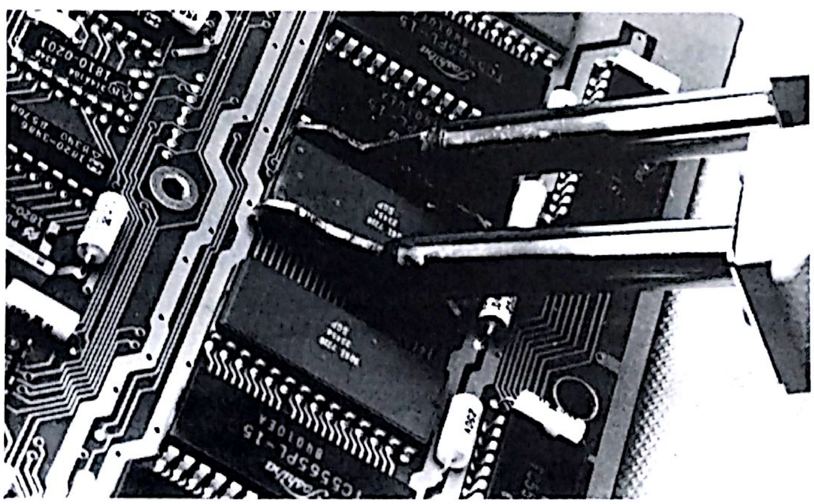


Figure 6-26. Extracting the IC

CAUTION

Xersin 2005 multicore solder (part number 8090-0873) is recommended because its special flux does not have to be removed. *If another solder is used, be sure that the flux is removed from the PCA*—flux contamination can cause conditions that may damage components or cause the system to malfunction.

4. Install the new IC using a conventional soldering tool.
5. If Xersin 2005 multicore solder was not used in step 4, remove all flux from the PCA using alcohol and a stiff brush.

6.11 Replacing Plug-In Drawer PCAs

The following steps describe the procedure for removing and replacing the PCA inside a plug-in drawer, such as a software (ROM) drawer or a memory (RAM) drawer. Although the drawers have different types of metal cases, they all use the same construction.

After removing the drawer from the unit:

1. Remove the four screws along the edge of the metal case.

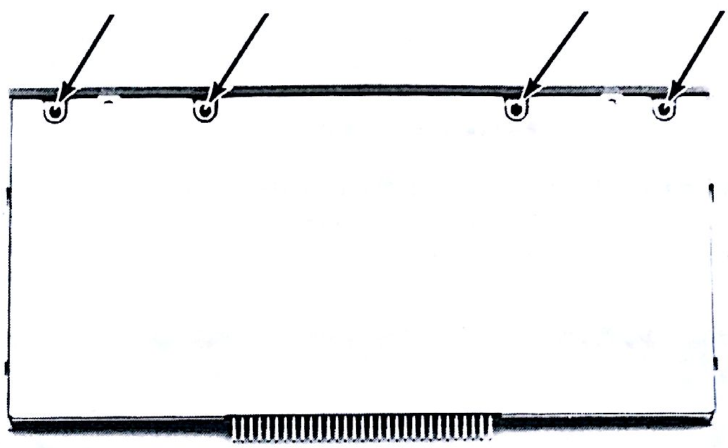


Figure 6-27. Removing the Case Screws

2. Remove the metal case. Slide it toward the connector until the metal tabs disengage, then lift the case off.

   Reassembly Note: Align the metal tabs with the slots in the plastic cover, then squeeze them together until the screw holes align. You'll feel some resistance as the foam tape inside the drawer is compressed.

3. Remove the four or five screws that hold the PCA to the plastic cover.

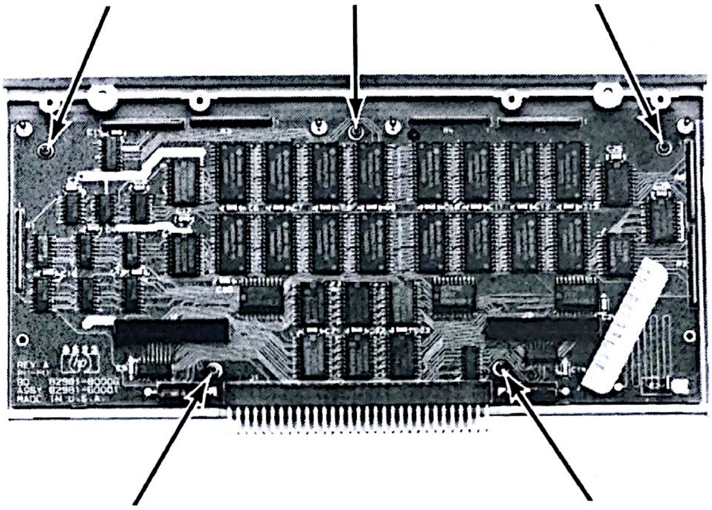


Figure 6-28. Removing the PCA Screws

4. Lift out the PCA.

To remove a piggyback PCA from a memory (RAM) drawer:

1. Remove the four screws along the edge of the metal case.
2. Remove the metal case. Slide it toward the connector until the metal tabs disengage, then lift the case off.

   Reassembly Note: Align the metal tabs with the slots in the plastic cover, then squeeze them together until the screw holes align. You'll feel some resistance as the foam tape inside the drawer is compressed.

3. Carefully pry the piggyback PCA from the main PCA using your fingers.

   Reassembly Note: Make sure a piece of tape (part number 5180-3035) is installed on the piggyback PCA along the row of ICs *farthest* from the connector.

Chapter 7
Adjustments

No adjustments are required on the Portable PLUS Computer.

Chapter 8
Troubleshooting

8.1 Overview

This chapter presents the procedures for checking and repairing the Portable PLUS at both the assembly and the component levels.

- Troubleshooting procedures (section 8.2).
- Using oscilloscope routines (section 8.3).
- Burning an EPROM (section 8.4).
- Testing the recharger (section 8.5).
- Testing the SNAL/3270 software drawer (section 8.6).

Troubleshooting is often begun by the customer, using the built-in diagnostic tests described in the owner's manual.

The troubleshooting procedures *you* will use are based upon additional, more extensive diagnostics. These *service* disc-based diagnostic tests and the diagnostic module oscilloscope routines are explained in table 8-1.

Table 8-1. Comparison of Diagnostic Tests

Diagnostic Test	Strengths	Limitations
Customer Tests:		
Built-in tests	Contained in ROM (requires minimum functionality).	Doesn't test all functions.
Additional Service Tests:		
Service disc tests	Tests most functions.	Loaded from disc into RAM (requires much functionality).
Diagnostic module oscilloscope routines	Contained in EPROM (requires minimum functionality).	Unit must be disassembled to probe signal lines.
	Tests many functions.	Doesn't test several functions.
		Oscilloscope required: fail mode information not displayed.

All repairs begin with the procedures described in section 8.2. Figure 8-1 illustrates the flow of these troubleshooting procedures.

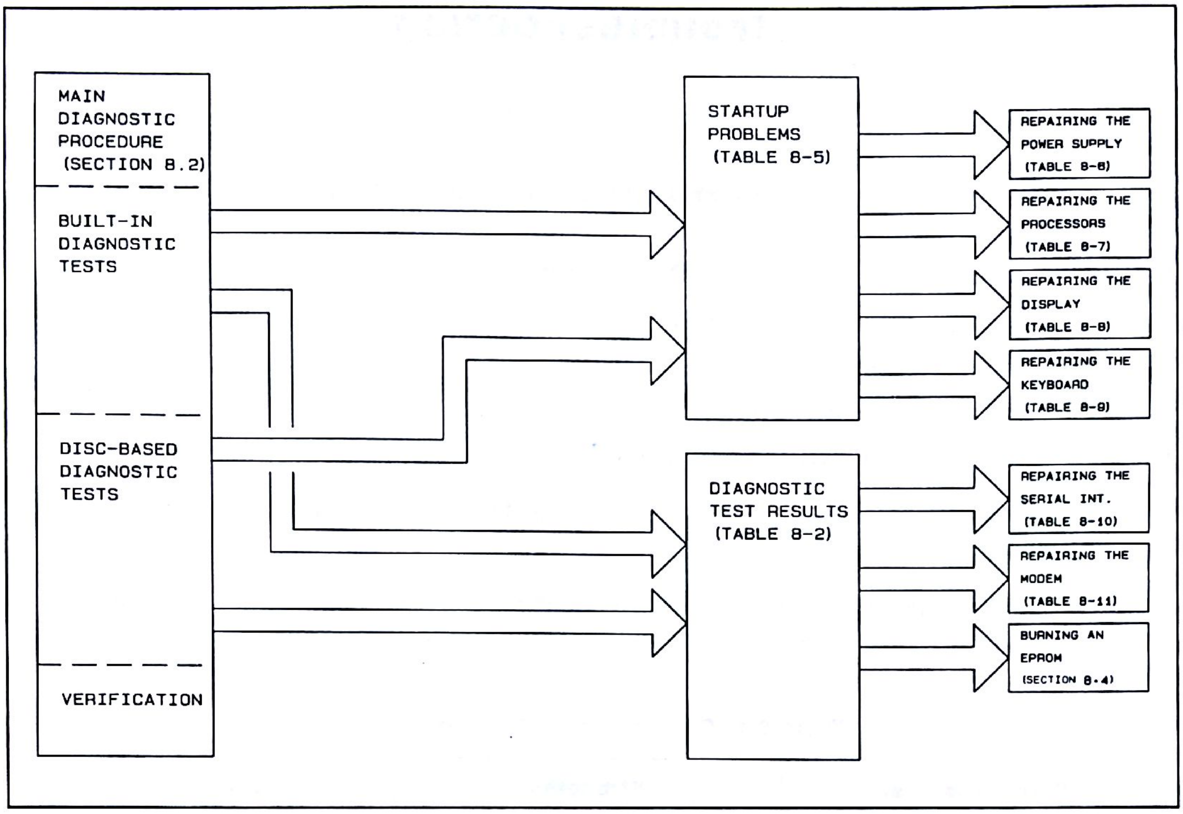


Figure 8-1. Overview of Troubleshooting Procedures

The troubleshooting procedures are described in section 8.2. They're based mainly upon the disc-based diagnostic tests. (The user receives some of these tests in the built-in diagnostics). For most problems, the disc-based tests indicate the assembly and component that are bad. Other tests are available to help determine and verify the problem with a unit. If the disc-based tests don't run, you'll use the built-in diagnostic tests.

The following list summarizes the tests that *you* can use:

- **Built-in diagnostic tests.** Tests that are included in and executed from internal ROM. You use a menu (figure 8-2) to select tests. These tests clear the Electronic disc (Edisc)—*be sure to back up all files onto a disc before running these tests, then reformat the Edisc and reload the files after the diagnostic tests are complete.*
- **Disc-based diagnostic tests.** Tests that are included on the service disc, loaded into internal RAM, and executed from RAM. You use a menu (figure 8-3) to select tests of each portion of the computer. (One of the routines burns new configuration EPROMs if the diagnostic module is plugged in.)
- **Diagnostic module oscilloscope routines.** Routines that are included in and executed from EPROM in the diagnostic module. They establish conditions for using an oscilloscope to check the circuits.

A summary of each diagnostic test is included in chapter 10, "Reference Information."

Test results will be printed automatically if an HP-IL "ThinkJet" printer (HP 2225B) is connected to the computer.

For assembly-level repair, the diagnostic tests indicate a bad assembly.

For component-level repair, the diagnostic tests indicate a bad component. You can use the oscilloscope routines to isolate and verify faults.

After repairing a unit, verify that it is good by performing a complete system test.

Tools and equipment needed for checking and repairing the computer are listed in table 1-3. (Reference information about special service equipment is in section 10.5.)

8.2 Troubleshooting Procedures

This section describes how to use the diagnostic tests and procedures to locate and repair a problem. Begin troubleshooting at the main diagnostic procedure in section 8.2.1 below.

CAUTION

Be sure to wear a grounded wrist strap and work at a bench that is electrostatically protected. Many electronic components, *especially the display module,* are highly susceptible to damage by electrostatic discharge.

8.2.1 Main Diagnostic Procedure

Check the unit by performing the following steps. For a good unit, you'll proceed thru the entire main sequence without branching to any of the repair procedures in section 8.2.2.

Problem Analysis:

1. **Read Comments.** Determine the customer's concern, if possible. Frequently, the customer includes with the unit a message describing the problem.
   - If the message indicates a problem with a particular portion of the unit, test only that section of the unit (and any other sections that may relate to the problem) in the steps below.
   - If the message indicates a problem with a *peripheral* (rather than with the computer), test the corresponding interface in the computer. Also check the HP-IL function of an HP-IL peripheral. To check a peripheral completely, test it according to its service manual.
   - If the message indicates a problem with a SNALink/3270 software drawer, test it according to the procedure in section 8.6.
   - If the customer's message indicates a problem with the recharger, test it according to the procedure in section 8.4.
2. **Observe Symptoms.** If possible, try to observe the trouble by duplicating the situation described in the customer's message. Determine how the observed or reported behavior differs from the proper behavior. Also take note of functions that *do* work properly.
3. **Separate Problems.** Separate the observed symptoms into distinct problems. Use the troubleshooting procedure below to correct *one problem at a time*, starting with the more critical *system* functions.
4. **Consider Causes.** Consider the possible causes for each problem. Keep them in mind as you troubleshoot.

Preparation:

5. **Turn On Computer.** With no external devices connected to the computer, press the (◑) key (or other keys) to turn on the computer.
   - If the main PAM screen appears, go to step 6. (For C and D versions and early E and F versions, check the amount of available memory shown at the upper-right corner of the PAM screen. If the amount is *unreasonable* considering the amount of RAM in the computer, check the memory PCA as described in chapter 11.)
   - If the MS-DOS system (not PAM) is active at turn on, type **exit** (Return) to obtain the main PAM screen, then proceed according to either of the other choices for this step.
   - If any other display appears, or if no display appears, repeat this step with all plug-in drawers replaced by dummy drawers (or install a port jumper—part number 45711-60918—between pins 1 and 2 in each plug-in connector). If the computer still doesn't turn on, *skip to step 9.*
6. **Set Up System.** Turn off the computer by holding the (◑) key for at least 15 seconds, then connect the computer to a good HP 9114 Disc Drive using two good HP-IL cables. (Don't connect any other HP-IL devices at this time.) Turn on the disc drive, then turn on the computer (press (◑) or other keys, if necessary).
   - If the main PAM screen appears, go to step 7.
   - If the MS-DOS system (not PAM) is active at turn on, type **exit** (Return) to obtain the main PAM screen, then proceed according to either of the other choices for this step.
   - If any other display appears, or if no display appears, *skip to step 9.*

7. **Save the Edisc.** If the customer has files stored in the computer's Electronic disc, copy the entire contents of the Edisc to an external disc. (The diagnostic RAM tests corrupt part of the Edisc.) Copy the contents using the File Manager program's "Copy File" option. (The procedure for copying the entire Edisc is explained in chapter 5 of *Using the Portable PLUS*.)
   - If the copy succeeds, go to step 8.
   - If this step doesn't work, check that the "External Disc Drives" field is set to 1 in the System Configuration screen. If this step still doesn't work, *skip to step 9.*
8. If the customer indicates a problem that's *not* related to the HP-IL function, *skip to step 14.*
9. **Turn Off Computer, Disconnect Peripherals.** If the computer is turned on, turn it off by pressing (f8) in the main PAM screen or by holding down (◐) (the contrast key) for approximately 15 seconds. If there is no response to the contrast key, press the reset button located in the battery compartment.

Built-In Diagnostic Tests:

10. **Start Test.** Start the built-in diagnostic tests by simultaneously holding down (Shift) and (Extend char) keys, and then pressing (f8). Hold all three keys for approximately 3 seconds, then release. This should cause the built-in self-test menu to be displayed.
    - If the test menu (figure 8-2) appears, proceed to step 11.
    - If the test menu *doesn't* appear, try to turn on the computer normally (by pressing the (◐) key, or other keys if necessary). If a normal display appears (such as PAM or MS-DOS), go to step 13; if a normal display *doesn't* appear, check the unit according to table 8-5, "Startup Problems."

```
Built-in self-tests:

f1: System test        Shift f1: RAM test *
f2: LCD test           Shift f2: Software/Memory drawer test *
f3: Timer test         Shift f3:
f4: RS-232 test        Shift f4:
f5: HP-IL test         Shift f5:
f6: Modem test         Shift f6:
f7: ROM test           Shift f7:
f8:                    Shift f8: Exit
* NOTE: The RAM test and RAM portion of the Software/Memory drawer
  test require approximately 5 minutes per 128K RAM checked.
```

Figure 8-2. Menu for Built-In Diagnostic Program

11. **Test HP-IL.** Connect a good HP-IL cable between the IN and OUT receptacles on the back of the computer (*no devices are connected*). Then press (f5) to select the HP-IL test.
    - If no problem occurs, proceed to step 12.
    - If the HP-IL test indicates a problem, replace the component or assembly indicated by the test. (Refer to table 8-2 for specific information.) Repeat the HP-IL test to ensure that the problem has been repaired.

12. **Test Peripheral.** If the customer has shipped a peripheral device with the computer, connect it to the computer using good HP-IL cables and turn it on. Then press (f5) to select the HP-IL test again.

- If no problem occurs, the computer HP-IL circuit is good, and the HP-IL portion of the peripheral is also good. (You can test the peripheral further according to its service manual.) Proceed to step 13.
- If the HP-IL test *does* indicate a problem, check the HP-IL cable connections and make sure that the peripheral is turned on. Replace the assembly or component indicated by the test. (Refer to table 8-2 for specific information.) Repeat the test to ensure that the problem has been repaired.

Disc-Based Diagnostic Tests:

13. **Set Up System.** Turn off the computer by holding the (◑) key for at least 15 seconds, then connect the computer to a good HP 9114 Disc Drive using two good HP-IL cables. (Don't connect any other HP-IL devices at this time.) Turn on the disc drive, then turn on the computer (press (◑) or other keys, if necessary).

- If the main PAM screen appears, go to step 14.
- If the MS-DOS system (not PAM) is active at turn on, type **exit** (Return) to obtain the main PAM screen, then proceed according to either of the other choices for this step.
- If any other display appears, or if no display appears, repeat the built-in diagnostic test (step 5 above), then press (f4) in the main PAM screen to select all of the tests. If the tests indicate a bad component, replace it (refer to table 8-2), then repeat the tests. If the tests find no problem, check the unit according to table 8-5, "Startup Problems."

14. **Load Service Disc.** Insert the service disc in the disc drive.

15. **Run EPROM Test.** Load and run the configuration EPROM test program. (Type **c:configts.exe** (Return), or else select "Test P+ EPROM" from the menu.) When the memory size and serial number are displayed, indicate whether they are correct or incorrect (refer to table 1-1 for memory information).

- If the memory size and serial number are correct, and if no errors are reported, go to step 16. *Do not burn a new EPROM.*
- If either the memory size or serial number is incorrect, burn a new configuration EPROM and use it to replace the old one. (Refer to section 8.4.)
- If the program reports a bad configuration EPROM, burn a new one and use it to replace the old one. (Refer to section 8.4.)
- If the program *doesn't* run, the system isn't operating properly. Check that the disc drive is connected properly and is turned on. Check that the service disc is inserted properly. Test the computer according to table 8-5, "Startup Problems."

16. **Run Diagnostic Test.** Load and run the disc-based diagnostic test program. (Type **c:stest2** (Return), or else select "Diagnostics" from the menu.)

- If the *disc-based diagnostic test* menu (figure 8-3) is displayed, go to step 17.
- If the test menu *doesn't* appear, the system isn't operating properly. Check that the disc drive is connected properly and is turned on. Check that the service disc is inserted properly. Test the computer according to table 8-5, "Startup Problems."

```
PORTABLE PLUS tests:

f1: System test               Shift f1: RS-232 test
f2: CPU test                  Shift f2: Beeper test
f3: ROM test                  Shift f3: Timer test
f4: RAM test                  Shift f4: Software/Memory Drawer test
f5: LCD test                  Shift f5: Modem test
f6: Keyboard test             Shift f6: Scope routines
f7: HP-IL test                Shift f7: Continuous loop
f8:                           Shift f8: Exit

Use Shift key and f1-f8 to select test.

Use Shift f8 to exit.
```

Figure 8-3. Menu for Disc-Based Diagnostic Program

17. **Select Test.** Select the appropriate test by pressing the corresponding function key (shifted or unshifted).

    Note the results of the tests. You can make a printout of the test results by connecting an HP-IL "ThinkJet" printer (HP 2225B) as the only device.

    - If the customer indicated a functional area that has a problem, select the test for that area. (If more than one area is noted, check all of the areas mentioned, starting from the top of the menu.)
    - If the nature of the problem isn't indicated, select the *system* test.

    Note: Four disc-based tests require special preparations:

    The *HP-IL test* requires either that you connect a good HP-IL cable between the IN and OUT receptacles or that you connect the computer and one or more devices in a loop.

    The *RS-232-C* (*serial interface*) *test* requires you to connect the RS-232-C test connector to the serial port.

    The *modem test* includes "dial" and "ring" options that require two phone lines to be connected to the modem port.

    The *system test* performs the three tests listed above and requires the preparations for each of them.

18. **Follow Up.** Take action according to the results of each test:

- If no problems occur, the tested functions are probably good and no action is required. Check the last three items listed below. (However, if the customer indicates a problem and you haven't found anything so far, consider whether another function might be involved—then test *that* function. If you think that a test might be missing the problem, check the unit using the oscilloscope routines described in section 8.3.)
- If a test *does* indicate a problem, replace the assembly or component indicated by the test. (Refer to table 8-2 for specific information.) Then repeat the test to ensure that the problem has been repaired.
- If a test doesn't operate properly, check the unit using the built-in diagnostic test menu (figure 8-2) instead of the disc-based menu. If the built-in tests don't operate, check the unit according to table 8-5, "Startup Problems."
- Modem: If a modem is installed, verify that its presence is noted. If the message "No modem installed" appears, check the unit according to table 8-11, "Repairing the Modem."

  If you're using the built-in modem test, look for a "bad device" message with no failure code. If this occurs, take action according to the "3??" failure code.
- Memory Drawer: If a memory drawer is installed, verify that its presence is noted ("Receptacle *n*: testing *xxx*K RAM"). Receptacle 1 is under the (Return) key; receptacle 2 is under the (f1) key. Also verify that the amount of RAM indicated by the test message ("*xxx*K RAM") is the same as the amount of memory in the drawer. If there is a problem, swap the RAM PCA (or piggy-back PCA, if installed) in the drawer.
- Software Drawer: If a software drawer is installed, verify that the list of occupied ROM sockets is correct ("Receptacle *n*: The following ROM(s) were found ..."). Receptacle 1 is under the (Return) key; receptacle 2 is under the (f1) key. If *all* of the ROM ICs aren't found, swap the ROM PCA in the drawer. If *some* ROM ICs aren't found, swap good ROM ICs in those locations. (Also check the jumper positions on the PCA—refer to table 8-4.) Replace the ROM PCA or the ROM ICs, as indicated. (For a SNALink/3270 software drawer, refer to section 8.6.)

Verification:

19. **Verify Operation.** After repairing any faults, verify that the unit is good by repeating steps 13 thru 18 above. In step 17, select the complete system test (press (f1) in the disc-based test menu). Recall that the HP-IL, RS-232-C, and modem tests require certain connections at the appropriate receptacles (refer to step 17 above).

20. **Set Time.** Set the time zone and time to their correct values: press (f3) (Time & Date Config) in the main PAM screen. Move thru the menu using the tab or cursor keys. Change entries as needed by pressing the "Next Choice" or "Previous Choice" keys. Press the "Exit Config" key to save the time you've selected.

21. **Format and Restore Edisc.** Format the Edisc (also called drive A). Use the File Manager program's "Format" option, specifying **a:** as the drive.

    Copy the old Edisc contents back into the computer from the external disc. Use the File Manager program's "Copy File" option. (The procedure for copying an entire disc is explained in chapter 5 of *Using the Portable PLUS.*)

22. **Recharge the Battery.** If power has been disconnected from the unit, the battery "gauge" resets to 0 percent, even though the battery may not be at that level. Connect the unit to a recharger and allow the battery to charge for at least 12 hours while the unit is turned off. This will return the "gauge" and battery to at least 95 percent (of full charge). Alternatively, include a note to the customer suggesting recharging the battery until the "gauge" reaches 95 percent.

This completes the main diagnostic procedure.

Table 8-2. Diagnostic Test Results

Use this table to interpret the results of built-in and disc-based diagnostic tests. (This table is repeated as table 10-1 in chapter 10.)

Messages sent by the built-in tests are translated into the *local* language of the computer. Disc-based messages are in English.

For assembly-level repair, replace the assembly indicated in the "assembly-level" column (or take the steps listed).

For component-level repair, replace the component indicated in the "component-level" column (or take the steps listed). However, replacing the IC may not solve the problem; there might be other problems, such as a short on the PC board or a bad passive component. When directed, use the oscilloscope routines indicated in the last column to help locate the fault, and refer to the waveforms on the schematic diagrams.

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes:			
116–118 127–129	Replace individual ROM ICs: 116–118→A1U16 127–129→A1U27 If not fixed, replace memory PCA.*†	Replace individual ROM ICs: 116–118→A1U16 127–129→A1U27 If latch or transceiver suspected, trace using scope routine.*†	Internal ROM read
130	A1U30 (configuration EPROM)—burn new EPROM IC before installing (section 8.4).	A1U30 (configuration EPROM)—burn new EPROM IC before installing (section 8.4).	Config EPROM
210	Motherboard PCA.	A2U10 (LCD controller).	LCD RAM write LCD RAM read
215	Motherboard PCA.	A2U15 (HP-IL controller).	HP-IL
216	Motherboard PCA.	A2U16 (modem multi-controller).	
217	Motherboard PCA.	A2U17 (PPU).	
218	Motherboard PCA.	A2U18 (serial multi-controller).	RS-232
314	Modem PCA.	A3U14 (modem controller).	
3??	Modem PCA	Check modem circuit according to table 8-11, "Repairing the Modem."	

Table 8-2. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes (continued):			
4*rcc* (*r* is row number) (*cc* is column number)	Swap the keyboard module, then retry. If fixed, replace keyswitch (or keyboard module) after checking continuity; if not fixed, replace the motherboard PCA.	Swap the keyboard module, then retry. If fixed, replace keyswitch (or keyboard module) after checking continuity; if not fixed, replace A2U16 (keyboard multicontroller, or SIP resistors A2R12, A2R13, and A2R14).	
0: *yy* ... 1: *yy* ... 2: *yy* ... 3: *yy* ...	Memory PCA.*†	If only one or two RAM ICs indicated (see table 8-3), replace individual ICs. (Note that one IC corresponds to several codes.) Replace memory PCA.*† If more than two RAMs indicated, latch or transceiver suspected. Trace using scope routine.*†	Internal RAM write Internal RAM read
A–0: *yy* ...	Memory drawer PCA in receptacle noted previously.	Memory drawer PCA in receptacle noted previously.	Find plug-in RAM
A–1: *yy* ...	For standard memory drawer, move piggyback RAM PCA from connector J2 to connector J3 in receptacle noted previously. Then if no "B–0" error, replace memory drawer PCA; if "B–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	For standard memory drawer, move piggyback RAM PCA from connector J2 to connector J3 in receptacle noted previously. Then if no "B–0" error, replace memory drawer PCA; if "B–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	Find plug-in RAM

Table 8-2. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes (continued):			
B–0: *yy* ...	For standard memory drawer, move piggyback RAM PCA from connector J3 to connector J2 in receptacle noted previously. Then if no "A–0" error, replace memory drawer PCA; if "A–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	For standard memory drawer, move piggyback RAM PCA from connector J3 to connector J2 in receptacle noted previously. Then if no "A–0" error, replace memory drawer PCA; if "A–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	Find plug-in RAM
A–ROM*yy*L ... A–ROM*yy*H ...	For receptacle noted previously, check that jumpers are in proper locations‡; swap known good ROM at socket marked *yy*L or *yy*H‡; replace ROM PCA or ROM IC as indicated.	For receptacle noted previously, check that jumpers are in proper locations‡; swap known good ROM at socket marked *yy*L or *yy*H‡; check ROM PCA using scope routine, or replace ROM IC, as indicated.	Plug-in ROM read Find plug-in ROM
Messages:			
Broken loop	Try new cable; check connections; check I/O plate (or swap and retry); replace the motherboard PCA.	Try new cable; check connections; inspect internal connections to I/O plate assembly (or swap assembly and retry); check continuity of HP-IL interface circuit (see schematic); replace A2U15 (HP-IL controller).	HP-IL
Loop error, data not received as sent	Remove peripherals and run the HP-IL test; try new cable; check connections; bad HP-IL peripheral; check I/O plate (or swap and retry); replace the motherboard PCA.	Remove peripherals and run the HP-IL test; try new cable; check connections; bad HP-IL peripheral; check I/O plate (or swap and retry); check HP-IL components using scope routine; replace A2U15 (HP-IL controller).	HP-IL

Table 8-2. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Messages (continued):			
Number of devices on HP-IL loop = *wrong number*	Check connections; if HP-IL/HP-IB interface connected, perform system configuration in PAM; check HP-IL peripheral; if occurs for every peripheral, replace the motherboard PCA.	Check connections; if HP-IL/HP-IB interface connected, perform system configuration in PAM; check HP-IL peripheral; if occurs for every peripheral, replace A2U15 (HP-IL controller).	HP-IL
Transmitted or Rcvd. Data line(s) bad	Check test connector; replace the motherboard PCA.	Check test connector; trace signals using scope routine.	RS-232
CTS line bad DSR line bad DTR line bad RTS line bad Carrier Det line bad	Check test connector; replace the motherboard PCA.	Check test connector; check serial interface according to table 8-10, "Repairing the Serial Interface."	
Beep Test Observations:			
Three beeps don't sound	Swap transducer; replace transducer or motherboard PCA, as indicated.	Swap transducer or check signal with scope during test; replace the transducer, A2U17 (PPU), or A2U21.	
Display Test Observations:			
Display doesn't scroll properly	Motherboard PCA.	Replace A2U10 (LCD controller).	LCD RAM write LCD RAM read
Border line improper	Display assembly.	Display assembly.	
Extra or missing pixels.	Swap top case assembly (if available) and retry; replace display assembly or the motherboard PCA, as indicated.	Check VccDS at A2U10 pins 10, 17, and 21; swap top case assembly and retry; check display circuit or replace display assembly, as indicated.	LCD RAM write LCD RAM read
Row (or column) dark or light	Display assembly.	Display assembly.	
Blinking or inverse display improper	Display assembly.	Display assembly.	
Two cursors improper	Motherboard PCA.	A2U10 (LCD controller).	

Table 8-2. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Display Test Observations (continued):			
Quadrant bad	Check continuity between A2U10 and display assembly; swap the motherboard PCA, then retry; replace display assembly or the motherboard PCA, as indicated.	Check continuity between A2U10 and display assembly; use scope to check for toggling signals at A2U10 pins 12–16 and 18–20; replace display assembly or A2U10 (LCD controller), as indicated.	LCD RAM write LCD RAM read
Adjacent rows (or columns) duplicated	Display assembly.	Display assembly.	
Modem Observations:			
During optional pulse dialing test, telephone doesn't ring	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; replace A3U17 or the modem PCA.	
During optional tone dialing test, telephone doesn't ring	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; replace A3U17 or the modem PCA.	
During optional ring-detect test, computer doesn't beep or indicate call received	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; check modem circuit according to table 8-11, "Repairing the Modem."	

* For A, B, C, and D versions and early E and F versions, refer to chapter 11.

† Whenever you replace the memory PCA, remove the configuration EPROM (A1U30) from the old PCA and install it in the new PCA. (This does not apply if you suspect that the configuration EPROM itself is bad.)

‡ All jumpers on the plug-in ROM PCA should be in position "A" for independent ROM ICs. Other configurations are listed in table 8-4. If jumpers XW3, XW4, XW5, and XW6 are all in position "B", test result "7L" points to sockets 4L through 7L, and test result "7H" points to sockets 4H through 7H.

Table 8-3. System RAM Diagnostic Identification

Failure Code	RAM Block	IC Identification (Memory PCA)*	
0: *yy*	Block 0	0:00 0:02 0:04 0:06 → A1U26	0:01 0:03 0:05 0:07 → A1U15
		0:08 0:10 0:12 0:14 → A1U25	0:09 0:11 0:13 0:15 → A1U14
1: *yy*	Block 1	1:00 1:02 1:04 1:06 → A1U24	1:01 1:03 1:05 1:07 → A1U13
		1:08 1:10 1:12 1:14 → A1U23	1:09 1:11 1:13 1:15 → A1U12
2: *yy*	Block 3	2:00 2:02 2:04 2:06 → A1U22	2:01 2:03 2:05 2:07 → A1U11
		2:08 2:10 2:12 2:14 → A1U21	2:09 2:11 2:13 2:15 → A1U10
3: *yy*	Block 3	3:00 3:02 3:04 3:06 → A1U20	3:01 3:03 3:05 3:07 → A1U9
		3:08 3:10 3:12 3:14 → A1U19	3:09 3:11 3:13 3:15 → A1U8

* For A, B, C, and D versions and early E and F versions, refer to chapter 11.

Table 8-4. Software Drawer Jumper Configurations

If Bank Number...	Contains These ICs...	Set Jumpers...
Bank 0, 1	Independent ROMs	XW1 = "A"
Bank 0, 1	Independent EPROMs	XW1 = "B"
Banks 4, 5, 6, 7	Independent ROMs	XW2 = "A" XW3 = "A" XW4 = "A" XW5 = "A" XW6 = "A"
Banks 4, 5, 6, 7	Independent EPROMs	XW2 = "B" XW3 = "A" or "B" XW4 = "A" XW5 = "A" XW6 = "A"
Bank 7*	Sequential ROMs	XW2 = "A" XW3 = "B" XW4 = "B" XW5 = "B" XW6 = "B"
Bank 7*	Sequential EPROMs	XW2 = "B" XW3 = "B" XW4 = "B" XW5 = "B" XW6 = "B"

* Four sequential pairs located in sockets for banks 5, 6, 7, and 4 (in that order). Banks 4, 5, and 6 aren't present in this configuration.

8.2.2 Repair Procedures

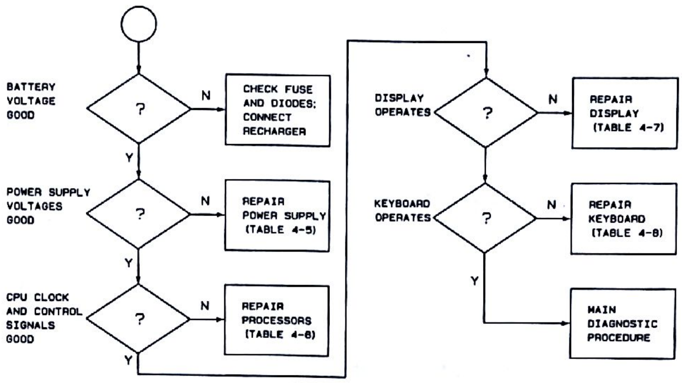
The following tables describe procedures that you should follow for repairing certain problems. Because these procedures assume certain results from previous tests, use them only when directed by other procedures.

For assembly-level repair, follow the indicated procedures only as far as required to make an informed decision as to which assembly is bad. After substituting a new assembly, repeat the appropriate test to verify the repair. Then complete the main diagnostic procedure in section 8.2.1.

For component-level repair, follow the indicated procedures as described.

Table 8-5. Startup Problems

Use this procedure if the unit doesn't turn on properly and you can't use any of the service diagnostic tests. If you make a repair at any step, check whether the unit seems to operate enough to use a diagnostic test; if it does, go back to the main diagnostic procedure in section 8.2.1.



Step	Response
1. If the display is turned on, turn it off (either press (f8) in the main PAM screen, or else press and hold (◑) key for at least 15 seconds).	
2. If the unit doesn't turn on, check (1) that the battery jumper (in the battery compartment) is in the ON position and (2) that each plug-in connector has a drawer installed (possibly a dummy drawer) or has a port jumper connected between pins 1 and 2.	

WARNING

The battery fuse is located on the motherboard PCA. Do not short the battery terminals or the battery positive to ground because it is not fused, and could produce an electric shock.

Step	Response
3. *For C and D versions and early E and F versions only,* check the jumpers and piggyback PCAs on the memory PCA. Refer to chapter 11.	
4. Separate the bottom case from the unit, and remove the motherboard and memory PCAs from the case (procedures 6.4 and 6.5). Reconnect these PCAs on your bench, then connect the keyboard using a keyboard extension cable and the display assembly using an LCD extension cable. Connect a recharger or the unit's battery.'	

Table 8-5. Startup Problems (Continued)

Step	Response
5. Try to start the built-in diagnostic tests by holding down (Shift) and (Extend char), and pressing (f8).	If the test menu appears, perform the system test. If indicated, repair the unit according to table 8-2; otherwise, go to the step 6. If the test menu *doesn't* appear, the system isn't operating properly; proceed to the step 6.
6. Measure the voltage (VBAT) at the battery terminals while the battery is connected to the system.	If the voltage is 6.2 Vdc or above, the battery is sufficiently charged. Go to the step 7. If VBAT is below 5 Vdc, recheck the battery while removed from the unit. Replace the battery if its terminal voltage is below 5 Vdc; otherwise, check the circuit for shorts. If the voltage is between 5 and 6.2 Vdc, connect a recharger. ■ If the voltage increases to 5.5 Vdc or above, proceed to the next step. (If the unit can turn on, perform the main diagnostic procedure in section 8.2.1 instead.) ■ If the voltage remains low (after approximately 5 minutes), first verify that the recharger is good (substitute a good recharger or test it according to section 8.5), then check the power supply using the procedure in table 8-6, "Repairing the Power Supply."
7. Measure VccDS at A2U17 (PPU) pin 40.	If VccDS is between 4.9 and 5.1 Vdc, proceed to step 8. If VccDS is between 3.2 and 3.4 Vdc, the power supply is in its power-down state. Repeat this step while pressing (◑) (and other keys, if necessary): if VccDS stays the same, check the power supply using the procedure in table 8-6, "Repairing the Power Supply." If VccDS is outside these ranges, check the power supply using the procedure in table 8-6, "Repairing the Power Supply."
8. Measure VccS at A2U1 pin 40.	If VccS is between 4.9 and 5.1 Vdc, go to step 9. If VccS is outside 4.9 and 5.1 Vdc, check the power supply using the procedure in table 8-6, "Repairing the Power Supply."

Table 8-5. Startup Problems (Continued)

Step	Response
9. Measure VLCD at the collector of A2Q77 (unstriped end) or at connector A2J9 pin 10.	If VLCD is between −7 and −13 Vdc, proceed to step 10. If VLCD is outside −7 and −13 Vdc, check the power supply using the procedure in table 8-6, "Repairing the Power Supply."
For assembly-level repair: Find the bad assembly by temporarily substituting a good motherboard PCA, memory PCA, or top case assembly, then repeating the main diagnostic procedure in section 8.2.1.	
For component-level repair: Continue testing using the following steps.	
10. Using a scope, check the following signals for the proper activity in order. Monitor each signal either while the computer is on or while it is *turning on*. (Turn on the computer by pressing (◑) or other keys while the unit is off. Turn off the computer by pressing and holding (◑).) CLK (A2U1, pin 19): 5.33-MHz signal. RESET (A2U1, pin 21): 5V for 200 ms at turn-on, then 0V. READY (A2U1, pin 22): toggles periodically. ALE (A2U1, pin 25): toggles at turn-on. RD* (A2U1, pin 32): toggles at turn-on. WR* (A2U1, pin 29): toggles at turn-on. DEN* (A2U1, pin 26): toggles at turn-on. DT/R* (A2U1, pin 27): toggles at turn-on. BHE* (A2U1, pin 34): toggles at turn-on. M/IO* (A2U1, pin 28): toggles at turn-on.	If all signals are proper, go to step 11. If any signal is improper, check the system processors using the procedure in table 8-7, "Repairing the Processors."
11. Note whether the display has properly shown the main PAM screen (or any other display) during the previous steps.	If the display appears to be operating properly (even though the expected PAM screen may not be displayed), go to step 12. If the display appears to be improperly presented (including altered characters), check the display function using the procedure in table 8-8, "Repairing the Display." If the display doesn't turn on (after pressing (◑) or other keys), check the display function using the procedure in table 8-8, "Repairing the Display."

Table 8-5. Startup Problems (Continued)

Step	Response
12. Note how the unit has responded to keystrokes during the previous steps.	If the unit has responded to some keys, but other keys don't get a response, check the keyboard function according to table 8-9, "Repairing the Keyboard." If the unit hasn't responded to any keys, check the keyboard function according to table 8-9, "Repairing the Keyboard." If the unit has responded to all keys, repeat the main diagnostic procedure (selecting the system test from the test menu).

Table 8-6. Repairing the Power Supply

Use this procedure if any of the supply voltages appears to be improper. If you make a repair at any step, check whether the voltage is proper; if it's good, go back to the main diagnostic procedure in section 8.2.1.

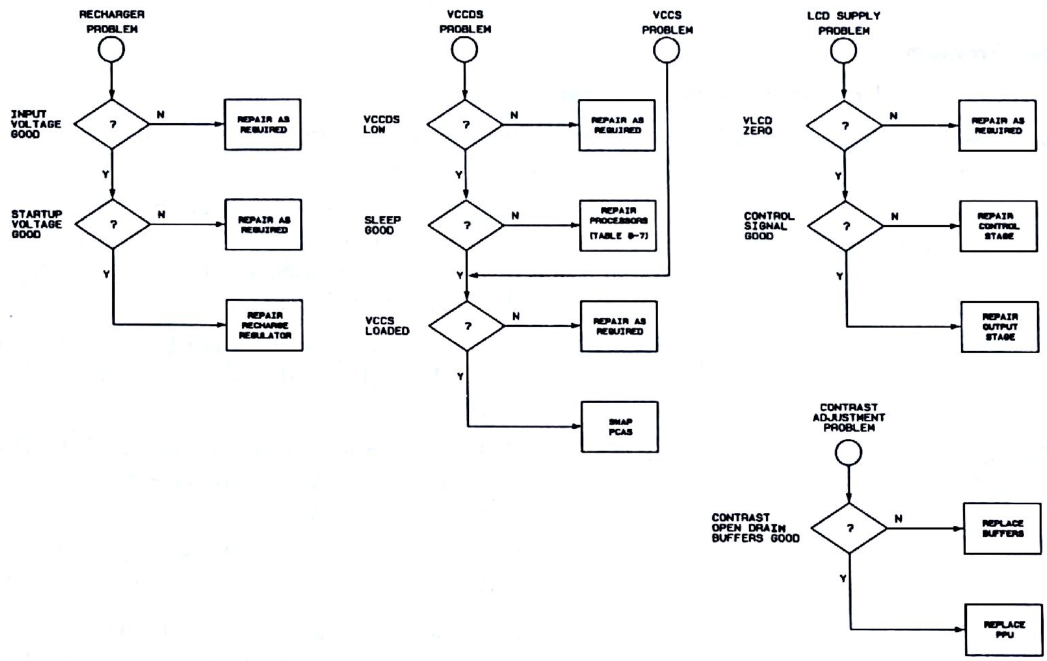


Table 8-6. Repairing the Power Supply (Continued)

Step	Response
1. Note the symptom that indicated a power supply problem.	If a good recharger, when connected to the unit with a low battery, doesn't increase the battery voltage, go to step 2. If the VccDS supply always stays at its power-down level (3.2–3.4 Vdc) but VBAT is above 6.2 Vdc, *skip to step 5.* If the VccDS supply is outside its proper range (4.9–5.1 Vdc or 3.2–3.4 Vdc) but VBAT is above 6.2 Vdc, *skip to step 5.* If the VccS supply is outside its proper range (4.9–5.1 Vdc) but VccDS is proper (4.9–5.1 Vdc), *skip to step 7.* If the VLCD supply is outside its proper range, but VccDS and VccS are proper (4.9–5.1 Vdc), *skip to step 8.* If the contrast adjustment doesn't operate properly, but VccDS, VccS, and VLCD are proper, *skip to step 10.*
Charger Problem:	
2. Connect a good recharger to the computer.	
3. Measure the voltage at A2C50 "+" lead.	If the voltage is between 10 and 20 Vdc, go to step 4. If the voltage is 0 Vdc, check the connections at the I/O plate (RECH receptacle), check A2CR64 thru A2CR67 (rectifiers), check A2C50; replace the motherboard PCA. If the voltage is greater than 0 Vdc but *not* between 10 and 20 Vdc, replace the motherboard PCA.
4. Measure the voltage at the cathode of A2CR51 (striped end).	If the voltage is between 10 and 20 Vdc, check A2Q50; replace A2U50; replace the motherboard PCA. If the voltage is 0 Vdc, check A2C51, A2CR51, and A2CR52; replace the motherboard PCA. If the voltage is greater than 0 Vdc but *not* between 10 and 20 Vdc, replace the motherboard PCA.

Table 8-6. Repairing the Power Supply (Continued)

Step	Response
VccDS Regulator Problem:	
5. Measure VccDS: A2U17 (PPU), pin 40.	If VccDS is less than 1 Vdc, check A2VR50 (produces regulated voltage of 1.23 Vdc), check A2Q63, A2Q66, and A2Q62 for open circuit; replace the motherboard PCA. If VccDS is between 3.2 and 3.4 Vdc, go to step 6. If VccDS is between 4.0 and 4.9 Vdc, go to step 6. If VccDS is the same as VBAT (measured at the battery terminals), replace A2Q63; replace the motherboard PCA. If VccDS is outside any of the above ranges, replace the motherboard PCA.
6. Monitor the SLEEP signal with a scope while pressing [◑] (or other keys): A2U17, pin 34.	If the SLEEP signal goes low (less than 1V), go to step 7. If the SLEEP signal stays high or "floats" between high and low, check the processors using the procedure in table 8-7, "Repairing the Processors."
7. Unsolder and lift the drain lead of A2Q70; then measure VccS at the lifted drain lead.	If the drain voltage is between 4.9 and 5.1 Vdc, swap the mempry PCA; swap the motherboard PCA. If the drain voltage stays low, check A2Q63; replace the motherboard PCA.
LCD Supply Problem:	
8. Measure $\overline{\text{LCDON}}$ signal on A2U17 pin 16.	If $\overline{\text{LCDON}}$ is high, use the procedure in table 8-7, "Repairing the Processors."
9. Measure the collector voltage of A2Q77.	If VLCD is between −7 and −13 Vdc, the supply voltage is in the proper range. *Skip to step 12.*

Table 8-6. Repairing the Power Supply (Continued)

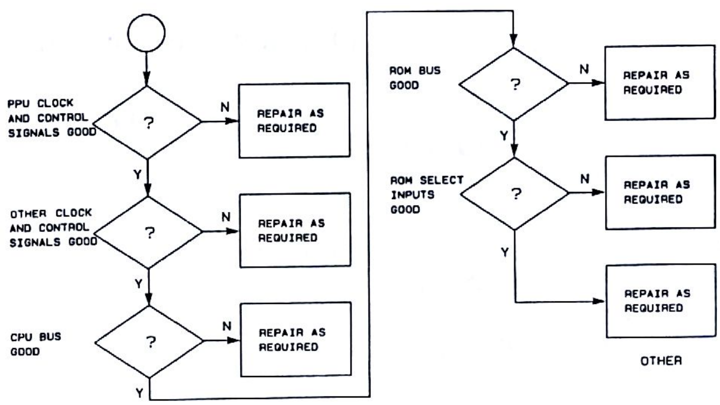
Step	Response
LCD Supply Problem (continued):	
10. Measure the anode of A2CR54 (unstriped end).	If the voltage is between −7 and −13 Vdc, the voltage is in its proper range; replace A2Q77. If the voltage at the anode of A2CR54 is between 0 and −1 Vdc, go to step 11. If the voltage is outside of the above ranges, swap the motherboard PCA. If the voltage is still out of range, remove the display load (unplug the keyboard cable from the motherboard PCA); if the voltage goes more negative than −10 Vdc, check for shorts in path to the display, replace the display module (if the voltage goes more negative than −20 Vdc, replace A2Q77 also).
11. Monitor the signal at A2U52, pin 7 with a scope. (Compare the observed signal with the corresponding waveform shown on the schematic diagram, figure 12-6.)	If the signal looks proper (with a peak voltage of VBAT), check A2Q75, A2CR54, A2L50, and A2VR51; replace the motherboard PCA. If the signal looks proper (but the peak voltage is lower than VBAT), check A2Q72; replace the motherboard PCA. If the signal stays at 0 Vdc or at VBAT, check A2Q72, and A2U52; replace the motherboard PCA. If the signal is improper in any other way, replace the motherboard PCA.
Display-Contrast Adjustment Problem	
12. Monitor the STEP1, STEP2, STEP4, and STEP8 signals with a scope while pressing (◑) and (Shift)(◑): A2U17, pins 29, 33, 31, and 32.	If all signals toggle between 0 and 5 Vdc in a binary pattern each time you press (◑) (or (Shift)(◑)), proceed to the next step. (STEP1 should change state every keystroke, STEP2 should change state every two keystrokes, and so on.) If any signal doesn't toggle between 0 and 5 Vdc in a binary pattern, replace A2U17.
13. Monitor the signals at the anodes of A2U22, pins 1, 3, 5, and 9 with a scope while pressing (◑) and (Shift)(◑).	If all signals toggle between 0 Vdc and a voltage less than 5 Vdc in a binary pattern each time you press (◑) (or (Shift)(◑)), the contrast adjustment is operating properly. If any signal doesn't toggle in a binary pattern, replace A2U22.

Table 8-7. Repairing the Processors

Use this procedure if the system processors aren't operating properly. If you make a repair at any step, check whether the unit can turn on. If it turns on, go back to the main diagnostic procedure in section 8.2.1.

In the following steps, use a scope to check the indicated signals for the proper activity in order. Monitor each signal either while the computer is on (or while the computer is *turning on*, if indicated). (Turn on the computer by pressing (◑) or other keys while the unit is off; turn off the computer by pressing and holding (◑).)

Refer to the schematic diagrams in chapter 12 while tracing bad signals. Signal levels other than 0V, 3.25V (power-up sequence), and 5V indicate a problem.



The following diagram illustrates the proper signal responses at power-up:

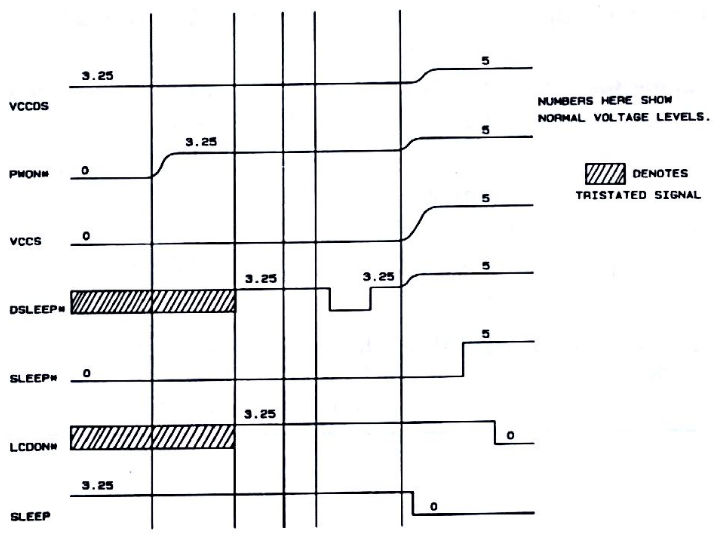


Table 8-7. Repairing the Processors (Continued)

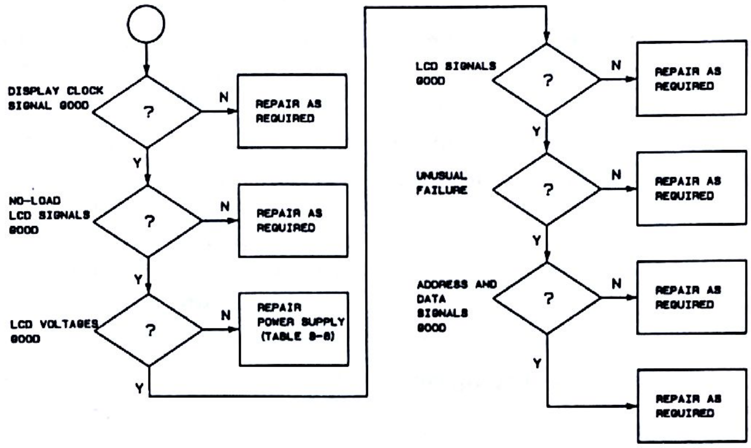
Step	Response
1. PWON* (test point A2E2): When reset button A2S1 is pressed, A2U17, pin 1 (PPU) goes to 0V, and the computer should go to sleep (VccS goes to 0V, and VccDS goes to 3.25V). As A2S1 is released, PWON* should rise to VccDS (3.25V) in 700–800 μs.	If bad, try replacing A2S1, A2C5, and A2R27 on the motherboard PCA. If still bad, replace the PPU (A2U17).
2. A2U17, pin 8 (PPU) should pulse low for approximately 176 μs every 128 ms. (The PPU inputs POWER*, HIGH CURRENT*, CARDSIN*, LOW BATTERY, and SHUTDOWN are valid only while pin 8 is low. Refer to section 5.12 for reference.)	If not, replace A2U1.
3. SLEEP* (PPU A2U17 pin 11) is 0V at turn-on, then goes to 5V.	If bad, replace the PPU (A2U17).
4. DSLEEP* (PPU A2U17 pin 10) pulses to 0V at turn-on, then goes to 5V. (DSLEEP* stays at VccDS (3.25V) when the computer is asleep.)	If bad, replace the PPU (A2U17).
5. A2U17, pin 6 (PPU) should alternately pulse low for 82 μs, then high for 20 μs while the computer is awake. (This line stays low occasionally when the PPU is processing a command.)	If bad, replace the PPU (A2U17).
6. Check the 80C86 CPU RESET line (A2U1, pin 21) for a 5V pulse as the computer wakes up; this line should then stay at 0V.	If bad, replace A2U23.
7. Check the LCD controller CLK line (A2U10, pin 36) for 5-MHz signal, 50% duty cycle.	If bad, replace A2U23.
8. Check HP-IL interface TSCLK* line (A2U15, pin 22) for 2-MHz signal, 50% duty cycle.	If bad, either clock controller A2U6 or the 16-MHz crystal A2Y1 is bad.
9. Check wait state counter line 2A (A2U2, pin 13) for 16-MHz signal, 50% duty cycle.	If A2U2, pin 13 is at 16 MHz and line 2QC on A2U2 (pin 9) is not at 2 MHz, replace A2U2.
10. Check the MCLK lines on the multicontrollers (A2U16 and U18, pins 23) for 2.667-MHz signal, 50% duty cycle.	If bad, replace clock controller A2U6 or 16-MHz crystal A2Y1.
11. SLEEP (A2U17, pin 34): pulses to 3.25V at turn-on, then 0V.	If bad, replace A2U17.
12. The clock signal (A2U19, pin 8): 5.33-Mhz signal, 33% duty cycle.	If bad, check for a 16-MHz signal at A2U6, pins 12 and 17. If absent, check A2Y1. Replace A2U6, as required.

Table 8-7. Repairing the Processors (Continued)

Step	Response
13. CLK (A2U1, pin 19): 5.33-MHz signal, 33% duty cycle.	If bad, trace signal back to A2U6, pin 8.
14. READY (A2U1, pin 22): 5V at turn-on, then toggles.	If bad, trace signal back to A2U6, pin 5 and A2U14, pin 11; check for correct READY signal at A2U10, pin 34, at A2U16, pin 35, and at A2U18, pin 35.
15. ALE (A2U1, pin 25): toggles at turn-on.	If bad, isolate the ALE line, then check whether signal toggles at turn-on; replace A2U1 (on the motherboard PCA).
16. SYSIRQ∗ (A2U17, pin 15): pulses to 0V 18 times per second while pressing almost any key.	If bad, check that the signal at A2C13 (A2U17, pin 36) pulses every 128 ms and that A2U17, pin 8 is low (0V) while pressing (◑). If A2C13 is good, replace A2U17; if A2C13 is bad, or if other keys get no response, check the keyboard function according to table 8-9, "Repairing the Keyboard."
17. Check that each of the following signals toggles at turn-on: RD∗ (A2U1, pin 32). WR∗ (A2U1, pin 29). DEN∗ (A2U1, pin 26). DT/R (A2U1, pin 27). BHE∗ (A2U1, pin 34). M/IO∗ (A2U1, pin 28).	If any signal is bad, isolate that line from the CPU, then check whether the signal toggles at turn-on; replace the CPU (A2U1) or exchange the motherboard PCA, as indicated.
18. Check the connectors and cables between the main PCAs and between the top case assembly and the motherboard PCA.	If bad, replace bad part.
19. While the system is turned on, press keys and check for a toggling signal on each CPU bus line at A2U1 (CPU): pins 2–16 and 39.	If any line never toggles, check the printed-circuit traces for shorts; swap the motherboard PCA and try again; replace A2U1 or check connectors.
20. While the system is turned on, press keys and check for a toggling signal on each ROM line (A1U16 and A1U27 only): all pins *except* 1, 14, 26, and 28.	If any line never toggles, trace input signal back to latches (such as A2U4 or A2U5), then isolate ICs; replace as required.
21. While the system is turned on, press keys and check for a toggling address and ROM-select signals at the ROM-select IC (A1U3, pins 2, 3, and 9).	If any input line never toggles, trace signal back to source (A2U3), then isolate ICs. If any output line never toggles, but all input lines toggle, replace the ROM-select IC.

Table 8-8. Repairing the Display

Use this procedure if the VLCD supply voltage has already been checked and is good and the system processors are operating, but the display doesn't operate properly. If you make a repair at any step, check whether the display seems to operate properly; if it does, go back to the main diagnostic procedure in section 8.2.1.



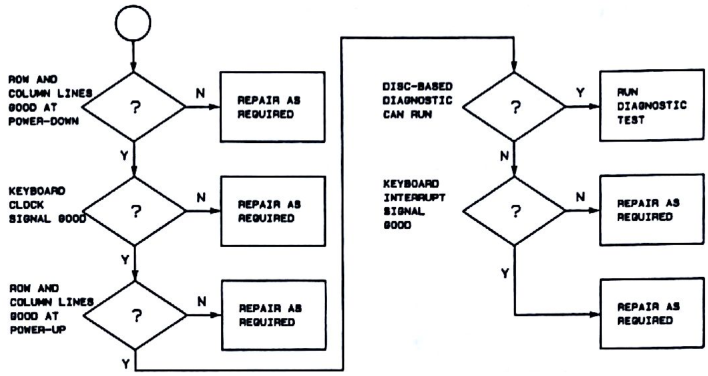
Step	Response
1. Using a scope, check for a 5-MHz signal, 50% duty cycle (LCDCLK) at A2U23, pin 8.	If a good LCDCLK signal is present, go to step 2. If signal is missing, verify that unit is turned on; then check the signal at A2U23, pin 8 again; if the signal is bad, replace A2U23.
2. Disconnect the keyboard cable from the motherboard PCA.	
3. Using a scope, check for toggling output signals at A2U10, pins 12–16 and 18–20.	If each signal toggles, go to step 4. If any signal never toggles, check traces. If A2U10, pins 16, 18, 19, and 20 are at 0V, and pins 12–15 are toggling, a software problem is indicated—swap the motherboard PCA or memory PCA to isolate the assembly.

Table 8-8. Repairing the Display (Continued)

Step	Response
4. Measure the voltages at the LCD connectors A2J9 and A2J10 on the motherboard PCA: Pin 8: 0 Vdc (GND). Pin 10: −7 to −13 Vdc (VLCD). Pin 7: 4.9 to 5.1 Vdc (VccS).	If all voltages are proper, go to step 5. If any voltage is out of range, check connections and traces; check the power supply according to table 8-6, "Repairing the Power Supply."
5. Using a scope, check for proper output signals at A2U10: Pins 16, 18–20: toggling (DI1–DI4). Pin 12: 260 Hz (M). Pin 3: 1.25 MHz (CL2). Pin 15: 5.2 kHz (CL1). Pin 13: 52 Hz (FLM).	If each signal is correct, go to step 6. If *any* signal is incorrect, check path through the display cable; replace the LCD module assembly.
6. Adjust the contrast by pressing (Shift)(◑) to see if the display becomes visible.	If the display can be seen with poor contrast, check the LCD negative power supply according to table 8-6, "Repairing the Power Supply."
7. Take action based upon the observed behavior of the display.	If the display doesn't turn on, replace A2U10. If the display pixels are observed, (most easily at high contrast) but the display is blank, replace A2U10. If only two horizontal black stripes are present, replace A2U10. If a repetitive pattern is displayed over the entire screen, press the reset button on the motherboard PCA (several times, if necessary); check for a bad cable connection. If a random pattern is displayed, go to step 8.
8. Using a scope, check for a toggling signal on these LCD controller lines: A2U10 pins 41–47 and 1–8.	If all lines toggle, swap the motherboard PCA. If any address line never toggles, replace A2U10; exchange the motherboard PCA. For further component-level troubleshooting, refer to the LCD oscilloscope routines (section 8.3).

Table 8-9. Repairing the Keyboard

Use this procedure if the system processors are operating, but the keyboard doesn't operate properly. If you make a repair at any step, check whether the keyboard seems to operate properly; if it does, go back to the main diagnostic procedure in section 4.2.1.



Step	Response
1. Turn off the computer. (Press (f8) in the main PAM screen, or else press and hold (◑) for at least 5 seconds.)	
2. Measure the voltage of each column line: A2U16, pins 6–14, 46–48. A2U17, pins 18 and 36.	If all voltages are above 2.5 Vdc, go to step 3. If any voltages are below 2.5 Vdc, check the voltage with the keyboard disconnected from the motherboard PCA. ■ If the voltages remain low, check continuity on the motherboard PCA; replace A2U16. ■ If the voltages go above 2.5 Vdc, check and repair the keyboard module.
3. Measure the voltage of each row line: A2U16 pins 15–22.	If all voltages are below 1 Vdc, go to step 4. If any voltages are above 1 Vdc, check the voltage with the keyboard disconnected from the motherboard PCA. ■ If the voltages remain high, check continuity on the motherboard PCA; replace A2U16. ■ If the voltages go below 2.5 Vdc, check and repair the keyboard module.

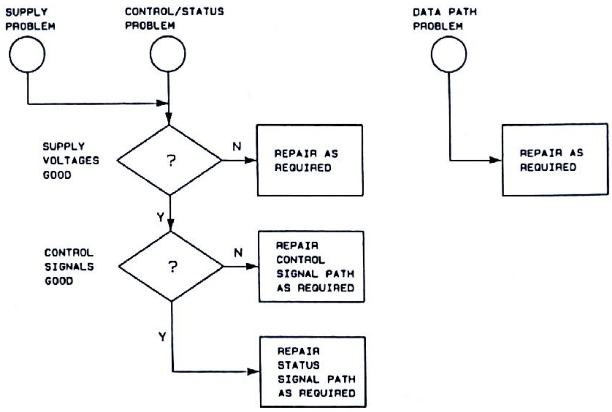
Table 8-9. Repairing the Keyboard (Continued)

Step	Response
4. Turn on the computer. (Press (◑) or other keys, if necessary.)	
5. Using a scope, check for a 2.67-MHz signal, 50% duty cycle (MCLK) at A2U16 pin 23.	If present, proceed to step 6. If signal is missing or bad, verify that unit is turned on. Then trace signal back to A2U6 pin 2; unsolder and disconnect pin at A2U6, then check signal to see if A2U6 is the problem.
6. Check individual keys: use a scope to monitor the corresponding column line (and then row line) at A2U16 while pressing and holding the key. (Refer to figure 12-11.) C1 (pin 14) R1 (pin 22) C2 (pin 13) R2 (pin 21) C3 (pin 12) R3 (pin 20) C4 (pin 11) R4 (pin 19) C5 (pin 10) R5 (pin 18) C6 (pin 9) R6 (pin 17) C7 (pin 8) R7 (pin 16) C8 (pin 7) R8 (pin 15) C9 (pin 6) C10 (pin 47) C11 (pin 46) C12 (pin 48) C13 (A2U17, pin 36)	For C10 through C13: if the signal is lower than 1V while the key is held and higher than 4V while the key is released, the key is good; otherwise, replace the keyboard module. For other lines: if an 11.25-μs-low, 12.0-μs-high square-wave signal is observed on both the row line and column line, the key is good. ■ If you can load and run the disc-based diagnostic tests, check the keyboard using the main diagnostic procedure in section 8.2.1. ■ If you can't use the disc-based diagnostic test, go to step 7. For other lines: if a different signal is observed on either the row line or column line, check the signals for other keys in that row and for other keys in that column. ■ If the signal is bad for only one key, replace the keyswitch (or keyboard module). ■ If the signal is bad for an entire row or column, check continuity between A2U2 and the keyboard; replace A2U2.
7. Using a scope, monitor the SYSINT* line (A2U16, pin 34) while pressing and holding any key (but *not* (◑)).	If signal periodically pulses low while key is pressed, swap the motherboard PCA. If signal *doesn't* pulse low while key is pressed, replace A2U16.

Table 8-10. Repairing the Serial Interface

Use this procedure if the diagnostic tests indicate a problem with the serial (RS-232) interface. If you make a repair at any step, repeat the RS-232 test to see if the circuit is repaired; if it's good, go back to the main diagnostic procedure in section 8.2.1.

Note: The RS-232 scope routine switches the interface circuit on and off while it's running. The signals described in the steps below should be those observed while the circuit is "on."



Step	Response
1. Note the outcome of the RS-232 diagnostic test.	If any of the CTS, DSR, DTR, RTS, Carrier Detect, or Ring Detect lines are indicated bad, go to step 2 If the Transmit or Receive Data lines are indicated bad, *skip to step 6.* If "Power Supply Stuck On" is indicated, go to step 2.
2. Start the diagnostic module "RS-232 Oscilloscope Routine" with the RS-232 test connector installed. (Alternatively, use the service disc scope routine.)	
3. Monitor V+232 while the RS-232 scope routine is running: A2U19 pin 14. (Use a scope, not a dc meter.)	If V+232 is at the same voltage as VBAT, go to step 4. (If "Power Supply Stuck On" was indicated, repeat the RS-232 test instead.) If V+232 is bad, check continuity to the battery.
4. Monitor V−232 while the RS-232 scope routine is running: A2U19 pin 1. (Use a scope, not a dc meter.)	If V−232 is more negative than −6 Vdc, go to step 5. (If "Power Supply Stuck On" was indicated, repeat the RS-232 test instead.) If V−232 is outside its range, *skip to step 8.*

Table 8-6. Repairing the Power Supply (Continued)

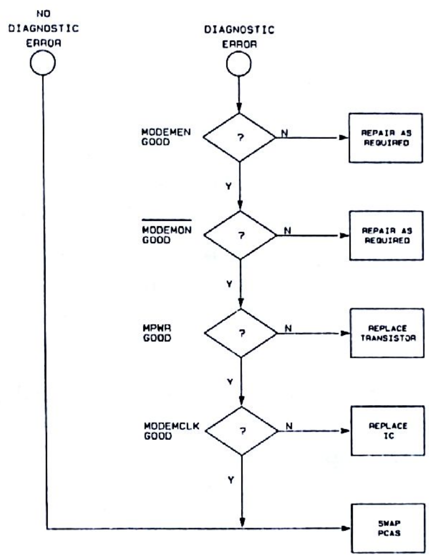
Step	Response
5. If the DTR, DSR, or Ring Detect line was indicated bad in step 1, monitor the DTR control signal while the RS-232 scope routine is running: A2U19, pin 6.	If the DTR signal pulses periodically between V+232 and V−232, trace the signal to RS-232 connector pin 1, then to RS-232 connector pins 6 (DSR line) and 9 (RS232RING). Trace DSR through the circuitry to the HP-IL IC A2U15, pin 15. (A2U15, pins 15 and 16 have internal pull-up resistors to supply current to open drain buffer A2U22, pins 11 and 13.) Trace RS232RING through the circuitry to the RS-232-C controller (A2U18, pin 3). Repair as required. (Use the schematic diagrams in chapter 12 for reference.) If the DTR signal doesn't pulse, trace the signal back through the circuitry to the PPU (A2U17, pin 4). Repair as required. (Use the schematic diagrams in chapter 12 for reference.) If the DTR signal pulses periodically at voltages less than V+232 and V−232, check traces, check again with RS-232 test connector removed, replace A2U19, as indicated.
6. If the RTS, CTS, or Carrier Detect line was indicated bad in step 1, monitor the RTS control signal while the RS-232 scope routine is running: A2U19, pin 8.	If the RTS signal pulses periodically between V+232 and V−232, trace the signal to RS-232 connector pin 4, then to RS-232 connector pins 5 (CTS line) and 8 (RS232CARRIER). Trace CTS through the circuitry to the HP-IL IC (A2U15, pin 16). Trace RS232CARRIER through the circuitry to the RS-232-C controller (A2U18, pin 2). Repair as required. (Use the schematic diagrams in chapter 12 for reference.) If the RTS signal doesn't pulse, trace the signal back through the circuitry to the PPU (A2U17, pin 5). Repair as required. (Use the schematic diagrams in chapter 12 for reference.) If the RTS signal pulses periodically at voltages less than V+232 and V−232, check traces, check again with RS-232 test connector removed, replace A2U19, as indicated.
7. Monitor the RS-232 data path while the RS-232 scope routine is running. Start from SOUT at the RS-232-C controller (A2U18, pin 25) and trace the signal through the circuitry to RS-232 receptacle pin 2 (TxD line), then to RS-232 receptacle pin 3 (RxD line). Trace RxD through the circuitry to SIN at the RS-232-C controller (A2U18, pin 45).	If the signal pulses periodically, continue tracing the signal through the circuitry. (Use the schematic diagrams in chapter 12 for reference.) If the signal *doesn't* pulse, trace it back to the bad component. Repair as required. (Use the schematic diagrams in chapter 12 for reference.)
8. Monitor the signals in the voltage doubler circuit.	Repair as required or replace the motherboard PCA.

Table 8-11. Repairing the Modem

Use this procedure if the diagnostic tests indicate a problem with the modem circuit. (This procedure assumes that the serial interface operates properly.) If you make a repair at any step, repeat the modem test to see if the circuit is repaired; if it's good, go back to the main diagnostic procedure in section 8.2.1.

CAUTION

Don't replace resistors or capacitors on the original modem PCA or on a new modem PCA. They have been selected at the factory to give transmission levels that meet FCC requirements.



Step	Response
1. Note the outcome of the modem diagnostic test.	If failure code 216 or 314 occurred (or the modem is not installed), go to step 2. If failure codes 216 or 314 were not indicated, but any other modem problem occurred, *skip to step 7.*
2. Start the "Find Modem oscilloscope routine." To select this routine, select routines from the main disc-based diagnostic menu, then select the modem option.	
3. Monitor the MODEMON signal while the modem scope routine is running: A3J2 pin 10.	If MODEMON is high while the circuit is "on," this signal is good; go to step 4. If MODEMON stays low, isolate the modem from A2U17 (PPU) by disconnecting, and check the signal again at A2U17, pin 33: if the signal is still low, replace A2U17; if the signal goes high, replace the modem PCA.

Table 8-11. Repairing the Modem (Continued)

Step	Response
4. Monitor the modem clock signal while the modem scope routine is running: A3U11, pin 8. (Use a scope.)	If the modem clock oscillates at 4.6 MHz while the circuit is "on," this signal is good; go to step 7. If the modem clock doesn't oscillate at 4.6 MHz, replace A3U11.
5. Monitor MSOUT at A3J2, pin 4 while the modem scope routine is running.	If this signal does *not* toggle, trace it back to A2U16, pin 25 on the motherboard PCA. If MSOUT still does *not* toggle, replace A2U16 (or the motherboard PCA). If MSOUT at A3J2, pin 4 *does* toggle, check MSOUT at buffer A3U1, pin 12. If A3U1, pin 12 does *not* toggle, replace A3U1; else check the demodulator A3U3, pin 21 to verify that it also toggles. If not, replace A3U3 or the modem PCA.
6. Monitor MSIN at A3J2, pin 6 while the modem scope routine is running.	If MSIN toggles, trace the signal back to A2U16, pin 45 (on the motherboard PCA). If the MSIN signal at A2U16, pin 45 does *not* toggle, replace A2U16 or the motherboard PCA. If MSIN at A3J2, pin 6 does *not* toggle, check the signal at the gate of A3Q2. If MSIN at the gate of A3Q2 does *not* toggle, replace demodulator IC A3U3. If this signal *does* toggle, replace A3Q2 or the modem PCA.
7. Swap the modem PCA, then recheck the operation. (Alternative: trace signals through the circuit using the schematic diagrams in figures 12-5 and 12-8 and replace faulty components.)	Replace the motherboard PCA or modem PCA, as indicated.

8.3 Using Oscilloscope Routines

You can use oscilloscope routines to isolate and verify problems while performing component-level repair on the Portable PLUS, including troubleshooting a unit that doesn't turn on. This section describes the procedure for setting up and using the scope routines.

In order to use these routines, you'll need the following equipment (as listed in chapter 1):

- HP 180C/1801A/1820C oscilloscope (or equivalent).
- HP 10004 oscilloscope probe (or equivalent).
- Diagnostic module (part number 45711-60910).
- Keyboard extension cable (part number 45711-60907).
- LCD extension cable (part number 45711-60908).
- RS-232 test connector (part number 00090-60914).

All items except the oscilloscope and probe are included in the expensed tool package (part number 45711-67801).

Oscilloscope routines are available from two sources. The first source is preferred for the reasons listed.

- **Diagnostic module.** This is the preferred source, which is described first below. The diagnostic module can run the scope routines with only a small portion of the system operable. In addition, it's the only source that can run the internal RAM routine.
- **Disc-based diagnostic program.** This is the alternate source, which is described second below. A large portion of the system must be operable in order to use this source. In addition, it doesn't provide a routine for internal RAM.

8.3.1 Diagnostic Module Scope Routines

Follow this procedure for using the diagnostic module scope routines:

> **CAUTION**
>
> If a modem is installed, be sure to place an insulating sheet between the modem PCA and the metal cover of the diagnostic module. Otherwise, components may be damaged.

1. Disconnect the battery, separate the case, and install the diagnostic module in left receptacle (receptacle 2, under the (f1) key).

   If modem is installed be sure to insulate it from the sheet metal cover of the diagnostic module.

> **CAUTION**
>
> Be sure the connectors are aligned properly when connecting the extension cables. If they're connected with pins misaligned, components may be damaged or system operation disrupted.

2. Connect the LCD extension cable between the motherboard PCA and the display cable. Connect the keyboard extension cable between the motherboard PCA and the keyboard cable. Check that all connectors are aligned properly.
3. Connect a recharger to the computer. Press (◑) to turn on the computer. If the oscilloscope menu appears, go to the next step.

   If nothing appears in the display, a default scope routine should be running while waiting for you to press a key. If the keyboard is working, you can select and use scope routines (even though the display is blank) according to the following steps. Otherwise, you can check the system using the default scope routine using waveshapes labeled "f0" on the schematic diagrams. If the system doesn't operate at all, you can check the unit according to table 8-5, "Startup Problems."

```
PORTABLE PLUS oscilloscope routines:

f1: RS-232 oscilloscope routine
f2: HP-IL oscilloscope routine
f3: Internal ROM read oscilloscope routine
f4: Internal RAM write oscilloscope routine
f5: Internal RAM read oscilloscope routine
f6: Plug-in ROM read oscilloscope routine
f7: Plug-in RAM write oscilloscope routine
f8: Plug-in RAM read oscilloscope routine

Shift f1: LCD RAM write oscilloscope routine
Shift f2: LCD RAM read oscilloscope routine
Shift f3: Find Plug-in RAM oscilloscope routine
Shift f4: Find Plug-in ROM oscilloscope routine
Shift f5: CONFIG ROM read oscilloscope routine
Shift f6:
Shift f7: Find Modem oscilloscope routine
Shift f8: Exit
```

Figure 8-4. Menu for Diagnostic Module Scope Routines

4. Press the function key that selects the scope routine indicated by table 8-2 for the observed problem. (Scope routines are also indicated in table 8-12 below.) If more than one test are indicated, use them in the order listed in the table. (The default routine is also available. It runs whenever the oscilloscope menu is displayed.)
5. Use your oscilloscope to observe system signals. Compare the signals with the waveshapes shown on the schematic diagrams in chapter 12. Each waveshape is labelled to indicate the corresponding scope routine. For example, "f2" indicates the HP-IL routine, selected by (f2); "sh f5" indicates the configuration EPROM read routine, selected by (Shift)(f5). (The label "f0" indicates the default routine.)

   Generally, you should start checking a faulty circuit from its outputs, working back until you find a good waveform. Replace the IC that seems to cause the improper signal.
6. Press (space) or any other key to stop the scope routine and return to the oscilloscope menu.
7. Select the next scope routine (step 4) and repeat the test procedure. Otherwise, press (Shift)(f8) to obtain the main PAM screen.

Table 8-12. Selecting Oscilloscope Routines

To Check This Circuit...	Use These Routines...
Serial interface (RS-232)	(f1) RS-232 routine
HP-IL interface	(f2) HP-IL routine
Internal ROM	(f3) Internal ROM read routine
Internal RAM	(f4) Internal RAM write routine* (f5) Internal RAM read routine*
Plug-in RAM	(Shift)(f4) Find plug-in RAM routine†
Plug-in ROM	(f6) Plug-in ROM read routine (Shift)(f5) Find plug-in ROM routine†
Display RAM	(Shift)(f1) LCD RAM write routine (Shift)(f2) LCD RAM read routine
Configuration EPROM	(Shift)(f5) Config EPROM routine
Modem	(Shift)(f7) Find Modem routine

* Use for A and B versions only.

† Use this routine if a plug-in RAM or ROM is not found by the diagnostic test.

8.3.2 Disc-Based Scope Routines

This is an alternate method for using scope routines. The diagnostic module is the preferred source for scope signals. Follow this procedure for using the disc-based scope routines:

1. Disconnect the battery and separate the case. (*Don't install the diagnostic module.*)

> **CAUTION**
>
> Be sure the connectors are aligned properly when connecting the extension cables. If they're connected with pins misaligned, components may be damaged or system operation disrupted.

2. Connect the LCD extension cable between the motherboard PCA and the display cable. Connect the keyboard extension cable between the motherboard PCA and the keyboard cable. Check that all connectors are aligned properly.
3. Connect a good HP 9114 Disc Drive using two good HP-IL cables.
4. Turn on the disc drive, then connect a recharger to the computer. If the computer doesn't turn on, press (◑) or any other key to turn it on. The main P.A.M. screen should appear in the display.

   If nothing appears in the display, you can check the system using the diagnostic module scope routines (described above). Otherwise, you can check the unit according to table 8-5, "Startup Problems."
5. Configure the computer for one disc drive. Press (f6) (System Config) in the main P.A.M. screen. Use the tab or cursor keys to select the "External disc drives" field, then use the "Next Choice" and "Previous Choice" function keys to select one drive. Use the "Exit Config" function key to return to the main PAM screen.
6. Insert the service disc in the disc drive.

7. Load and run the disc-based diagnostic program. Type **c:stest2** (Return). The disc-based diagnostic menu should appear in the display.
8. Press (Shift)(f6) to activate the oscilloscope routines. When the oscilloscope menu appears, a default scope routine begins running.

```
PORTABLE PLUS oscilloscope routines:

f1: RS-232 oscilloscope routine
f2: HP-IL oscilloscope routine
f3: Internal ROM read oscilloscope routine
f4:
f5:
f6: Plug-in ROM read oscilloscope routine
f7: Plug-in RAM write oscilloscope routine
f8: Plug-in RAM read oscilloscope routine

Shift f1: LCD RAM write oscilloscope routine
Shift f2: LCD RAM read oscilloscope routine
Shift f3: Find Plug-in RAM oscilloscope routine
Shift f4: Find Plug-in ROM oscilloscope routine
Shift f5: CONFIG ROM read oscilloscope routine
Shift f6:
Shift f7: Find Modem oscilloscope routine
Shift f8: Exit
```

Figure 8-5. Menu for Disc-Based Scope Routines

9. Press the function key that selects the scope routine indicated by table 8-2 for the observed problem. (Scope routines are also indicated in table 8-12 above.) If more than one test are indicated, use them in the order listed in the table. (The default routine is also available. It runs whenever the oscilloscope menu is displayed.)
10. Use your oscilloscope to observe system signals. Compare the signals with the waveforms shown on the schematic diagrams in chapter 12. Each waveform is labelled to indicate the corresponding scope routine. For example, "f2" indicates the HP-IL routine, selected by (f2); "sh f5" indicates the configuration EPROM read routine, selected by (Shift)(f5). (The label "f0" indicates the default routine.)

    Generally, you should start checking a faulty circuit from its outputs, working back until you find a good waveform. Replace the IC that seems to cause the improper signal.
11. Press (space) or any other key to stop the scope routine and return to the oscilloscope menu.
12. Select the next scope routine (step 9) and repeat the test procedure. Otherwise, press (Shift)(f8) to obtain the main disc-based diagnostic menu.

8.4 Burning an EPROM

Use the following procedure to prepare a 27C64 configuration EPROM (A1U30) before installing it in the system. This procedure requests the serial number of the unit, and then burns the entire EPROM memory.

A new EPROM must be burned and installed whenever the original is bad.

1. Turn off the computer (press (f8) in the main PAM screen or remove power).
2. Install the diagnostic module in the left receptacle (receptacle 2, under the (f1) key—see figure 8-5).
3. Ensure that a "good" EPROM (A1U30) is present in the memory PCA. A "good" EPROM is one that functions properly, but which may not have the proper serial number stored internally (such as the original one if it still functions, or a "dummy" EPROM—part number 45711-60925). *This is not the EPROM that will be burned*—it merely allows the system to operate.
4. Connect a good HP 9114 Disc Drive using two good HP-IL cables.
5. Turn on the disc drive, then connect a recharger to the computer—it isn't necessary to connect the battery. If the computer doesn't turn on, press (◑) or any other key to turn it on. If the oscilloscope menu appears, go to the next step.

   Note: If the system isn't able to turn on properly, press the reset button on the motherboard PCA.

6. Exit from the oscilloscope menu by pressing (Shift)(f8).
7. Configure the computer for one disc drive. Press (f6) (System Config) in the main PAM screen. Use the tab or cursor keys to select the "External disc drives" field, then use the "Next Choice" and "Previous Choice" function keys to select one drive. Use the "Exit Config" function key to return to the main PAM screen.
8. Insert the service disc in the disc drive.
9. Load and run the disc-based EPROM-burning program. Type **c:burn** (Return) or else select "Burn P+ EPROM" from the menu.
10. Turn on a 25-Vdc power supply and adjust it to 24.8 to 30 Vdc.
11. Connect the 25V power supply to the red and black wires at the two-pin power connector on the extension of the module: RED (+25 Vdc) and BLACK (Ground and Common, if present). (For a new module, first trim the insulation from the ends of the wires.) (See figure 8-5.)

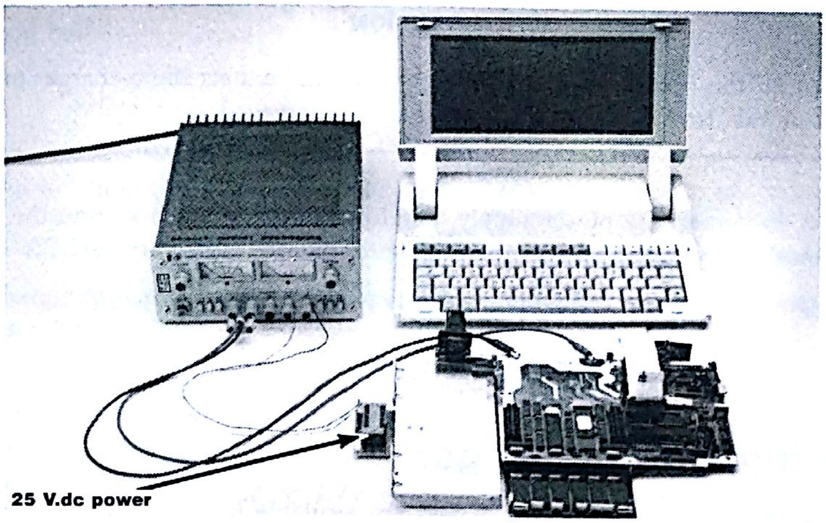


Figure 8-6. Connecting EPROM-Burner Power Supply

12. Press any key to continue.
13. When prompted by the program, raise the locking lever on the EPROM socket, install the new EPROM in the socket with pin 1 nearest the lever, then press the locking lever down. (Be sure the pins are *between* the contacts in the holes.)
14. Press any key to continue. If a "BLANKCHECK" error occurs, check the power supply connections. The inserted EPROM may be bad or not blank; try clearing it under UV light, if available; then try burning it again or use another EPROM.)
15. When prompted, enter the serial number from the bottom case of the unit being repaired—including letters in upper case. Use the (Back space) key to correct an error. (The serial number is located next to the bottom label. Refer to section 1.3 to check the proper format for a serial number.) Use the U.S. keyboard layout when using the 45711-60925 "dummy" EPROM.
16. Confirm the serial number by pressing (Y) (yes) or (N) (no). If it's not correct, go back to step 15. Burning the EPROM takes about 6 minutes.
17. When prompted, use the arrow keys to select the memory size according to the amount of RAM built into the computer (*don't* include RAM in plug-in drawers). Refer to table 1-1 to relate the model number to the amount of RAM.
18. Take action according to the message that appears after the EPROM is burned.
    - "Verify-ok" indicates that the EPROM was burned correctly. Proceed to the next step.
    - "Verify-error" indicates that the EPROM *wasn't* burned correctly, and that it must be discarded (or erased, if an EPROM eraser is available). Possible causes for this result are that the power supply voltage is too low (refer to step 10) or that the power supply wires or connector aren't providing a good path for the EPROM-burning current (you can measure the supply voltage on the module).
19. Remove the EPROM from the socket after raising the lever.

> **CAUTION**
>
> Be sure to turn off the +25V power supply *before* you disconnect the recharger or battery from the computer. If this isn't done, components may be damaged.

20. Turn off and disconnect the power supply. Carefully wrap the wires around the module. Tape or cover the ends of the wires so that they don't touch each other or the PCA.

21. Disconnect power from the computer.

22. Remove the diagnostic module.

8.5 Testing the Recharger

Various ac rechargers (table 8-13 and figure 8-7) are available for use with the Portable PLUS.

Table 8-13. Rechargers

Model Number	Voltage*	Identification
HP 82059D	110	United States
HP 82066B	220	Europe
HP 82067B	220	United Kingdom
HP 82067B Opt 001	220	United Kingdom—RSA plug
HP 82068B	220	Australia
HP 82069B	110	Europe

* Indicates nominal voltage; acceptable ranges are 210 to 250 Vac and 90 to 120 Vac.

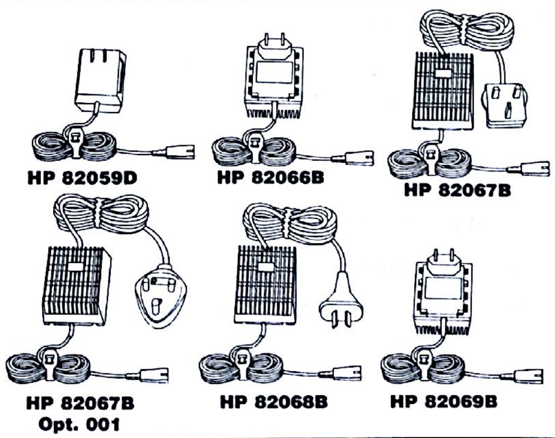


Figure 8-7. Rechargers

The serial number located on the recharger indicates the month that the unit was manufactured. The format is described below.

```
Y Y  M M
 ↑    ↑
 |    └──────── Month manufactured.
 └───────────── Year manufactured (years since 1960).
```

To determine whether the recharger is functioning properly, perform this procedure:

1. Plug the recharger into an outlet of the proper voltage. (Refer to table 8-13.) Measure the power-outlet voltage (VIN) using an ac voltmeter.
2. Measure the recharger ac output voltage (VOUT) under no-load conditions using an ac voltmeter. VOUT should be between 9.9 and 13.3 Vac at power voltages of 110.0 or 220.0 Vac. More generally, VOUT should equal

   $$(VIN / 110) \times 11.6 \text{ Vac} \pm 1.7V \quad \textit{or} \quad (VIN / 220) \times 11.6 \text{ Vac} \pm 1.7V$$

   where VIN is the ac voltage of the power outlet.

   - If VOUT is inside the allowable range, proceed to the next step.
   - If VOUT is outside the allowable range, the recharger is bad and should be discarded. Stop testing here.
3. Connect a 12-ohm, 5%, 5W resistor across the recharger output contacts.
4. Measure the ac voltage (VOUT) across the load using an ac voltmeter. The voltage should be between 5.3 and 7.3 Vac at power voltages of 110.0 and 220.0 Vac. More generally, VOUT should equal

   $$(VIN / 110) \times 6.3 \text{ Vac} \pm 1.0V \quad \textit{or} \quad (VIN / 220) \times 6.3 \text{ Vac} \pm 1.0V.$$

   - If VOUT is inside the allowable range, proceed to the next step.
   - If VOUT is outside the allowable range, the recharger is bad and should be discarded. Stop testing here.
5. While measuring the ac voltage across the load, wiggle and pull the wire at the transformer and at the connector.
   - If the voltage stays above 5 Vac, the recharger is good.
   - If the voltage drops below 5 Vac, the recharger is bad and should be discarded.

8.6 Testing the SNALink/3270 Software Drawer

Use the following procedure to check an HP 50922A SNALink/3270 Software Drawer.

1. Write down the numbers of the sockets in the SNALink drawer that contain ROM ICs (for example, "1L" and "1H").
2. Install the SNALink drawer in a good Portable PLUS computer (in either the left or right slot).
3. Connect the computer to a good HP 9114 Disc Drive using two good HP-IL cables.
4. Connect the drawer to the SNALink test board using the standard SNALink cable.
5. Turn on the disc drive, then turn on the computer (press (◐) or other keys, if necessary).
   - If the main PAM screen appears, go to step 6.
   - If the MS-DOS system (not PAM) is active at turn on, type **exit** (Return) to obtain the main PAM screen, then proceed according to either of the other choices for this step.
   - If any other display appears, or if no display appears, remove the SNALink drawer and try this again. If the computer turns on normally only when the drawer is removed, replace the SNALink PCA. Otherwise, check the computer.
6. Turn on a 5-Vdc power supply and adjust it to 4.9 to 5.1 Vdc.
7. Connect the 5V power supply to the two-pin connnector on the test board: ground to "GND", +5V to "VCC".
8. Insert the service disc in the disc drive. Load and run the SNALink diagnostic program. (Type **c:snalink.exe** (Return), or else select "SNALink Diag" from the menu.) The test checks in *both* slots for SNALink drawers.
9. Observe the displayed test results. In particular, check that the displayed list of occupied ROM sockets is correct (step 1 above).
   - If the program finds the drawer in the correct slot, if no "ERROR" messages are displayed, *and* if the program lists all of the occupied ROM sockets, then the SNALink drawer and ROM ICs are good. *Stop testing here.*
   - If the program *doesn't* find the drawer, repeat the test with the drawer installed in the other port. If the problem remains, replace the PCA.
   - If the program displays an "Interrupt" error, replace the PCA.
   - If the program displays a "Control" or "Transmission" error, swap the SNALink cable, test board, or PCA to isolate the problem. Replace the indicated item.
   - If the program finds *no* occupied ROM sockets (although some are occupied), replace the PCA.
   - If the displayed list of occupied ROM sockets is wrong (but the program finds *some* occupied sockets), swap the improper ROM ICs or the PCA to isolate the problem. Replace the indicated item.
   - If the program displays a "Checksum" error, check that the jumper in J2 is installed properly (it should be in the "ROM" position unless 32K-byte EPROMs are installed in the drawer). Then swap the indicated ROM IC or PCA to isolate the problem. Replace the indicated item.
10. Verify the repair by repeating the previous steps.

Chapter 9
Replaceable Parts

This chapter lists the replaceable parts and assemblies of the Portable PLUS.

The following structure illustrates how the replaceable assemblies are related and gives references to the figures and tables for replaceable parts:

- Portable PLUS final assembly (figure 9-1, table 9-1).
- Top case assembly (figure 9-2, table 9-2).
- Display assembly (figure 9-3, table 9-3).
- Base assembly (figure 9-4, table 9-4).
- Motherboard PCA (figure 12-3, table 9-5).
- Memory PCA (figure 12-1, table 9-6).
- Optional modem PCA, U.S. version (figure 12-7, table 9-7).
- System ROMs (table 9-8).
- Configuration EPROM (table 9-9).
- Software (ROM) drawer (table 9-10).
- Memory (RAM) drawer (table 9-11).
- Plug-In ROMs (table 9-12).
- SNALink/3270 software drawer (table 9-13).

You can order replacement parts and assemblies from Hewlett-Packard Corporate Parts Center or from Parts Center Europe.

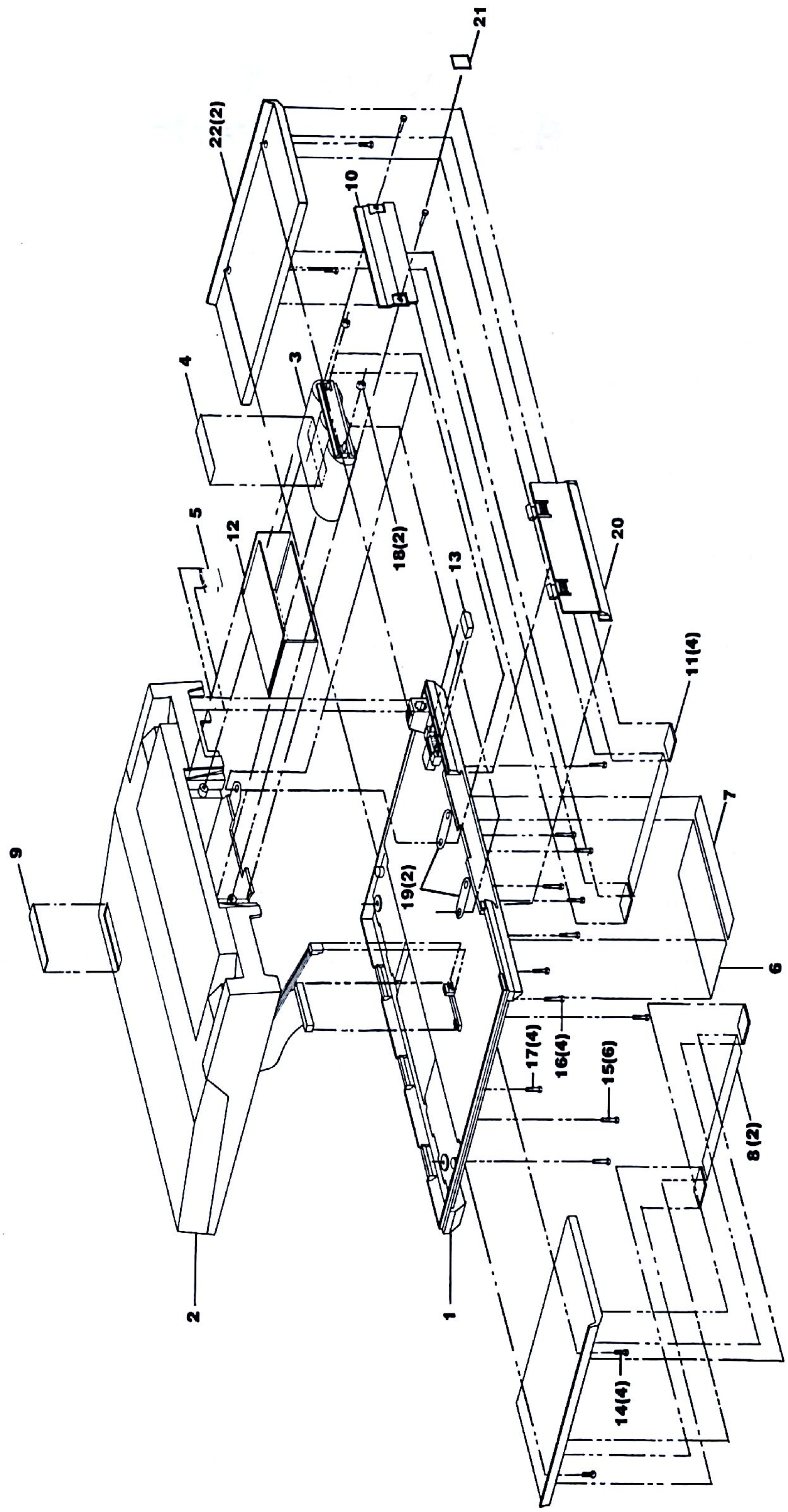


Figure 9-1. Portable PLUS Exploded View

Table 9-1. Portable PLUS Replaceable Parts

Index Number, Figure 9-1	HP Part Number	Description	Quantity
1	(Table 9-4)	Assembly, base	1
2	(Table 9-2)	Assembly, top case	1
3	1420-0346	Battery	1
4	7120-5635	Label, battery caution	1
5	5041-4306	Cover, modem (no modem)	1
6	45711-80009	Label, bottom	1
7	45711-80018	Label, modem	1 (optional)
8	45711-80022	Label, dummy drawer	2
9	45711-80008	Label, HP ID.	1
10	45711-40004	Cover, terminal	1
11	00090-80022	Foot, rubber	4
12	00090-80017	Cushion, battery	1
13	1252-0220	Dust cap, RS-232	1
14	0515-1486	Screw, slotted, Torx T8	4
15	0515-1378	Screw, Torx M2.5 × 10	6
16	0515-1379	Screw, Torx M2.5 × 26	4
17	0515-1380	Screw, Torx M2.5 × 8	4
18	0535-0063	Nut, flanged	2
19	45711-00007	Power strap	2
20	00090-40004	Door, battery	1
21	82985-80011	Shield, terminal	1
22	45711-60016	Drawer, dummy	2

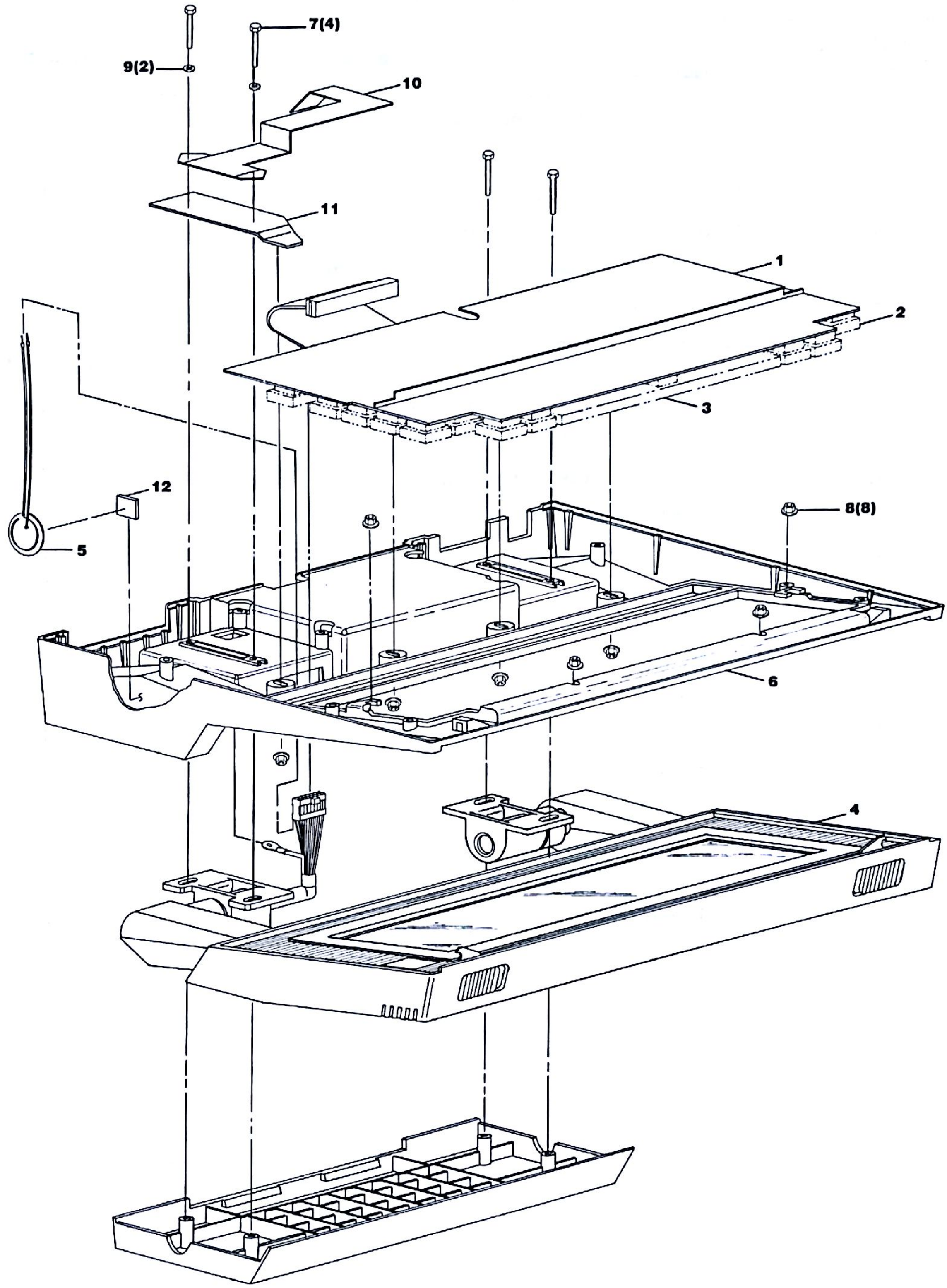


Figure 9-2. Top Case Assembly Exploded View

Table 9-2. Top Case Assembly Replaceable Parts

Index Number, Figure 9-2	HP Part Number	Description	Quantity
1	45711-60905	Keyboard Assembly, English	1
	45711-60921	Keyboard Assembly, German	
	45711-60922	Keyboard Assembly, French	
	45711-60923	Keyboard Assembly, U.K.	
	45711-60924	Keyboard Assembly, Italian	
	45711-60937	Keyboard Assembly, Swiss-French	
	45711-60938	Keyboard Assembly, Swiss-German	
	45711-60939	Keyboard Assembly, Belgian	
	45711-60940	Keyboard Assembly, Dutch	
	45711-60941	Keyboard Assembly, Danish	
	45711-60942	Keyboard Assembly, Norwegian	
	45711-60943	Keyboard Assembly, Swedish/Finnish	
2	00090-80025	Keyswitch	1
3	00090-80026	Keyswitch, spacebar	1
4	(Table 9-3)	Display Assembly	1
5	00090-60017	Transducer Assembly	1
6	45711-60011	Case, top	1
7	0515-1881	Screw, machine	4
8	0535-0063	Hex nut, flanged	8
9	3050-0367	Washer	2
10	45711-80011	Ground strap	1
11	5180-3021	Ground plate	1
12	0460-1802	Tape, transducer	1

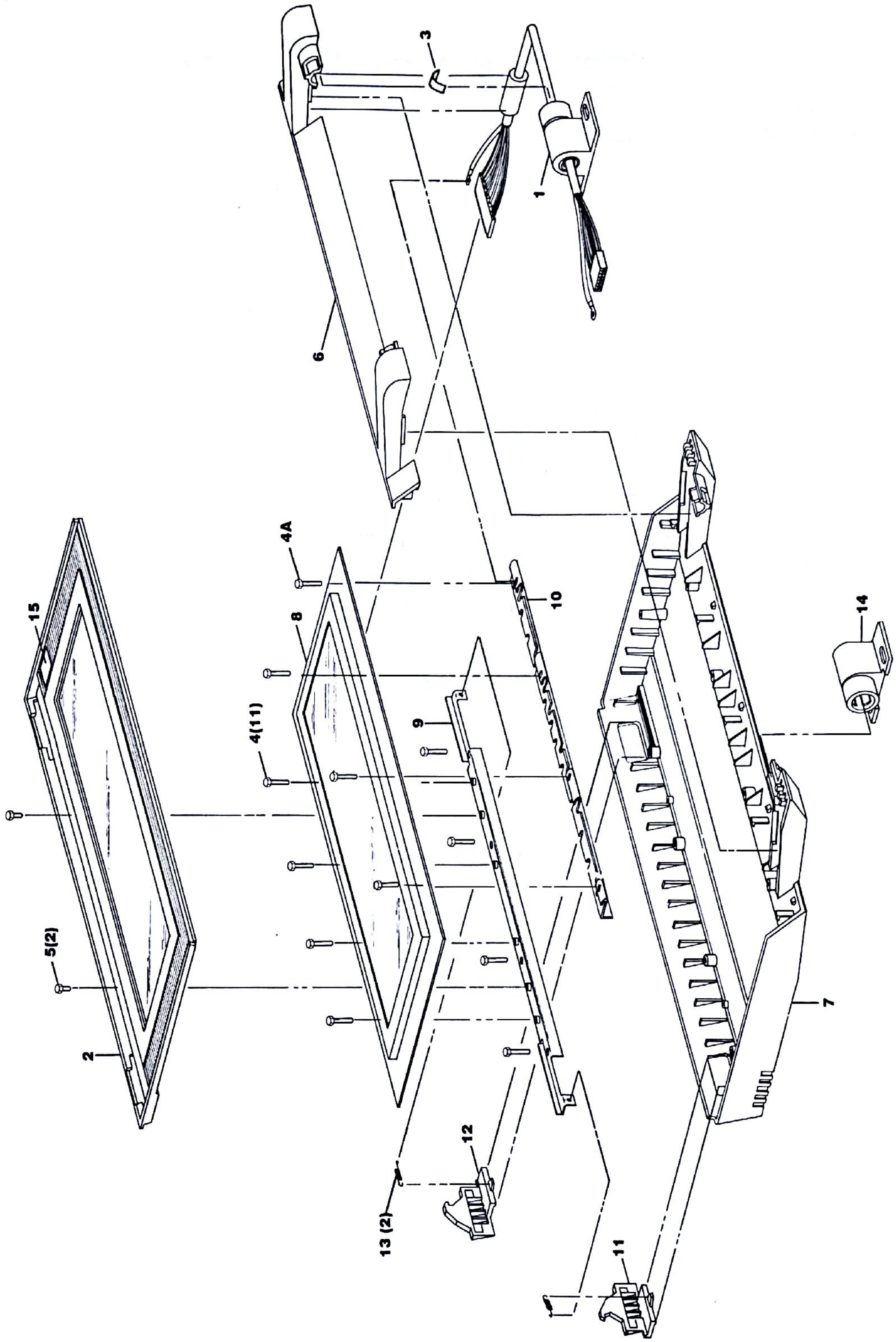


Figure 9-3. Display Assembly Exploded View

Table 9-3. Display Assembly Replaceable Parts

Index Number, Figure 9-3	HP Part Number	Description	Quantity
1	45711-60916	Assembly, clutch/cable, service	1
2	45711-60911	Assembly, bezel, service	1
	45711-60917	Assembly, bezel cap/tape, service	1
3	0460-1797	Tape, ferrite bead	1
4	0515-1380	Screw, LCD, short	11
4A	0515-1378	Screw, LCD, long	1
5	0515-1381	Screw, bezel	2
6	5041-4119	Front, display	1
7	45711-60007	Back, display	1
8	45711-60953	Assembly, LCD module	1
9	45711-00001	Bracket, display top	1
10	45711-00002	Bracket, display bottom	1
11	00090-40007	Latch, left	1
12	00090-40008	Latch, right	1
13	00090-80032	Spring, latch	2
14	5180-3012	Clutch	1
15	45711-80015	Label, bezel	1

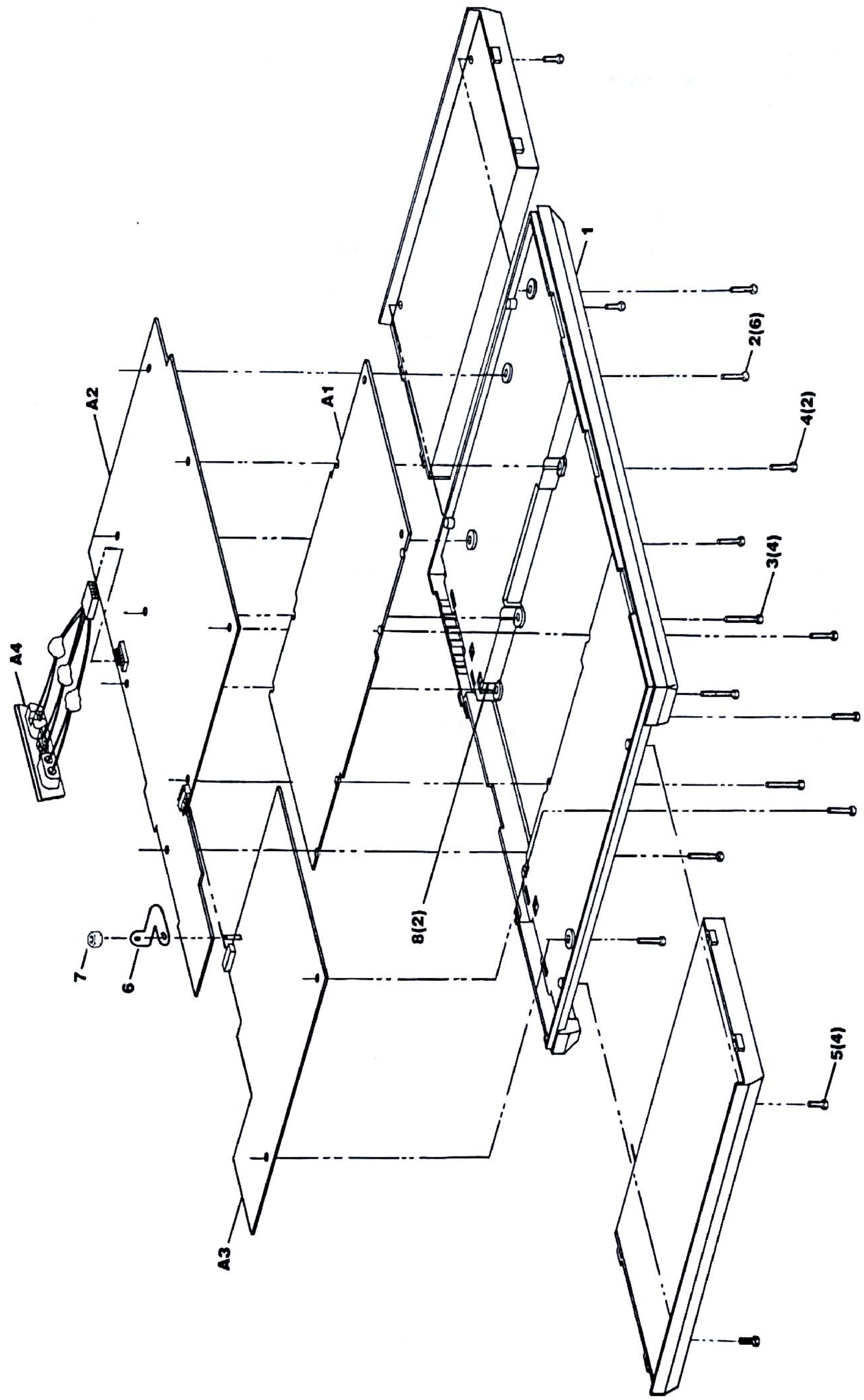


Figure 9-4. Base Assembly Exploded View

Table 9-4. Base Assembly Replaceable Parts

Index Number, Figure 9-4	HP Part Number	Description	Quantity
A1	45711-60984* 45711-69122†	PCA, memory, 512K	1
A2	45711-60901* 45711-69001†	PCA, motherboard	1
A3	45711-60902* 45711-69002†	PCA, modem, U.S. version	1 (optional)
A4	45711-80114	Assembly, I/O plate	1
1	45711-40001	Case, bottom	1
2	0515-1378	Screw, M2.5 × 10 Torx	6
3	0515-1379	Screw, M2.5 × 26 Torx	4
4	0515-1380	Screw, M2.5 × 8 Torx	2
5	0515-1486	Screw, T8 slotted Torx	4
6	45711-00008	Ground strap, modem	1 (optional)
7	0535-0063	Nut, hex	1 (optional)
8	45711-00005	Spring, contact	2

* New part.

† Exchange part. This part may consist of a 256K memory PCA with two piggyback PCAs, as described in section 11.4, "Reference Information for Early C/D/E/F Versions."

Table 9-5. Motherboard PCA Replacement Parts

(A2) Reference Designation	HP Part Number	Description	Quantity
C1, C2	0160-4805	Capacitor, 47 pF 5% 100V	2
C3, C4	0160-4812	Capacitor, 220 pF 5%	2
C5, C72	0180-3422	Capacitor, 10 μF 10V	3
C6, C7, C71	0160-4787	Capacitor, 22 pF 5% 100V	3
C10	0160-4810	Capacitor, 330 pF 5% 100V	1
C13-C15	0160-5941	Capacitor, 0.047 μF 20% 100V	3
C16, C20-C22	0160-5332	Capacitor, 0.1 μF 20% 50V	4
C17-C19, C24-C37	0160-4840	Capacitor, 0.047 μF	17
C39	0160-4801	Capacitor, 100 pF 5%	1
C41	0160-6145	Capacitor, fixed	1
C50	0180-3167	Capacitor, 1000 μF	1
C51	0180-3680	Capacitor, 10 μF 10% 50V	1
C52, C60, C63	0160-4822	Capacitor, 1000 pF 100V 5%	3
C53, C67-C70	0180-2951	Capacitor, 33 μF 16V	5
C54, C55	0180-1735	Capacitor, 0.22 μF 35V	2
C57	0160-4832	Capacitor, 0.01 μF 100V	1
C58	0160-4835	Capacitor, 0.1 μF 50V	1
C61	0160-4791	Capacitor, 10 pF 5% 100V	1
C62	0160-3490	Capacitor, 1 μF 20% 50V	2
CR1, CR51-CR53, CR58, CR63	1901-1098	Diode switch, 1N41506	6
CR54, CR59-CR62, CR64-CR68	1901-0734	Diode, Schottky, 1A 30V	10
F1	2110-0716	FUSE, 0.5A	1
J1-J4	1252-0697	Connector, bottom entry	4
J5	1251-5927	Connector, 2 × 13 HDR	1
J6	1251-4926	Connector, 2 × 4	1
J7	1251-8906	Connector, 9 pin	1
J8	1252-0776	Connector, 2 × 6 HDR RA	1
J9	1252-0864	Connector, 2 × 7 HDR RA	1
J10	1200-1190	Connector, 1 × 8 female	1
J11	45711-60945	Jumper, battery	1
L50	9140-1090	Inductor, choke, TDK	1

Table 9-5. Motherboard PCA Replacement Parts (Continued)

(A2) Reference Designation	HP Part Number	Description	Quantity
Q1, Q53, Q56, Q64, Q65, Q71, Q76	1853-0563	Transistor, PNP 2N3906	7
Q50	1853-0558	Transistor, PNP 2N6554	1
Q51, Q72-Q74, Q82-Q87	1855-0556	Transistor, N-ch enh FET 60V	10
Q52, Q54, Q55	1854-0215	Transistor, NPN 2N3904	3
Q59, Q60	1853-0569	Transistor, 2N5087	2
Q61, Q62, Q88	1854-1040	Transistor, NPN 2N5088	3
Q63	1853-0559	Transistor, PNP MPSW55	1
Q70	1855-0522	Transistor, power MOSFET P-ch	2
Q75	1853-0271	Transistor, PNP 2N440	1
Q77	1854-1039	Transistor, NPN 2N4401	1
Q78	1855-0598	Transistor, VN2222LL	1
Q79	1855-0550	Transistor, MOSFET 30V	1
Q80	1855-0555	Transistor, MOSFET N-Ch 30V	1
R1, R110	0683-4725	Resistor, 4.7K 5% ¼W	2
R2	0683-4705	Resistor, 47Ω 5% ¼W	1
R4, R20, R21, R33, R37, R119	0683-4735	Resistor, 47K 5%	6
R5	1810-0281	Resistor, 100K × 9	1
R6, R7	0683-1535	Resistor, 15K 5% ¼W	2
R8, R9	0698-3446	Resistor, 383Ω 1% ⅛W	2
R10	1810-0367	Resistor, 4.7K × 5	1
R11	0683-1065	Resistor, 10M 5% ¼W	1
R12-R14, R22	1810-0378	Resistor, 47K × 9	4
R15	1810-0792	Resistor, 470K × 5	1
R27	0683-3335	Resistor, 33K 5% ¼W	1
R31, R32, R38, R60, R65, R114, R115, R118	0683-1045	Resistor, 100K 5% ¼W	8
R35, R36	0683-1815	Resistor, 180Ω 5% ¼W	2
R39	0683-1015	Resistor, 100Ω 5% ¼W	1
R40-R45	0683-1515	Resistor, 150Ω 5% ¼W	6
R51	0683-4715	Resistor, 470Ω 5% ¼W	1

Table 9-5. Motherboard PCA Replacement Parts (Continued)

(A2) Reference Designation	HP Part Number	Description	Quantity
R52, R53, R109	0683-1025	Resistor, 1K 5% ¼W	3
R54	0698-8354	Resistor, 15.6K 0.25% ⅛W	1
R55	0698-8180	Resistor, 4.22K 0.25% ⅛W	1
R56	0698-4056	Resistor, 9.09K 0.25% ⅛W	1
R57	0683-1045	Resistor, 100K 5% ¼W	1
R61, R62, R99, R105	0683-6835	Resistor, 68K 5% ¼W	4
R63	1810-0791	Resistor, 1M × 4 SIP	1
R66	1810-0438	Resistor, 470K × 4 SIP	1
R69	0683-4745	Resistor, 470K 5% ¼W	1
R70, R120	0683-8235	Resistor, 82K 5% ¼W	2
R71, R111	0683-2245	Resistor, 220K 5% ¼W	2
R74	0683-3315	Resistor, 330Ω 5% ¼W	1
R75-R77	0683-3345	Resistor, 330K 5% ¼W	3
R78, R86	0683-1545	Resistor, 150K 5% ¼W	2
R79	0698-3454	Resistor, 215K 1%	1
R80	0698-8827	Resistor, 1M 1% ⅛W	1
R81	0699-1254	Resistor, 536K ⅛W	1
R93	1810-0477	Resistor, 220K × 4 SIP	1
R97	0683-2745	Resistor, 270K 5% .25W	1
R98	0683-1345	Resistor, 130K 5% ¼W	1
R100	0698-4493	Resistor, 34K ⅛W	1
R101	0757-0442	Resistor, 10K 1% ⅛W	1
R102	0757-0462	Resistor, 75K 1% ⅛W	1
R103	0757-0416	Resistor, 511Ω	1
R104	0757-0289	Resistor, 13.3K 1%	1
R106, R107	0683-2235	Resistor, 22K 5% ¼W	2
R108	1810-0444	Resistor, 100K × 4 SIP	1
R116	0683-3935	Resistor, 39K 5% ¼W	1
R117	0683-1055	Resistor, 1M 5% ¼W	1

Table 9-5. Motherboard PCA Replacement Parts (Continued)

(A2) Reference Designation	HP Part Number	Description	Quantity
S1	3101-2816	Switch, reset	1
T1	9100-4226	Transformer, 5V	1
U1	1820-3533	Integrated Circuit, 80C86 CPU	1
U2	1820-3208	Integrated Circuit, 74HC393	1
U3, U4, U5	1820-3486	Integrated Circuit, 82C82	3
U6	1820-3488	Integrated Circuit, 82C84	1
U7, U9, U13	1820-3079	Integrated Circuit, 74HC138	3
U8, U11, U12	1820-3330	Integrated Circuit, 74HC245	3
U10	5061-7274	Integrated Circuit, LCD controller II	1
U14	1828-2924	Integrated Circuit, 74HC02	1
U15	1LB3-0003	Integrated Circuit, HP-IL interface	1
U16, U18	1LK5-0001	Integrated Circuit, multicontroller	2
U17	1820-4105	Integrated Circuit, PPU	1
U19	1820-4311	Integrated Circuit, LT1032	1
U20, U21	1820-3185	Integrated Circuit, 74HC14N	2
U22	1820-1655	Integrated Circuit, 47C906	1
U23	1813-0459	Integrated Circuit, 5-MHz oscillator	1
U50	1826-1358	Integrated Circuit, UC3906	1
U52	1826-1162	Integrated Circuit, LP311N	1
U53	1820-1745	Integrated Circuit, MC14001 BCP	1
VR1, VR2	1902-0953	Diode, zener 6.2V 5%	2
VR3, VR4	1902-0970	Diode, zener 33V 0.4W	2
VR5	1902-0952	Diode, zener 5.6V 0.4W	1
VR50	1826-1167	Diode, reference	1
VR51	1902-0962	Diode, zener 15V 5%	1
W50, W51	8159-0005	Jumper, 0Ω	2
Y1	0410-1519	Crystal, 16 MHz	1
Y2	0410-1567	Crystal, 1 MHz	1

Table 9-6. Memory PCA Replaceable Parts

(A1) Reference Designation	HP Part Number	Description	Quantity
U8–U15, U19–U26	1818-4100	Integrated Circuit, 32K-byte RAM	16
U16	1818-4053	Integrated Circuit, 128K-byte ROM, odd	1
U27	1818-4054	Integrated Circuit, 128K-byte ROM, even	1
U30	(Table 9-9)	Integrated Circuit, configuration EPROM	1
XU16, XU27, XU30	1200-0567	Socket, IC 28-pin	3
	45711-80104	Spacer, rubber	11

Table 9-7. Optional Modem PCA Replaceable Parts (U.S. Version)

(A3) Reference Designation	HP Part Number	Description	Quantity
J1	1251-7532	Phone Jack, RJ11C	1
J2	1252-0696	Connector, 2 × 6 female RA	1
Q1, Q2, Q7, Q11	1855-0556	Transistor, N-ch FET 60V	4
T1	9100-4454	Transformer, audio	1
U1	1820-1145	Integrated Circuit, MC14049UBCP	1
U2	1826-1348	Integrated Circuit, demodulator 40038C	1
U3	1826-1347	Integrated Circuit, modulator 37	1
U4, U5, U7, U10	1826-1075	Integrated Circuit, dual op-amp LF44	4
U6, U9	1826-0501	Integrated Circuit, triple analog	2
U8	1826-0139	Integrated Circuit, LM1458	1
U11	1813-0460	Integrated Circuit, oscillator	1
U12	1826-1060	Integrated Circuit, AMI S3522P	1
U13	1820-3207	Integrated Circuit, 74HC390	1
U14	1820-3968	Integrated Circuit, MPU 80C50	1
U15	1826-0412	Integrated Circuit, LM393N	1
U16	1826-0603	Integrated Circuit, UA74S40 reg.	1
U17	1990-1066	Integrated Circuit, opto-isolator LCA	1
U18	1990-1074	Integrated Circuit, opto-isolator 4N3	1

Table 9-8. System ROMs

Reference Designation	HP Part Number	Function/Revision
A1U16 A1U27	1818-3668 1818-3671	Diagnostics, boot code; PAM: help, menu, commands, directory.
A1U17 A1U28	1818-3669 1818-3672	HPLINK, AMIGO sys., COMMAND Com, EDLIN, MORE, PRINT, PACK, FORMAT.
A1U18 A1U29	1818-3670 1818-3673	I/O operating system; system file SECURE.

Table 9-9. Configuration EPROMs

Reference Designation	HP Part Number (Service)	Function
A1U30	45711-60909 (blank, must be programmed)	Keyboard mapping, localized messages, default PAM configurations, serial number, memory size.

Table 9-10. Software (ROM) Drawer Replaceable Parts

Reference Designation	HP Part Number	Description	Quantity
	82982-60901	ASSEMBLY, printed-circuit	1
C1-C25	0160-4840	• Capacitor, .047μF	25
U1-U3	1820-3933	• Integrated Circuit, 74HC365N	3
U4, U5	1820-3330	• Integrated Circuit, 74HC245	2
U6	1820-3182	• Integrated Circuit, 74HC173N	1
U7	1820-3079	• Integrated Circuit, 74HC138	1
U8	1820-4569	• Integrated Circuit, 74HC540	1
U9, U13	1820-2924	• Integrated Circuit, 74HC02	2
U10	1820-3201	• Integrated Circuit, 74HC4075N	1
U11	1820-3184	• Integrated Circuit, 74HC11	1
U12	1820-3192	• Integrated Circuit, 74HC266	1
U14	1820-3788	• Integrated Circuit, 74HC58	1
R1, R2	1810-0281	• Resistor, 100K × 9	2
W1-W6	8150-4814	• Wire, jumper	6
	82982-00001	Cover, metal	1
	5041-4304	Drawer, plastic case	1
	00090-80022	Foot, rubber	2
	82982-80002	Label, identification	1
	9320-4856	Label, serial number	1
	0624-0671	Screw, self-tapping	9

Table 9-11. Memory (RAM) Drawer Replaceable Parts

Reference Designation	HP Part Number	Description	Quantity
	82981-60901* 82981-69001†	Assembly, printed-circuit, standard	1
	or	*or*	
	82992-60901* 82992-69001†	Assembly, printed circuit, 1M-byte	1
	82984-60901* 82984-69001†	Assembly, printed-circuit, piggyback	1 or 2 (optional)
	5001-6301	Cover, metal	1
	5041-4304	Drawer, plastic case	1
	00090-80022	Foot, rubber	2
	82981-80003	Label, identification, standard	1
	or	*or*	
	82992-80002	Label, identification, 1M-byte	1
	9320-4856	Label, serial number	1
	0624-0671	Screw, self-tapping	9
	5180-3035	Tape	1

* New part.

† Exchange part.

Table 9-12. Plug-In ROM Replaceable Parts

HP Part Number	Description
45711-60928	ROM, high, Executive Card Manager
45711-60929	ROM, low, Executive Card Manager
45711-60930	ROM, MemoMaker/Time Manager
45711-60931	ROM, high, Lotus 1-2-3
45711-60933	ROM, low, Lotus 1-2-3
45711-60934	ROM, high, MS-Word
45711-60935	ROM, low, MS-Word
45711-60936	ROM, PC2622
45711-60946	ROM, low, Multimate
45711-60947	ROM, high, Multimate
45711-60948	ROM, BASIC
45711-60950	ROM, Reflection 1
82986-60903	ROM, high, SNALink/3270
82986-60904	ROM, low, SNALink/3270

Table 9-13. SNALink/3270 Software Drawer Replaceable Parts

Reference Designation	HP Part Number	Description	Quantity
	82986-60901	Assembly, printed-circuit	1
WJ2	8150-5010	• Wire, configuration jumper	1
	5061-4331	Assembly, RS-232 cable	1
	82986-60903	Assembly, SNALink ROM, high, service	1
	82986-60904	Assembly, SNALink ROM, low, service	1
	82986-40002	Bezel, connector	1
	82986-00001	Cover, metal	1
	82986-40001	Drawer, plastic case	1
	00090-80022	Foot, rubber	2
	82986-80003	Label, identification	1
	9320-4856	Label, serial number	1
	0624-0671	Screw, self-tapping	8

Chapter 10
Reference Information

10.1 Introduction

This chapter contains Portable PLUS reference information and additional service information:

- 10.2 Diagnostic test results.
- 10.3 Descriptions of diagnostic tests.
- 10.4 Service references.
- 10.5 Service equipment.

10.2 Diagnostic Test Results

Use the information in table 10-1 to interpret the results of built-in and disc-based diagnostic tests.

Table 10-1. Diagnostic Test Results

This table is a repeat of table 8-2.

Messages sent by the built-in tests are translated into the *local* language of the computer. Disc-based messages are in English.

For assembly-level repair, replace the assembly indicated in the "assembly-level" column (or take the steps listed).

For component-level repair, replace the component indicated in the "component-level" column (or take the steps listed). However, replacing the IC may not solve the problem; there might be other problems, such as a short on the PC board or a bad passive component. When directed, use the oscilloscope routines indicated in the last column to help locate the fault, and refer to the waveforms on the schematic diagrams.

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes:			
116–118 127–129	Replace individual ROM ICs: 116–118→A1U16 127–129→A1U27 If not fixed, replace memory PCA.*†	Replace individual ROM ICs: 116–118→A1U16 127–129→A1U27 If latch or transceiver suspected, trace using scope routine.*†	Internal ROM read

Table 10-1. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes (Continued):			
130	A1U30 (configuration EPROM)—burn new EPROM IC before installing (section 8.4).	A1U30 (configuration EPROM)—burn new EPROM IC before installing (section 8.4).	Config EPROM
210	Motherboard PCA.	A2U10 (LCD controller).	LCD RAM write LCD RAM read
215	Motherboard PCA.	A2U15 (HP-IL controller).	HP-IL
216	Motherboard PCA.	A2U16 (modem multicontroller).	
217	Motherboard PCA.	A2U17 (PPU).	
218	Motherboard PCA.	A2U18 (serial multicontroller).	RS-232
314	Modem PCA.	A3U14 (modem controller).	
3??	Modem PCA	Check modem circuit according to table 8-11, "Repairing the Modem."	
4*rcc* (*r* is row number) (*cc* is column number)	Swap the keyboard module, then retry. If fixed, replace keyswitch (or keyboard module) after checking continuity; if not fixed, replace the motherboard PCA.	Swap the keyboard module, then retry. If fixed, replace keyswitch (or keyboard module) after checking continuity; if not fixed, replace A2U16 (keyboard multicontroller, or SIP resistors A2R12, A2R13, and A2R14).	
0: *yy* ... 1: *yy* ... 2: *yy* ... 3: *yy* ...	Memory PCA.*†	If only one or two RAM ICs indicated (see table 8-3), replace individual ICs. (Note that one IC corresponds to several codes.) Replace memory PCA.*† If more than two RAMs indicated, latch or transceiver suspected. Trace using scope routine.*†	Internal RAM write Internal RAM read

Table 10-1. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes (Continued):			
A–0: *yy* ...	Memory drawer PCA in receptacle noted previously.	Memory drawer PCA in receptacle noted previously.	Find plug-in RAM
A–1: *yy* ...	For standard memory drawer, move piggyback RAM PCA from connector J2 to connector J3 in receptacle noted previously. Then if no "B–0" error, replace memory drawer PCA; if "B–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	For standard memory drawer, move piggyback RAM PCA from connector J2 to connector J3 in receptacle noted previously. Then if no "B–0" error, replace memory drawer PCA; if "B–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	Find plug-in RAM
B–0: *yy* ...	For standard memory drawer, move piggyback RAM PCA from connector J3 to connector J2 in receptacle noted previously. Then if no "A–0" error, replace memory drawer PCA; if "A–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	For standard memory drawer, move piggyback RAM PCA from connector J3 to connector J2 in receptacle noted previously. Then if no "A–0" error, replace memory drawer PCA; if "A–0" error, replace piggyback PCA. For 1M-byte memory drawer, replace the memory drawer PCA.	Find plug-in RAM

Table 10-1. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Failure Codes (Continued):			
A–ROM*yy*L ... A–ROM*yy*H ...	For receptacle noted previously, check that jumpers are in proper locations‡; swap known good ROM at socket marked *yy*L or *yy*H‡; replace ROM PCA or ROM IC as indicated.	For receptacle noted previously, check that jumpers are in proper locations‡; swap known good ROM at socket marked *yy*L or *yy*H‡; check ROM PCA using scope routine, or replace ROM IC, as indicated.	Plug-in ROM read Find plug-in ROM
Messages:			
Broken loop	Try new cable; check connections; check I/O plate (or swap and retry); replace the motherboard PCA.	Try new cable; check connections; inspect internal connections to I/O plate assembly (or swap assembly and retry); check continuity of HP-IL interface circuit (see schematic); replace A2U15 (HP-IL controller).	HP-IL
Loop error, data not received as sent	Remove peripherals and run the HP-IL test; try new cable; check connections; bad HP-IL peripheral; check I/O plate (or swap and retry); replace the motherboard PCA.	Remove peripherals and run the HP-IL test; try new cable; check connections; bad HP-IL peripheral; check I/O plate (or swap and retry); check HP-IL components using scope routine; replace A2U15 (HP-IL controller).	HP-IL
Number of devices on HP-IL loop = *wrong number*	Check connections; if HP-IL/HP-IB interface connected, perform system configuration in PAM; check HP-IL peripheral; if occurs for every peripheral, replace the motherboard PCA.	Check connections; if HP-IL/HP-IB interface connected, perform system configuration in PAM; check HP-IL peripheral; if occurs for every peripheral, replace A2U15 (HP-IL controller).	HP-IL
Transmitted or Rcvd. Data line(s) bad	Check test connector; replace the motherboard PCA.	Check test connector; trace signals using scope routine.	RS-232

Table 10-1. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Messages (continued):			
CTS line bad DSR line bad DTR line bad RTS line bad Carrier Det line bad	Check test connector; replace the motherboard PCA.	Check test connector; check serial interface according to table 8-10, "Repairing the Serial Interface."	
Beep Test Observations:			
Three beeps don't sound	Swap transducer; replace transducer or motherboard PCA, as indicated.	Swap transducer or check signal with scope during test; replace the transducer, A2U17 (PPU), or A2U21.	
Display Test Observations:			
Display doesn't scroll properly	Motherboard PCA.	Replace A2U10 (LCD controller).	LCD RAM write LCD RAM read
Border line improper	Display assembly.	Display assembly.	
Extra or missing pixels.	Swap top case assembly (if available) and retry; replace display assembly or the motherboard PCA, as indicated.	Check VccDS at A2U10 pins 10, 17, and 21; swap top case assembly and retry; check display circuit or replace display assembly, as indicated.	LCD RAM write LCD RAM read
Row (or column) dark or light	Display assembly.	Display assembly.	
Blinking or inverse display improper	Display assembly.	Display assembly.	
Two cursors improper	Motherboard PCA.	A2U10 (LCD controller).	
Quadrant bad	Check continuity between A2U10 and display assembly; swap the motherboard PCA, then retry; replace display assembly or the motherboard PCA, as indicated.	Check continuity between A2U10 and display assembly; use scope to check for toggling signals at A2U10 pins 12–16 and 18–20; replace display assembly or A2U10 (LCD controller), as indicated.	LCD RAM write LCD RAM read
Adjacent rows (or columns) duplicated	Display assembly.	Display assembly.	

Table 10-1. Diagnostic Test Results (Continued)

Test Result	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
Modem Observations:			
During optional pulse dialing test, telephone doesn't ring	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; replace A3U17 or the modem PCA.	
During optional tone dialing test, telephone doesn't ring	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; replace A3U17 or the modem PCA.	
During optional ring-detect test, computer doesn't beep or indicate call received	Check modem connections; check phone number; check modem PCA connection; swap modem PCA and retry; replace modem PCA or motherboard PCA, as indicated.	Check modem connections; check phone number; verify circuit using standard modem test; check modem circuit according to table 8-11, "Repairing the Modem."	

* For A, B, C, and D versions and early E and F versions, refer to chapter 11.

† Whenever you replace the memory PCA, remove the configuration EPROM (A1U30) from the old PCA and install it in the new PCA. (This does not apply if you suspect that the configuration EPROM itself is bad.)

‡ All jumpers on the plug-in ROM PCA should be in position "A" for independent ROM ICs. Other configurations are listed in table 8-4. If jumpers XW3, XW4, XW5, and XW6 are all in position "B", test result "7L" points to sockets 4L through 7L, and test result "7H" points to sockets 4H through 7H.

10.3 Descriptions of Diagnostic Tests

The following paragraphs summarize the operation of the built-in, disc-based, and EPROM diagnostic tests. This information may be useful for interpreting test results.

In order for the test program to run and display its menu, certain functions of the computer must operate, either partially or entirely. These functions include:

- Display.
- Display controller.
- Display RAM.
- Latches, buffers, and decoders for the CPU circuit, display circuit, and address/control circuit.
- Clock circuit.
- PPU.
- Power supply.
- Configuration EPROM.
- Keyboard (key *not* stuck).
- Certain ROM ICs (several for disc-based test; hightst two for built-in and EPRPM tests).
- Multi-controller (for disc-based test).

The built-in test checks part of the CPU and display RAM during its startup routine.

10.3.1 System Test

The System test includes all of the tests described below except for the SLEEP test.

10.3.2 CPU Test

The CPU test checks about 90 percent of the CPU functionality, including tests of its registers, addressing, and stack operations.

10.3.3 ROM Test

The ROM test computes the checksum for each system ROM IC (plus the configuration EPROM) by stepping through the address space sequentially; then it compares the value with the proper value stored in the configuration EPROM. The test further computers the checksum for each system ROM IC by cycling through the address space in 16-byte steps; then it compares the value with the proper value from the configuration EPROM.

10.3.4 RAM Test

The EPROM-based RAM test clears memory; the disc-based RAM test preserves memory. This test checks system RAM and mass storage RAM, but it *doesn't* check the display RAM.

The RAM test checks the RAM select circuit, RAM address latches, and transceivers by sending one byte to each of the RAM ICs, then reading those bytes back from all ICs. It repeats this cycle starting at each RAM IC.

The test checks data retention by storing 0's at all addresses, waiting 4 seconds, then reading from alladdresses. This cycle is repeated using 1's.

The test checks internal addressing of the RAM Ics by repeating a read-store cycle four times, using 0's (then 1's) and working from low to high addresses (then from high to low). The test further checks the internal addressing by storing at each address the lower eight bits of that address, then reading them back; it then repeats this cycle using the upper eight bits of the address.

10.3.5 LCD Test

The LCD test checks the LCD controller registers by writing to and reading from them.

The test checks the LCD controller and display module using messages and visual patterns. The visual test includes scrolling (in alpha and graphics modes), border lines, horizontal and vertical lines, blinking and inverse characters, xx- and yy-line alpha displays, and dual cursors.

The test checks the display RAM using all of the RAM tests described above for the RAM test. While this test is executing, the display reflects the patterns caused by the bytes stored in display RAM.

10.3.6 Keyboard Test

The keyboard test displays the keyboard layout derived from the configuration EPROM and prompts the operator to press each key sequence. The test provides no key roll-over (unlike normal keyboard operation). As each key is pressed, the test checks the operation of the interrupt register, row/column registers, and the debounce function in the multi-controller.

10.3.7 HP-IL Test

The HP-IL test checks operation of the HP-IL interface. This includes internal functions of the HP-IL controller IC, the interrupt line from the HP-IL IC, and the continuity of the HP-IL loop from the HP-IL *OUT* receptacle to the HP-IL *IN* receptacle.

The test may be run with or without HP-IL peripherals connected to the computer. If no peripherals are connected to the computer, connect an HP-IL cable from the OUT receptacle to the IN receptacle. If one or more peripherals are connected, make sure all are turned on, otherwise a "Broken Loop" message will appear when the HP-IL test is run.

10.3.8 Modem Test

The modem test puts the multi-controller UART (universal asynchronous reciever-transmitter) function in its self-test mode, then sends and receives 256 bytes of data at 9600 baud to check its operation. During the data transfer, the test checks the UART control and status registers and the interrupt function.

The test checks the operation of the modem circuit and PPU by setting the modem to its self-test mode, then sending and receiving data at both 300 and 1200 baud. These are both done in both Originate and Answer modes.

The optional tone-dialer part of the test exercises the tone-dial generator IC, and related circuitry. The test requires that the computer be connected to a phone line; it dials the phone number entered by the user.

The optional pulse-dialer part of the test exercises the PPU and related circuitry. The test requires that the computer be connected to a phone line; it dials the phone number entered by the user.

The optional ring-detect part of the test exercises the ring-detect circuitry. The test requires that the computer be connected to a phone line and that its number be dialed from another phone; it beeps and displays a message when it detects a ring signal.

10.3.9 RS-232-C Test

The RS-232-C test checks the serial interface. The test requires that the RS-232-C test connector be installed at the serial receptacle. This connector provides a path for output signals be fed back to inpuy lines.

The test toggles the output (control) lines and checks the status of the input (status) lines. This checks the operation of the PPU, HP-IL controller, and serial interface circuits.

The test then checks the data path by sending 256 bytes of data on the transmit and receive lines. If an error occurs, the test checks the multi-controller by sending the multi-controller UART to its self-test mode, then sending and receiving data at two baud rates.

10.3.10 Beeper Test

The Beeper test checks the PPU and beeper (transducer) by sounding three normal beeps.

10.3.11 Timer Test

The Timer test first checks the real-time clock in the PPU by writing to and reading from its clock registers.

The test then checks the count-down timer in the multi-controller by writing to and reading from its registers, and by starting and stopping the timer at different values. The test also checks the CPU-interrupt function of the multi-controller.

10.3.12 Sleep Test

The Sleep test checks that the CPU and PPU can power-down the system.

10.4 Service References

The following references provide additional information about the Portable PLUS and about components used in it.

Hewlett-Packard Company. *HP Portable PLUS Owner's Manual.* HP reorder number 45711-90002, ©1985.

Hewlett-Packard Company. *Portable PLUS Technical Reference Manual,* model HP 45559K, ©1985.

Intel Corporation. *Microsystem Components Handbook,* Volume I. ©1984.

Kane, Gerry, et al. *The HP-IL System: An Introductory Guide to the Hewlett-Packard Interface Loop.* Osborne/Mc Graw-Hill, Berkeley, California, ©1982.

MaNamara, John E. *Technical Aspects of Data Communication.* Digital Equipment Corporation, Bedford, Massachusetts, ©1977.*

10.5 Service Equipment

10.5.1 RS-232-C Test Connector

Figure 10-1 shows the wiring for the RS-232-C test connector.

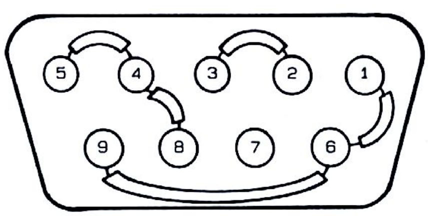


Figure 10-1. RS-232-C Connector Wiring Diagram

10.5.2 SNALink/3270 Test Board

The SNALink/3270 test board (part number 82986-60902) provides two RS-232 clock signals (TxDCE and RxDCE) to the SNALink/3270 software drawer. The test board receives its power from an external +5V power supply.

Table 10-3 lists replaceable parts for the test board. Figure 10-5 shows the schematic diagram for the test board.

10.5.3 Diagnostic Module

The diagnostic module can be used while the computer is either assembled or disassembled. The module connects in the *left* port of the computer. The module (figure 10-2) contains circuitry to burn configuration EPROMs for the computer and two 8K-byte EPROMs that contain diagnostic 'scope routines. The code on the service disc provides the software for EPROM burning.

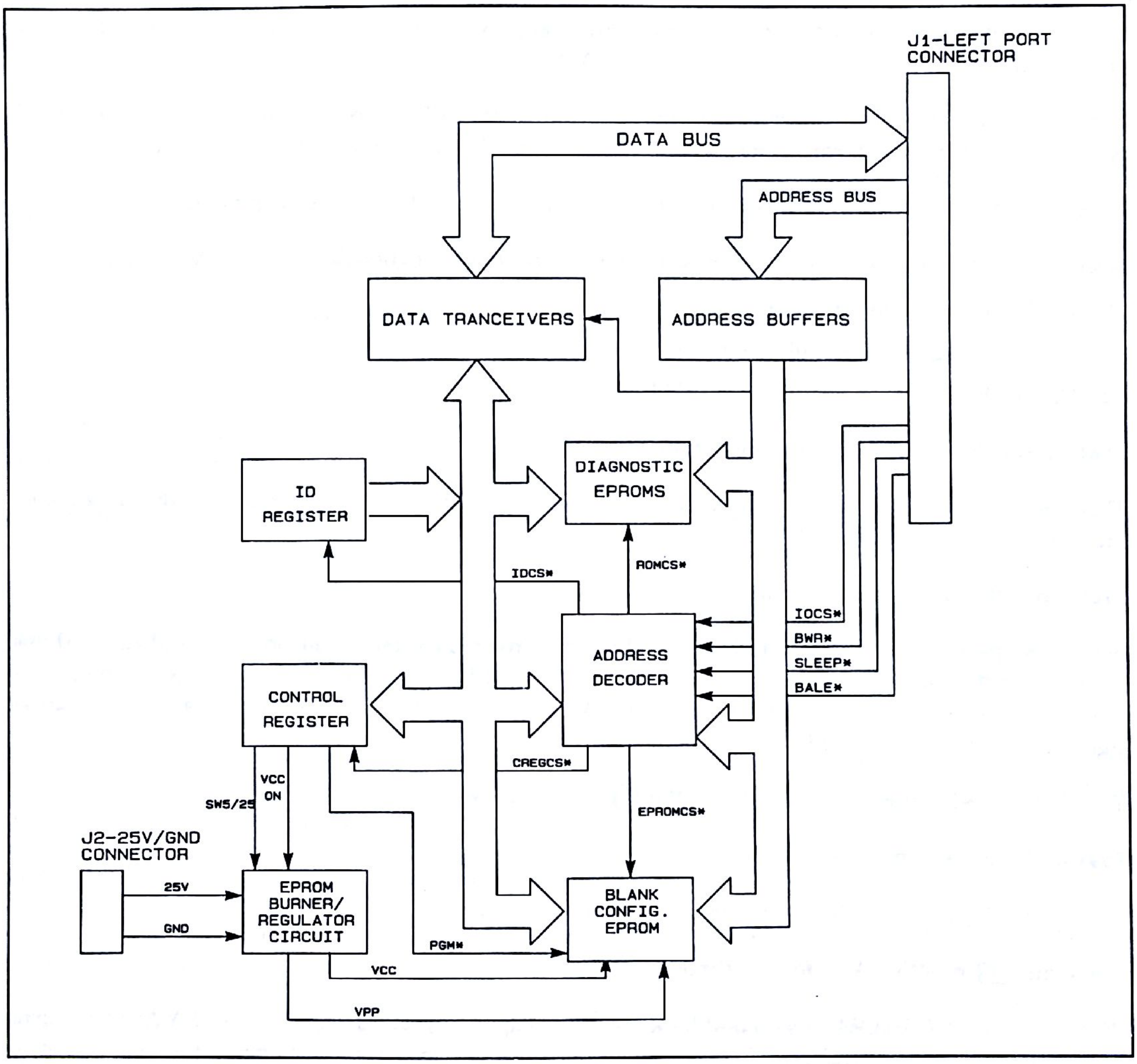


Figure 10-2. Diagnostic Module Block Diagram

The diagnostic module is contained on one PCA. This PCA contains all circuits necessary to communicate with the HP Portable PLUS Computer. (Table 10-3 lists the replaceable parts for the diagnostic module. Figures 10-3 and 10-4 show its component location and schematic diagrams.)

The diagnostic module buffers the addresses and data sent on the CPU bus by the computer's circuits. The addresses are decoded to determine what function the module should perform. The computer must write data to I/O address 00C2 and then either read an EPROM address (for diagnostic testing), or write data to addresses (for EPROM burning).

EPROM Diagnostic Test Function. The diagnostic EPROM is located in the first 16K bytes of plug-in ROM (addresses 90000 through 93FFF). When the module is connected to the computer, the scope routines are run at power-up.

EPROM Burner Function. The configuration EPROM in the HP Portable PLUS Computer has information that is unique to the unit (such as the serial number). When a configuration EPROM is bad, the diagnostic module is used to burn another EPROM. To burn an EPROM, the diagnostic module must be plugged into the *left* port, a 25 Vdc power supply connected to J2, and the EPROM-burner program must be loaded into the computer's RAM.

Data sent to the diagnostic module determines whether the EPROM is to perform a "read" or "write" operation, controls the burn-in voltage, and enables the burn duration (one-shot) timer.

Checking the EPROM Burner. Run the DMTEST program on the service diagnostic disc.

Select the test to be performed by pressing the appropriate function key on the display:

1. Calibrate the EPROM timer.
2. Test the diagnostic module switches.
3. Check the diagnostic module EPROM code.

Test 1. Set the EPROM programmer timer.

This test allows you to calibrate and/or check the 51 ms timer pulse generated by the diagnostic module (for burning EPROMs):

Press the (f1) function key to run this test.

Set the scope for 1 V/division and 10 ms/division. Probe U18, pin 6 and look for pulses at 51-ms intervals. If the pulses are *not* 51 ms apart, adjust R14 until the pulse duration is correct. If no pulses are present, check U18, pin 3 for a 5-MHz clock signal and U18, pin 2 for a 51-ms pulse. If either signal is missing, check U17.

To exit this test, press and hold down the (◑) contrast key.

Test 2. Diagnostic module switch tests.

These tests toggle the EPROM programmer control registers:

Press the (f2) function key to run these tests.

Probe X1, pin 28 (EPROM socket) and look for the voltage to switch between 0 and 5 Vdc. (This turns Vcc to the EPROM on and off.) If this voltage does not toggle, check U14, pin 3 for toggling. Also check that the signals at U14, pins 4 and 5 do not change.

Press any key to proceed to the next switch test.

Probe X1, pin 1 (EPROM socket) and look for the signal to switch between 5 and 21 Vdc. (This turns the Vpp EPROM programming voltage on and off.) If this signal does *not* switch, check the 21 Vdc regulator VR1. Also check that U14, pin 4 is switching between 0 and 5Vdc, and that U14, pins 3 and 5 do not change states.

Press any key to proceed to the next switch test.

Probe A2U17, pin 11 and look for the voltage to switch between 0 and 5 Vdc. This test checks that the 51 msec timer is enabled. If the voltage does *not* toggle, check whether A2U14, pin 5 toggles. If *this* does not toggle, check that the proper signals are present on U14, pins 10 and 11–15.

Press any key to return to the main menu.

Test 3. Diagnostic module EPROM checksum test.

This test does a checksum test on the code in the diagnostic module EPROMs.

Press function key (f3) to run this test.

This test takes approximately 60 seconds to run. If the EPROMs have the proper checksums, the test will respond with "Diagnostic EPROMs OK" in the display. If the test fails, one or more of the following messages will appear:

error format: XXX EPROM BAD #

XXX = HIGH or LOW

= data bit where error occurred (D0–D15)

If an EPROM(s) fails, check that the EPROM(s) is installed correctly, and that the data lines indicated by the test toggle when the test is run.

Circuit Description. Connector J1 is the connection to the computer motherboard PCA. Address buffers U1 and U2 are always enabled, and gate 17 bits of the latched address to the diagnostic module. These buffers reduce load capacitance on the address lines.

Tristate data transceivers U4 and U5 control the transfer of data between the diagnostic module and the computer. The DT/R* line controls the direction of data transfer; a combination of DEN* and address space decoding enables the data transfer.

U6, U7, U12, and U13 determine when the module is enabled, decode the plug-in address range, and provide chip select signals to the EPROM. U8 responds to a "read" from 00C0 (hex.) to tell the system that a ROM drawer is installed in the *left* port.

EPROM U15 contains the odd-address memory; EPROM U16 contains the even-address memory.

Data latch U14 is enabled at I/O address 00C2. A high line MD0 turns on the voltage to EPROM X1 (a blank 8K-byte service EPROM). When MD3 and BWR* are asserted, the "clear" input to multivibrator U17 is also asserted. When MD1 is high, Q1 turns on. This raises the output voltage from regulator U7, causing the X1 programming voltage to increase approximately 5 Vdc to about 21 Vdc.

U17 is a dual-trigger monostable multivibrator. It determines the EPROM burn-in time for data at each address (50 to 55 ms). U17 is triggered when the EPROM chip select is low, and is asserted. The second multivibrator is used to generate a 5-MHz DEN* signal to clock the D-type flip-flop U18. U18 generates a READY* signal. The flip-flop is triggered when U17 asserts the PGM* line. The output of flip-flop U18 is connected to FET Q5 to pull the open drain READY signal low.

Table 10-2. Diagnostic Module Replaceable Parts

Reference Designation	HP Part Number	Description	Quantity
C1-C18	0160-5332	CAPACITOR, 0.1 μF 20% 50V	18
C19	0180-0269	CAPACITOR, 1 μF 150V	1
C20	0180-0291	CAPACITOR, 1 μF 35V	1
C21	0160-4787	CAPACITOR, 22 pF 5%	1
CR1, CR2	1901-1098	DIODE, switch 1N4150	2
J2	1251-6978	CONNECTOR, housing AMP 1V2	1
Q1	1854-0477	TRANSISTOR, NPN 2N2222	1
Q2	1854-0215	TRANSISTOR, NPN 2N3904	1
Q3, Q4	1853-0036	TRANSISTOR, PNP 2N3906	2
Q5	1855-0556	TRANSISTOR, VN2222L	1
R1, R2	1810-0281	RESISTOR, 100K × 9	2
R3, R9, R10, R11, R12	0683-2235	RESISTOR, 22K 5% ¼W	5
R4	0683-2225	RESISTOR, 2.2K 5% ¼W	1
R5	0698-3440	RESISTOR, 196Ω 1% ⅛W	1
R6	0757-0394	RESISTOR, 51.1Ω 1%	1
R7	0699-0208	RESISTOR, 1Ω	1
R8	0757-0421	RESISTOR, 25Ω	1
R13	0683-4725	RESISTOR, 4.7K	1
R14	2100-3253	RESISTOR, variable 50K 10%	1
R15	0683-3935	RESISTOR, 39K 5% ¼W	1
R16	0683-1025	RESISTOR, 1K 5% ¼W	1

Table 10-2. Diagnostic Module Replaceable Parts (Continued)

Reference Designation	HP Part Number	Description	Quantity
U1-U3	1820-3933	INTEGRATED CIRCUIT,74HC365N	3
U4, U5	1820-3330	INTEGRATED CIRCUIT, 74HC245	2
U6, U14	1820-3182	INTEGRATED CIRCUIT, 74HC173N	2
U7, U13	1820-3079	INTEGRATED CIRCUIT, 74HC138	2
U8	1820-1441	INTEGRATED CIRCUIT, 74HC540	1
U9	1820-2924	INTEGRATED CIRCUIT, 74HCO2	1
U10	1820-3201	INTEGRATED CIRCUIT, 74HC4075N	1
U11, U19	1820-2922	INTEGRATED CIRCUIT, 74HC00N	2
U12	1820-1441	INTEGRATED CIRCUIT, 74HC283N	1
U15	45711-60913	INTEGRATED CIRCUIT, EPROM, low byte	1
U16	45711-60914	INTEGRATED CIRCUIT, EPROM, high byte	1
U17	1820-3673	INTEGRATED CIRCUIT, 74HC123	1
U18	1820-3081	INTEGRATED CIRCUIT, 74HC74	1
VR1	1826-0772	DIODE, regualtor LM3176	1

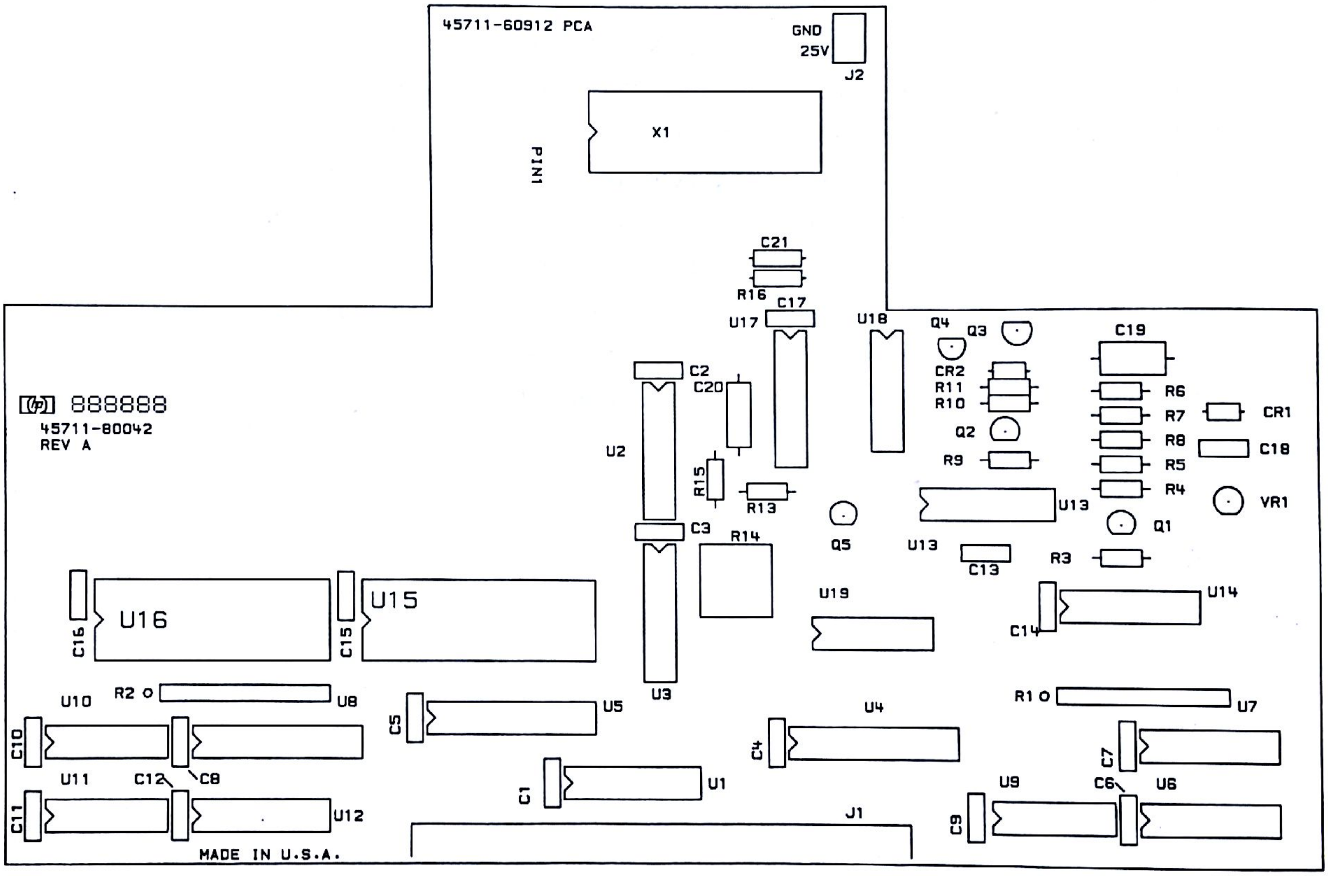
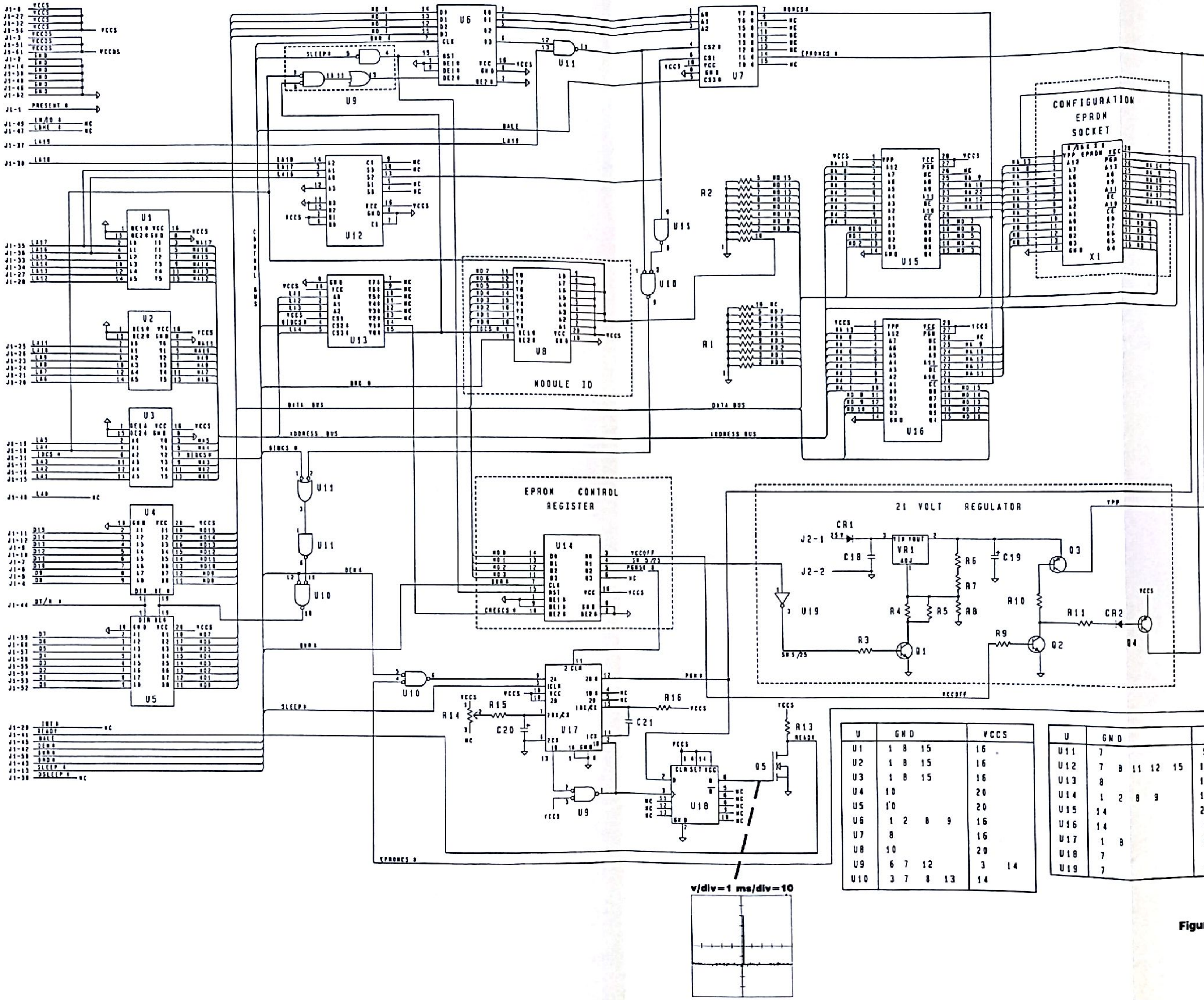


Figure 10-3. Diagnostic PCA Component Location Diagram



U	GND	VCCS
U1	1 8 15	16
U2	1 8 15	16
U3	1 8 15	16
U4	10	20
U5	10	20
U6	1 2 8 9	16
U7	8	16
U8	10	20
U9	6 7 12	3 14
U10	3 7 8 13	14

U	GND	VCCS
U11	7	5 10 14
U12	7 8 11 12 15	16
U13	8	16
U14	1 2 8 9	16
U15	14	27 28
U16	14	1 27 28
U17	1 8	3 10 16
U18	7	1 4 14
U19	7	2 14

Figure 10-4. Diagnostic PCA Schematic Diagram

Table 10-3. SNALink/3270 Test Board Replaceable Parts

Reference Designation	HP Part Number	Description	Quantity
U1	1820-3185	INTEGRATED CIRCUIT, 74HC14	1
U2	1820-1429	INTEGRATED CIRCUIT, 74LS160	1
U3	1820-3081	INTEGRATED CIRCUIT, 74HC74	1
Y1	0410-1294	CRYSTAL, 32.768 kHz	1

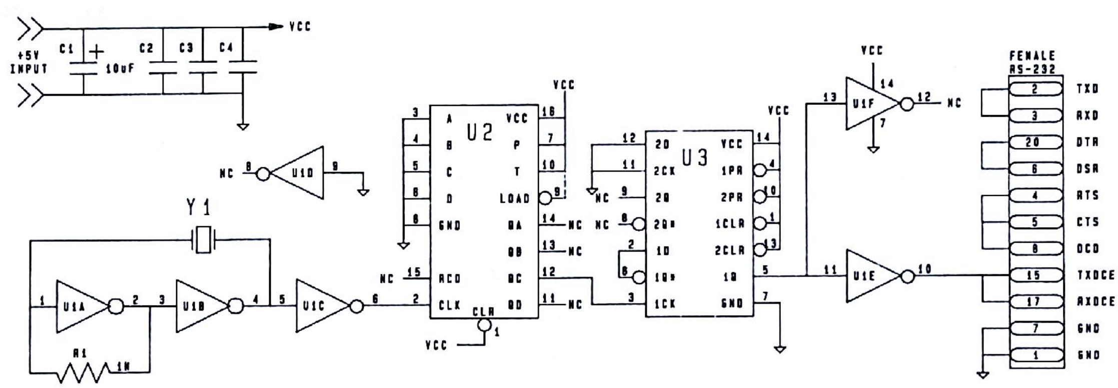


Figure 10-5. SNALink/3270 Test Board Schematic Diagram

Chapter 11
Product History

11.1 Introduction

This chapter contains information for using this manual with earlier units for which the content doesn't apply directly.

To use this manual with an earlier unit, refer to table 11-1 to determine the backdating information that applies to a particular unit. Then refer to section 11.2 for a detailed description of each item. (Units not identified in the table have no backdating information.)

Table 11-1. Backdating Summary

Product (and Version)	Serial Numbers	Applicable Items*
HP 45711		
A and B	before 2532A-----	1, 2, 3, 4, 5, 6, 7
A and B	2532A-----	2, 3, 4, 5, 6, 7
A and B	2533A----- to 2536A-----	3, 4, 5, 6, 7
A and B	2537A----- to 2602A-----	4, 5, 6, 7
A and B	2603A----- to 2608A-----	5, 6, 7
A and B	after 2608A-----	6, 7
C and D	all	8
E and F	before 2713A-----	8
HP 82981A Memory Drawer		
—	before 2547A-----	9
HP 82982A Software Drawer		
—	*no* serial number	10, 11
—	before 2547A-----	11

* Certain items may not apply if a unit has been repaired previously. Check the unit to determine if the item applies.

11.2 Backdating History

The following list provides detailed information about each backdating item. (Also, the indicated service notes describe the backdating items.) Refer to table 11-1 to find the items that apply to a particular unit.

1. **HP 45711A/B, serial numbers before 2532A-----.** Install a terminal shield (part number 82985-80011) in the battery compartment. This shield prevents the customer from shorting the battery terminals while installing an HP 82985A Video Interface. (Service Note 45711-04.)
2. **HP 45711A/B, serial numbers before 2533A-----.** Install a rubber foot (part number 00090-80022) over each of the two ESD springs inside the bottom case. Be sure the hole in each spring lines up with its hole in the bottom case, and that the foot lines up with the edge of the recessed area of the case. (See figure 11-1.) This prevents shorting the motherboard PCA to the spring while drawers are installed. (Service Note 45711-05.)

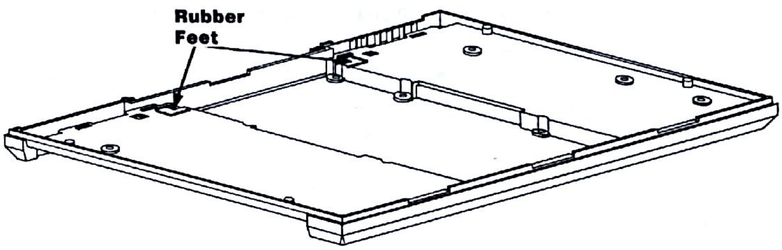


Figure 11-1. Installing Feet Over Springs

3. **HP 45711A/B, serial numbers before 2537A-----.** If a customer notes a problem with battery recharging, replace resistors A2R54, A2R55, and A2R57 on the motherboard PCA. (Refer to table 9-5.) If you replace any one of these resistors, *you must replace all three*—early units used a different combination of resistors.

   Recommend to the customer to leave the unit charging whenever possible. This gives maximum battery capacity when the recharger's not connected. The battery can't overcharge. (Service Note 45711-07.)
4. **HP 45711A/B, serial numbers before 2603A-----.** The ROM ICs on the memory PCA are installed in sockets (part number 1200-0567), and you can replace the ICs during assembly-level repair. Refer to table 11-2 for IC identification.

   Replacement memory PCAs will contain *soldered* ROM ICs.
5. **HP 45711A/B, serial numbers before 2609A-----.** The front and back of the display assembly *don't* have molded bumps at the hinges to center the assembly in the top case. Instead, a felt pad (part number 0330-0392) should be present on each leg of the display assembly.

   If you replace either the front or back of the display assembly, you should replace *both* parts (listed in table 9-3).

6. **HP 45711A/B, all units.** The A and B versions of the computer provide 128K bytes of built-in RAM on the memory PCA (A1).

   In addition, the original battery power straps are flexible. *You must replace the flexible straps with new ones* if you open the case. (Replace them with the newer "stiff" straps, part number 45711-00007.)

   The troubleshooting procedures, replaceable parts list, component location diagram, and schematic diagram for these versions are presented in section 11.3, "Reference Information for A and B Versions."

7. **HP 45711A/B, all units.** The A and B versions of the computer incorporate a *gray* liquid-crystal display (LCD) that functions like the *green* display of current units, except that the green display offers greater contrast and a wider viewing angle. The two LCD module assemblies are interchangeable. The gray LCD module assembly is available as part number 45711-60904.

   - If a gray LCD module tests bad in an A or B version, you can replace it either with another gray module or with a green module.
   - If a gray LCD module tests good in an A or B version, but the customer requests a green display, you can make this "upgrade" replacement.

8. **HP 45711C/D, all units. HP 45711E/F, serial numbers before 2713A-----.** The C and D versions and early E and F versions of the computer contain a memory PCA (A1) that provides 256K bytes of RAM. The memory PCA contains two connectors for mounting two piggyback PCAs (each containing 128K bytes of RAM) and two jumpers for configuring these piggyback PCAs. For all of these these versions, RAM blocks 0 and 1 are contained on the memory PCA. For the E and F versions, RAM blocks 2 and 3 are contained on the two piggyback PCAs.

   In addition, the memory PCA contains system ROM in six ICs, which are soldered to the PCA.

   The replacement procedure, troubleshooting procedures, replaceable parts list, component location diagram, and schematic diagrams for these versions are presented in section 11.4, "Reference Information for Early C/D/E/F Versions."

9. **HP 82981A Memory (RAM) Drawer, serial numbers before 2547A-----.** Earlier versions of the plastic case used metal inserts in the screw holes, requiring the use of machine screws for assembly. Replacement screws are part number 0515-0346.

   If the plastic case is damaged, replace the case and screws with the parts listed in table 9-11. (Service Note 82981-01.)

10. **HP 82982A Software (ROM) Drawer, with no serial number.** (The serial number, if present, is located on the metal cover.) Plating slivers from manufacturing may cause failure of the PCA. If bad, replace the PCA with a new PCA. (Service Note 82982-01.)

11. **HP 82982A Software (ROM) Drawer, serial numbers before 2547A-----.** Earlier versions of the plastic case used metal inserts in the screw holes, requiring the use of machine screws for assembly. Replacement screws are part number 0515-0346.

    If the plastic case is damaged, replace the case and screws with the parts listed in table 9-10. (Service Note 82981-02.)

11.3 Reference Information for A and B Versions

This section presents reference information for troubleshooting and repairing A and B versions of the Portable PLUS. (The version is indicated by the model number printed on the bottom label of the unit—refer to table 1-1.)

11.3.1 Troubleshooting A and B Versions

Troubleshooting procedures for A and B versions are identical to those presented in chapter 8 with one exception: ROM and RAM IC identifications differ from those for E and F versions. Table 11-2 lists actions you should take for the indicated diagnostic test results.

Table 11-2. Diagnostic Test Results for A and B Versions

Failure Code	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
116–118 127–129	Memory PCA.	If only one or two ROMs indicated, replace individual A1U16–A1U18 or A1U27–A1U29 (ROM). If more than two ROMs indicated, latch or transceiver suspected. Trace using scope routine.	Internal ROM read
0: *yy*	Memory PCA.	If only one or two RAMs indicated, replace individual RAM ICs: 0:00 → A1U26 0:08 → A1U22 0:01 → A1U15 0:09 → A1U11 0:02 → A1U25 0:10 → A1U21 0:03 → A1U14 0:11 → A1U10 0:04 → A1U24 0:12 → A1U20 0:05 → A1U13 0:13 → A1U9 0:06 → A1U23 0:14 → A1U19 0:07 → A1U12 0:15 → A1U8 If more than two RAMs indicated, latch or transceiver suspected. Trace using scope routine.	Internal RAM write Internal RAM read

11.3.2 Replaceable Parts for A and B Versions

Table 11-3 lists certain replaceable parts for A and B versions. Other parts are as listed in chapter 9 except as may be noted in section 11.2 above.

Table 11-3. Replaceable Parts for A and B Versions

Reference Designation	HP Part Number	Description	Quantity
A1	45711-60903* 45711-69003†	Assembly, memory PCA, 128K	1
A1C1–A1C30	0160-4840	• Capacitor, 0.047 μF	30
A1C31–A1C34	0180-3440	• Capacitor, 7 μf 10V	4
A1J1, A1J2	1252-0695	• Connector, pin female	2
A1J3, A1J4	1252-0678	• Connector, 2×19 HDR	2
A1R1–A1R5	1810-0281	• Resistor, 100K × 9	5
A1U1, A1U6, A1U7	1820-3486	• Integrated Circuit, 82C82	3
A1U2	1820-3176	• Integrated Circuit, 74HC151	1
A1U3–A1U5	1820-3079	• Integrated Circuit, 74HC138	3
A1U8–A1U15, A1U19–A1U26	1818-3183	• Integrated Circuit, 8K-byte RAM	16
A1U16	1818-3668	• Integrated Circuit, 32K-byte ROM	1
A1U17	1818-3669	• Integrated Circuit, 32K-byte ROM	1
A1U18	1818-3670	• Integrated Circuit, 32K-byte ROM	1
A1U27	1818-3671	• Integrated Circuit, 32K-byte ROM	1
A1U28	1818-3672	• Integrated Circuit, 32K-byte ROM	1
A1U29	1818-3673	• Integrated Circuit, 32K-byte ROM	1
A1UX30	1200-0567	• Socket, IC 28-pin	1
	45711-60904	Assembly, LCD module	1
	45711-00007	Strap, power, replacement	2

* New part.
† Exchange part.

11.3.3 Diagrams for A and B Versions

Figures 11-2 and 11-3 show the component location diagram and schematic diagram for A and B versions.

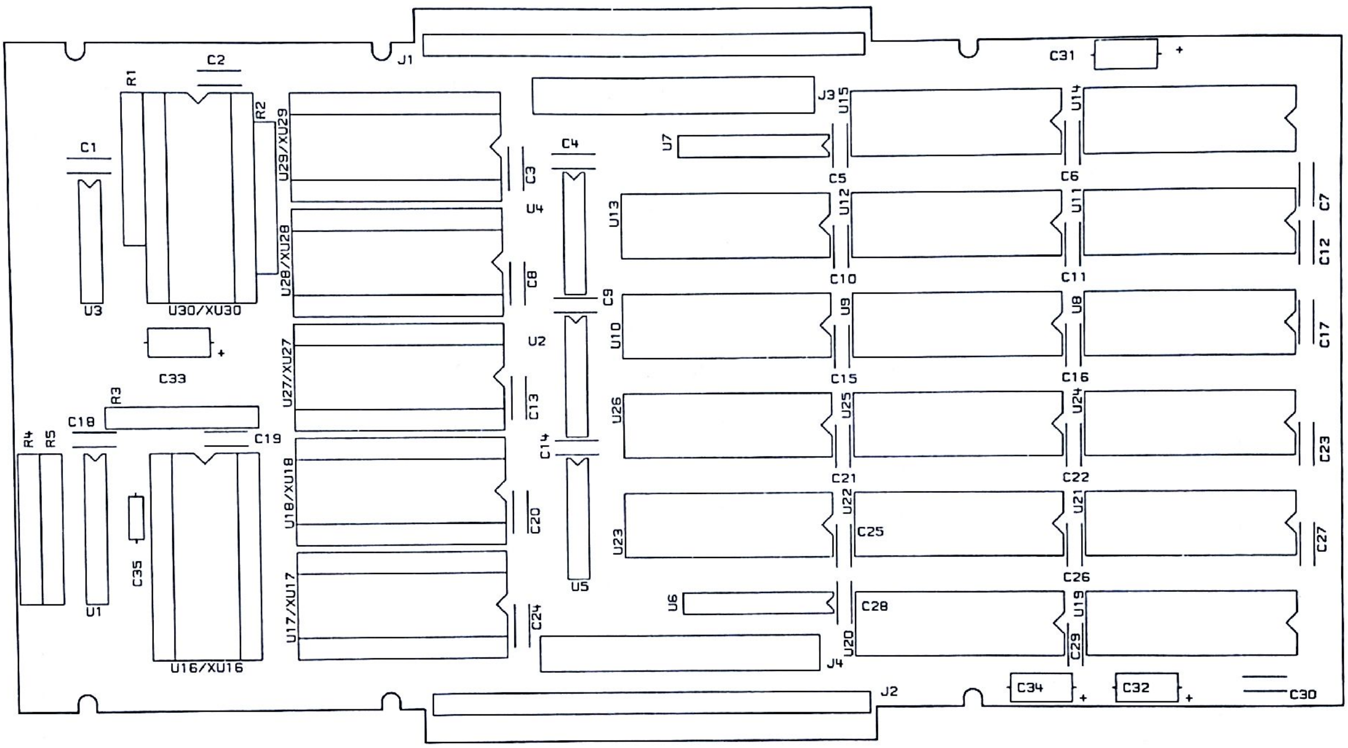


Figure 11-2. Memory PCA Component Location Diagram (A and B Versions)

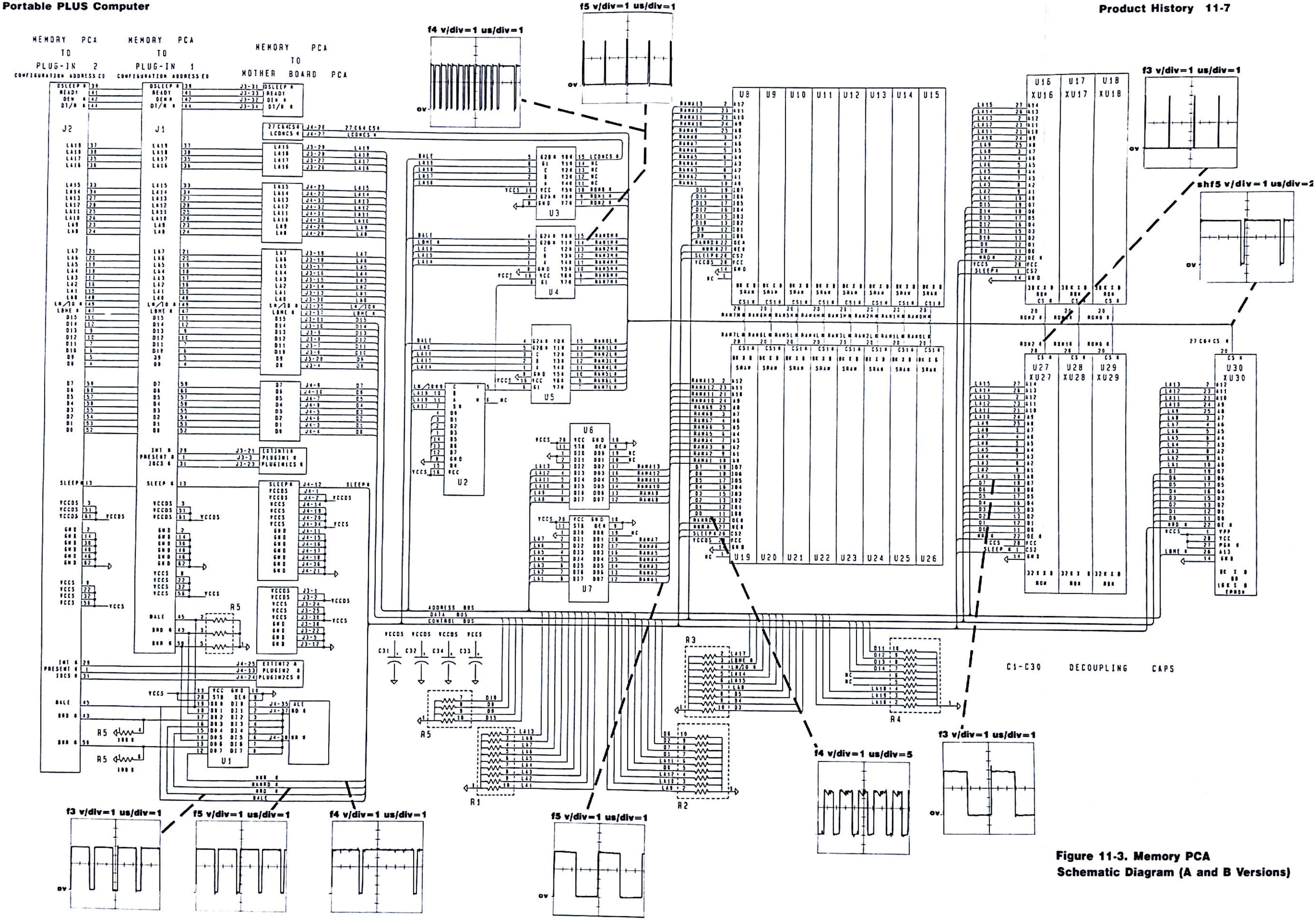


Figure 11-3. Memory PCA Schematic Diagram (A and B Versions)

11.4 Reference Information for Early C/D/E/F Versions

This section presents reference information for troubleshooting and repairing C and D versions and early E and F versions of the Portable PLUS. (The version is indicated by the model number printed on the bottom label of the unit—refer to table 1-1.) The E and F versions contain two piggyback PCAs mounted on the memory PCA.

11.4.1 Removal and Replacement for Early E/F Versions

To remove the piggyback PCAs from the memory PCA, first remove the two nuts that hold each PCA, then use a screwdriver to carefully pry up the edge of the PCA next to its connector.

> **Reassembly Note:** Be sure a spacer is installed on each mounting stud before installing the piggyback PCA. After installing the two nuts, place a drop of thread adhesive (part number 0470-1306) on each nut. Finally, install a piece of tape (part number 0460-2027) along the gap between the piggyback PCAs—it should cover the connector pads on both PCAs.

11.4.2 Troubleshooting Early C/D/E/F Versions

Troubleshooting procedures for C and D versions and early E and F versions are identical to those presented in chapter 8 with these exceptions (detailed information follows):

- Main Diagnostic Procedure. When you first turn on the computer, you must verify that the memory PCA is configured properly by checking the amount of available memory.
- Interpreting Diagnostic Test Results. You must interpret the ROM failure codes to account for the presence of six ROM ICs that are soldered in place. You can't perform component-level repair on the RAM ICs because they're surface-mounted.
- Repair Procedures. For startup problems, you must verify the configuration of the memory PCA. For repairing the processors, the ROM-select IC generates six select signals.

Main Diagnostic Procedure. When you first turn on the computer and the main PAM screen appears, you should check the amount of available memory shown at the upper-right corner of the PAM screen. If the amount is unreasonable considering the amount of RAM in the computer, check the configuration of the memory PCA as described under "Repair Procedures" below.

Interpreting Diagnostic Test Results. Table 11-4 lists actions you should take for the indicated diagnostic test results.

Table 11-4. Diagnostic Test Results for Early C/D/E/F Versions

Failure Code	Assembly-Level Replacement	Component-Level Replacement	Oscilloscope Routines
116–118 127–129	Memory PCA.	If only one or two ROMs indicated, replace individual A1U16–A1U18 or A1U27–A1U29 (ROM). If more than two ROMs indicated, latch or transceiver suspected. Trace using scope routine.	Internal ROM read
0: *yy* ... 1: *yy* ...	Memory PCA.	If only one or two RAMs indicated, inspect for solder bridges or shorts on surface-mounted RAM ICs (see table 11-5). Replace memory PCA. If more than two RAMs indicated, latch or transceiver suspected. Trace using scope routine.	Internal RAM write Internal RAM read
2: *yy* ...	Swap piggyback RAM PCAs between connectors A1J5 and A1J6 (a PCA must be installed at A1J5). Then if the error changes to "3", replace piggyback PCA now at A1J6; if error "2" recurs, replace memory PCA.	Swap piggyback RAM PCAs between connectors A1J5 and A1J6 (a PCA must be installed at A1J5). Then if the error changes to "3", replace piggyback PCA now at A1J6; if error "2" recurs, replace memory PCA.	
3: *yy* ...	Swap piggyback RAM PCAs between connectors A1J5 and A1J6. Then if the error changes to "2", replace piggyback PCA now at A1J5; if error "3" recurs, replace memory PCA.	Swap piggyback RAM PCAs between connectors A1J5 and A1J6. Then if the error changes to "2", replace piggyback PCA now at A1J5; if error "3" recurs, replace memory PCA.	

Table 11-5. RAM Identification for Early C/D/E/F Versions

Failure Code	RAM Block	PCA Identification	
0: *yy*	Block 0	Memory PCA:	
		0:00 → A1U19	0:08 → A1U23
		0:01 → A1U8	0:09 → A1U12
		0:02 → A1U20	0:10 → A1U24
		0:03 → A1U9	0:11 → A1U13
		0:04 → A1U21	0:12 → A1U25
		0:05 → A1U10	0:13 → A1U14
		0:06 → A1U22	0:14 → A1U26
		0:07 → A1U11	0:15 → A1U15
1: *yy*	Block 1	Memory PCA:	
		1:00 → A1U39	1:08 → A1U43
		1:01 → A1U31	1:09 → A1U35
		1:02 → A1U40	1:10 → A1U44
		1:03 → A1U32	1:11 → A1U36
		1:04 → A1U41	1:12 → A1U45
		1:05 → A1U33	1:13 → A1U37
		1:06 → A1U42	1:14 → A1U46
		1:07 → A1U34	1:15 → A1U38
2: *yy*	Block 2	Piggyback PCA in A1J5	
3: *yy*	Block 3	Piggyback PCA in A1J6	

Repair Procedures. For startup problems (table 8-5), you must verify the configuration of the memory PCA. To do this, open the case, then check (on the memory PCA) the positions of jumpers A1W1 and A1W2 and the presence or absence of piggyback PCAs in connectors A1J5 and A1J6. The correct configuration depends upon the version:

- For C and D (256K-byte) versions, both jumpers should be in position "2-3" and both connectors should be empty.
- For early E and F (512K-byte) versions, both jumpers should be in position "1-2" and piggyback PCAs should be installed in both connectors.

For repairing the processors (table 8-7, last step), the ROM-select IC is A1U2. While the system is turned on and you're pressing keys, toggling signals should be present at A1U2 pins 1, 2, 3, 6, 7, 9, and 10.

11.4.3 Replaceable Parts for Early C/D/E/F Versions

Table 11-6 lists certain replaceable parts for C and D versions and early E and F versions. Other parts are as listed in chapter 9.

Table 11-6. Replaceable Parts for Early C/D/E/F Versions

Reference Designation	HP Part Number	Description	Quantity
A1	45711-60962*‡ 45711-69062†‡	Assembly, memory PCA, 256K	1
A1U16	1818-3668	• Integrated Circuit, 32K-byte ROM	1
A1U17	1818-3669	• Integrated Circuit, 32K-byte ROM	1
A1U18	1818-3670	• Integrated Circuit, 32K-byte ROM	1
A1U27	1818-3671	• Integrated Circuit, 32K-byte ROM	1
A1U28	1818-3672	• Integrated Circuit, 32K-byte ROM	1
A1U29	1818-3673	• Integrated Circuit, 32K-byte ROM	1
A1XU30	1200-0567	• Socket, IC 28-pin	1
	45711-80104	• Spacer, rubber	8
	82984-60901*‡ 82984-69001†‡	Assembly, piggyback PCA	2 (E, F ver.)
	0470-1306	Adhesive, thread, piggyback PCA	— (E, F ver.)
	0535-0018	Nut, hex, piggyback PCA	4 (E, F ver.)
	45711-20001	Spacer, piggyback PCA	4 (E, F ver.)
	0460-2027	Tape, piggyback PCA	1 (E, F ver.)

* New part.

† Exchange part.

‡ For E and F versions you can use a 512K memory PCA (part numbers: 45711-60984 new, or 45711-69122 exchange) to replace the combined 256K memory PCA and piggyback PCAs.

11.4.4 Diagrams for Early C/D/E/F Versions

Figures 11-4, 11-5, and 11-6 show the component location diagram and schematic diagrams for C and D and early E and F versions.

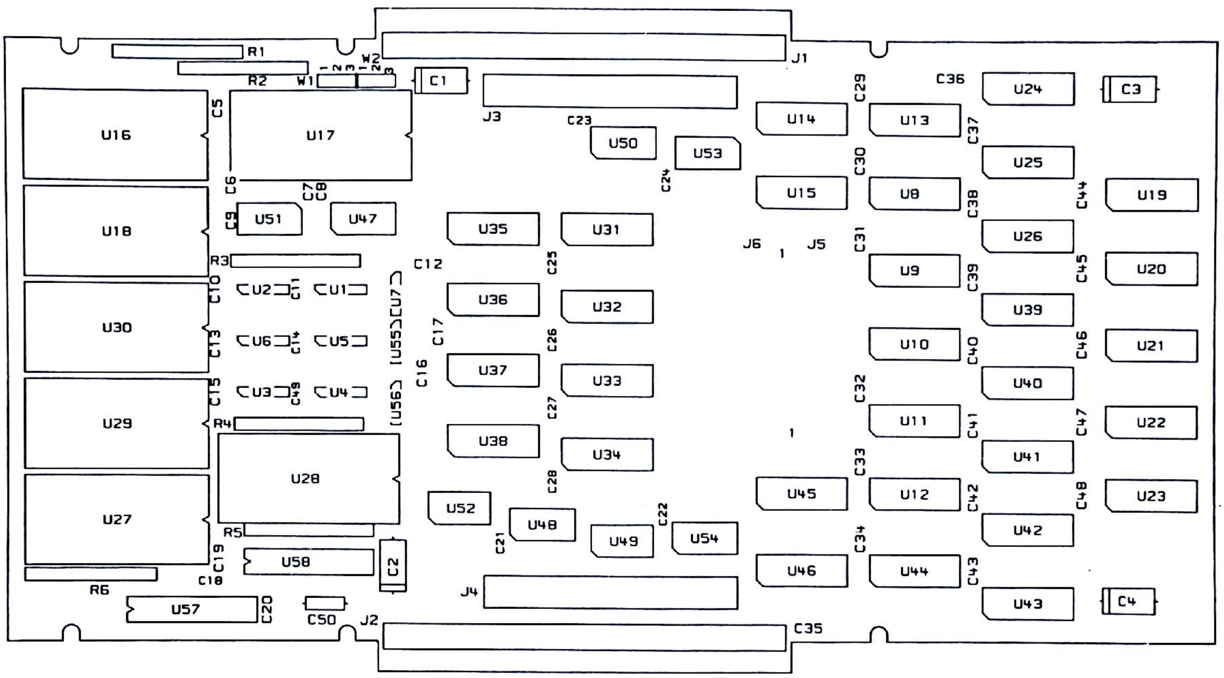


Figure 11-4. Memory PCA Component Location Diagram (Early C/D/E/F Versions)

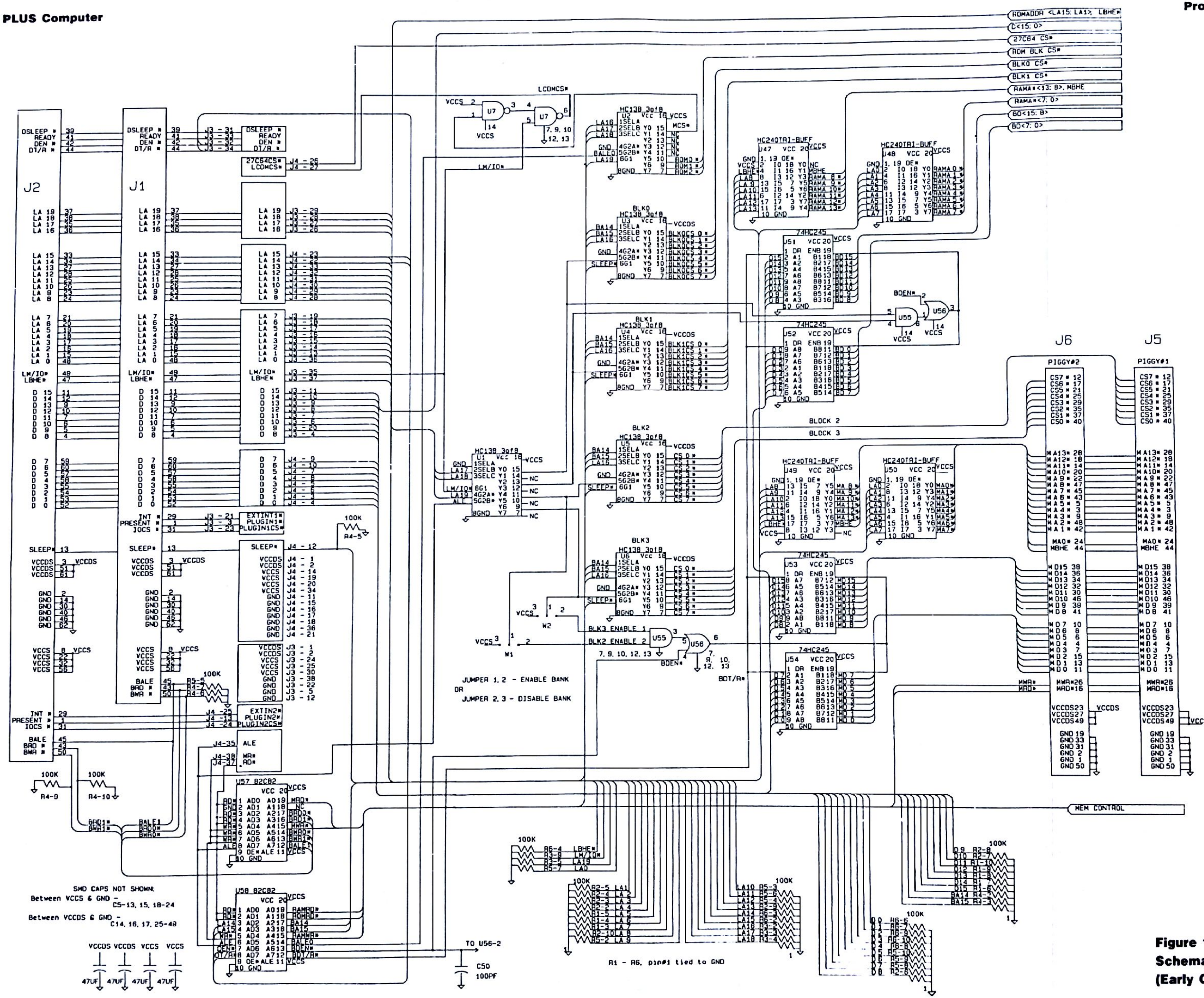


Figure 11-5. Memory PCA Schematic Diagram—Sheet 1 (Early C/D/E/F Versions)

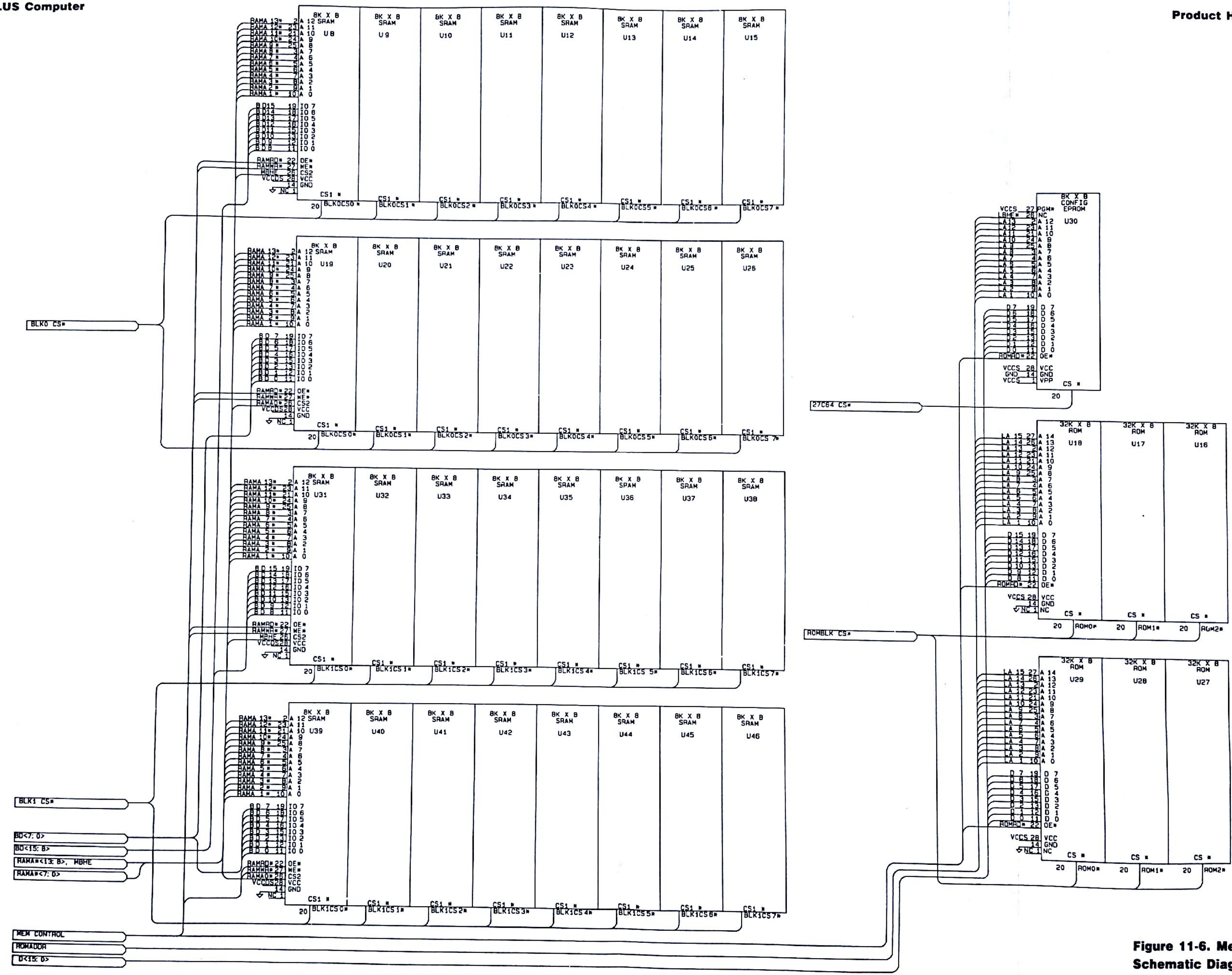


Figure 11-6. Memory PCA Schematic Diagram—Sheet 2 (Early C/D/E/F Versions)

Chapter 12
Diagrams

This chapter includes reference diagrams for the Portable PLUS: schematic diagrams and component-location diagrams for the memory PCA, motherboard PCA, modem PCA, and keyboard.

Replaceable parts for these assemblies are listed in chapter 9.

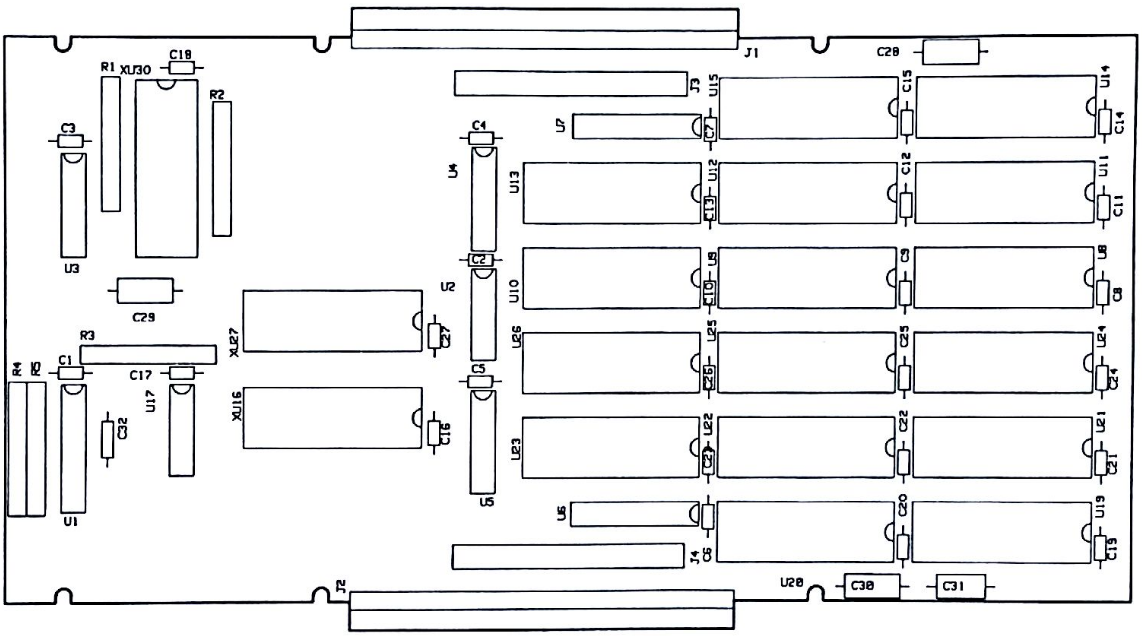


Figure 12-1. Memory PCA Component Location Diagram

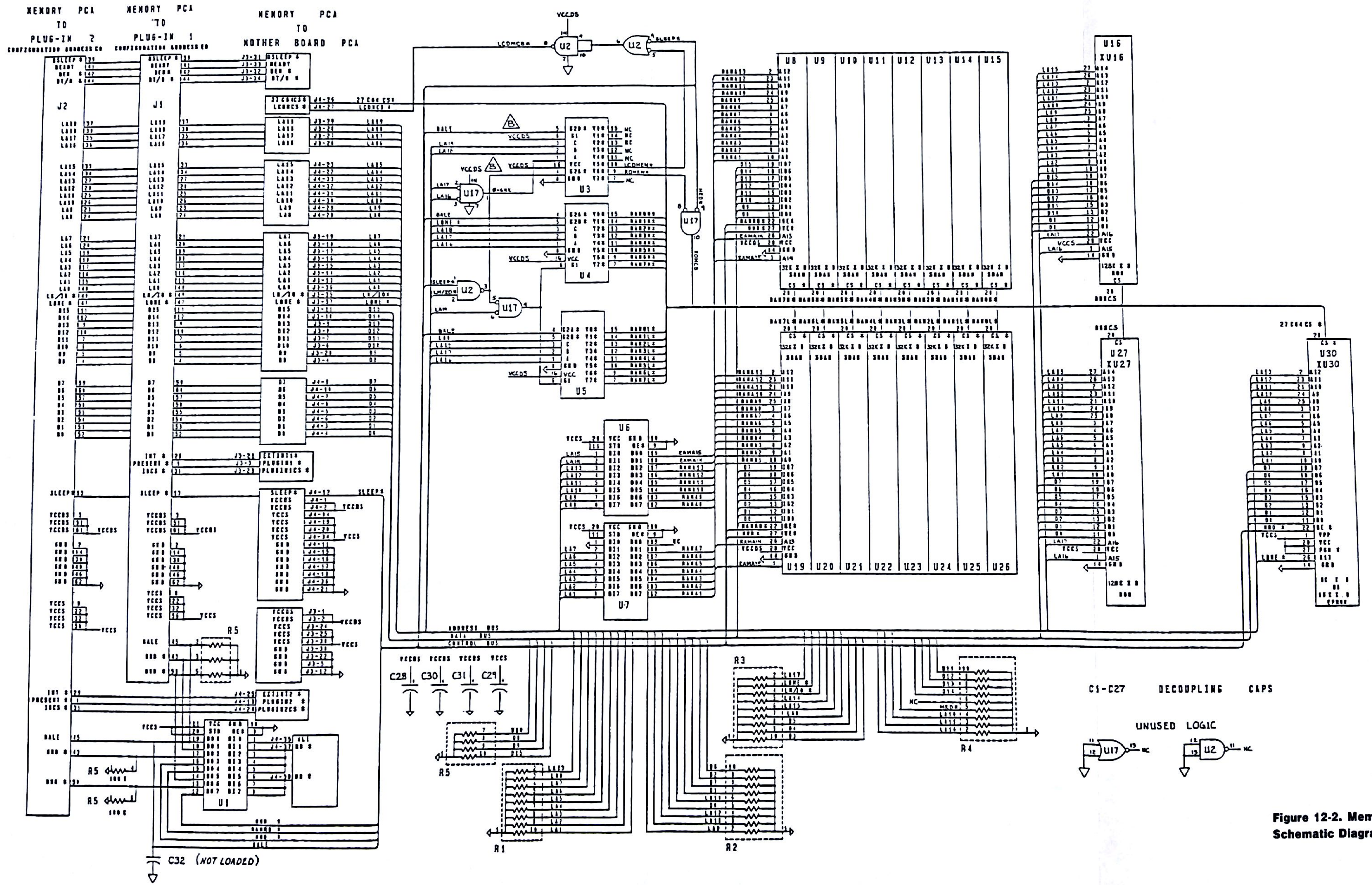


Figure 12-2. Memory PCA Schematic Diagram

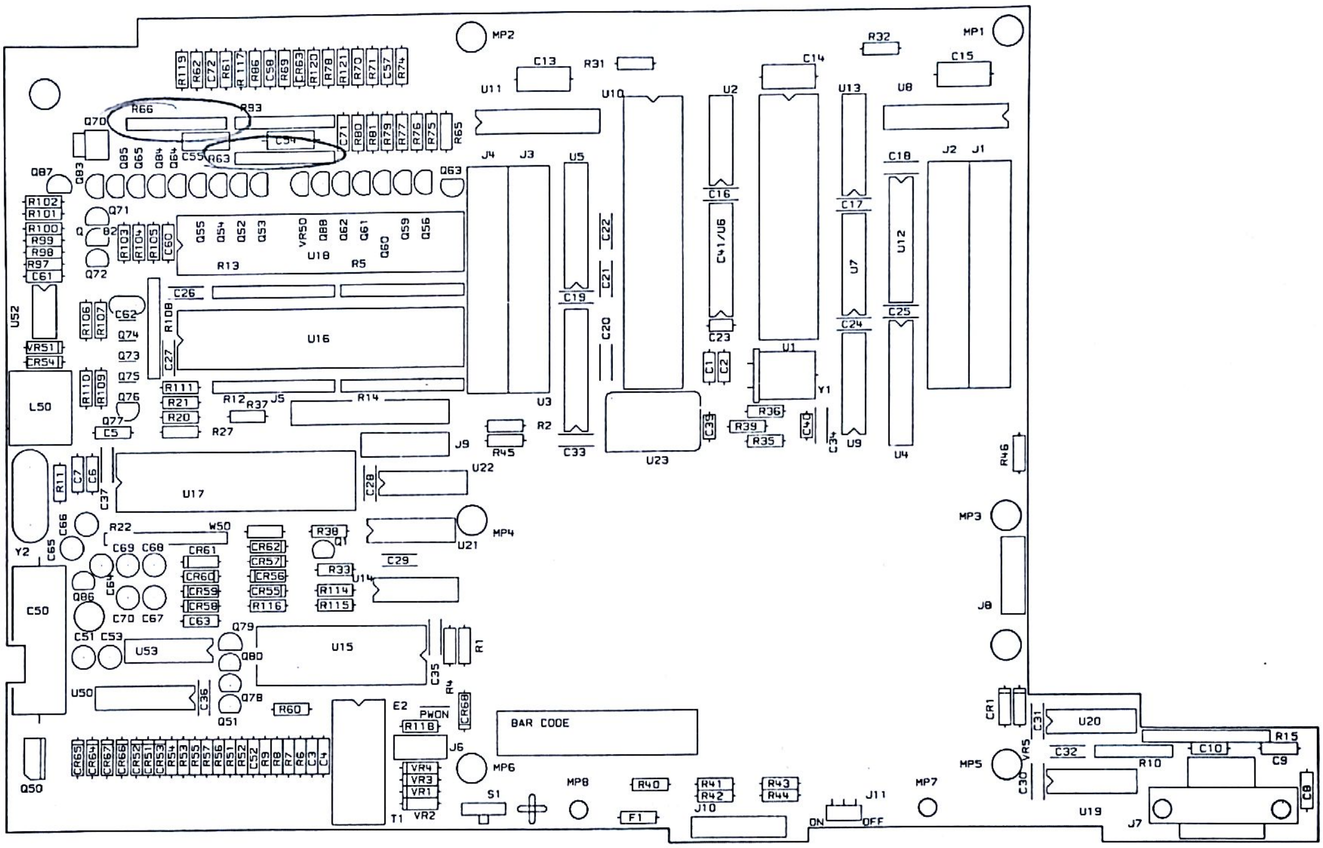


Figure 12-3. Motherboard PCA Component Location Diagram

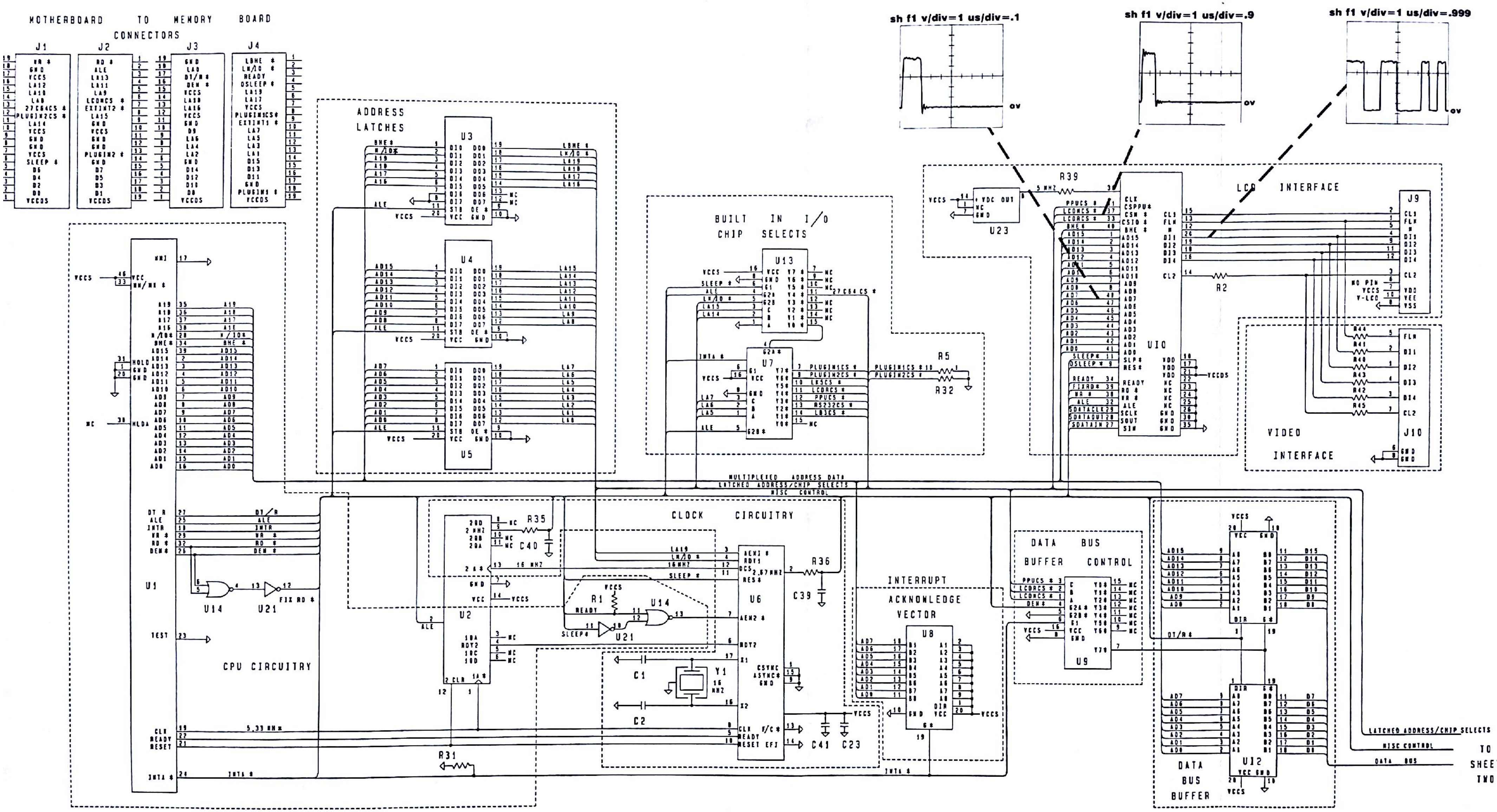


Figure 12-4. Motherboard PCA Schematic Diagram—Sheet 1 (CPU)

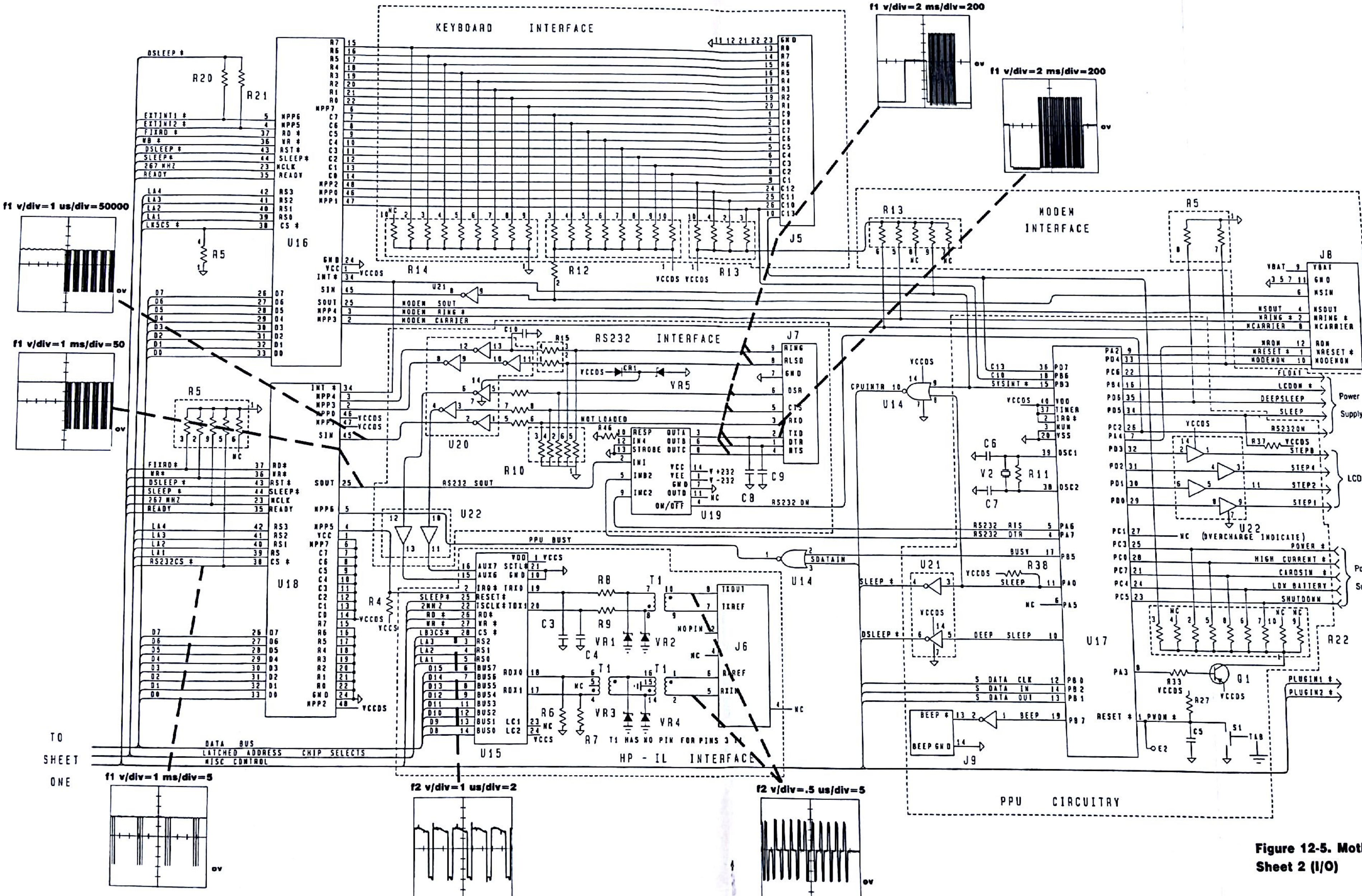
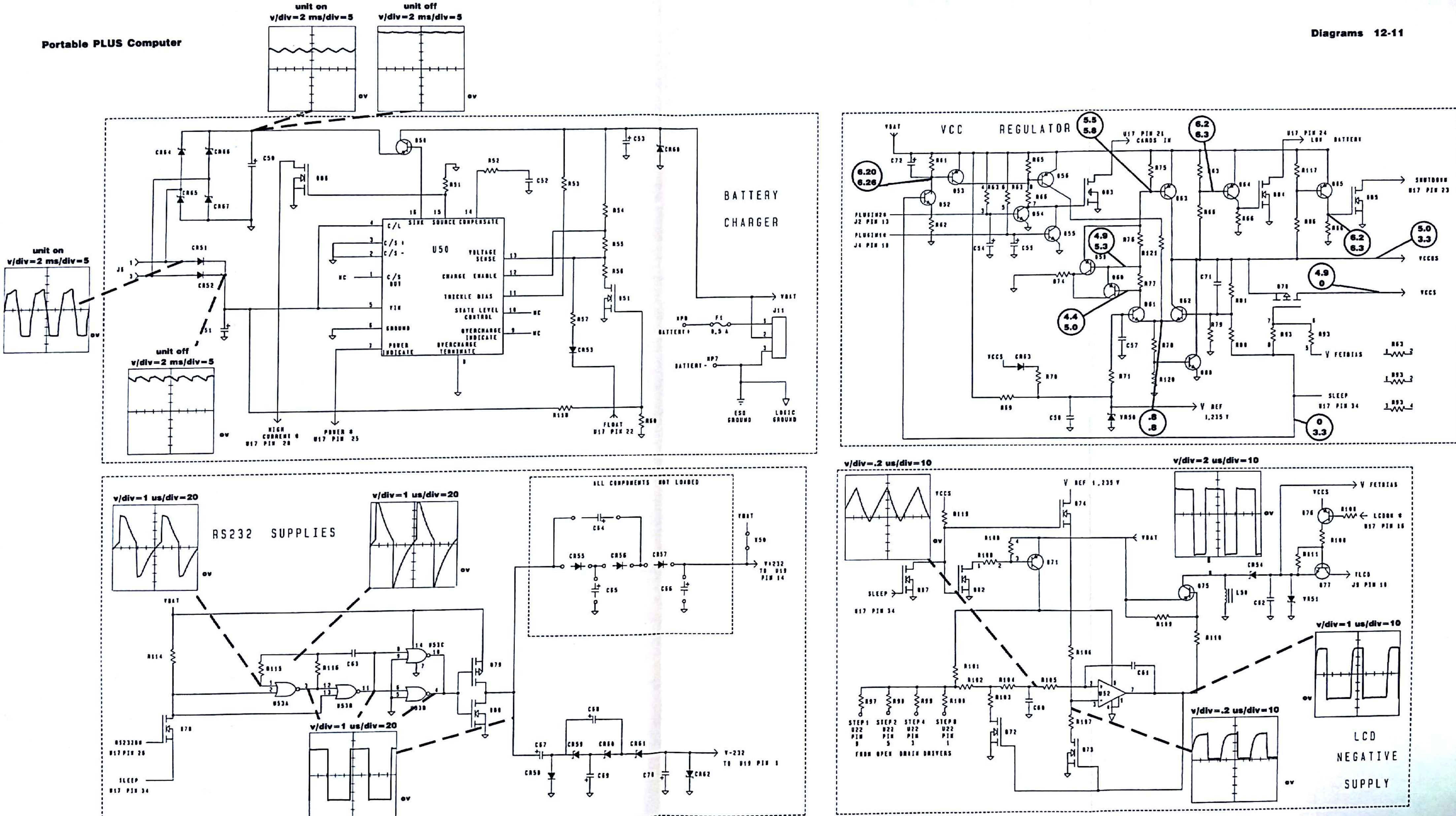


Figure 12-5. Motherboard PCA Schematic Diagram—Sheet 2 (I/O)



Note 1: LCD signal frequencies will vary with contrast.

Note 2: For waveforms assume unit is on unless noted.

Figure 12-6. Motherboard PCA Schematic Diagram—Sheet 3 Power Supply

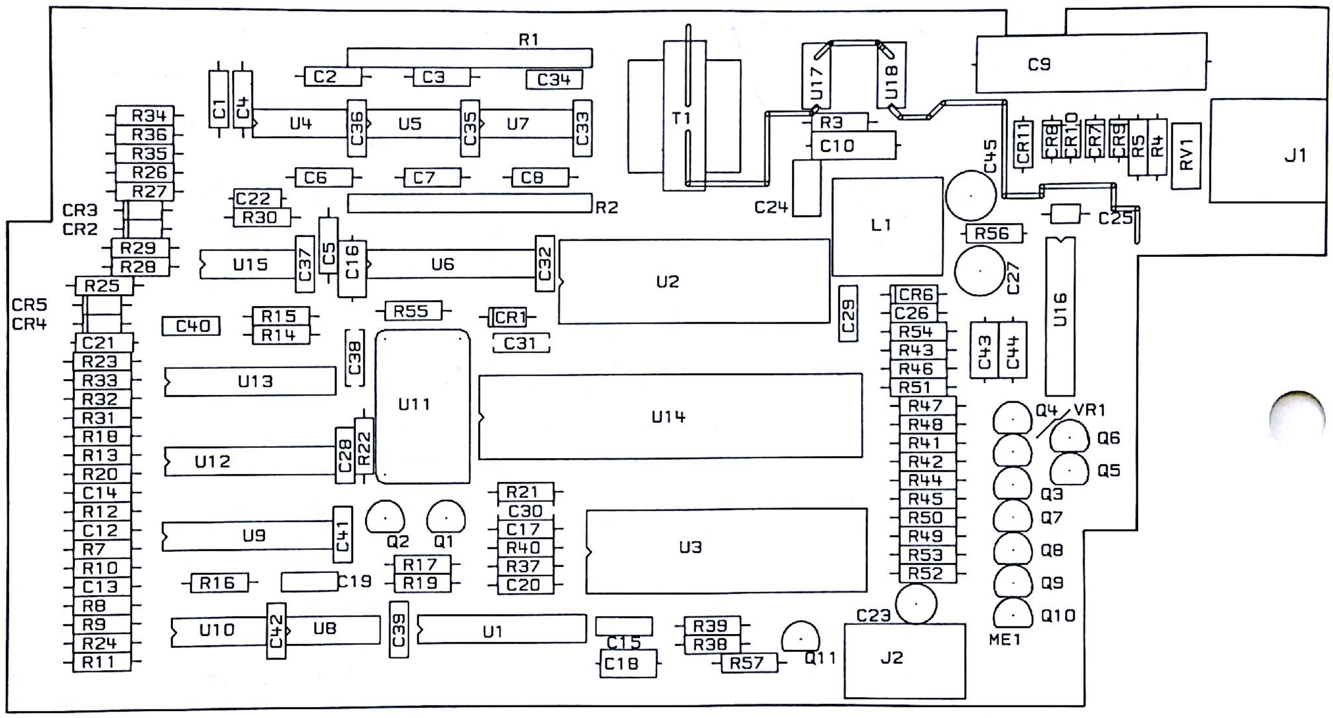
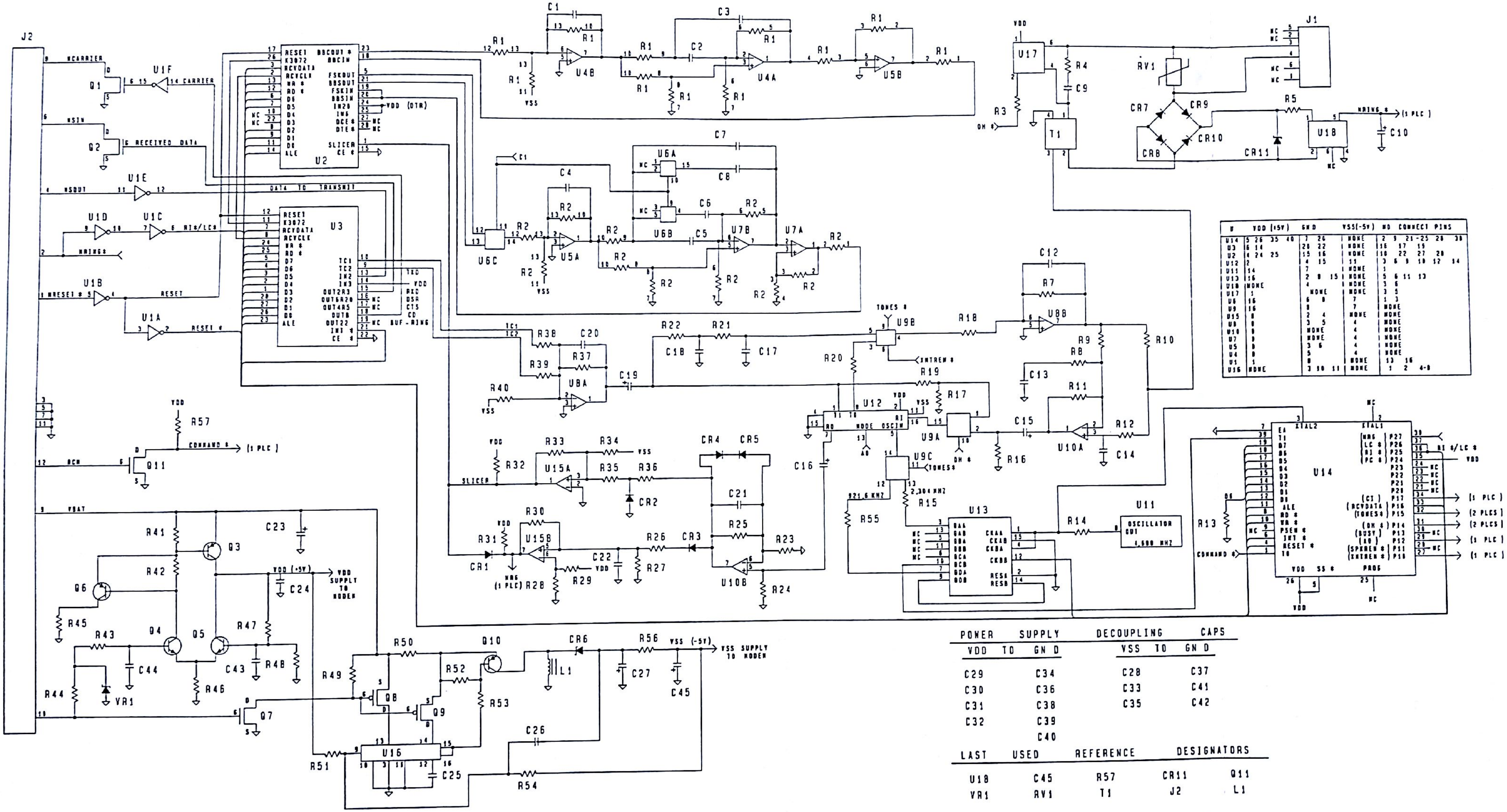


Figure 12-7. Modem PCA Component Location Diagram



U	VDD (+5V)	GND	VSS(-5V)	NO CONNECT PINS
U14	5 26 35 40	7 20	NONE	2 9 21-25 28 38
U3	6 14	20 22	NONE	18 17 19
U2	4 24 25	15 16	NONE	10 22 27 28
U12	2	4 15	11	3 6 9 10 12 14
U11	14	7	NONE	1
U13	16	2 8 15	NONE	5 6 11 13
U18	NONE	4	NONE	3 6
U17	1	NONE	NONE	3 5
U6	16	6 8	7	1 3
U9	16	8	7	NONE
U15	8	2 4	NONE	NONE
U8	8	3 5	4	NONE
U10	8	NONE	4	NONE
U7	8	NONE	4	NONE
U5	8	3 6	4	NONE
U4	8	5	4	NONE
U1	1	8	NONE	13 16
U16	NONE	3 10 11	NONE	1 2 4-8

POWER SUPPLY DECOUPLING CAPS

VDD TO	GND	VSS TO	GND
C29	C34	C28	C37
C30	C36	C33	C41
C31	C38	C35	C42
C32	C39		
	C40		

LAST USED REFERENCE DESIGNATORS

U18	C45	R57	CR11	Q11
VR1	RV1	T1	J2	L1

UNUSED REFERENCE DESIGNATORS

R6	C11

Figure 12-8. Modem PCA Schematic Diagram

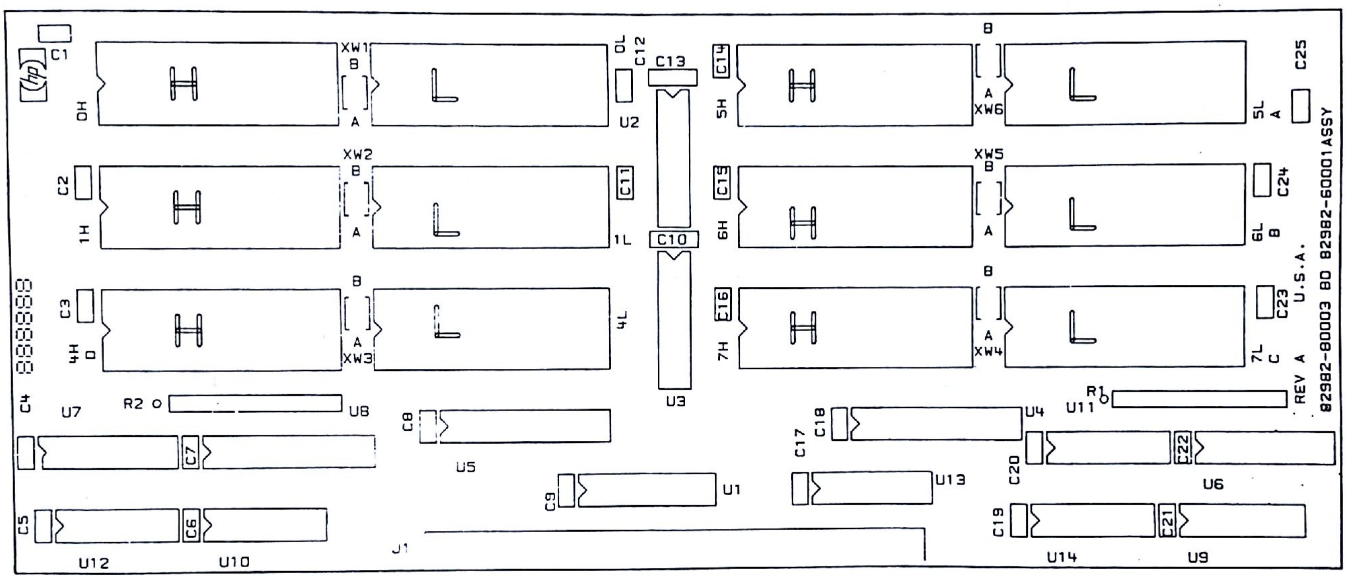
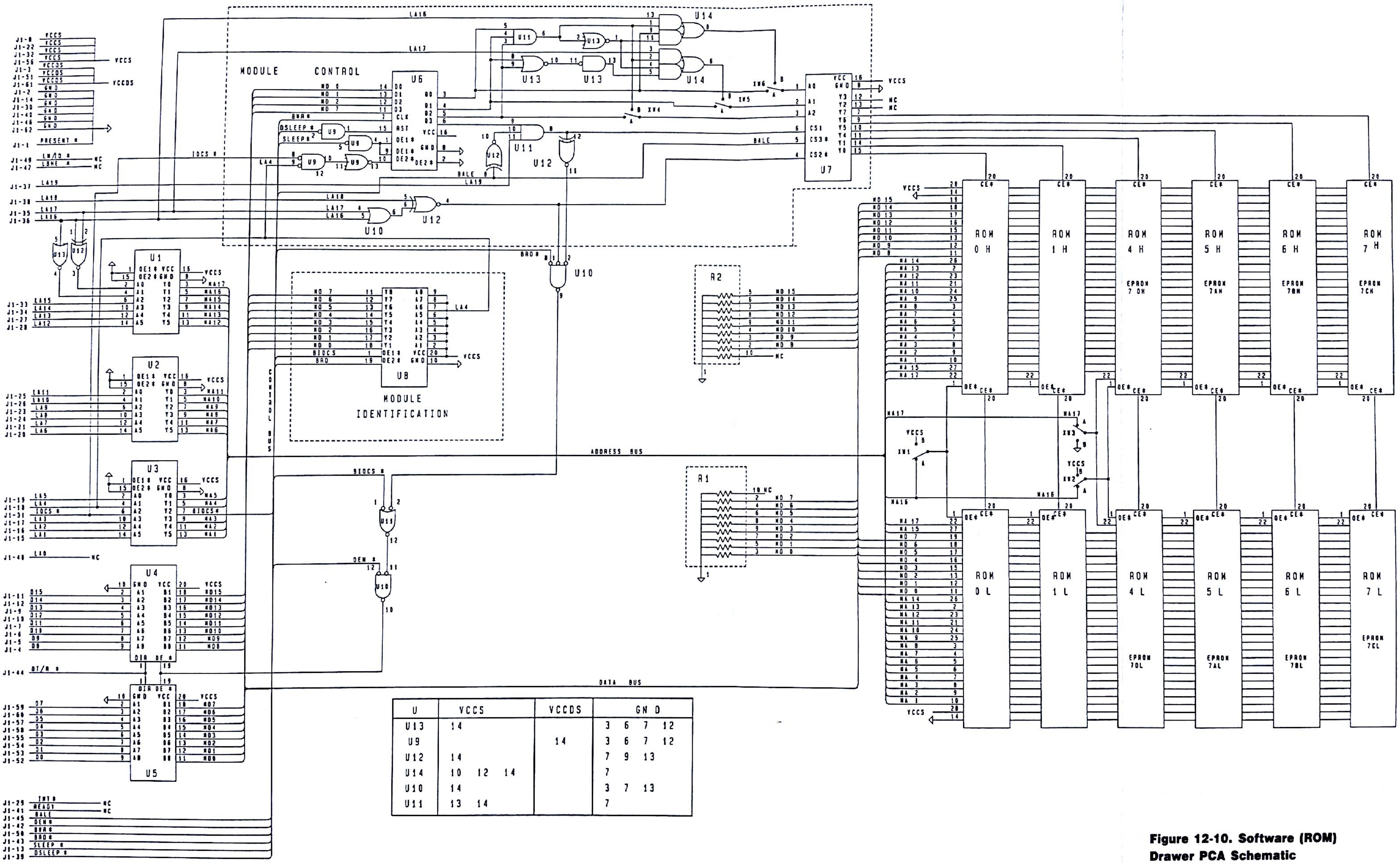


Figure 12-9. Software (ROM) Drawer PCA Component Location Diagram



U	VCCS	VCCDS	GND
U13	14		3 6 7 12
U9		14	3 6 7 12
U12	14		7 9 13
U14	10 12 14		7
U10	14		3 7 13
U11	13 14		7

Figure 12-10. Software (ROM) Drawer PCA Schematic Diagram

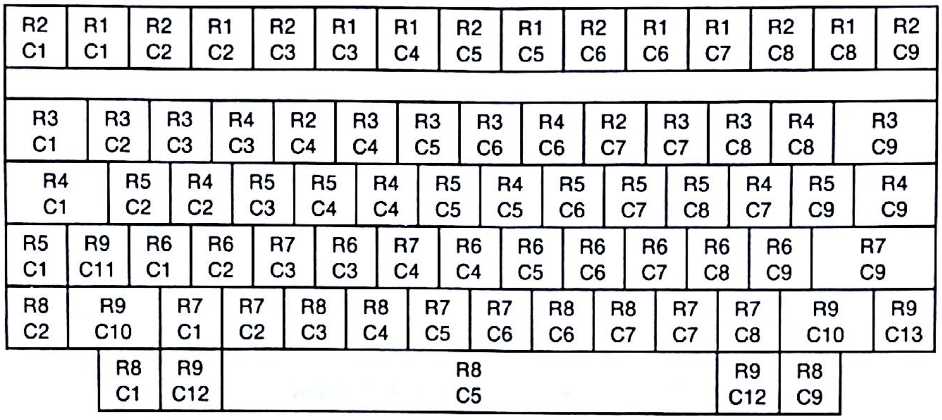


Figure 12-11. Keyboard Rows and Columns

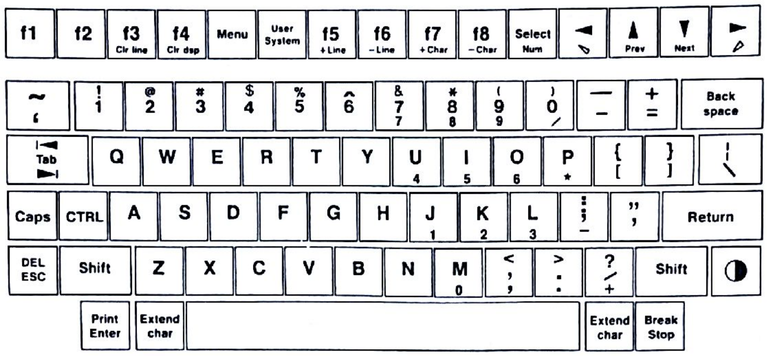


Figure 12-12. U.S. Keyboard Layout

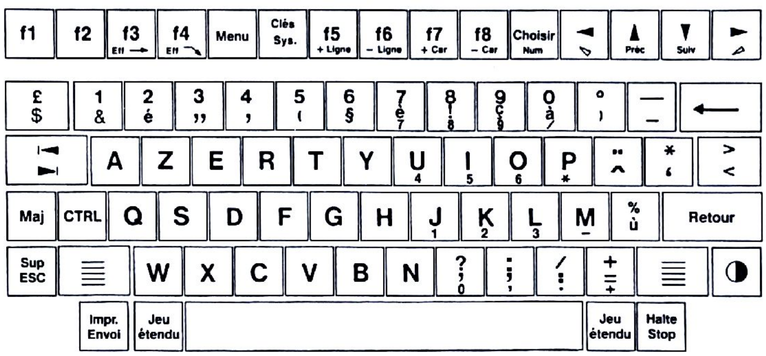


Figure 12-13. French Keyboard Layout

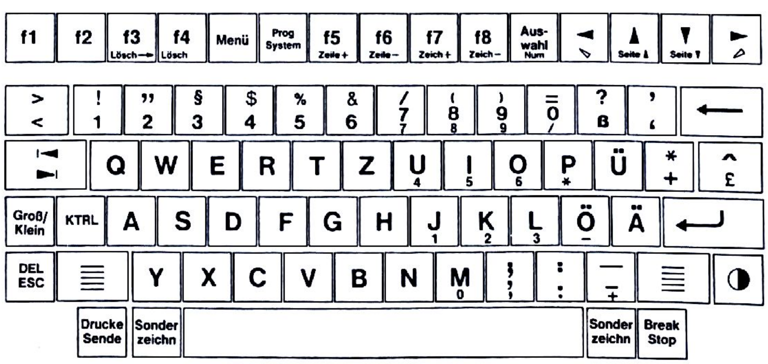


Figure 12-14. German Keyboard Layout

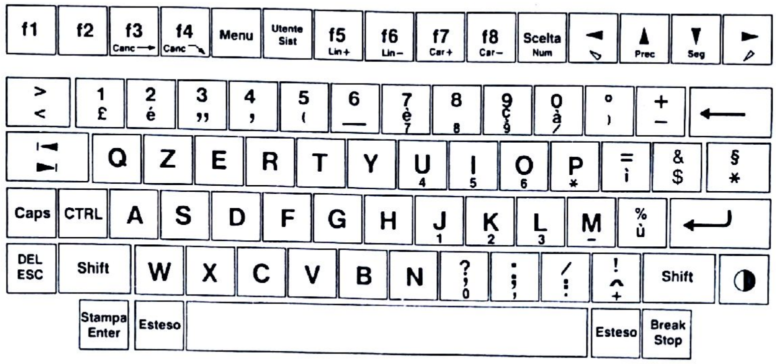


Figure 12-15. Italian Keyboard Layout

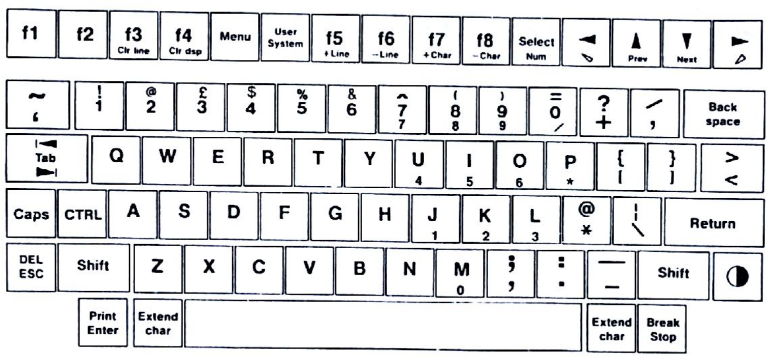


Figure 12-16. U.K. Keyboard Layout

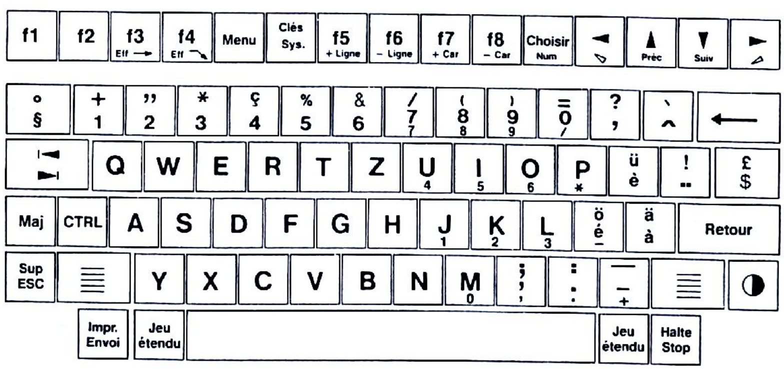


Figure 12-17. Swiss-French Keyboard Layout

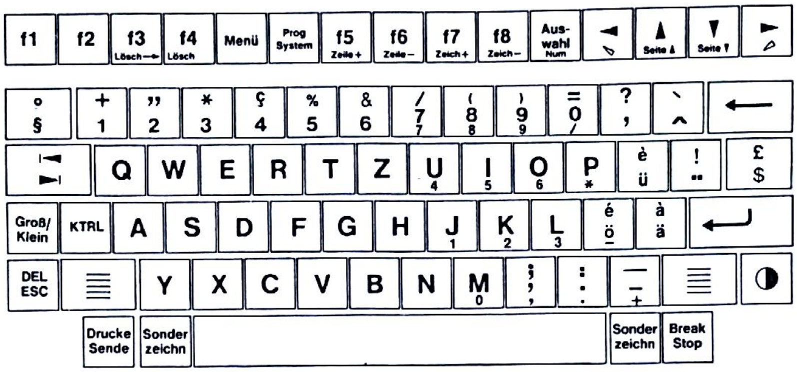


Figure 12-18. Swiss-German Keyboard Layout

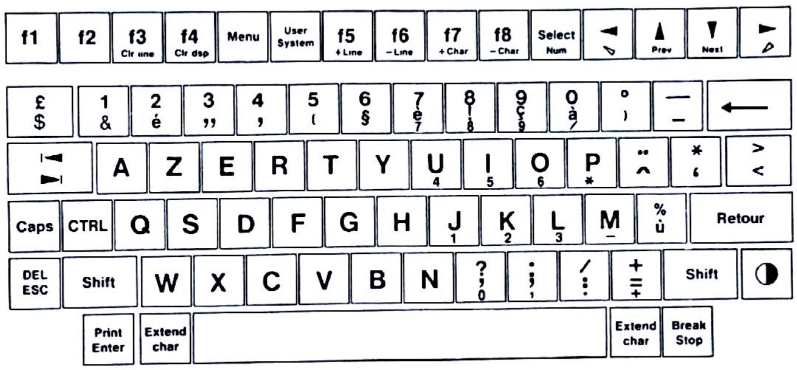


Figure 12-19. Belgian Keyboard Layout

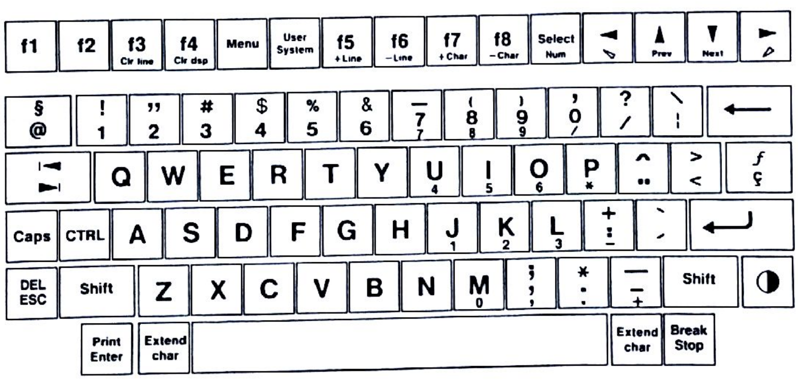


Figure 12-20. Dutch Keyboard Layout

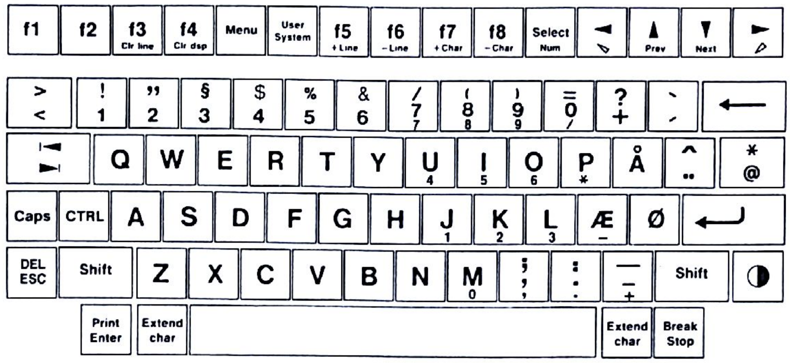


Figure 12-21. Danish Keyboard Layout

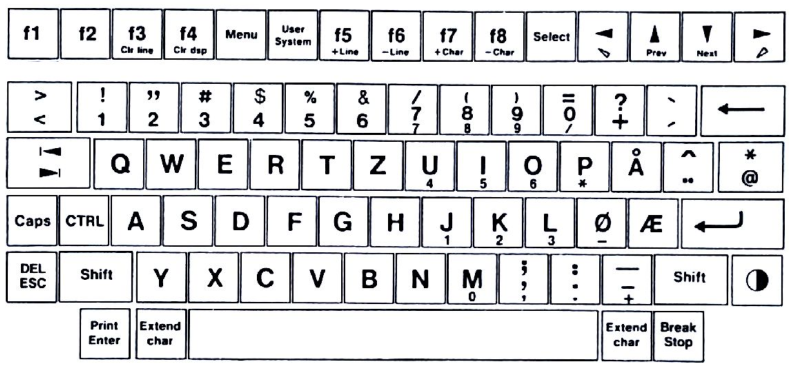


Figure 12-22. Norwegian Keyboard Layout

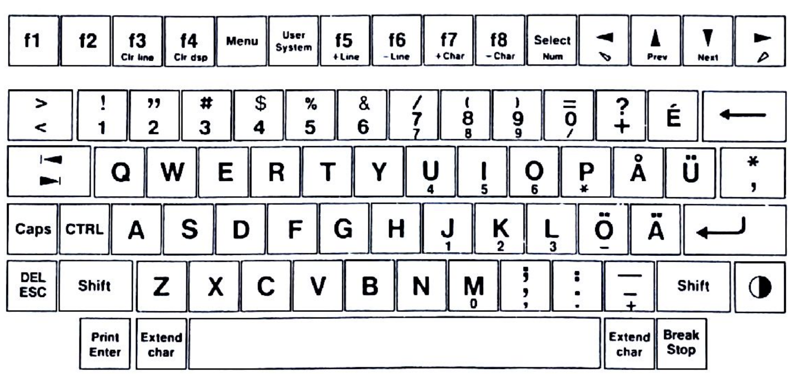


Figure 12-23. Swedish Keyboard Layout

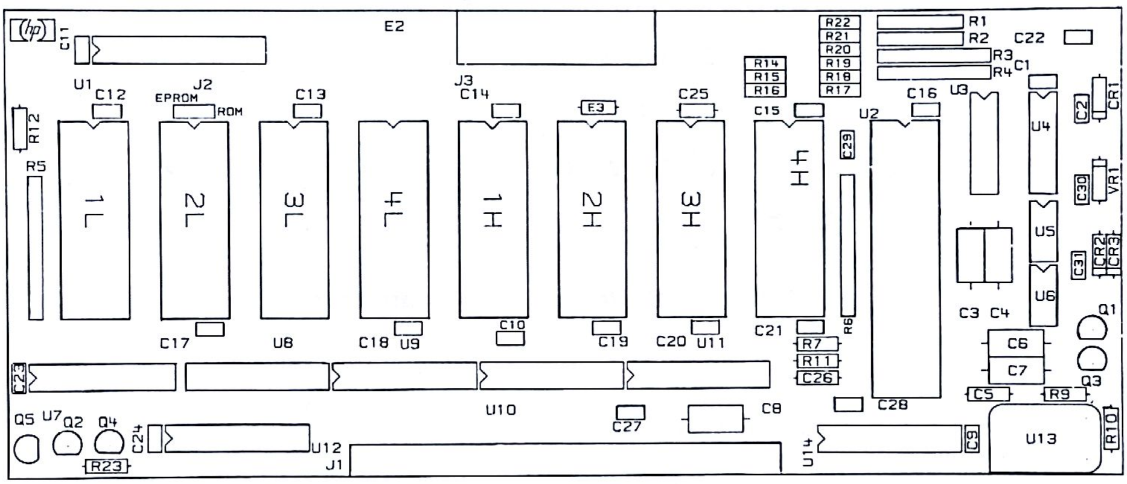


Figure 12-24. SNALink/3270 Software Drawer Component Location Diagram

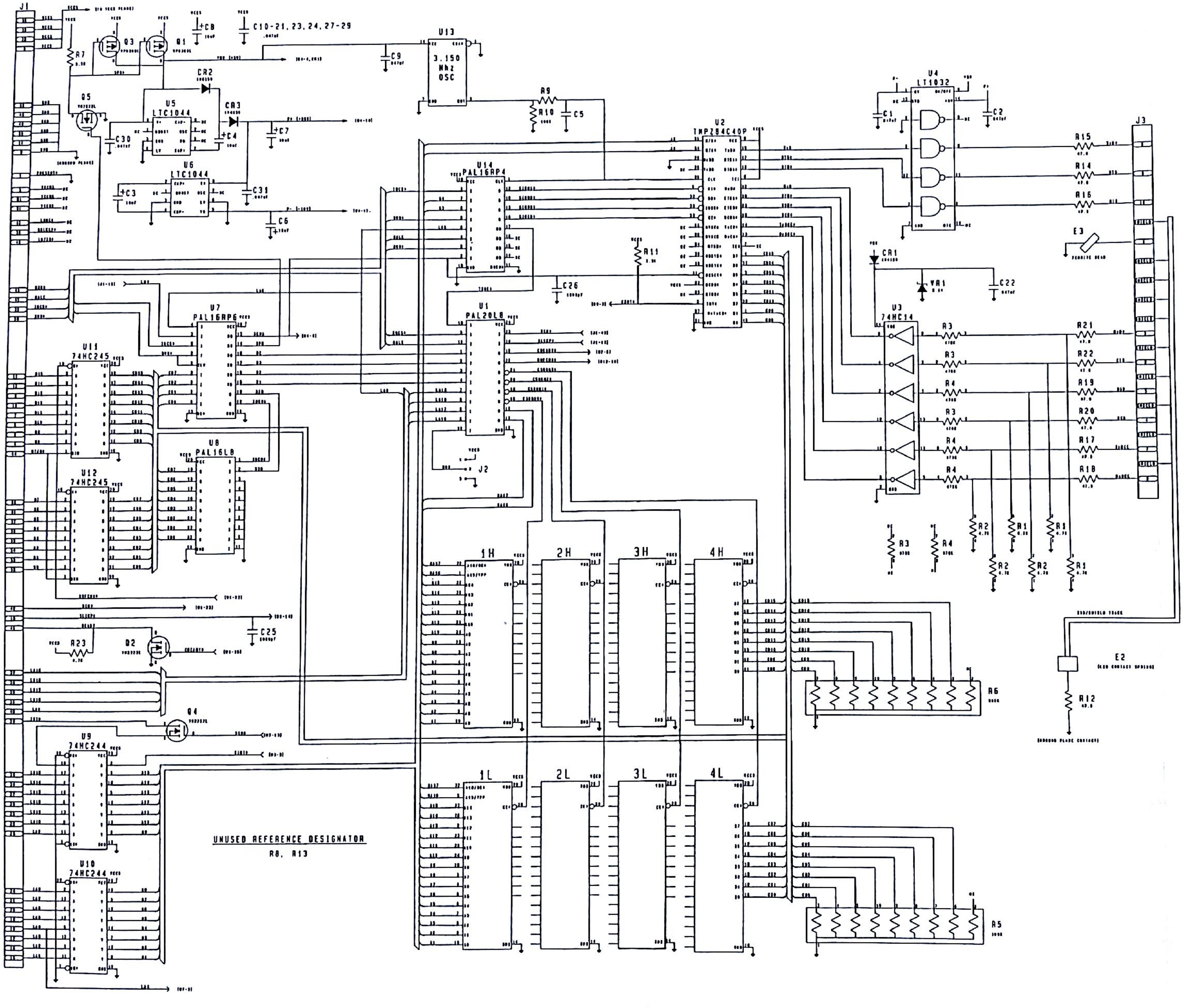


Figure 12-25. SNALink/3270 Software Drawer Schematic Diagram

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