

HP 86A/B Personal Computer



Self-Paced Learning Guide



HP Computer Museum
www.hpmuseum.net

For research and education purposes only.



HP 86A/B Personal Computer Self-Paced Learning Guide

First Edition, 1983

PRINTING HISTORY

New editions of this manual will incorporate all material updated since the previous edition. Update packages may be issued between editions and contain replacement and additional pages to be merged into the manual by the user. Each update will be indicated by a revised date at the bottom of the page. Note that pages which are rearranged due to changes on a previous page are not considered revised.

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.)

First Edition August 1983

NOTICE

The information contained in this document is subject to change without notice.

HEWLETT-PACKARD MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Hewlett-Packard assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Hewlett-Packard.

This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another program language without the prior written consent of Hewlett-Packard Company.

Contents

	Page		Page
Before You Begin This Course _____	iii	Lesson 4	
Materials Needed to Take This Course _____	iii	Disassembly and Reassembly _____	4-1
Standard Repair Tools _____	iii	Overview _____	4-1
Course Description _____	iii	Disassembly Safety _____	4-1
How to Take This Course _____	iv	Special Handling Tips _____	4-1
Course Structure _____	iv	Lab Project 3 _____	4-4
Lesson 1		Lesson 5	
General Theory _____	1-1	Product Troubleshooting _____	5-1
Overview _____	1-1	Overview _____	5-1
Introduction to the HP 86 _____	1-1	An Overview of Troubleshooting _____	5-1
System Components _____	1-3	Lab Project 4 _____	5-4
Main Logic Board _____	1-4	Lab Project 5 _____	5-6
Quiz 1 _____	1-6	Lab Project 6 _____	5-9
		Lab Project 7 _____	5-11
Lesson 2		Lesson 6	
Initial Set-Up _____	2-1	How to Keep It Running _____	6-1
Overview _____	2-1	Maintenance _____	6-2
Safety Guidelines _____	2-1	Alignments and Adjustments _____	6-2
Rear Panel Assembly _____	2-2	Planning for Success _____	6-2
Initial Set-Up Instructions _____	2-3	Elements of a Support Program _____	6-3
Connecting a Display Monitor _____	2-4	Determining Need _____	6-3
Installing and Removing Plug-in Modules _____	2-4	Evaluating Resources _____	6-3
Installing and Removing ROMs _____	2-5	Response Time _____	6-3
Connecting HP 9130A Flexible Disc Drives _____	2-6	Repair Time _____	6-4
Disconnecting Peripherals _____	2-6	Planned Maintenance _____	6-4
Lab Project 1 _____	2-7	Establishing a Measurement Program _____	6-5
Quiz 2 _____	2-9	User Requirements Worksheet _____	6-6
		Resource Analysis Worksheet _____	6-8
Lesson 3		Response Time Analysis Summary _____	6-11
Testing Procedures _____	3-1	Resource Analysis Worksheet _____	6-12
Overview _____	3-2	Uptime Graph _____	6-15
Failure to Power-Up _____	3-2	Uptime Graph _____	6-16
Service ROMs _____	3-2		
Self-Test _____	3-2		
Running a Service ROM Test _____	3-2		
Lab Project 2 _____	3-4		

	Page
Lesson 7	
Interfaces and Enhancements _____	7-1
General Concepts _____	7-1
Disassembly and Reassembly of Modules _____	7-1
Setting Internal Switches _____	7-3
Required Tools and Equipment _____	7-4
Safety Precautions _____	7-4
General Description _____	7-4
Running the Diagnostic Test Programs _____	7-6
HP 82940A GPIO Interface _____	7-6
Troubleshooting Guidelines _____	7-7
HP 82941A BCD Interface _____	7-8
HP 82949A Parallel Printer Interface _____	7-8
HP 82938A HP-IL Interface _____	7-8
HP 82950A Modem _____	7-8
HP 82967A Speech Synthesis Module _____	7-9
HP 82966A Data Link Interface _____	7-9
HP 82907/8/9A Memory Modules _____	7-9
HP 82929A Programmable ROM Module _____	7-9
HP 82928A System Monitor _____	7-10
HP 82900A CP/M® System _____	7-10
HP 82936A ROM Drawer and Enhancement ROMS _____	7-10
Lab Project 8 _____	7-11

	Page
Appendices	
Appendix A—Diagrams _____	A-1
Appendix B—Self-Tests _____	B-1
Appendix C—Problem Chart (not used) _____	C-1
Appendix D—Quiz Answers _____	D-1
Appendix E—Course Completion Summary _____	E-1
Appendix F—Glossary _____	F-1
Appendix G—Bibliography _____	G-1

Introduction

Before You Begin This Course

This self-paced program has been designed to optimize the learning experience for the student with the minimum of special tools and equipment requirements for successful support of the HP 86 and its options and accessories. At the completion of this guide, the technician should have the knowledge to test, troubleshoot, repair, and maintain the HP 86 to the assembly level.

To successfully complete this program you should have:

1. A good understanding of digital electronics.
2. At least one year of experience in digital electronics repair or direct supervision of each course lesson by a person with more than one year of experience in microcomputer repair.
3. A working HP 86A or HP 86B Personal Computer and a display monitor, and an HP 82936A ROM drawer for the entire program.
4. The HP 86 Self-Paced Learning Package (this document) and the required tools and equipment listed on this page.

Materials Needed to Take This Course

The HP 86 Self-Paced Learning Package which includes:

1. This *HP 86 Self-Paced Learning Guide* (35121-90011).
2. The *HP 86A Assembly-Level Service Manual* (00086-90038).
3. The *HP 86B Assembly-Level Service Manual* (00086-90080).
4. The *HP 82937A HP-IB Interface Service Manual* (82937-90013).
5. The *HP 82912A/13A Video Monitor Service Manual* (5957-3338).
6. Final Review Envelope. (Give to supervisor or administrator before beginning course.)
7. System Service ROM (00087-60912).
8. Keycap Extractor Tool (5040-7433).
9. Disc/Printer Service ROM (00086-60904).
10. HP-IB Interface Service ROM (00087-60913).
11. System Service ROM for foreign language versions of the HP 86B (00086-60922).
12. Power Supply Test Connector (00086-60910).

Standard Repair Tools

1. #1 and #2 Pozidriv screwdriver.
2. ¼-inch nut driver.
3. HP 3469B Multimeter (or equivalent).
4. ½-inch nut driver.

Course Description

Products Covered:

- HP 86A Personal Computer.
- HP 86B Personal Computer
- HP 82912A (9-inch) Monitor.
- HP 82913A (12-inch) Monitor.
- HP 82937A HP-IB Interface.
- HP 82939A Serial (RS-232-C) Interface.
- HP 82940A GPIO (8/16-Bit Parallel) Interface.
- HP 82941A BCD (Binary Coded Decimal) Interface.
- HP 82949A Parallel Printer (Centronics) Interface.
- HP 82966A Data Link Interface.
- HP 82950A Modem Interface.
- HP 82967A Speech Synthesis Interface.
- HP 82928A System Monitor.
- HP 82929A Programmable ROM Drawer.
- HP 82900A CP/M® System.
- HP 82936A ROM Drawer.
- HP 00087-15002 HP 86/87 Plotter ROM.
- HP 00087-15003 HP 86/87 Input/Output ROM.
- HP 82908A 64K Memory Module.
- HP 82909A 128K Memory Module.

How to Take This Course

1. Give the sealed Final Review Envelope to your supervisor or administrator.
2. Read each lesson in sequence.
3. Observe all warning notes before attempting the defined procedures!
4. Follow the instructions given before or after each lesson, i.e., Do Quiz 1 Now, Start Lab Project 2 Now, etc. If you correctly answer 8 out of 10 quiz questions (quiz answers are located in Appendix D), continue with the course. If you miss 3 or more of 10 questions, go back and review the lesson and retake the quiz.
5. The Appendices contain a glossary and bibliography. Refer to them as necessary.

When you take this course you will need a basic HP 86 Personal Computer System consisting of an HP 86 mainframe and HP 82912A (9-inch) or HP 82913A (12-inch) Video Monitor. A video monitor is needed to display the results of the tests.

After completing the course, complete the Final Review Package at the end of the guide. If you score less than 80%, review the areas you had trouble with and retake the Final Review.

Optional

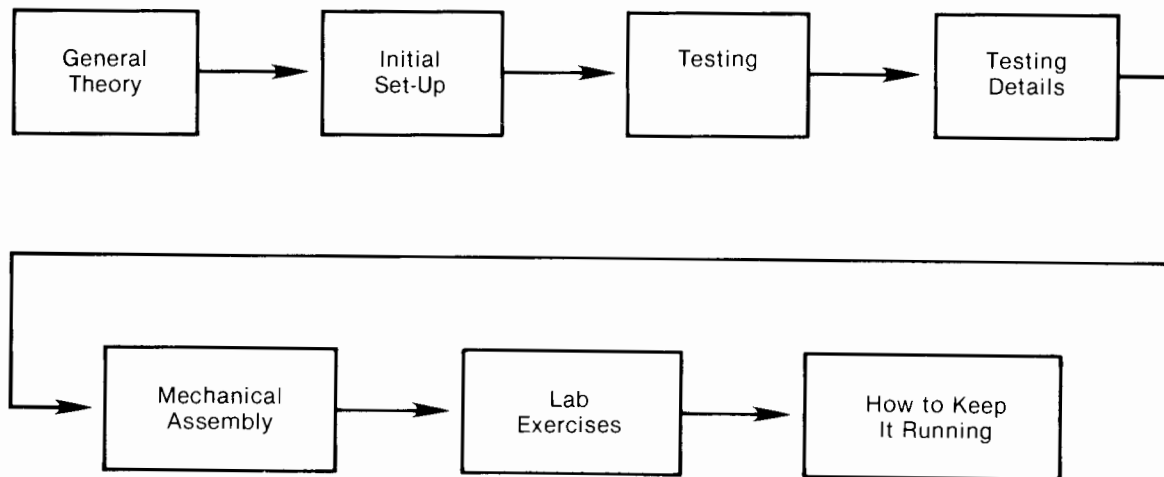
For the lab in Lesson 7, you will need two HP 82937A HP-IB Interfaces, unless you are using an HP 86B, in which case one HP 82937A will be enough. The HP-IB troubleshooting lab was chosen as representative of interface repair procedures. By working with this common module, you will be prepared to read the service manuals for other interfaces and easily troubleshoot and repair them.

Course Structure

The sequence below explains the plan of this self-paced guide. The elements of the flowchart are the major points to be covered to repair the products to the modular (board) level. This guide does not intend to develop good electronics technicians. It is designed to teach good technicians to repair the products covered to the modular level only.

WARNING!

Always remove AC power before opening any electrical device. If the servicing requires that power be on while protective covers are removed, proceed with extreme caution. Be careful not to touch any exposed areas. Failure to do so can result in serious injury. Heed all WARNING—HAZARDOUS VOLTAGE labels.



Course Objectives

- The primary goal of this self-paced guide is to train an individual to repair the products covered in the most direct and efficient manner through logical troubleshooting to the modular level.
- To teach efficient troubleshooting techniques.
- To enhance the technical knowledge on the products covered.
- To train engineers or technicians to service the products through hands-on testing and experimenting.
- This guide will enhance the repair person's technical knowledge and enable the individual to reap greater benefits from Product Training and/or Service Training classes. These classes are designed for more complex hands-on classroom instruction.

NOTICE!

This guide is intended for use by qualified service personnel only. Normal safety precautions must be observed at all times while servicing electronic equipment.

Many Hewlett-Packard products are designed to be easily repaired to the modular level. Hewlett-Packard has used this approach in designing all Series 80 products.

This self-paced learning guide supplies the basic information for modular repair of HP 86A, HP 86B, Series 80 monitors, Series 80 interfaces, and Series 80 enhancement modules and firmware for the HP 86. Operator errors, installation configuration problems, program coding procedures, and data communications problems are areas not covered in detail and are part of other training programs available from HP through Customer Training. Consult your local training catalog for more information.

All the material and information needed to repair the standard product are included in this guide. Please note that variations, options, and accessories to the standard computer are covered in Lesson 7 of this guide. Lesson 7 is optional because not all systems may have the hardware to be tested.

A reference list to supplemental information such as Owner's Manuals, Service Manuals, etc., is included at the end of this guide in the Bibliography.

Course Completion Checklist

HP 86A/B Self-Paced Learning Package

Lesson Title	Date Completed	Time Required	Supervisor's Initials
1. General Theory	_____	_____	_____
2. Initial Set-up	_____	_____	_____
3. Test Procedures	_____	_____	_____
4. Disassembly/Reassembly	_____	_____	_____
5. Troubleshooting	_____	_____	_____
6. How to Keep It Running	_____	_____	_____
7. Interfaces and Enhancements	_____	_____	_____

Program Completion Date _____

Student's Signature _____

Company Name _____

Address _____

Final Review Administered By: _____ Date: _____

General Theory

Lesson 1

Overview

This lesson is an introduction to the design of the HP 86A and HP 86B personal computers. The overall HP 86 system is described from a user's point of view, and then each of the replaceable components is described from a repair technician's point of view. The differences between the HP 86A and HP 86B versions will be covered, so that if you have access to only one of the versions for the self-paced course, you will also be familiar with the other version in terms of its design and method of repair. Although the HP 86 will be repaired only to the modular level, you will find that the detailed description of important areas on the printed circuit assemblies (PCAs) is helpful in isolating failures.

Learning Objectives

After completing the "General Theory" lesson you will be able to:

- Describe the basic design features of the computer.
- Identify each of the replaceable assemblies of the computer.
- Understand the various functional blocks on the logic PCA for the purpose of identifying malfunctions.

Refer to Appendix A-2—Basic Block Diagram.

Introduction to the Series 80 HP 86 Personal Computer

The HP 86 is a low-cost, modular, personal computing system designed for use by scientific and technical professionals. The HP 86A consists of a mainframe with CPU, keyboard, 48K-bytes ROM, 64K bytes RAM, CRT controller, and disc and printer interfaces. The HP 86B has an HP-IB (IEEE-488 standard) interface built-in, instead of the disc and printer interfaces, and 128K bytes of RAM. For both systems, display monitors, disc drives, printers, and other interfaces are ordered separately.

The disc controller of the HP 86A will support two double-sided, double-density 5¼-inch flexible disc drives. Each drive can store 270K bytes of information. Also included in the HP 86A is a built-in parallel printer interface (Centronics).

The HP 86B has neither of these interfaces built-in, but has an HP-IB interface (as does the HP 87) for use with many types of peripheral devices, including disc drives and printers. In addition, the HP 86B is available in 10 different language versions, especially designed to satisfy the European market.

The HP 86 has four I/O slots that allow the user to expand the system with up to 512K bytes of external RAM, plug-in enhancement ROMs, and any Series 80 I/O interface card. The system is fully software compatible with the HP 87.

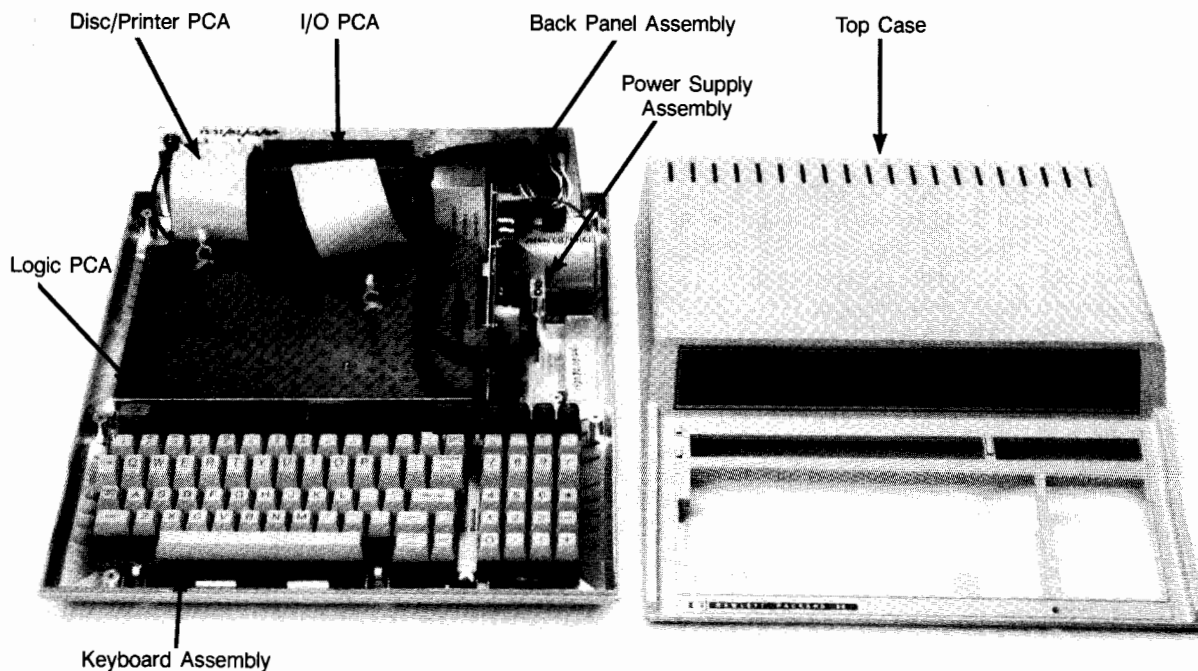
Servicing the HP 86

The HP 86 is designed to be easy to service. Most parts are included in the following assemblies:

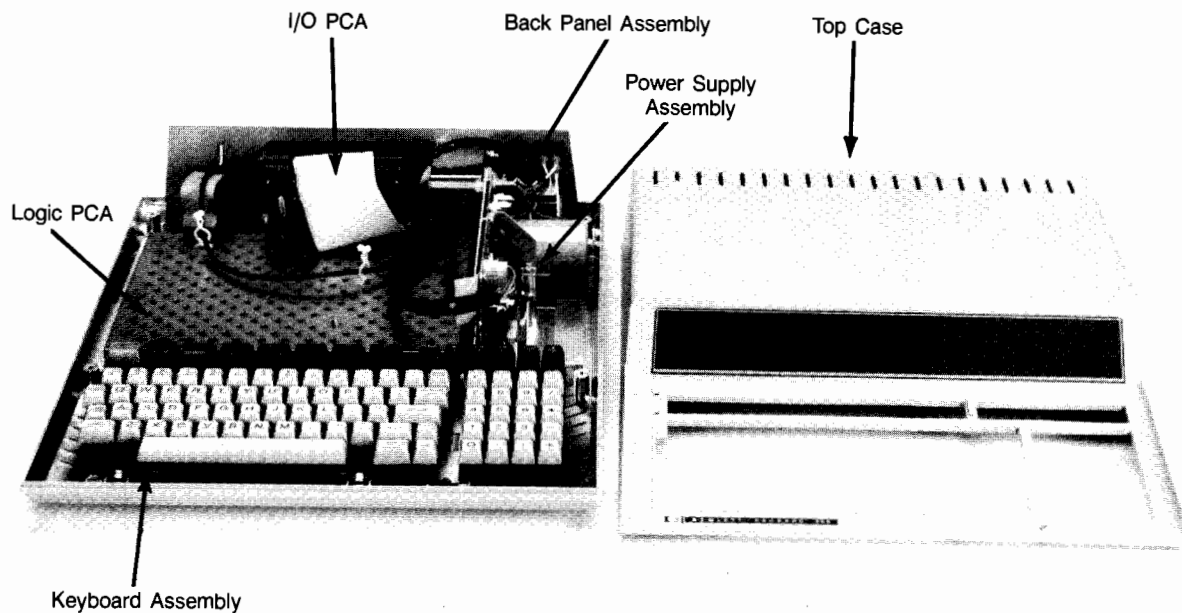
- Logic PCA.
- Power supply PCA.

- Back panel assembly, with I/O PCA and either a disc/prINTER PCA, or an HP-IB connector.
- Top case assembly.
- Bottom case assembly.
- Keyboard.

Also see Appendix A-3 and A-4 Logic PCA.



HP 86A



HP 86B

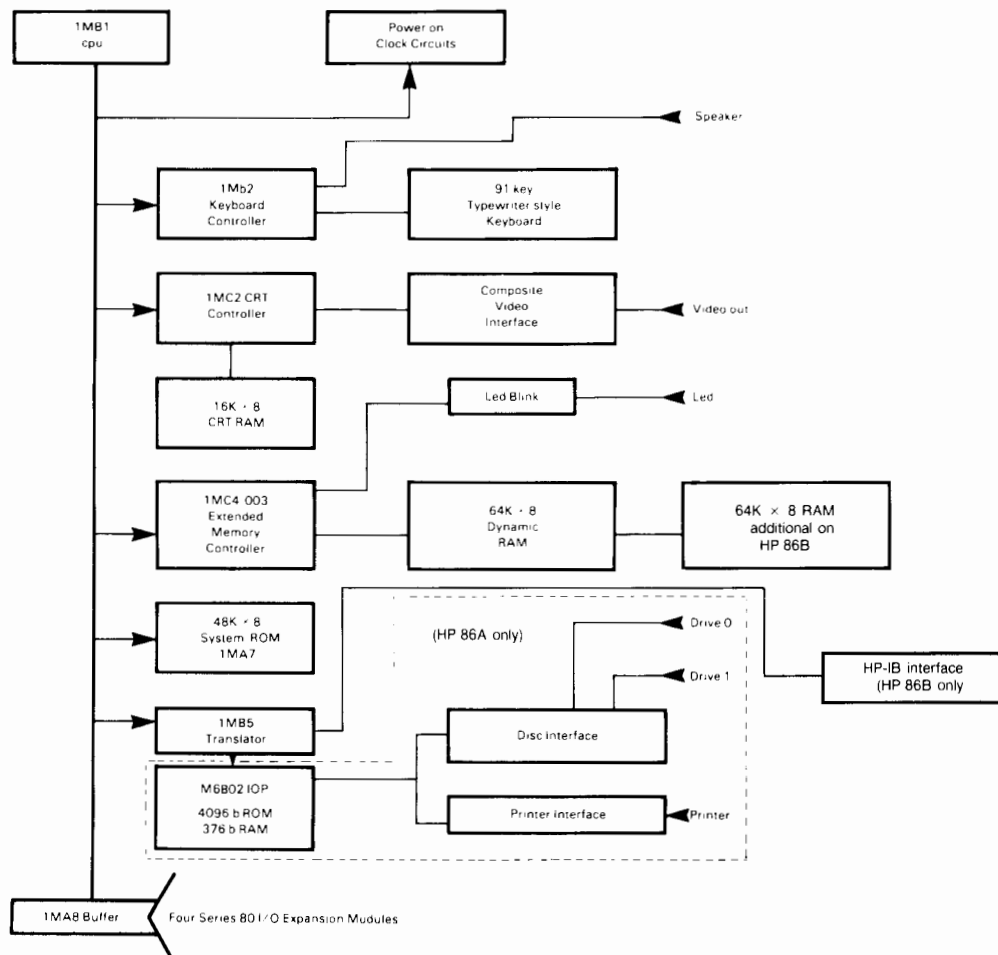
System Components

The HP 86 (see illustration below) consists of:

- The CPU (central processing unit), an 8-bit microprocessor.
- Read-only memory (ROM) containing microprogrammed instructions. The HP 86 has 48K bytes of ROM distributed among six ICs. Foreign versions have an additional 8K bytes of ROM.
- Random access memory (RAM) for storage of user programs and data and the BASIC operating system. The HP 86A has 64K bytes of RAM, which are distributed among eight ICs and accessed through the RAM controller. The HP 86B has 128K bytes of RAM. Approximately 4K of RAM is used for the BASIC operating system.
- A 91-character keyboard which is controlled by the CPU via the keyboard controller. There are 10 language versions for the 86B. The keyboard controller (located on the logic PCA) also provides four timers for use by the operating system and the user.
- A composite video output capable of driving a high-quality monitor to display the program statements and output from running programs.

This output is governed by a separate microprocessor, the CRT controller, with 16K bytes of RAM. An RCA phono connector in the back panel provides easy connection to the monitor.

- HP 86A: A built-in parallel printer interface that adheres to Centronics requirements. An industry-standard connector is provided on the rear panel.
- Four I/O ports for plug-in modules that provide additional memory and functional capabilities; for connecting HP-IB or non-HP-IB peripheral devices such as printers, plotters, etc. An I/O buffer IC interfaces between the CPU and modules or devices plugged into the I/O ports.
- HP 86A: A built-in disc controller circuit capable of supporting two dedicated drives. Two standard connectors are supplied on the back panel.
- A 1 3/4-inch speaker, controlled by the CPU to produce audible tones ("beeps") of variable frequency and duration.
- An 8-bit bus that transfers instructions and addresses between the CPU and the various controllers, the I/O buffer, and the ROMs.
- HP 86B: A built-in HP-IB interface. A standard HP-IB connector is supplied on the back panel.



HP 86 Block Diagram

Main Logic Board

The logic board contains the HP custom-designed CPU. This CPU accesses the system bus that contains the following circuits:

- Keyboard controller—which controls 91 keys and 4 timers.
- CRT controller—which controls 16K bytes RAM and composite video output.
- User RAM—64K on the HP 86A, 128K on the HP 86B.
- System ROMs—with 48K bytes of operating system.
- Disc/printer interface—with one printer and two disc drive connectors on the HP 86A; an HP-IB interface on the HP 86B.
- I/O buffer—interfaces CPU to Series 80 I/O cards.

1. Keyboard

The keyboard assembly is a 91-key matrix keyboard that interfaces directly to the keyboard controller IC on the logic board through two 11-connector flat cables. Besides providing a standard typewriter-style keyboard it also gives the user a numeric entry pad, 14 softkeys with labels, and various special keys for program or cursor control. There are 10 different language versions for the HP 86B, each with its own keyboard layout.

2. CRT Controller

The video output device for the HP 86 is an external monitor. The CRT circuit provides the signal necessary to drive the monitor. The CRT circuit consists of three parts:

- CRT controller.
- 16K bytes of RAM for display storage.
- Composite video driver.

The composite video driver circuit takes the horizontal and vertical pulses from the CRT controller, delays them, and then shapes them to the proper pulse width. The resulting pulses are then added to the video output pulses to form a composite video signal.

3. RAM Memory

The HP 86A contains 64K bytes of read/write memory on the logic board. It comprises eight 64K × 1 memory ICs and a dynamic RAM controller. The 86B contains 128K bytes (sixteen 64K × 1 memory ICs). The logic board also contains circuitry to allow the internal memory to be expanded by the addition of external plug-in memory.

The extended memory system in the HP 86 allows a total addressing space of 1,000K bytes. A practical limitation of 576K bytes is imposed on the 86A by having only four expansion slots for plug-in memory (640K max. on the HP 86B).

4. ROM Memory

The system software is contained in 48K bytes of read-only memory. This is contained in six 8K-byte ROM ICs. Four of these are system ROMs and the other two are actually built-in accessory ROMs. The first three system ROMs remain active all the time, while the fourth system ROM can be switched off and another accessory ROM activated in its place, such as the built-in mass storage ROM, graphics extensions ROM, or any of the plug-in ROMs such as the plotter ROM, the I/O ROM, or the assembler ROM. Foreign language versions have an additional 8K ROM which is bank-switched also. The HP 86B also contains an 8K electronic disc ROM.

To accomplish the bank selection process, all ROMs other than the first three system ROMs are assigned numbers that are actually encoded into the ROMs. When you run the system test programs in Lesson 3 you will receive messages that identify these ROMs by number as follows:

Bank Select ROM Addressing (value stated in decimal):

- 000 system ROM (on logic PCA). (Will actually be identified as "ROM 3" not "XROM 000" during system testing.)
- 001 graphics ROM (on logic PCA).
- 208 mass storage ROM (on logic PCA).
- 024 foreign language ROM (on logic PCA of HP 86B foreign language versions).
- 240 plotter ROM (plug-in ROM).
- 192 I/O ROM (plug-in ROM).
- 040 assembler (plug-in ROM).
- 224 system test service ROM (plug-in ROM).
- 225 disc/printer test service ROM (plug-in ROM).
- 175 matrix ROM 1 (plug-in ROM).
- 176 matrix ROM 2 (plug-in ROM).
- 231 advanced programming ROM 1 (plug-in ROM).
- 232 advanced programming ROM 2 (plug-in ROM).

5. Disc/Printer or HP-IB Interface

HP 86A:

The disc/printer interface provides for communication to a parallel printer and two 9130A disc drives. The interface circuit on the logic PCA consists of a translator IC and an I/O processor (IOP).

HP 86B:

The HP-IB interface conforms to IEEE-488 standards, allowing the interconnection of several peripherals, including mass storage devices, printers, and plotters.

Disc/Printer interface:

The select code of this interface is preset to 7. In effect, the CPU sees a translator chip that looks as if it were an HP-IB interface with a dual disc drive at address 0 and a printer at address 1. This allows the system software to access the discs and printer in exactly the same manner as if they were connected through an HP-IB interface.

The two disc drives that may be connected will appear to the CPU at MSUSs of ":D700" and ":D701". All mass storage operations that can be done with an external dual disc drive can also be done with these.

The printer interface allows the HP 86 to directly drive one 8-bit parallel printer with a Centronics-compatible interface. The printer must be selected by typing:

PRINTER IS 701, (line length, e.g., 80 columns)

in order to be able to print. Attempting to print when there is no printer connected will cause the interface to lock up and require resetting.

HP-IB interface:

The select code of this interface is set to 7. A DIP-switch is mounted on the logic PCA to allow the select code and other device indicators to be modified. The device address is preset to 21, and the HP 86B is set to "active controller".

For both HP 86A and HP 86B:

The internal interface occupies one select code in the I/O space, so care must be taken to ensure that no cards are inserted at the same select code. As a guide, the following are the factory preset select codes and interface IDs (Status Register 0) for several I/O cards:

Interface	Select Code	Interface ID
HP 86	7	6
HP-IB	7	1
RS-232	10	2
GP-IO	4	4
BCD	3	3
HP-IL	5	5
Printer	8	4
Modem	6	2

6. I/O Buffer

The I/O buffer provides isolation between the CPU and the I/O back panel.

STOP!

Complete Quiz 1 now — General Theory.

2. Name five replaceable assemblies in the HP 86.

3. True ____ or False ____? The HP 86A contains 64K of user read/write (RAM) memory for program or data storage, and 16K of CRT RAM on the main logic board; while the HP 86B has 128K of user RAM.

4. Match the following circuits to the printed-circuit assembly on which they are located.

- | | |
|------------------------|------------------|
| Keyboard controller | Logic PCA |
| CRT controller | I/O PCA |
| RAM controller | Disc/printer PCA |
| System ROMs | Power supply |
| Disc/printer interface | Keyboard |
| I/O buffer | HP-IB connector |

5. True ____ or False ____? The HP 86 requires an external mass storage ROM to communicate with a disc drive.

6. True ____ or False ____? The HP 86 requires an external printer ROM to communicate with a printer.

7. True ____ or False ____? The HP 86 has two built-in service ROMs.

8. The disc/printer or HP-IB interface is located at select code _____?

9. True ____ or False ____? The HP 86 is a complete personal computer system and requires no additional peripherals to perform useful computations.

10. How many I/O slots (excluding the built-in disc, printer, HP-IB and video connectors) does the HP 86 have on the back panel _____?

Correct Quiz 1 now using Appendix D.

Initial Set-up

Lesson 2

Overview

This lesson will show you the proper safety precautions and installation techniques to connect the HP 86 to a display monitor and a disc drive, and how to correctly install ROMs and plug-in modules. While the primary emphasis of this course is on troubleshooting and repairing the HP 86 Personal Computer, you will need to know how other system components are attached, in order to run self-test programs and to repair plug-in modules such as the HP-IB interface, the serial interface, and the CP/M system. To run the diagnostic programs, you need to have a disc drive to load the programs and a display monitor to view the results of the tests; therefore, this lesson is required.

Learning Objectives

After completing the "Initial Set-Up" lesson you will be able to:

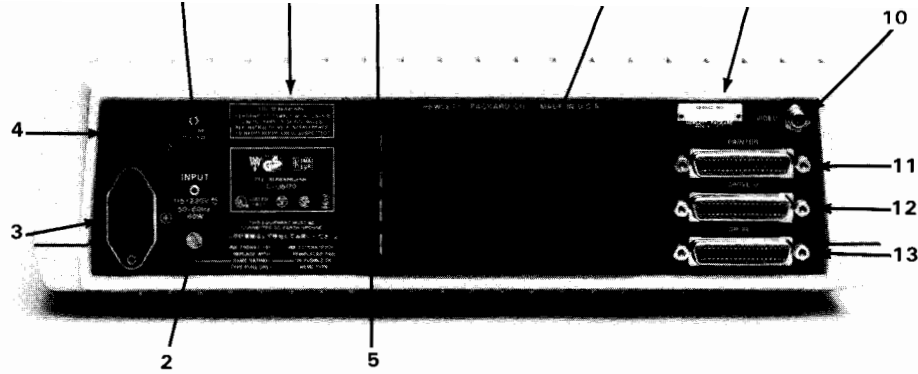
- Safely set up and connect the HP 86A or HP 86B Computer to an HP 82912 (9-inch) or HP 82913 (13-inch) monitor.
- Connect the HP 86A to an HP 9130A single flexible disc drive, or an HP 86B to an HP-IB compatible disc drive system.

- Safely install and remove plug-in modules, and safely install and remove plug-in ROMs.
- Install the HP 86 Service ROMs.

Safety Guidelines

WARNINGS are provided to prevent personal injury during set-up and servicing. **CAUTIONS** inform you of procedures which, if not performed properly, could damage equipment. Read all **CAUTIONS** and **WARNINGS** thoroughly, and strictly observe them.

To obtain an overview of the installation procedure, you should read through this entire lesson before you start to set up an HP 86 system. Then, follow the instructions carefully as you perform Lab Project 1.



Rear Panel

Rear Panel

An understanding of the rear panel layout and features of your HP 86 is essential for safe and efficient operation. Use the photographs above to locate the following features of both HP 86A and HP 86B:

1. Line voltage selector switch.
2. Fuse receptacle.
3. Power cord receptacle.
4. ON-OFF switch.

5. Ground information.

6. Module ports and covers.

7. Serial number plate.

8. Worldwide safety approval nomenclature.

9. RFI (Radio Frequency Interference) compliance statement (applicable in U.S.A. only).

10. VIDEO jack.

Additionally the HP 86A has these features:

11. Printer receptacle.

12. Disc DRIVE 0 receptacle.

13. Disc DRIVE 1 receptacle.

The HP 86B has this feature instead of the above three connectors:

14. HP-IB interface connector.

Grounding Requirements

To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that all class 1 equipment be properly grounded. The HP 86 is equipped with a three-conductor power cable which, when connected to an appropriate power receptacle, grounds the machine. To preserve this protection feature, do not operate the machine from a power outlet that has no earth ground connection.

FUSES

For 110/117 VAC operation

When the voltage selector switch is set 115V, use a 750 mA fuse.

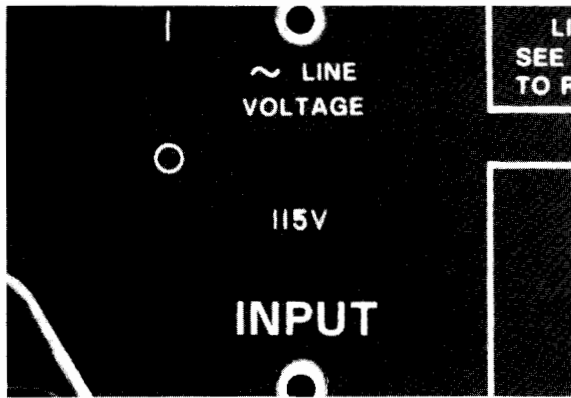
For 220/240 VAC operation

When the voltage selector switch is set to 230V, use a T315 mA fuse.

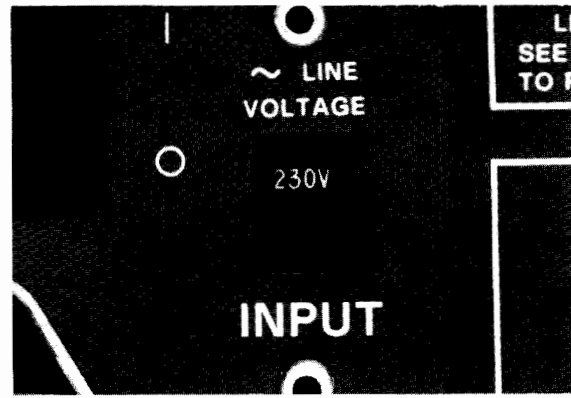
Additional fuses can be ordered from Hewlett-Packard:

750 mA HP part number 2110-0360

T315 mA HP part number 2110-0639



Voltage selector switch in 115V position.



Voltage selector switch in 230V position.

Initial Set-Up Instructions

1. Make sure the power cord is disconnected and that the ON/OFF switch is set to OFF (setting 0; the red "0" on the switch will be visible).

WARNING!

Check the voltage selector switch before applying power. Damage to the computer will occur if the selector switch is set to 115 volts AC and 230 volts AC is applied to the power receptacle.

To avoid the possibility of injury, always disconnect the computer from any AC power source before setting the voltage selector switch.

2. Ensure that the voltage selector switch is set for the nominal line voltage in your area. The computer is shipped with the voltage selector switch in the 230V position. If it is necessary to alter the setting of the voltage selector switch, insert the tip of a small screwdriver into the slot on the switch. Slide the switch so that the position of the slot corresponds to the desired voltage as shown above.

WARNING!

Before installing or removing a fuse, make sure the computer is disconnected from the AC power source. Otherwise, a chance of electrical shock to personnel exists, and the new fuse might be immediately overloaded.

3. Install the appropriate fuse. A 750 mA fuse is required for 115VAC operation; a T315 mA fuse is required for 230VAC operation. To install or replace the fuse, first disconnect the power cord from the machine. Insert the proper fuse in the fuse cap holder; either end of the fuse can be inserted into the cap. Now, install the fuse and fuse cap into the fuse receptacle by pressing the cap inward and then turning it clockwise until it locks in place.

WARNING!

Use only the HP 86 power cord specified by Hewlett-Packard for your area. If it is necessary to replace the power cord, the replacement cord must have the same polarity as the original. Otherwise, a safety hazard from electrical shock might exist, and the equipment could be extensively damaged.

4. Connect the power cord to the power cord receptacle on the back of the computer. Plug the other end of the cord into the AC power outlet.
5. Set the computer ON/OFF switch to ON (setting 1). The amber power light below the keyboard should come on. If the power light is not on, set the ON/OFF switch to OFF and check to see that you've performed steps 2 through 4 correctly. If the power light still fails to come on, the computer requires servicing.

Connecting a Display Monitor

To connect a monitor:

1. Set the computer power switch to OFF. Also, turn the monitor power switch to the OFF position.

CAUTION!

To prevent possible damage to equipment, set the power switches on both the monitor and the computer to OFF before connecting the monitor to the computer.

2. Place the monitor in its operating position, either on top of or beside the HP 86.
3. Plug the monitor power cord into the power receptacle on the monitor and into an appropriate AC power source.
4. If the monitor controls include a switch for changing the impedance, set the impedance to 75Ω.
5. Attach one end of the video cable to the VIDEO jack on the back of the HP 86. Attach the other end of the video cable to the VIDEO input jack on the monitor.



Video Monitor Connector

Turn on the computer and monitor. Within 12 seconds, a cursor (rectangular block) should appear in the upper left corner of the display. When the cursor appears on the screen, the HP 86 is ready for use. If the cursor fails to appear or if it is too pale or too bright, adjust the monitor brightness and contrast controls.

Each time the power is turned on the system performs a self-test. Should the cursor not appear, or if the computer displays "Error 23: SELF TEST," turn the machine off, then on again.

Note: The length of time required by the computer to complete the power-on self-test depends on the amount of user-available memory present. For example, with four HP 82909A 128K memory modules installed, the cursor appears approximately 35 seconds after the power is turned on.

Installing and Removing Plug-In Modules

The four module ports on the rear of the computer are designed to accept a number of plug-in modules. The ports are numbered 1 through 4 from top to bottom. Before shipping, each port is covered with a removable protective cover. It is recommended that ports not in use be kept covered.

WARNING!

Do not place fingers, tools, or other foreign objects into the module ports. Such actions may result in minor electrical shock hazard and interference with pacemaker devices worn by some persons. Damage to module port contacts and the computer internal circuitry may also result.

To install a plug-in module:

1. Turn off the computer and any connected peripheral devices. However, make sure the computer is plugged into a grounded (three-wire) AC outlet.

Note: Most plug-in modules can be inserted into any of the four ports. However, examine the documentation included with each module for any instructions regarding the use of a specific plug-in port. If it is intended that a module fit into a particular port, it must be inserted into that port.

2. Remove the protective cover from any one of the unused ports, keeping the remaining unused ports covered. You do not need to remove any previously installed modules.



Rear Port Plug-in Location

CAUTION!

To ensure proper computer operation and to prevent damage to equipment:

- Always switch off the computer and all peripherals before inserting or removing modules. Use only plug-in modules approved by Hewlett-Packard for the HP 86.
- Do not force a module into a port. The port tracks are keyed to prevent the module from being inserted upside down. Forcing an upside-down module into a port could result in damage to the module and/or the computer.

3. Line up the module with the port opening and gently slide the module into the port. When you feel a small amount of resistance, firmly press the module into the port until the module grips meet the side of the port. A slight side-to-side motion may be necessary to seat the module in the port.



CAUTION!

Do not touch the spring-finger connectors in the ROM drawer with your fingers or insert tools or other foreign objects. Static discharge could damage electrical components.

To remove a plug-in module:

1. Turn off the computer and any connected peripherals.
2. Firmly grasp the module and pull it from the port. Side-to-side motion may be necessary to dislodge the module. When not in use, modules should be stored in their original container or in a box where they are protected from damage.
3. Replace the port cover.



2. Inside each ROM drawer slot are two rows of spring-finger connectors. These connectors correspond to the two rows of holes on the underside of the ROM. ROMs can be inserted in only one direction; insert the ROM into the slot with its label up and its beveled edge toward the connector side of the ROM drawer. Push the ROM into place so that the top of the ROM is flush with the top of the ROM drawer.

ROMs are removed from the ROM drawer by the same procedure used to remove the protective cap (refer to Step 1, above).



Installing and Removing ROMs

To insert a ROM into the ROM drawer:

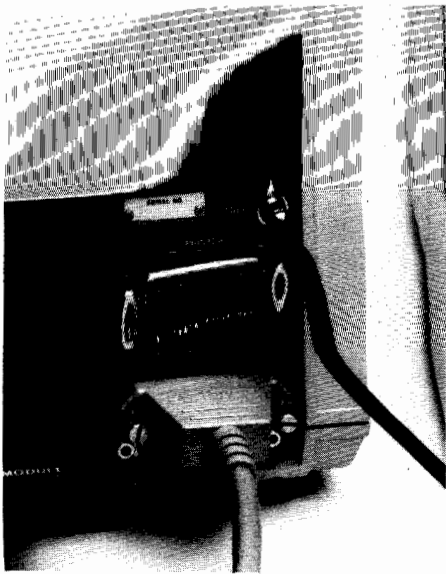
1. Remove the protective cap from the desired slot in the drawer by inserting the eraser end of a pencil into the circular hole on the underside of the ROM drawer and pressing upwards until the cap snaps off. Leave the cap on any slots not in use.

0 receptacle on the rear of the computer. A second unit is connected using the DRIVE 1 receptacle.

CAUTION!

Do not attach a peripheral printer to the DRIVE 0 or DRIVE 1 receptacle. Likewise, do not attach a disc drive unit to the PRINTER receptacle. The PRINTER receptacle will physically accept a disc drive cable connector, and vice versa. However, the computer will fail to power-up properly if the wrong type of peripheral device is connected to a printer/disc interface receptacle, and fuses in the computer and/or the printer can fail.

To connect a disc drive, attach the disc drive connecting cable to the proper receptacle on the rear of the computer. The cable connector fits onto the receptacle only when the connector is oriented properly. Hand tighten the two mounting fasteners on the cable housing.



disc drive. If your system includes two units, attach the label to the front case of the unit connected to the DRIVE 1 receptacle.

Disconnecting Peripherals from the HP 86A

To disconnect a peripheral device from a printer/disc interface receptacle:

1. Turn off the computer and all peripheral devices.
2. Disconnect the peripheral device connecting cable from the receptacle on the computer back panel.

To disconnect peripheral devices attached using optional interface modules, follow instructions in the documentation accompanying the interface.

Connecting Devices to the HP-IB Interface of the HP 86B

Many types of peripheral devices may be connected to the HP-IB interface built-in to the HP 86B, including

disc drives, printers, plotters, and test instruments. Connecting and disconnecting these peripherals to and from the interface built-in to the HP 86B are identical to these processes for a plug-in HP-IB interface, which would be required for an HP 86A.

WARNING!

Connecting and disconnecting HP-IB peripherals to the HP-IB interface connectors while the computer is powered up may cause damage to the computer or the peripheral. Always turn off the computer before installing a plug-in device or attaching an HP-IB device to the HP-IB interface.

STOP!

Do Lab Project 1 first and then complete Quiz 2 — Initial Set-Up.

Lab Project 1

Initial Set-Up

In this lab project, you will perform the preliminary set-up procedures necessary before you can begin product testing. Check off each step as you complete it.

Equipment Required:

- HP 86A or HP 86B Personal Computer.
- HP 9130A Single Flexible Disc Drive or HP-IB compatible disc drive (optional).
- HP 82912 (9-inch) or HP 82913 (12-inch) Monitor.
- HP 82936A ROM Drawer.
- HP 00087-60912 System Service ROM (Mainframe Tests) for the HP 86A and English 86B, and 00086-60922 for the HP 86B (foreign version).
- HP 00086-60904 Interface Service ROM (Disc/Printer Interface Tests) for the HP 86A.
- HP 00087-60913 HP-IB Service ROM for all versions of the HP 86B.

Start now.

- ___ 1. Collect together the equipment you'll need and set up your work area in a clean, uncluttered area. Be sure to have a grounded (three-wire) power supply available, and be sure to have a properly grounded wrist strap available for handling electronic assemblies.

Do not connect or power-on any of the devices until you've read through all the instructions first.

- ___ 2. On the rear panel of the HP 86 locate the following features:
- ___ Line voltage selector.
 - ___ Fuse receptacle.
 - ___ Power cord receptacle.
 - ___ ON-OFF switch.
 - ___ PRINTER receptacle (HP 86A).
 - ___ Disc DRIVE 0 receptacle (HP 86A).
 - ___ Disc DRIVE 1 receptacle (HP 86A).
 - ___ HP-IB interface connector (HP 86B).
 - ___ Ground information.
 - ___ Module ports and covers.
 - ___ Serial number plate.
 - ___ RFI (Radio Frequency Inteferece) compliance statement.
 - ___ Video jack.
- ___ 3. Check the voltage selector switch. Set it to the proper voltage for your area.
- ___ 4. Check the fuse. If it's not the right fuse for the voltage in your area, change it.
- ___ 5. Install the service ROM(s) into the ROM drawer.
- ___ 6. Install the ROM drawer into one of the I/O ports.
- ___ 7. Plug the HP 86 power cord into the power receptacle on the back panel of the computer and into an appropriate AC power source.

- Ground information.
 - Serial number plate.
 - Identification/safety approval label.
- ___ 9. Check the line voltage requirements for the monitor as described on the back label. Option 001 monitors require 230 volts AC.
- ___ 10. On the front of the monitor locate the following features:
- On-off-volume control.
 - Brightness control.
 - Contrast control.
- ___ 11. Place the monitor in its operating position, plug in the power cord, and connect the video cable from the computer video connector to the VIDEO-IN connector on the monitor.
- ___ 12. For the HP 86A, place the disc drive in its operating position and attach the disc drive connecting cable to the DRIVE 0 or DRIVE 1 receptacle on the rear of the computer. For the HP 86B, attach an HP-1B flexible disc drive to the HP-1B interface connector on the rear of the computer.
- ___ 13. Hand tighten the two mounting fasteners.
- ___ 14. Turn on the monitor. Turn on the computer. When the cursor appears on the screen, the HP 86 is ready for use.
- ___ 15. Ignore the messages that appear on the monitor display (they'll be explained in Lesson 3), and adjust the monitor brightness and contrast controls.
- ___ 16. Turn off the computer and monitor and leave the system set up for Lab Project 3 in Lesson 3.

Closed Book Quiz 2

Score 10 points for each correct answer.

1. True ___ or False ___? The primary concern of hardware personnel repairing electronic equipment is safety.
2. Describe the difference between CAUTIONs and WARNINGs.

3. True ___ or False ___? The computer will not be damaged if 230V are applied while the voltage selector is set to 115V.
4. True ___ or False ___? The same specification fuse is recommended for both 230V and 115V operation.
5. When connecting peripherals and plug-in modules to the computer, power to the computer and devices should be ___ ON or OFF ___?
6. The impedance setting for the video monitor should be set to high ___ or 75 ohms ___?
7. Without the service ROMs installed, what does the system do each time power is cycled on the computer?

8. True ___ or False ___? Adding enhancement modules to the computer does not affect the time it takes to perform the power-on self-test.
9. True ___ or False ___? Never plug the HP 86 or any of its peripherals into a grounded (three-wire) outlet.
10. How many different service ROMs are used to troubleshoot all HP 86 (A or B) computers _____?

Correct Quiz 2 now using Appendix D.

Product Test Procedures

Lesson 3

Overview

This lesson explains the tests provided by the service ROMs. These tests are used to diagnose failures of the logic PCA, plug-in RAM modules, plug-in ROMs, the keyboard, and the monitor. All the test programs can be run under control of the service ROM(s), or under the control of the BASIC system. Under control of the BASIC system, tests can be run individually, or grouped in a BASIC program. In Lab Project 2 you will run most of the test routines in the service ROM(s).

In order to run service ROM tests and/or the computer self-test, the computer must power-up properly. Failure to power-up properly can be caused by a variety of malfunctions. Lesson 5 includes the procedures to follow to isolate the problem causing the failure to power-up. Lesson 5 also includes additional troubleshooting and testing procedures for the disc and printer interface, (86A), and HP-IB interface, (86B), keyboard, and power supply.

Learning Objectives

When you've completed Lesson 3, you should be able to:

- Verify that the computer is operating properly using the computer self-test and the service ROM tests.
- Identify malfunctions that must be corrected before the service ROM tests can be run.
- Understand the messages that are obtained during the service ROM tests if components or assemblies are not operating properly.
- Run test procedures to identify malfunctions of the logic PCA, keyboard, and monitor.

CAUTION!

The top case of the computer should not be removed until Lesson 4, "Product Disassembly and Assembly." You should not attempt to fix any problems you discover until you've completed Lesson 4.

Service ROMs

Troubleshooting the HP 86 is greatly facilitated by the use of the service ROMs. Tests provided in these ROMs enable you to check for proper operation of the principal circuits of the HP 86.

One of two System Service ROMs is used, depending on the language version. Both System Service ROMs contain the following tests:

Table 3-1

Test	Key	Command
System	A	SYSTEM
CPU	B	CPU
RAM	C	RAM
ROM	D	ROM
Beeper	E	BEEPER
CRT	F	DISPLAY
Timer	J	TIMER
Key	K	KBD
External RAM	L	XRAM
External ROM	M	XROM
Heat	N	HEAT X
Focus Pattern	O	FOCUS
Pincushion Pattern	P	PATTERN
QA	Q	QA X
Raster Screen	R	
Cycle	V	CYCLE

The Disc/Printer Interface ROM contains two tests:

Test	Key	Command
Printer	H	PRINTERTEST
Disc	I	DISC

The HP-IB Interface Service ROM contains two tests:

Test	Key	Command
Short HP-IB	H	HPIBx*
Long HP-IB	I	HPIBy

*For these tests "x" must be an odd integer, "y" must be even.

Although any of the tests in a service ROM can be run individually, most of the tests are run automatically as part of the system test.

The system test, which incorporates several individual tests, is the basic test you should use to begin assembly-level troubleshooting of an entire computer. Even when you know that there is a problem in a particular circuit checked by an individual test, you should first run the entire system test. The first few tests in the system test check components that could cause operating problems in the assemblies checked by subsequent tests. You may run an individual test alone in the following circumstances:

- You have replaced a component or assembly that the system test indicated was bad, and you want to verify, without running the entire system test again, that replacing the component or assembly has corrected the problem.

Self-Test

The HP 86 performs a self-test each time the computer is switched on. This test does a simplified version of the ROM test and portions of the RAM and keyboard tests. The CPU, CRT, and timers are not checked. If the computer is switched on with the system service ROM installed, the ROM takes control immediately, and the self-test is not done until control is returned the BASIC system. At that time—if a problem is found—the computer beeps twice, and the message ERROR 23:SELF TEST is displayed. If the self-test is completed successfully, only the cursor appears on the display.

The self-test executed by pressing the TEST key is identical to that performed when the computer is switched on, except that if the test is completed successfully, a line of characters is displayed at the end.

Running a Service ROM Test

When an HP 86 with the service ROMs installed is turned on, control is passed to the service ROMs. The following messages should be displayed:

```
{CPU OK}
{RAM OK}
{2RAM OK}
{EMC OK}
{ROM 0 OK}
{ROM 1 OK}
{ROM 2 OK}
{ROM 3 OK}
{XROM 001 OK}
{XROM 208 OK}
{XROM 224 OK}
{XROM 225 OK}
{PRINTER INTERFACE TEST}*
{PRINTER STATUS=xxxxxx}*
{SERVICE ROM: SELECT TEST A-V}
```

If you press one of the keys A through V within 15 seconds after the messages appear, the service ROMs should perform the corresponding test listed in Table 3-1.

Note: Refer to the "No-Turn-On" section of Lesson 5 for troubleshooting procedures in any of the following circumstances:

- The Service ROM message does not appear within 15 seconds after the computer is switched on.
- A NO KEY! or KEY STUCK! message appears 15 seconds after the Service ROM message appears.
- Pressing a key has no result within 15 seconds after the Service ROM appears.
- Pressing a key results in the wrong test.

*The printer tests will not be performed for the HP 86B; instead, an HP-IB status message will be displayed. The printer status message (for the HP 86A) should be 011111 with no printer installed.

When the selected test is completed, the Service ROM message appears again, and you can then run any Service ROM test by pressing the corresponding key.

Note: If you press the W key within 15 seconds after the Service ROM message appears, the computer will wait indefinitely for you to press another key.

If you press any key other than those listed in Table 3-1, control will be passed to the BASIC system. (The space bar is a convenient key to press if you want to return to the BASIC system.) When this happens, the message RETURN TO BASIC SYSTEM is momentarily displayed (followed by a character that indicates which key was entered). After a few seconds the cursor appears in the display. The cursor signifies that the BASIC system is in control.

If no key is pressed within 15 seconds after the Service ROM message appears, the computer will beep, the messages NO KEY! and RETURN TO BASIC SYSTEM are momentarily displayed, then the cursor appears in the display. If a key is not released (or a key is struck) within 15 seconds after the Service ROM message appears, the messages KEY STUCK! and RETURN TO BASIC SYSTEM appear in the display.

Whenever the BASIC system is in control (as signified by the presence of the cursor on the CRT), you can select any test by typing in the corresponding BASIC command listed in Table 3-1, followed by END LINE.

This capability enables you to write and run a BASIC program that automatically runs and repeats a test or group of tests from the service ROMs. For normal testing and troubleshooting it is more convenient to run the test under the direct control of the service ROMs.

Running a BASIC program—including a program that contains BASIC commands from the service ROMs—requires that the CPU, ROM, and RAM are OK. Therefore, do not run a test using a BASIC command until you have control of the service ROMs.

If you want to run a BASIC program that automatically runs and repeats a test or group of tests from the service ROM, do not include the keyboard test, or the disc test, (or the system test, which incorporates these tests) in your program. These tests require interaction from the user.

STOP!

Do Lab Project 2 now—Test Procedures.

Lab Project 2

Test Procedures

In this lab project, you will run the service ROM tests listed below. The objective of this lab is to know the different tests that are available with the service ROMs, and to understand how they are run from both the control of the service ROMs, and from the control of the BASIC system.

- Self-Test.
- Power-on Test group—CPU, RAM, ROM, External ROM, and Printer Interface.
- Timer Test.
- ROM Test and External ROM Test.
- RAM Test and External RAM Test.
- Keyboard Test.
- CRT Test.

The Printer Interface Test, Disc Interface Test, HP-IB Tests, and System Test are covered in the Troubleshooting Labs of Lesson 5.

If any of the tests return a message indicating that a part or assembly is not operating properly, do not attempt any repairs until you complete the entire course.

Equipment required:

- HP 86A Personal Computer.
- HP 82912 (9-inch) or HP 82912 (12-inch) Monitor.
- HP 82936A ROM Drawer.
- HP 00087-60912 System Service ROM for the HP 86A and English version HP 86B; use HP 00086-60922 for foreign versions of the HP 86B.

Optional—

- HP 00086-60904 Disc/Printer Interface Service ROM.
- HP 00087-60913 HP-IB Service ROM.
- HP 00087-15003 HP 86/87 Input/Output ROM.
- HP 82908A 64K or HP 82909 128K Memory Module.

Proceed with the lab project by completing each step in sequence.

Start now.

Self-test

- ___ 1. If you have not done so already, set up your HP 86 computer system as described in Lab Project 1 of Lesson 2.

- ___ 2. With the computer turned off, remove the ROM drawer containing the System Service ROM and the Interface Service ROM. Power-on the computer and run the self-test by holding down the SHIFT key and pressing the TEST key.

Describe what happens during the Self-Test.

___ 3. If the self-test was successful, which of the following components or assemblies have successfully passed the test?

- ___ Disc/printer PCA
- ___ I/O PCA
- ___ Power supply
- ___ Logic PCA
- ___ Keyboard

- ___ ROM drawer
- ___ Service ROMs
- ___ Speaker
- ___ Monitor
- ___ Power light

___ 4. Turn the computer off, install the ROM drawer with the system service ROM (and interface service ROM—optional), and then power-on the computer. Press the W key after the printer interface test completes.

___ 5. List by name, key, and command the test that the service ROMs perform after the computer is powered on.

Name	Key	Command
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

___ 6. Press the space bar to return to the BASIC operating system. From BASIC, issue the commands listed in column three above, for example, type in CPU and press the END LINE key.

___ 7. From control of the BASIC system, enter and run the following program.

```
100 FOR I=1 TO 5
200 BEEPER
300 CPU
400 RAM
500 NEXT I
600 END
```



___ 8. Cycle power-on the computer (i.e., turn the power switch from ON to OFF and back to ON again), and when the power-on tests are completed press the W key to put the service ROMs in a wait state.

___ 9. From column two of Step 5, request each test by letter. Return to BASIC by pressing the space bar.

___ 10. Run the Timer Test by pressing the J key if the service ROMs are in control, or typing in TIMER if the BASIC system is in control.

ROM Test and External ROM Test (Optional)

The ROM Test checks the system ROMs by performing a signature analysis on their contents. The ROM contents are treated as data; the test manipulates this data and checks for the correct results.

The External ROM Test checks the internal mass storage ROM and the internal graphics ROM, and any plug-in enhancement ROMs by performing a signature analysis on their contents. This check is performed in the same way that the ROM Test checks the system ROMs.

If you are checking the internal ROMs, turn off the power to the computer, remove all ROMs except the service ROMs from the ROM drawer, and insert the ROM drawer into one of the module ports on the back panel. However, if you are checking an external ROM, install it in the ROM drawer along with the service ROMs.

- ___ 11. Run the ROM Test.
 - ___ 12. Run the XROM Test.
 - ___ 13. Turn off the computer, install the HP 86/87 I/O ROM, turn on the computer, and run the XROM Test again. Describe your observations:
-
-

RAM Test and External RAM Test

The RAM Test checks the RAM controller IC and the first 32K addresses of RAM ICs by filling them with alternate ones and zeroes and reading back the results to see if the contents have been changed. If an error is found in one bit or only a few bits at a particular address, the message will indicate that the corresponding RAM IC is bad. If an error is found in all eight bits at a particular address, the message will indicate that the RAM controller is bad.

The RAM test also checks the extended memory controller (EMC), and an error message is displayed if it is bad.

When run under control of the service ROMs, this test checks the address register in the RAM controller. When run under the control of the BASIC system, the address register is not checked, since doing so would not allow you to continue using the BASIC system.

In order to check all memory addresses, the XRAM Test must be run. The External RAM Test checks the RAM controller IC, the higher-address internal RAM chips (from 32K to maximum contained internally), and the RAM chips contained in the HP 82907A/8A/9A Memory Modules. The check is performed in the same way that the RAM Test checks the internal RAM controller and ICs.

As with the RAM Test, the XRAM Test performs a more complete check when run under control of the service ROMs than under control of the BASIC system.

The XRAM Test returns messages of the type:

```
XRAM OK THRU 00XXX  
XRAM BAD! 00XXX
```

where XXX is a multiple of 32. There is 64K of user RAM in the HP 86A, but the first 32K is in the primary address space and is tested by the "internal" RAM test, while the second 32K is in the extended memory address space and is tested by the "external" RAM test. A value of 032 for XXX indicates 32K of RAM that is on the HP 86A logic PCA, while values of 64, 96, 128, etc., indicate successive blocks of 32K of RAM beginning with the plug-in RAM modules from the top port to the bottom port.

Since there is 128K of user RAM in the HP 86B, the upper 96K is tested by the "external RAM test". A value of 096 for XXX indicates 96K of internal RAM. Plug-in RAM modules are numbered 128, 160, etc.

- ___ 14. Run the RAM Test.
- ___ 15. Run the XRAM Test.

Optional

- ___ 16. Turn off the computer, install a plug-in memory module, turn on the computer, and run the XRAM Test again. Describe your observations:
-
-

Keyboard Test

Since the keyboard test uses the computer ROM and RAM, do not run the keyboard test alone unless the computer has already passed the CPU, ROM, and RAM tests. If the keyboard test is run with a bad ROM or RAM IC, the computer may appear to "go dead" during the test.

The keyboard test requires you to press certain keys. In particular, at certain times you will press and hold the CTRL or SHIFT key while the next key or keys are pressed. The same is true for the CAPS LOCK key, (CAPS key for foreign version) except that you need not hold it. The service ROM will prompt you with messages indicating whether these keys are to be down or up while pressing the next key or keys.

17. Before you begin the following test, make sure that the CTRL and SHIFT keys are not pressed and that the CAPS LOCK or CAPS key is released to the same level as the other keys. If this is not done, the results of the test will be invalid.
- ___ 18. Begin the keyboard test. Press the K key if the service ROM is in control, or type in KBD if the BASIC system is in control.

Follow the directions of this test until you reach the point where the test displays SHIFT DOWN; PRESS KEYS. For this test you must hold down the SHIFT key and press all the keys of the keyboard beginning with the upper leftmost key, KEY LABEL, and proceed from left to right one row at a time.

To simulate a bad key, press a key out of sequence. For example, the test expects A S D F G in order; instead, press the A, S, and X keys and see what happens.

CRT Test

The service ROMs contain four tests that can be used to troubleshoot the video driver circuitry: the CRT test, the focus pattern, pincushion pattern, and the raster test.

The CRT test is a combined test; it checks the CRT controller IC and the CRT RAM ICs, and also causes the monitor to display various test patterns. By checking whether each pattern is displayed correctly, you can determine whether the rest of the circuitry is operating properly.

The focus pattern, pincushion pattern, and raster tests are subsets of the CRT test and merely display the focus, pincushion patterns, and a full white screen, respectively.

- ___ 19. Open the *HP 86 Service Manual* to the CRT Test Patterns in Section II (pages 2-49 through 2-51).
- ___ 20. Run the CRT Test. Press the F key if the service ROMs are in control, or type in DISPLAY from BASIC.
- ___ 21. Compare the patterns in the manual to the patterns on the display.
 - ___ Test Pattern 1 (vertical bars)
 - ___ Test Pattern 2
 - ___ Focus Pattern (Bs and Js; Test Pattern 3)
 - ___ Pincushion Pattern (Test Pattern 4)

Disassembly and Assembly

Lesson 4

Overview

This lesson describes how to access, remove, and replace the major assemblies of the HP 86 and the parts of the top and bottom case.

Learning Objectives

After completing the "Disassembly and Assembly" lesson you will be able to:

- Safely disassemble the computer to the modular level.
- Assemble the complete computer.
- Remove and replace all of the modules.

Fold out the exploded views of the HP 86, Keyboard, and Back Panel in Appendix A. Having the exploded views available will be helpful in identifying parts.

Disassembly Safety

Read through this section before attempting to disassemble the computer or start the lab.

WARNING!

Line voltages are exposed when the top case of the HP 86 is removed. Electrical and mechanical failures may cause dangerous voltages to be present at points that normally are safe.

Observe the following safety guidelines while working on an HP 86:

- Do all possible operations with the computer turned off and the power cord unplugged.
- NEVER WORK ALONE. Be familiar with the location of power switches in your service area and what they control.
- In case of an accident, know where to obtain respiratory resuscitation and/or cardiopulmonary resuscitation (CPR).
- Keep your work area neat and free of nonessential conduction material or sharp objects. Remember that reaction to an electrical shock can make you strike nearby objects, which could result in serious injury.

Refer to Appendix A-1—Exploded view.

Special Handling Tips

CAUTION!

Ensure that the bench set up for troubleshooting and repair has adequate electrostatic protection; otherwise, ICs may be damaged. Wear a properly grounded conductive wrist strap to protect ICs from damage.

If ribbon cables are not inserted properly into their connectors, components could be damaged.

Removing and Tightening Screws

The main tools you will need to remove and replace major HP 86 assemblies are two Pozidriv screwdrivers #1 and #2, and a ¼-inch nut driver. All screws used in the HP 86 have Pozidriv heads, not Phillips heads. Although Phillips screwdrivers will work, they can easily strip the screw heads. Pozidriv screwdrivers require much less effort to remove and insert screws.

Due to the nature of the plastic used in HP 86 parts, the threads in screw holes can easily be stripped if you overtighten the screws. All screws should be tightened only until they feel snug; if you strip the threads by overtightening the screws, you will have to replace the part. Also, try to engage screws (especially small screws) in the original threads; if a screw cuts new threads, they can be easily stripped.

Cable Interconnections

The HP 86 assemblies are electrically connected with two types of ribbon cable. The first type is used to connect the keyboard assembly to the logic PCA and has thin metallized-film connectors that must be handled with extra care. The second type of cable is terminated in pin connectors that require no more than normal special handling.

Special Handling for Keyboard Assembly Cables

These ribbon cables can be connected and disconnected with your fingers; no special tool is required.

However, if you insert a cable into its connector without properly aligning it first, it will not make the proper electrical connection. Furthermore, it will be very difficult to remove the cable, and doing so may damage it.

Connecting a Cable

When repairing the computer, if you notice that the contacts of a cable are split, have come loose from their backing, or otherwise have deteriorated, use a new cable when you reassemble the computer.

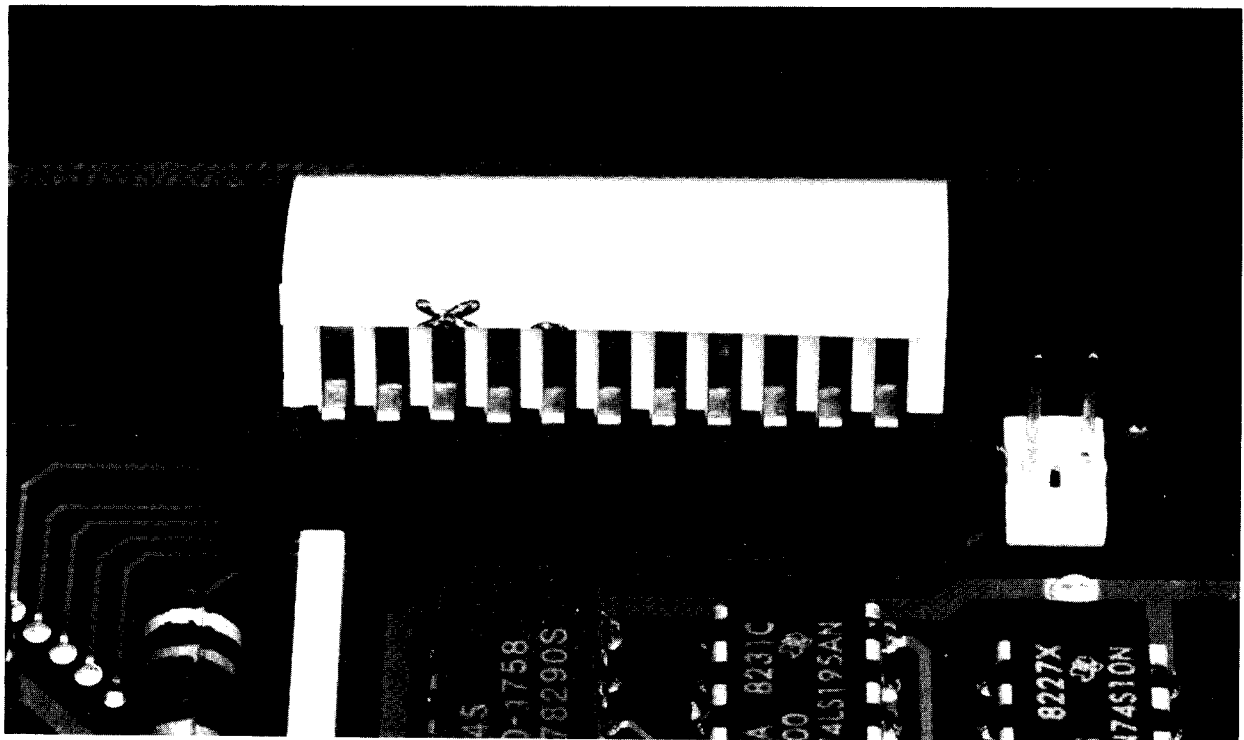
To connect a cable properly

Carefully align the contacts of the cable with the contacts of its connector, as shown below:

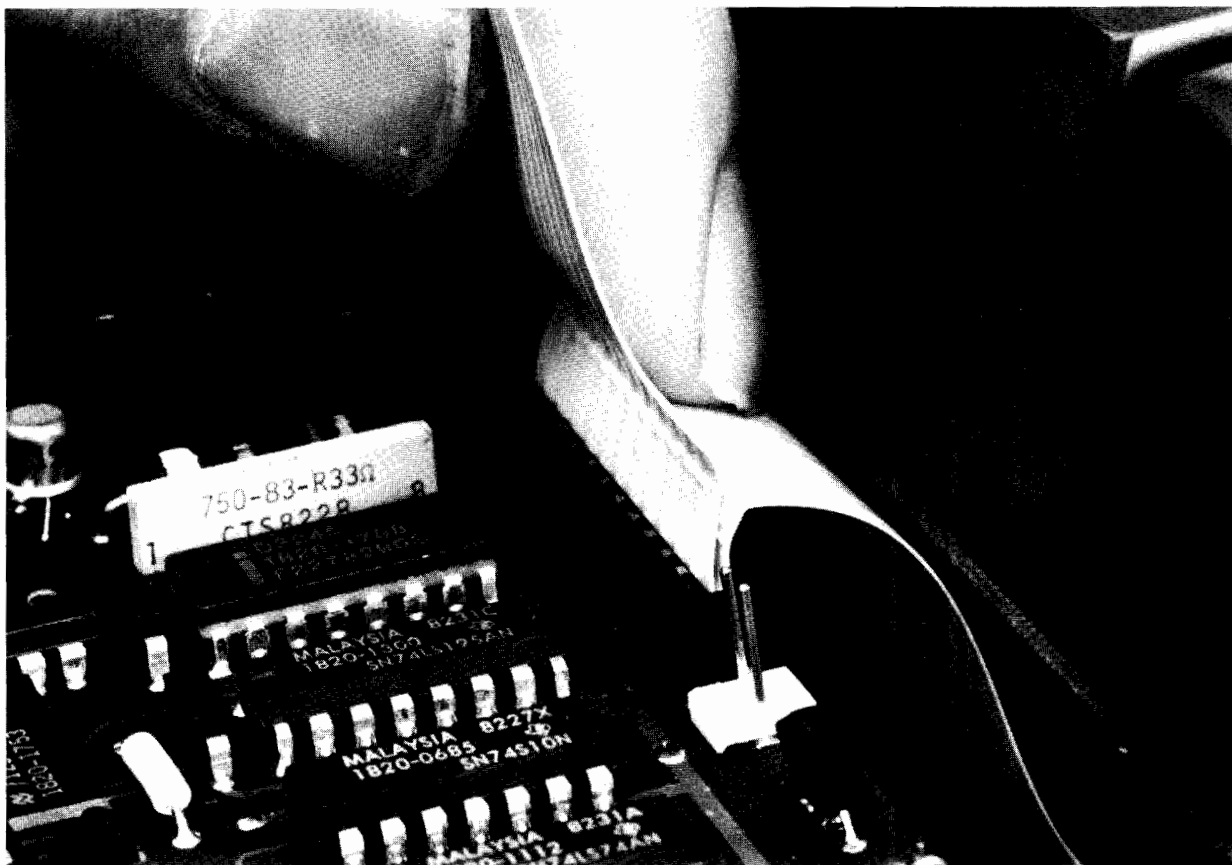
NOTICE!

If alignment is done improperly, the HP 86 ICs and power supply will be destroyed.

- Press the end of the cable into the connector gently but firmly.
- Make sure that the cable contacts are properly aligned with the connector contacts and that neither edge of the cable is folded over. The figure below shows a cable connected properly.



Aligning Cable Contacts



Removing a Trapped Cable

Removing a Trapped Cable

To remove an improperly connected cable from its connector:

- Insert a spare cable of the same type and width into the connector between the trapped cable and the connector contacts as shown below. The contacts of

the spare cable should face the contacts of the trapped cable, not the contacts of the connector.

- Pull the two cables together out of the connector.

STOP!

Do Lab Project 3 now — Disassembly/Reassembly.

Lab Project 3

Disassembly/Reassembly

TASK: In this exercise you will separate the two cases of the computer and remove all of the major assemblies. Then you will reverse the procedures to reassemble the computer.

OBJECTIVES: The objectives of this exercise are to know disassembly procedures and safety precautions for removing replaceable assemblies from the computer and to know the special handling techniques for connecting and disconnecting ribbon connectors.

Equipment Required:

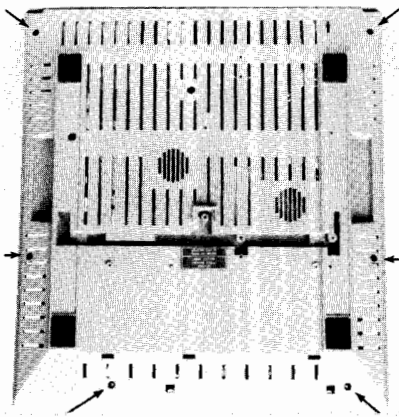
- HP 86A or HP 86B Personal Computer.
- #1 and #2 Pozidriv screwdrivers.
- ¼-inch nut driver.
- ½-inch nut driver.

Proceed with the lab exercise by completing each step in sequence as given.

Start now.

Separating the Top Case from the Bottom Case

- ___ 1. Disconnect the power cord from the back panel.
- ___ 2. Remove any plug-in modules from the I/O ports and any peripherals from the printer or disc ports. Disconnect the video cable.
- ___ 3. Remove the six screws in the bottom case after turning the computer over on its top case. Be careful not to damage the video connector if you need to set the computer on its back panel.
- ___ 4. Separate the front of the top case from the front of the bottom case. To do so, turn the computer back over and place your thumbs on the front edge of the top case. Push upward until the cases separate slightly.
- ___ 5. Lift the top case off of the computer. To do so, place your hands on the sides of the top case and lift it straight up.



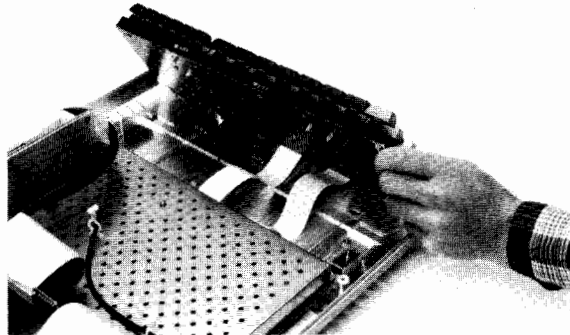
Bottom View



Top Cover Lifting Position

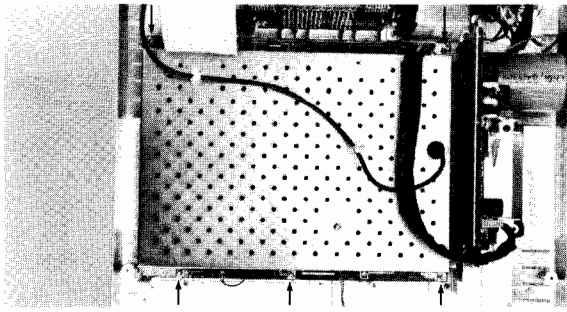
Removing the Keyboard Assembly

- ___ 1. Remove the nut at the left back of the keyboard and the two screws securing the keyboard to the bottom case. (See below left.)
- ___ 2. Rotate the back of the keyboard forward and up to a 45° angle and maintain that angle.
- ___ 3. Lift the keyboard out of the bottom case straight up. Grasp its ends and lift up and slightly forward until the keyboard hinge pins snap out of their retainers in the bottom case. With the keyboard still inclined, lift it straight up until the two cables disconnect from the logic PCA.
- ___ 4. Remove the cables from the keyboard assembly.

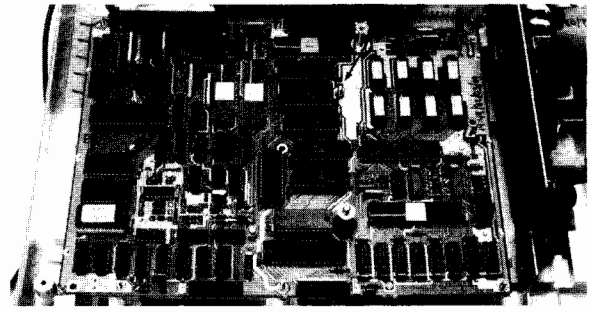


Removing the Logic PCA

- ___ 1. Disconnect the cables from the logic PCA to the power supply, the I/O PCA, and the disc/printer PCA (or HP-IB connector). Remove the video cable from the two twistlocks and disconnect it from the logic PCA. With the keyboard propped forward, remove the cables from the keyboard, the power light, and the speaker from where they attach to the logic PCA.
- ___ 2. Remove the six nuts that hold the EMI box in place, using a ¼-inch nut driver (see next page).
- ___ 3. Lift the EMI box straight up and off. Do not bend the mounting tabs since there is a chance of shorting to PCA traces if the solder mask is damaged and the tabs are angled incorrectly or sharp-edged.
- ___ 4. Remove the two nuts holding the board down in the center (see next page). Remove the six lockwashers from each stud. The logic board may now be lifted up and off the studs. (This is accomplished most easily by lifting the PCA off the back studs, then off the front.)
- ___ 5. Remove the screw that secures the I/O PCA ground strap to the back panel assembly, also on the left side.
- ___ 6. Remove the brass spacers from the eight studs.
- ___ 7. The insulator and shield may now be removed.



EMI Box Removal

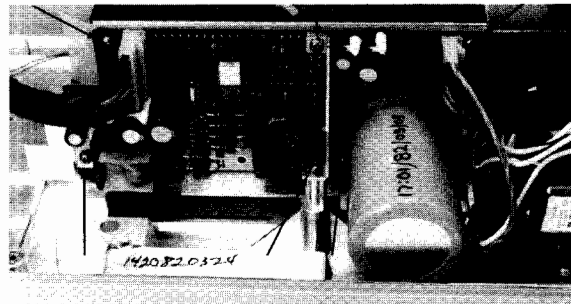


Logic PCA Nut Locations

WARNING!

The large capacitor on the power supply PCA may remain charged to approximately 40V for hours after power is shut off. Do not touch the capacitor terminals or set the power supply PCA on a metal surface.

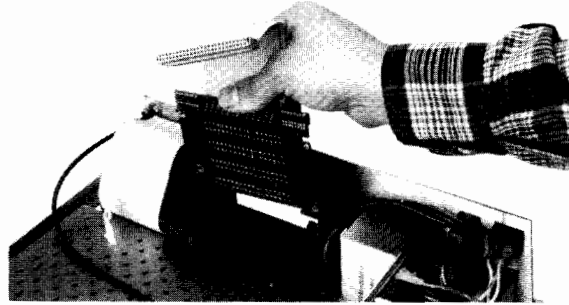
- ___ 1. Remove the screw which secures the power supply bracket to the post in the bottom case.
- ___ 2. Remove both power supply connectors and the six screws securing the PCA to the power supply mount.
- ___ 3. The power supply PCA may now be lifted straight up and out.
- ___ 4. Remove the nut holding the power supply bracket to the back panel assembly. Remove the screw holding the power supply bracket to the bottom case. Lift out the bracket.



Removing the Power Supply

Removing the I/O PCA

- ___ 1. Remove the screw, washer, and nut securing the grounding strap to the I/O PCA.
- ___ 2. Remove the I/O cable from the logic PCA.
- ___ 3. Remove the two screws which fasten the PCA to the I/O box.
- ___ 4. The I/O PCA will slide straight up, out of the I/O receptacle.



Removing the Disc/Printer PCA (86A only)

- ___ 1. Remove the six jack posts securing the disc/printer PCA to the back panel. Disconnect the connector at the logic PCA and remove the PCA.

Removing the HP-IB Connector (86B only)

- ___ 1. Remove the two jack posts securing the HP-IB connector to the back panel. Disconnect the connector at the logic PCA and remove it.

REMOVING THE BACK PANEL ASSEMBLY

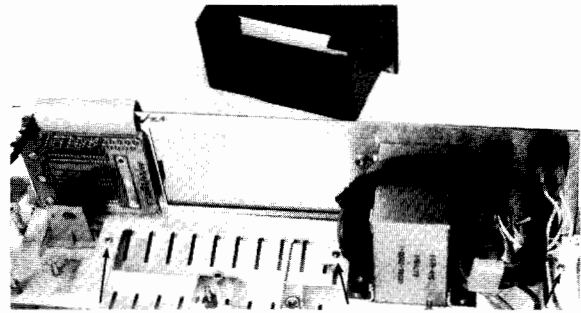
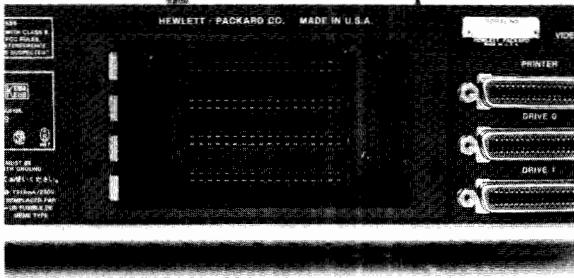
- ___ 1. Turn the computer around so that the back panel is facing you.
- ___ 2. Remove the four screws securing the I/O box to the back panel.
- ___ 3. Remove the I/O box.
- ___ 4. Remove the video cable jack from the back panel. Be careful not to scratch the back panel.
- ___ 5. Remove the three screws securing the back assembly to the bottom case (see next page).
- ___ 6. Remove the back panel by rotating it up and back.

Other Replaceable Assemblies

The following parts are also replaceable, and the procedures for their disassembly and replacement are covered in the HP 86 Service Manuals:

- Key caps.
- Key plunger and spring.
- CAPS LOCK mechanism.
- Key contacts.
- Keyboard hinge.
- Speaker.
- Case foot.
- Power light.
- Transformer.

Refer to Appendix A-5—Back Panel Exploded View.



Back Panel Screw Locations

Installing the Back Panel Assembly

- ___ 1. Reinstall the back panel assembly by reversing the removal instruction. Be careful not to trap any cable when reinstalling.

Installing the Disc/Printer PCA or HP-IB Connector

- ___ 1. Reinstall the disc/printer PCA by inserting the six jack posts and their washers through the back panel into the PCA. Reinstall the HP-IB connector by inserting the two jack posts and their washers through the back panel into the connector.
- ___ 2. Tighten the jack posts enough that they will not come loose with repeated connections and disconnections of interface cables.

Installing the I/O PCA

- ___ 1. To reinstall the I/O PCA, simply reverse the removal steps.

Installing the Power Supply Assembly

- ___ 1. Reinstall the power supply bracket.
- ___ 2. Reinstall the power supply assembly by tightening the four corner screws before installing the two screws which retain the power supply bracket and the screw below the large capacitor. Replace both power supply connectors.

Also refer to Appendix A-6 and A-7.

Installing the Logic PCA

- ___ 1. Reinstall the logic PCA shield and insulator.
- ___ 2. Reinstall the brass spacers on the eight studs.
- ___ 3. Secure the I/O PCA ground strap with a screw.
- ___ 4. Place the logic PCA over the mounting studs. Be sure not to trap any of the cables underneath the PCA.

CAUTION!

In the next step, be sure all washers are in place. Otherwise, the EMI box may short out the board causing the power supply to fail.

- ___ 5. Place a lockwasher over all six studs. Install the nuts over the middle two studs and tighten.
- ___ 6. Connect the two small plugs to the logic PCA. Be sure that the wires to the speaker do not get caught in the studs. Also be sure that the plug from the power light is connected so that the wires come out of the plug toward the front of the computer. The power light will not turn on if the plug is connected backwards. Reconnect the keyboard cables (be sure to observe the **CAUTIONS** listed earlier in this lesson).
- ___ 7. Arrange the power light wires down against the logic PCA and the bottom case, and lower the EMI box over the six studs.
- ___ 8. Connect to the logic PCA the cables from the I/O PCA, the power supply, and the disc/printer PCA or HP-IB PCA. Reconnect the video cable, and tie down this cable with the twistlocks.
- ___ 9. Install and tighten the six nuts which secure the EMI box.

Installing the Keyboard

- ___ 1. Do not install the keyboard at this time. Instead do Lab Project 7 of Lesson 5. Then re-install the keyboard by lowering the keyboard into place and tightening screws and the nut at the left-back corner.

Product Troubleshooting

Lesson 5

Overview

This lesson covers additional test and troubleshooting procedures that were not covered in Lesson 3. During this lesson you will perform labs that show you how to pinpoint failures in the keyboard, power supply, and the disc/printer interface.

Learning Objectives

After completing the troubleshooting labs you will be able to:

- Perform assembly level repairs on the computer.
- Identify assembly failures.

An Overview of Troubleshooting

In general, troubleshooting includes the following procedures:

1. Note the customer's concern. This information can be very helpful in troubleshooting. Be sure to find out how the computer was set up at the customer's location and ask to have any suspect peripherals also shipped to you.
2. Remove all the peripherals from the computer. Attempt to power-on the computer. If the power light does not turn on, check the line fuse. If the fuse is good, test the power supply. If the power supply is good, replace the logic PCA.
3. Attach a monitor and install the ROM drawer and service ROMs. If the computer does not beep, messages do not appear, and the power LED does not blink when the computer is switched on, the HP 86 is not "turning on" properly. This condition could be caused by any of the following:
 - The power supply is not operating properly.
 - One or more circuits of the logic PCA is bad.
 - A fuse is blown.

- The line voltage is incorrect.
- The transformer is bad.
- A peripheral is pulling the power supply low.
- A connector is shorted or improperly installed.

4. If the computer powers on correctly, use the error messages from the diagnostic tests to isolate the problem to a failure in an external component:

- Plug-in ROM.
- Plug-in memory module.
- Monitor.

Or, an internal component:

- Logic PCA.
- Power supply PCA.
- Keyboard.
- Loose or shorted cable.
- I/O PCA.
- Disc/printer PCA.
- HP-IB interface.

The power-on test group will uncover failures of the CPU, RAM, external RAM, ROM, external ROM, and the printer interface. (all of which are repaired by replacing the logic PCA). And the system test will perform the same or more extended tests, as well as tests of the beeper, CRT, timer, keyboard and disc interface. (Again, all failures are repaired by replacing the failed assembly.)

5. If the computer powers-on without any peripherals attached, but seems to "die" when peripherals are attached, then isolate the bad peripheral and troubleshoot according to the standard test procedures for that product.
6. Begin testing with the power-on test group of the service ROMs. Then, if this does not uncover the problem, use the system test (described later in this lesson).

7. If the keyboard is not functioning properly, you may not be able to run the system test from the service ROMs. If any of the following occur while attempting to start the system test, refer to the "Keyboard Troubleshooting" lab in this lesson.
 - The message RETURN TO BASIC SYSTEM appears.
 - The message KEY STUCK appears.
 - The message NO KEY appears.
 - There is no response to pressing any key.
 - The wrong service ROM test is performed when you press a key.
8. If the customer has an intermittent problem, attempt to reproduce it by running the cycle test or by writing and running a BASIC program containing a loop of one or more tests.
9. After you've corrected all problems and have reassembled the computer, run the System Test.
10. If the monitor fails to power-on, then check the fuse inside the monitor. If the monitor fails to pass the CRT test, there are few alignment adjustments that can be made (see Lab Project 5 in this lesson). If a new fuse or adjustment does not fix the CRT, then replace it—there are no subassemblies to the CRT.
11. If an enhancement module causes the system to die, or does not seem to operate properly, then disassemble the module (as necessary) and perform the test procedures spelled out in the Service Manual for that module. If a module is bad, replace the module PCA, the cable assembly, or the entire unit as determined by testing.
12. ROMs contain no replaceable assemblies; if any of these fail, replace the entire unit.

Troubleshooting Tips

CAUTION!

Always switch the power off before disconnecting or connecting an assembly or cable. If power is on while this is done, ICs may be damaged.

Do not attempt to leave the keyboard PCA connected with its short ribbon cables while the keyboard hinge pins are disengaged from their retainers in the bottom case. If this is done, the strain on the ribbon cable connectors may open the connection between a connector pin and the keyboard PCA.

If ribbon cables are not inserted properly into their connectors, components could be damaged.

To set up an HP 86 for checkout and troubleshooting:

- a. Disconnect the power cord and ensure that the ON-OFF switch on the back panel is set to OFF.
- b. Make sure that the line voltage selector switch on the back panel is set correctly.

CAUTION!

The computer will be damaged if the switch is set to 115V and the computer is switched on while connected to a 230V supply.

- c. Ensure that an intact fuse of the proper rating is installed in the fuse receptacle on the back panel. Use a 750 mA fuse for 115V operation; use a T315 mA fuse for 230V operation.
- d. Connect the power cord to its receptacle on the back panel. Plug the other end of the cord into an AC power source of the proper voltage.

CAUTION!

The computer must be switched off when the ROM drawer (as well as any other plug-in module) is inserted into a module port. If the power were on, ICs could be damaged.

- e. Install the service ROMs in a ROM drawer, and insert the ROM drawer into one of the I/O ports in the back panel assembly.
- f. Connect the computer to a suitable video monitor with a phono-plug cable. Turn on the video monitor.
- g. If a disc drive is being used in the HP 86 system, connect it to the dedicated disc interface, or to the HP-IB connector, as appropriate.

Initial Troubleshooting

With the service ROM installed, immediately after the power is switched on, the power LED should blink on and off. Within 10 to 15 seconds after you switch the computer on, the following message should be displayed:

SERVICE ROM: SELECT TEST A-V

This message will be preceded by other messages indicating tests of the CPU, RAM, the four system ROMs, external ROMs, and the printer interface or HP-IB interface. These messages may identify bad ICs; they will be repeated during the system test (if the system test can be run). Watch the display for these messages.

If the Service ROM message appears correctly on the monitor, run the system test from the system service ROM as described in Lesson 3. If the computer has a keyboard problem, the system test may not run. In this situation your HP 86 keyboard is bad. Get another HP 86 keyboard which is known to be good.

If no message appears within 15 seconds after you switch the computer on, the power LED does not blink, and the computer does not beep, the computer is not turning on properly. Redo this section with a known good HP 86.

If no message appears but the computer beeps once, watch the monitor display while you switch the computer off and immediately on again.

If the Service ROM message does not appear on the display but a CPU BAD!, RAM BIT n BAD!, EMC BAD!, ROM n BAD!, or XROM nnn BAD! message appears, replace the logic PCA. (Refer to the table in the Service Manual for the reference designation of the IC identified by a service ROM message if that IC is socketed and therefore replaceable.)

If the Service ROM message does not appear on the display but the message CPU BAD! or n RAM BAD! appears, replace the logic PCA.

No Turn-On

If the computer does not beep, messages do not appear, and the power LED does not blink when the computer is switched on with the service ROMs installed, the HP 86 is not "turning on" properly. This condition could be caused by any of the following:

- The power supply, PWO, or clock circuitry is not operating properly.
- An output of one of these three circuits is being pulled low by a failure of another circuit.
- The CPU is bad.
- One of the bus lines or control lines is being pulled low by a failure of another circuit.
- ROM 0 is bad. This IC is necessary for turn-on.
- The RAM controller or any of the RAM ICs is bad. A portion of RAM is used by the service ROMs and the CPU.
- The I/O buffer is bad. This IC is necessary to interface between the service ROMs and the CPU.
- One of the power supply, PWO, clock, bus, or control lines to an IC is bad.

- The connector on the I/O PCA is bad.
- The connection between the I/O PCA and the logic PCA is bad.
- The service ROMs are bad.

Note: Always check the power supply voltages when first trying to isolate a no turn-on condition.

To isolate a no turn-on condition to a socketed IC or an assembly, perform the following steps until the computer turns on:

- a. Check the voltage on the power supply lines at the power supply connector on the logic PCA.
- b. Check the PWO and clock lines.
- c. Check the control and bus lines at the pins of the CPU with an oscilloscope. Each line should be switching between 0 and 6 volts.
- d. Replace the logic PCA.
- e. Check continuity through the ribbon cable from the logic PCA to the I/O PCA. Replace the PCA that is found to have a bad connector.
- f. Try different service ROMs.

Troubleshooting the Control and Bus Lines

The three control lines (LMA, RD, and WR) and the eight bus lines (B0-B7) should be switching between 0 and 6 volts. Since these lines are asynchronous (their waveforms do not have a regular period), with an oscilloscope, you can only verify that they are active (switching).

If one of the bus or control lines is not active, either an IC is holding the line constant or line is shorted somewhere in the system.

See Appendix A-7.

Power Supply Troubleshooting

If you suspect the power supply may be bad, then follow the troubleshooting procedure outlined in Lab Project 4.

STOP!

Do Lab Project 4 now—Troubleshooting the Power Supply.

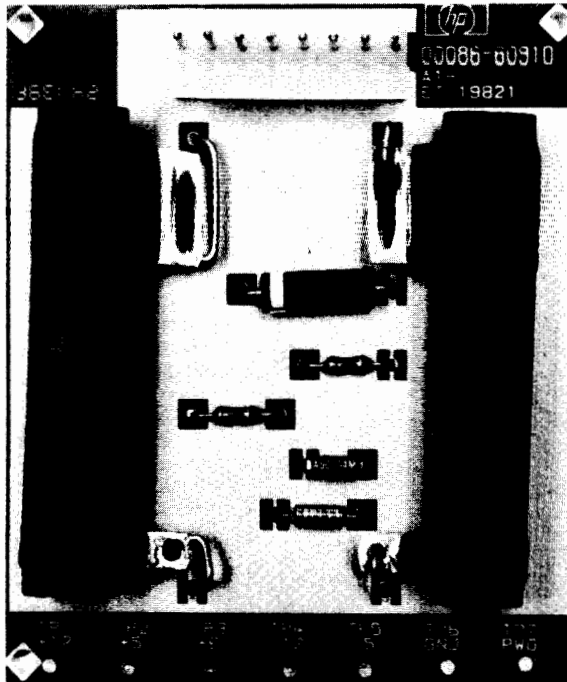
Lab Project 4

Troubleshooting the Power Supply

Equipment Required:

- HP 86A or HP 86B Personal Computer.
- #1 Pozidriv screwdriver.
- HP 00086-60910 Supply Test Connector (optional)
- Multimeter.

- ___ 1. Turn off the computer.
- ___ 2. Disconnect all peripherals.
- ___ 3. Remove the top case from the bottom case.
- ___ 4. Disconnect the power supply cable from the logic PCA and install the HP 00086-60910 power supply test connector (optional).



Power Supply Test Connector

___ 5. Turn on the computer and measure the voltage at the following test points:

TP1 _____

TP4 _____

TP7 _____

TP2 _____

TP5 _____

TP3 _____

TP6 _____

___ 6. From the power supply and PWO test points table in the *HP 86 Service Manual* (Table 2-1), what are the acceptable ranges for these test points:

TP1 _____

TP4 _____

PWO _____

TP2 _____

TP5 _____

TP3 _____

TP6 _____

___ 7. Is the power supply within tolerance on all lines?

If this were an actual repair situation, and you were troubleshooting a no turn-on problem, then you would be concerned with one of the following three situations:

- a. All lines are out of range.
- b. All lines are within range.
- c. One or more lines, but not all, are out of range.

___ 8. In case (a), you would first check the fuse; if that didn't cure the problem, you would replace the power supply PCA and then the back panel assembly including the back panel switches and the power supply transformer.

Case (b) indicates the failure is caused by the logic PCA or an external peripheral. To decide which, use the following procedure:

- ___ a. Turn off power to the computer.
- ___ b. Remove the power supply test connector.
- ___ c. Reconnect the power supply cable from the power supply to the logic PCA.
- ___ d. Disconnect the ribbon cable that connects the logic PCA to the I/O PCA.
- ___ e. Disconnect the ribbon cable that connects the logic PCA to the disc/printer PCA or HP-IB connector.
- ___ f. Using a probe, test the following pins through the power supply connector plug.

P1 _____

P4 _____

P8 (PWO) _____

P2 _____

P5 _____

P3 _____

P6 _____

If these values are now in the acceptable range listed in Step f then either the I/O PCA, disc/printer PCA or HP-IB connector, or a peripheral is bad. In most cases this problem will be caused by a bad peripheral or plug-in module. If more than one peripheral is connected, use a process of elimination to determine which one.

If these values are out of range, then replace the logic PCA.

- ___ g. Turn off the computer and reconnect the I/O PCA and disc/printer PCA or HP-IB connector ribbon cables.

In case (c) you would replace the power supply.

___ 9. This is the end of testing that requires that the computer cases be apart. Reassemble the computer now.

Refer to Disassembly and Reassembly in the *HP 86 Service Manual* (for the HP 86A or B).

Equipment Required:

- HP 86, Monitor, and disc drive. (9130A for the HP 86A, an HP-IB compatible drive for the HP 86B).
- CRT alignment tool (8710-1355).
- ROM drawer and service ROMs.

After troubleshooting any no turn-on problems, the next step is to install the service ROMs and run diagnostic test programs. With the service ROMs installed, the power-on test group runs as soon as the power switch is turned on. This test will uncover problems with the CPU, RAM, external RAM, ROM, external ROM, and some printer failures.

A more extensive group of tests is run when the system test is selected after the power-on group completes.

- ___ 1. Set up the computer and monitor. Install the service ROMs and ROM drawer.
- ___ 2. Select the system test from control of the service ROMs. Let the program go through all tests. Respond to the keyboard test as in Lesson 3.
- ___ 3. List the tests that were performed and explain which assemblies are being tested by each test.

Test	Assembly or Unit Being Tested
a) _____	_____
b) _____	_____
c) _____	_____
d) _____	_____
e) _____	_____
f) _____	_____
g) _____	_____
h) _____	_____
i) _____	_____

If a problem is found during any of the tests in the system test, the appropriate message appears, the individual test is terminated, and the next test is begun.

The message SYSTEM TEST ENDS appears after all tests are run.

If the service ROMs find a bad IC during the system test, they display a message identifying the IC, then skip to the next test. If a bad IC is identified, replace the logic PCA.

The service ROMs may indicate that more than one IC is bad. If so, replace the logic PCA, and run the system test after replacement.

If the computer appears to "die" during any test, replace the logic PCA.

If the message RAM n BAD! or 2 RAM n BAD! appears, replace the logic PCA.

If the ROM n BAD! message appears, or a message followed by the letter C appears, replace the logic PCA.

If the beeper is not operating properly, try replacing the logic PCA. If this does not result in proper operation, replace the speaker.

If any of the following occur, troubleshoot the monitor. (Reference: *86 Service Manual*, page 2-48). (It may be necessary to adjust the contrast and brightness front-panel controls first).

- The monitor screen does not go blank at Step d of the CRT test.
- The monitor does not go entirely white at Step i of the CRT test.
- Test pattern 4 is not displayed.

CRT Adjustments

- ___ 4. Turn off the monitor, pull out the power plug.
- ___ 5. With the power cord removed, position the monitor so that it is tilted forward and remove the screws from under the carrying handle (HP 82912A) or from the upper left and right sides (HP 82913A).
- ___ 6. Remove the small screw near the power receptacle. Do not mix the various screw types; as you remove a screw, note its location for reassembly.
- ___ 7. Tilt the monitor toward the CRT screen until it rests at an acute angle with the work surface. Then remove the two screws that are exposed on the bottom of the case.

WARNING!

Lethal voltages are exposed when the back case of the monitor is removed. At certain points these voltages are present not only while power is on, but also for up to several days after power has been turned off. Electrical and mechanical failures may cause dangerous voltages to be present at points that normally are safe. For your own safety, carefully follow the procedures below.

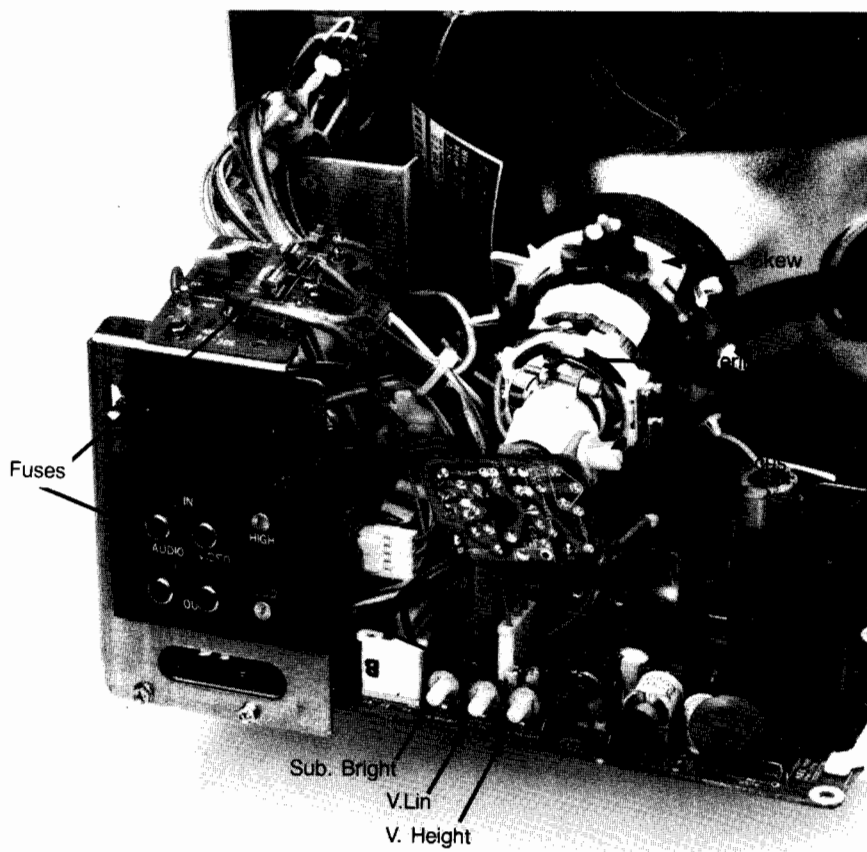
- ___ 8. Gently slide the back case to the rear of the monitor, exposing the printed circuit assemblies and the picture tube. Do not curl your fingers inside the case.
- ___ 9. Reconnect the power cord and turn on the monitor for the following adjustments.
- ___ 10. Run the CRT test and pause the system at the focus pattern (screen filled with B's and J's) by pressing any key. (Pressing any key again will cause the test to go to the next pattern.)
- ___ 11. Using a CRT alignment tool, adjust the focus pot on the small printed circuit board at the back of the CRT tube to obtain the best focus on the CRT screen (see illustration on page 5-8).
- ___ 12. With the focus pattern still on the screen, adjust the vertical linearity pot so that the height of the top row of letters is the same as the height of the bottom row of letters.
- ___ 13. Then adjust the vertical height pot so that the test pattern fills as much of the screen as possible without distortion.
- ___ 14. Repeat steps 12 and 13 until best picture is achieved.
- ___ 15. Locate the horizontal width pot to the right of the yoke and adjust the screen as wide as possible without distortion at the sides of the screen.

- ___ 16. Press a key to select the pincushion pattern and pause the test program by pressing another key after the pattern appears.
- ___ 17. Loosen the clamp that is located behind the yoke with a #1 Pozidriv screwdriver, and, with your fingers on the plastic prongs that hold the pincushioning magnets in place, adjust the skew of the pattern on the screen. Retighten the clamp just enough to hold the yoke in place.
- ___ 18. Behind the yoke are two circular metal tabs. With an insulated screwdriver, use one of these to vertically center the pattern on the screen, and use the other tab to adjust the horizontal centering of the pattern.
- ___ 19. Locate the two fuses in the CRT assembly (see figure).
- ___ 20. Turn off the monitor, and remove the power plug.
- ___ 21. Align the back case with the chassis so that the rails on the bottom of each part mesh as the back case is gently slid over the monitor. The five screw holes should be aligned, and the adjustment knobs for V HOLD and H HOLD should protrude through the holes in the back case.

CAUTION!

Due to the nature of the plastic used in the case, the threads in screw holes can easily be stripped if you overtighten screws. All screws should be tightened only until they feel snug; if you strip the threads by overtightening the screws, you will have to replace the monitor. Also, try to engage screws—especially small screws—in the original threads; if a screw cuts new threads, they can easily be stripped.

- ___ 22. Insert and tighten the five screws in their proper holes, tilting the monitor forward as necessary.



Optional Lab Project 6

Troubleshooting the Disc/Printer Interface

This lab explains how to use the service ROMs to test the disc/printer interface circuit on the HP 86A logic PCA.

Equipment required:

- HP 86A, Monitor, and HP 9130A Single Flexible Disc Drive.
- ROM drawer and service ROMs.
- 5¼-inch scratch disc.
- Logic probe.

Perform each step in sequence.

Start now.

Disc Interface Test

- ___ 1. Turn off the computer.
- ___ 2. Plug in one (or two) disc drive units with the cables supplied with the disc drives, onto the connectors on the back of the computer. These connectors are labeled DRIVE 0 and DRIVE 1.
- ___ 3. Turn on the computer. There should not be a disc in the drive when it is first turned on, while it is coming up to speed, or when the computer is turned off.
- ___ 4. To run the disc test while the service ROMs are in control, press the I key. Follow the instructions as they appear on the display.
- ___ 5. Press the 0 key to test DRIVE 0 (or the 1 key to test DRIVE 1). Record the computer's response.

- ___ 6. Remove any disc which is in the drive, and press the CONT key to continue.
- ___ 7. After inserting a suitable scratch disc halfway into the drive, press CONT to test the write-protect switch. Record the computer's response.

- ___ 8. After inserting the disc all the way and closing the drive latch, press the continue key. The computer will run a format/verify/seek test to completely check the read and write operation of the disc interface and the disc drive hardware.

What is the response from the computer if this test is successful?

In order to isolate a disc-related failure it will sometimes be necessary to try a known-good disc drive with the computer being repaired. There may be cases where the computer will appear to function without fail and the customer did not ship the disc drive (which is the more likely source of errors). If possible, begin testing with the customer's units to verify reported errors.

you should replace the logic PCA. But, in most other cases, the error messages could be caused by a failure of either the logic PCA or the disc drive. (The disc/printer PCA is strictly a mechanical part and has no electronic components to troubleshoot. The only way the disc/printer PCA may fail is if it is physically damaged.)

In the event the disc test uncovers an error that may be caused by either the disc drive or the logic PCA, you should first substitute a known-good disc drive and repeat the test. If the error still persists, then replace the logic PCA.

In the event of any of these error messages, there is likely to be a problem with the disc system. However, a second scratch disc should be used and the test run again if there is any possibility of a damaged disc. Refer to the Service Manual for the disc drive unit for repair procedures for that assembly.

- ___ 9. Repeat steps 1 through 8 to test DRIVE 1.

Printer Interface Test

The printer test included in the service ROM power-on sequence is adequate to verify that the printer interface is working if the customer has not reported a problem. However, if there appears to be a problem, or the printer interface needs to be checked in detail, the following procedures can be used.

The printer interface test is initiated from the service ROMs by pressing the H key when the service ROMs are in control, or by typing in PRINTERTEST in BASIC mode. The test then writes alternate ones and zeroes to the printer data lines and also reads the printer status lines, displaying them on the screen.

- ___ 10. Run the printer interface test.

- ___ 11. To check the data lines, place the logic probe on the following pins on the printer interface connector. The lines should be toggling between high and low states at about a 1 Hz rate. (If you are using a probe that requires an external power supply, then separate the cases, remove the EMI box, and use the logic PCA schematic to locate a +5V supply; VCC on any of the TTL ICs will work fine.)

Pin No.	Switching?
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____
8	_____
9	_____

- ___ 12. To check the status lines, use a grounding wire to short the following pins together. Watch the monitor and record the status value as you short the following pins together:

Pin Nos.	Status Value
11-19	_____
12-19	_____
13-19	_____
14-19	_____
32-19	_____
1-10	_____

If either of these tests fail, replace the logic PCA and repeat.

Lab Project 7

Troubleshooting the Keyboard

Refer to Appendix A-8—Keyboard.

Equipment Required:

- Multimeter.
- ¼-inch nut driver.
- HP 86 computer with video monitor.
- HP 86 service ROMs and ROM drawer. (The foreign version Service ROM is required to test the foreign language versions of the HP 86Bs.)

Proceed with the lab exercise by completing each step in sequence as given.

Procedure and checklist:

- ___ 1. After Lab Project 3, the computer cases should be apart and the keyboard removed from the bottom case. (If not, reread Lesson 3 and disassemble the cases and remove the keyboard now.)
- ___ 2. Locate the J1 and J2 connectors on the back side of the keyboard.

With the bottom, soldered side of the keyboard facing you, the first bank of pins is called J1 and is numbered 1-11 from left to right, and the second bank of pins is called J2 and is numbered 1-11 from left to right.

J1 (Right Side)	J2 (Left Side)
1 Row 0	1 Column 5
2 Row 1	2 Column 6
3 Row 2	3 Column 7
4 Row 3	4 CTRL
5 Row 4	5 Column 4
6 Row 5	6 Column 3
7 Row 6	7 Column 2
8 Row 7	8 Column 1
9 Row 8	9 Column 0
10 Row 9	10 CAPS LOCK
11 Vss	11 SHIFT

- ___ 3. With your ohmmeter and probes, verify that the CTRL, CAPS LOCK, and SHIFT keys all connect to Vss (logic ground) when pressed.

- ___ 4. Jot down the orientation of the pins or ribbon connectors and locate the KEYLABEL key at COL-6, ROW-0; connect your probes to the appropriate lines, press the KEYLABEL key, and watch the ohmmeter drop to 0.
- ___ 5. Complete the following table; use the Service Manual to look up the row and column of indicated keys, and use your probes to verify their location on the J1 and J2 cables.

KEY	ROW	COLUMN	VERIFY
LABEL KEY	0	6	x
a			
+			
SPACE			

Keyboard problems are caused by either a failure in the keyboard controller (located on the logic PCA), or the key itself; common key failures are dirty contacts, a bent return spring, or an improperly installed or broken ribbon connector. In practice, if a customer has brought you a computer and his comments lead you to believe that there is a problem in the keyboard, you would first install the service ROMs and run the keyboard test to check for a faulty keyboard controller or bad key. If the service ROM key test locates a bad key, then you would pull the keyboard from the machine, and make a final continuity check before rebuilding the bad key(s).

Now that you know how to verify key failures, let's go back and run the service ROM tests for the keyboard.

- ___ 6. Put the keyboard back into the computer and set the top case back on top. Do not screw the top and bottom case back together.

How to Keep It Running



Lesson 6

Maintenance of the HP 86 consists of keeping it clean. The top case, bottom case, monitor screen, and keyboard should be cleaned periodically with a soft cloth dampened with water or a solution of water and mild detergent. Do not use an excessively damp cloth, and do not let any water spill inside the computer. Do not use abrasive cleaners or solvents.

It should not be necessary to clean accessory module cases or cable contacts. The action of installing the modules into an I/O port and plugging the cable connector into the interface is normally sufficient to clean contamination from the contacts.

WARNING!

Do not spill water inside the computer. The water could cause a shock hazard.

CAUTION!

Never use solvents of any kind on the top case, bottom case, keys, or monitor.

Overview

The focus of the lesson is to learn proper maintenance procedures and couple your newly acquired product knowledge with the resources available to you to keep the equipment functioning.

Learning Objectives

After completing this lesson you will be able to:

- Perform the recommended maintenance procedures for your HP 86.
- Identify key user needs, requirements, and expectations.

- Identify key resource requirements and limitations for support.
- Establish a support and maintenance program to optimize system utilization.

Maintenance Procedures

The HP 86 has been designed for maximum reliability with a minimum amount of planned maintenance. Your planned maintenance program should establish at least a front panel or keyboard cleaning schedule to maintain the new appearance of your HP computer.

Materials Required

Nonconsumable

- DC voltmeter - HP 427 or equivalent 0 to 50 volt range.
- Small Phillips-head screwdriver.

Consumable

- Isopropyl alcohol or contact cleaner.
- Small cotton or paper towels for use as wipers.

The HP 86 computer was designed for minimal maintenance. Normally no calibration or alignment is required as part of the planned maintenance routine.

Keyboard

The keyboard will collect dirt and small foreign objects as the HP 86 computer is in use. Cleaning the keycaps with water and a small towel every three months is all that is required.

Time required: Approx. 1/2 hour.

The keyboard will also collect dirt inside the cover. It should be cleaned out every year. Separate the top and bottom cover by removing the bottom screws. Dust the dirt out of the keyboard and the bottom inside cover.

Time required: Approx. 5 minutes.

Display

Clean the front of the display every three months.

Time required: Approx. 5 minutes.

indicates some visual adjustment is necessary (such as focus or brightness) or when a module (PCA) is added to or replaces one in the HP 86 computer. The maximum amount of time required to do all the alignments and adjustments is 30 minutes.

Planning for Success

Preventive maintenance is also an important element of any support program, but how much is necessary? What type? When should it be scheduled? When should it be performed on an "as needed" basis? How much can the user do? These questions you must consider for your particular application and needs if you are to be successful in applying your new skills.

Up to this point in the training program you have focused on understanding and repairing the HP 86. Your progress through this program has been measured on your ability to understand the material presented and your troubleshooting expertise. While these are important aspects of product repair, they are only a single link in the overall repair and support process. Your true success can only be measured in the overall results of how well you keep the equipment running, not how well you understand the product or how fast you find the problem. Take, for example, the case of a

defective fuse—isolating the problem quickly is of little

value if you do not have a spare fuse. Having a large quantity of the wrong fuse neither increases the utilization of the equipment, nor helps you fix it faster. What then is a support program and how do you use it for your success?

Elements of a Support Program

A successful support program involves four (4) major elements:

1. Definition of the needs/requirements and expectations of the user.
2. Evaluation of the support resources available to meet the needs of the user.
3. Effective allocation of resources.
4. A mutually agreeable measurement system to record results.

The first element, "Definition of the needs," establishes the goals of the user. None of the key points can be addressed properly until the product application and need of the user is defined.

For instance, is the application one of monitoring on-line manufacturing processes, as in a production line system, or a less critical application in an engineering or research environment? These applications can require very different levels of support and resources. Further, the expectations of the users can vary dramatically.

1. Determining Need

To identify needs you should find answers to the following questions for each site or user you will support.

- What is the application of the product? Know how it is currently used and any new applications planned. These sometimes change the support requirements.
- What type of equipment is being used? Different products require more maintenance or interaction with other areas.
- How many hours/day is the equipment expected to be used? Will the system be expected to function 24 hours/day or something less? What about after hours?
- Are some times more critical than others? Most operations have critical times either daily, weekly or monthly when the operation must run. Find out!
- How long can the users or process be inoperable? It is important to establish alternate plans for critical times. Suggest alternatives for the user. Backup procedures, etc.

The User Requirements Worksheet on page 6-6 will help answer some of these questions and should be completed for each site and product that you will support.

For this program select one site you will support and answer the questions the way you feel the user would answer. (If you wish to use the worksheet for other sites you should make several copies before you complete the form.)

STOP!

Complete Steps 1 through 6 of the User Requirements Worksheet located on page 6-6.

2. Evaluating Resources

With steps 1 through 6 completed in the User Requirements Worksheet, you can begin to identify the resources required to meet the users needs in the areas of Response Time, Repair Time, and Planned Maintenance. These three key areas impact the overall system utilization. You should have a good understanding of each of these areas for your organization for normal working hours, after hours, weekends and holidays.

A. Response Time

Response time is a measure of the efficiency of the dispatching process. It is an issue that varies with each organization and location. Consider the effect of the following areas on response time for your organization.

Communication

Communication is important in any interaction with people. In response time it can mean long delays in responding to service requests or worse, missed service requests.

- How are requests for service received?
- Who received them?
- How are service personnel notified?
- What about after hours, weekends or holddays?

Manpower Availability

Manpower is a difficult issue in any organization and it is not the intent of this program to suggest a simple solution. You must, however, understand what procedures are in place in your organization for available manpower. For example:

- How are service requests assigned?
- Can you leave immediately?
- What happens if you can't go immediately?
- Do you have a backup plan?
- What happens after hours?
- Weekends and holidays?

Parts/Tools Availability

This area is the most overlooked area of response time, but perhaps the most critical. If you don't have the proper parts and tools you must get them from somewhere before you can respond. Will they be carried by service personnel, stored in a central location, or will they be available once you arrive? What about access during normal working hours? After hours? Weekends/holidays? This can waste valuable time if parts are stored miles away from your current location.

User's Location

The user's location can definitely affect your ability to respond.

- Distance from support personnel.
- Geographic territory (mountains etc.).
- Travel time consideration (traffic etc.).
- Travel method (airplanes etc.).
- Security issues.

Check your situations! How does your organization handle each of these? What is your estimate of the time required for you to receive a service request? What do you feel your response time will be?

STOP!

Complete Section I of the Resource Analysis Worksheet on page 6-8.

B. Repair Time

Repair time is mainly a function of your ability to locate and solve the problem once you have arrived at the user's site. Other areas that impact your ability to repair the product are:

- Product availability — Can you begin work on the system immediately once you arrive on site?
- Parts availability — How do you get the part you need when you find the failing assembly?
- Consulting Assistance — What about the times you can't isolate the problem? Who is your technical back-up?

STOP!

Complete Section II of the Resource Analysis Worksheet on page 6-12.

C. Planned Maintenance

The first portion of this lesson described the preventive maintenance (PM) procedures for the HP 86. You should understand that planned maintenance is a means to an end. Performing PMs 100% of the time would result in the equipment being utilized 0%. No PMs may cause unnecessary failures during critical operations. This raises several questions concerning preventive maintenance. What is a proper PM? How often should they be performed? The answer is dependent on three major factors:

- Product design.
- Environment.
- Equipment usage.

Any successful maintenance program must constantly evaluate each of these major areas to establish a Planned Maintenance program to fit the user's needs.

Product Design

The Hewlett-Packard HP 86 has been designed as a high-reliability, minimum-maintenance product. Under normal conditions it requires no scheduled maintenance. Still, you should evaluate the user's particular environment and usage situation to determine preventive measures for optimum product usage.

User Environment

What type of environment is the equipment subjected to. Is it a manufacturing facility? Computer room environment or office area? Is it subjected to high/low temperature extremes? Power fluctuation? Dirt? Caustic atmosphere, etc.? All of these affect the equipment utilization and should be monitored on a continuing basis.

Equipment Usage

Equipment usage involves the amount of time the specified product is used, i.e., 2 hrs/day, 10 hrs/day or 24 hrs/day, etc. Generally, the more the equipment is used the higher the probability that mechanical components may wear.

STOP!

Complete Section III of the Resource Analysis Worksheet on page 6-14.

With the Resource Analysis Worksheet completed, compare your capabilities to those identified in the User's Requirements Worksheet. What do you feel the measurement criteria should be?

Establishing a Measurement Program

One of the easiest and most comprehensive methods of measuring your results is equipment utilization or uptime. The uptime measurement allows an easy way to set user expectations and graphically identify potential problems or reduced performance.

Uptime Calculations

Many definitions and calculations exist for uptime. It is not important that only one definition or formula is correct. It is, however, important that once the criterion have been established that they not be changed.

The general formula for Uptime calculations is:

$$\text{Uptime \%} = \frac{\text{PPM-Downtime}}{\text{PPM}} \times 100$$

PPM = Principal Period of Maintenance per month determined by the number of hours service is provided.

Downtime = the amount of downtime during the covered period.

Table 6-1 shows PPM for typical applications.

Hours of Service Coverage/day	# of days covered/week		
	5	6	7
8	174	208	242
12	261	312	363
16	348	416	484
24	522	624	728

Example:

Assume you provide support for a particular system or product for 8 hours/day, 5 days/week. (8:00 a.m. to 4:00 p.m. Monday through Friday.) Downtime is 6 hours total for the month of January.

$$\begin{aligned} \text{Monthly Uptime \%} &= \frac{\text{PPM-Downtime}}{\text{PPM}} \times 100 \\ \text{Monthly Uptime \%} &= \frac{174-6}{174} \times 100 \\ \text{Monthly Uptime \%} &= 96.6 \end{aligned}$$

The uptime graph provided on page 6-15 and 6-16 can be used to record graphically the uptime results for both the site and service person.

STOP!

Complete Steps 7 through 11 of the User's Requirements Worksheet on page 6-6.

User Requirements Worksheet

Date: _____

Prepared by: _____

1. a) User's description of application: (Name, purpose, etc: _____

Site Name: _____ Installation Location: _____

Contact Name: _____ Telephone Number: _____

b) Used in production of process control? Yes ___ No ___

c) As part of Network System? Yes ___ No ___

2. HP System Configuration: System Model _____ Memory Size _____

of Discs _____ Model _____

of Mag Tapes _____ Model _____

of Line Printers _____ Model _____

of CRTs _____ Model _____

Other Equipment _____

Types of modems: Manufacturer _____ SYNC _____ ASYNC _____ Model _____

3. Software used: HP ___ O.E.M. ___ Other ___

4. System Usage:

Hours:

___ 5 days/week: 8 to 5 ___ 12 hours/day ___ 16 hours/day ___ 24 hours/day ___

___ 7 days/week Other ___

5. Critical Periods: Days: (Circle appropriate days M T W TH F S S)

Hours: From: ___ to: ___ Days of Month: ___ Months of the year: ___

Other: _____

6. Maximum Down Time/Day:

___ Less than 1 hour ___ 4 hours ___ 10 hours ___ 12 hours Other ___

7. What service coverage is required to meet the System usage?

5 days/week ___ 7 days/week ___ Other _____

8 hrs/day ___ 12 hrs/day ___ 24 hrs/day ___ Other _____

8. What response time is required to meet the users requirements?

___ 4 hours ___ 10 hours ___ 12 hours ___ 24 hours Other _____

9. Do you have a service contract with HP? _____ No _____ Yes

Contract Number _____

Type Contract(s):

_____ Hardware _____ Software _____ Cooperative

10. Service Information:

Location providing: _____ HP location providing: _____

Service Telephone # _____ HP Service Phone # _____

After Hrs Phone #: _____ HP After Hrs Phone # _____

Site Manager: _____ HP District CE Manager: _____

Trained Service Personnel: _____ HP Account CE: _____

11. Special Considerations:

Resource Analysis Worksheet

Section I

Response Time Analysis

Communication System

A. Normal Working Hours

1. How are service requests received/recorded?
 Central location Other _____
2. Requests are recorded by: Secretary Dispatcher
 Service Personnel Other _____
3. How are service personnel notified? Pager Phone Message
 Wait for call in Other _____
4. Estimated average amount of time required to notify service personnel of a pending service request: _____ hours

B. After Hours

1. How are service requests received/recorded?
 Central location Other _____
2. Requests are recorded by: Secretary Dispatcher
 Service Personnel Other _____
3. How are service personnel notified? Pager Phone Message
 Wait for call in Other _____
4. Estimated average amount of time required to notify service personnel of a pending service request: _____ hours

C. Weekends/Holidays

1. How are service requests received/recorded?
 Central location Other _____
2. Requests are recorded by: Secretary Dispatcher
 Service Personnel Other _____
3. How are service personnel notified? Pager Phone Message
 Wait for call in Other _____
4. Estimated average amount of time required to notify service personnel of a pending service request: _____ hours

Manpower Availability

A. Normal Working Hours

1. How are service requests assigned? Designated Service Personnel
 Next Available Service Person Other _____

2. Can you respond immediately? Yes No

If no, what happens? _____

3. Do you have a backup plan? No Yes: What is it?

4. Estimated average amount of time before service person is available: _____ hours

B. After Hours

1. How are service requests assigned? Designated Service Personnel

Next Available Service Person Other _____

2. Can you respond immediately? Yes No

If no, what happens? _____

3. Do you have a backup plan? No Yes: What is it?

4. Estimated average amount of time before service person is available: _____ hours

C. Weekends/Holidays

1. How are service requests assigned? Designated Service Personnel

Next Available Service Person Other _____

2. Can you respond immediately? Yes No

If no, what happens? _____

3. Do you have a backup plan? No Yes: What is it?

4. Estimated average amount of time before service person is available: _____ hours

Parts/Tools Availability

A. Normal Hours

Parts Availability

Parts Available: On-Site Carried by Service Personnel

Other _____

Tool Availability

Standard Tools: On-Site Carried by Service Personnel

Other _____

Estimated average amount of time required to pick-up parts and tools per call: _____ hours

B. After Hours

Parts Availability

Parts Available: On-Site Carried by Service Personnel

Other _____

Tool Availability

Standard Tools: On-Site Carried by Service Personnel

Other _____

Estimated average amount of time required to pick-up parts and tools per call: _____ hours

C. Weekends/Holidays

Parts Availability

Parts Available: On-Site Carried by Service Personnel

Other _____

Tool Availability

Standard Tools: On-Site Carried by Service Personnel

Other _____

Estimated average amount of time required to pick-up parts and tools per call: _____ hours

User's Location

A. General

1. Estimated distance to user's site: _____ miles

2. Geographic territory: City Mountainous Rural Other _____

B. Normal Working Hours

1. Travel method used: Car Walk Airplane Van Other _____

2. Estimated travel time: _____ hours

3. What type of security clearance is necessary? None Pass

Special Other _____

4. Estimated time delay for acquiring security access to site: _____ hours

C. After Hours

1. Travel method used: Car Walk Airplane Van Other _____

2. Estimated travel time: _____ hours

3. What type of security clearance is necessary? None Pass

Special Other _____

4. Estimated time delay for acquiring security access to site: _____ hours

D. Weekends/Holidays

1. Travel method used: Car Walk Airplane Van Other _____

2. Estimated travel time: _____ hours

3. What type of security clearance is necessary? None Pass

Special Other _____

4. Estimated time delay for acquiring security access to site: _____ hours

Response Time Analysis Summary

A. Normal Working Hours

Estimated average amount of time required to notify service personnel: _____ hours
Estimated amount of time before service person is available: _____ hours
Estimated amount of time to pick-up parts and tools: _____ hours
Estimated travel time: _____ hours
Estimated time delay for security access to site: _____ hours
Total Response Hours: _____ **hours**

B. After Hours

Estimated average amount of time required to notify service personnel: _____ hours
Estimated amount of time before service person is available: _____ hours
Estimated amount of time to pick-up parts and tools: _____ hours
Estimated travel time: _____ hours
Estimated time delay for security access to site: _____ hours
Total Response Hours: _____ **hours**

C. Weekends/Holidays

Estimated average amount of time required to notify service personnel: _____ hours
Estimated amount of time before service person is available: _____ hours
Estimated amount of time to pick-up parts and tools: _____ hours
Estimated travel time: _____ hours
Estimated time delay for security access to site: _____ hours
Total Response Hours: _____ **hours**

Section II
Repair Time Analysis

A. Normal Working Hours

1. Product Availability

- a. Is the product or system available to use when you arrive on-site? Yes No
- b. How long must you normally wait? _____ hours
- c. What can you do while you wait? _____

- d. What can the user do before you arrive? _____

2. Parts Availability

- a. What are the procedures for obtaining a part? _____

- b. Estimated average time to receive part: _____ hours

3. Consulting Assistance

- a. Is technical assistance available? Yes No

Name _____

Location _____

Phone No. _____

- b. Estimated amount of time to contact technical backup: _____ hours
- c. Is management assistance available? Yes No

Name _____

Location _____

Phone No. _____

B. After Hours

1. Product Availability

- a. Is the product or system available to use when you arrive on-site? Yes No
- b. How long must you normally wait? _____ hours
- c. What can you do while you wait? _____

- d. What can the user do before you arrive? _____

2. Parts Availability

- a. What are the procedures for obtaining a part? _____

- b. Estimated average time to receive part: _____ hours

3. Consulting Assistance

- a. Is technical assistance available? Yes No

Name _____

Location _____

Phone No. _____

- b. Estimated amount of time to contact technical backup: _____ hours

- c. Is management assistance available? Yes No

Name _____

Location _____

Phone No. _____

C. Weekends/Holidays

1. Product Availability

- a. Is the product or system available to use when you arrive on-site? Yes No

- b. How long must you normally wait? _____ hours

- c. What can you do while you wait? _____

- d. What can the user do before you arrive? _____

2. Parts Availability

- a. What are the procedures for obtaining a part? _____

- b. Estimated average time to receive part: _____ hours

3. Consulting Assistance

- a. Is technical assistance available? Yes No

Name _____

Location _____

Phone No. _____

- b. Estimated amount of time to contact technical backup: _____ hours

- c. Is management assistance available? Yes No

Name _____

Location _____

Phone No. _____

Resource Analysis Worksheet

Section III

Planned Maintenance

A. Product Design

1. What is the recommended interval for preventive maintenance? _____ months
2. Who can best perform the maintenance procedures? Service Personnel
 User Other _____

B. User Environment

1. What type of environment is the equipment subjected? Industrial Manufacturing
 Office Area Computer Room Other _____
2. What temperatures will equipment operate in? High Low
 Moderate Other _____
3. What types of humidity? High Low
 Moderate Other _____
4. What type of atmosphere? Caustic Dirt Laden
 Other (please describe) _____
5. What power setup is available? Line Conditioned
 Line Filtered Other _____
6. What is the voltage range? _____ Volts to _____ Volts

C. Equipment Usage

1. The equipment is in constant use for approximately: 2 hours/day 4 hours/day
 8 hours/day 16 hours/day Other _____

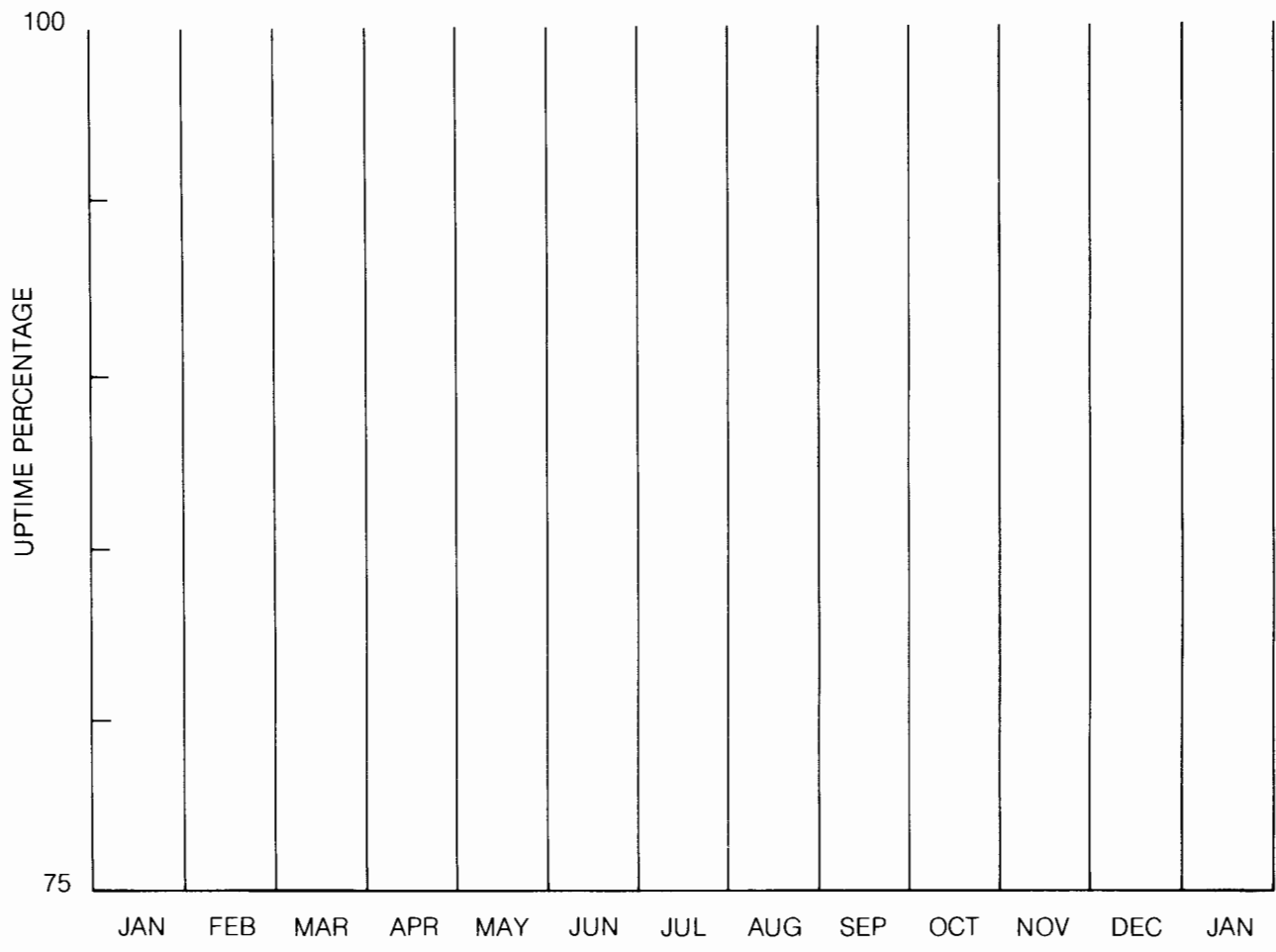
Uptime Graph

Service Person _____

Name _____

Number of Products _____

Product Types _____



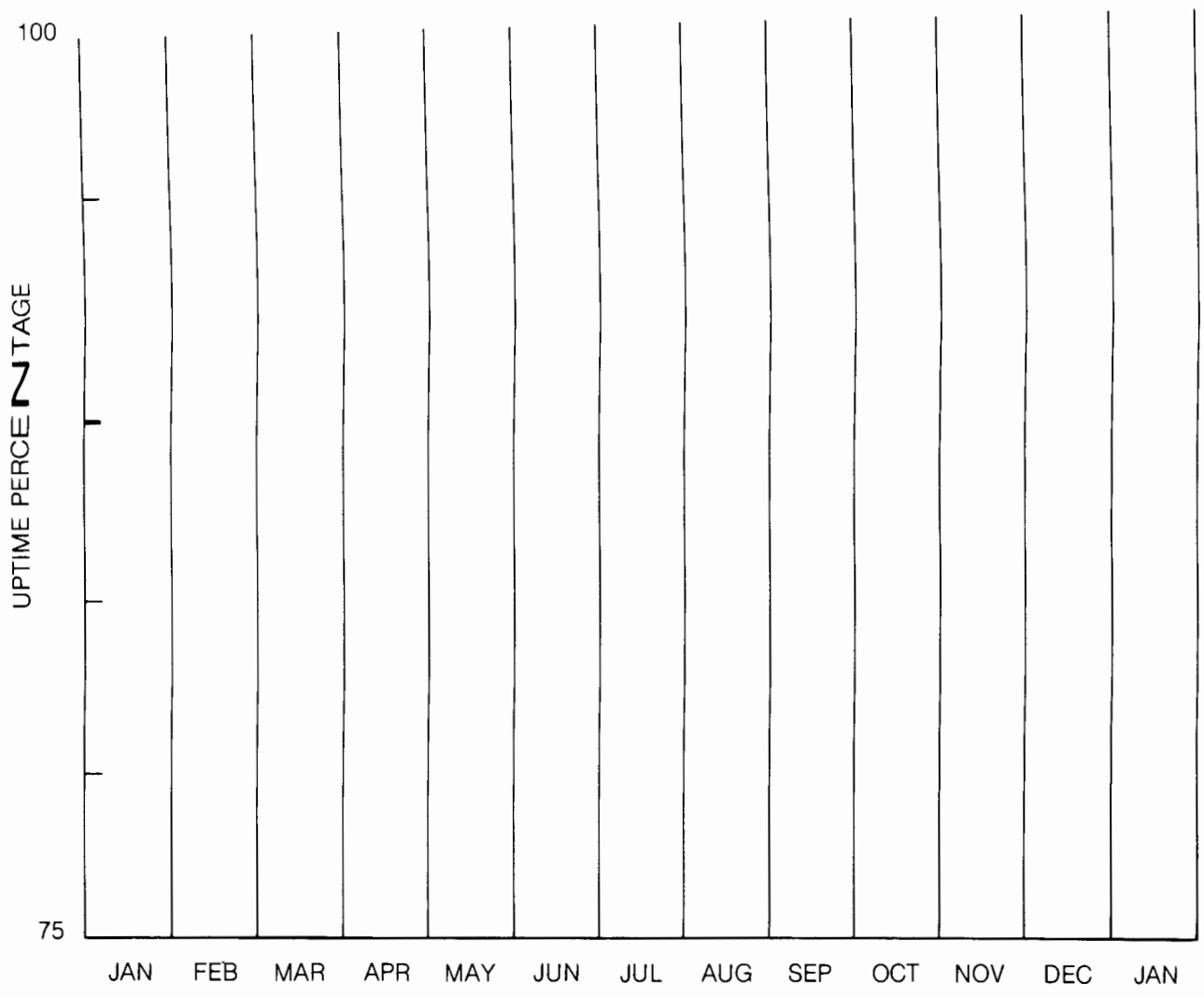
Uptime Graph

User Name _____

Product Type _____

Serial # _____

Service Person: _____



Interfaces and Enhancements

Lesson 7

Overview

This lesson covers the accessory modules that are available for use with the HP 86. Each of the modules will be briefly described. You'll also have the opportunity to perform a testing procedure for one of these accessories—the HP-IB interface.

Learning Objectives

After this lesson, you will be able to:

- Describe the accessory modules that can be added to the HP 86 to enhance its capabilities.
- Identify each of the replaceable assemblies of the interfaces.
- Use the Service Manual for a particular module to troubleshoot failures.

Optional

In Lesson 7, you will have the opportunity to do a lab project in which you test and troubleshoot one commonly used module—the HP-IB interface.

General Concepts

The accessory modules available for the HP 86 are listed in Table 7-1. All modules except the ROMs and the CP/M system are compatible with the entire line of Series 80 Personal Computers. Nine of these modules (the seven interface modules, the modem, and the speech synthesis module) use internal switches to set the module select code. The select code is used by the computer to differentiate the modules and to route input/output operations to the appropriate device.

Lesson 7 will concentrate on the repair strategy for these nine modules. To troubleshoot each module you will need an HP 82936A ROM Drawer, an HP 86/87 I/O ROM, and the I/O Exerciser Disc, to run the diagnostic test programs. The basic repair strategy for

each module is to determine whether the module cable assembly (if present), or the module logic PCA is at fault. In most cases it will be the module logic PCA.

The following general concepts apply to servicing these modules:

- Safety Precautions.
- General Description.
- Troubleshooting Guidelines.
- Recommended Tools and Equipment.
- Disassembly and Reassembly of Modules.
- Setting Internal Switches.
- Running the Diagnostic Test Programs.

Lesson 7 covers each of these topics as they apply generally to all the interfaces. The HP-IB interface is used as an example in the interface troubleshooting lab at the end of the lesson. Following this lab there is a summary description of each of the accessory modules and special troubleshooting tips for each.

Table 7-1 itemizes the accessories covered in Lesson 7. Columns 3 and 4 pertain to testing procedures covered later in this lesson.

Refer to Appendix A-9.

Disassembly and Reassembly of Modules

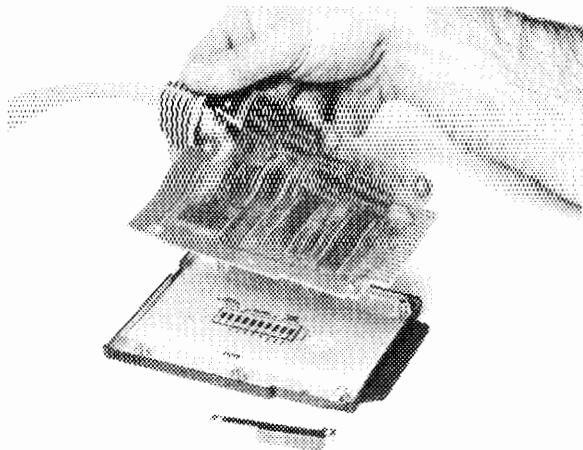
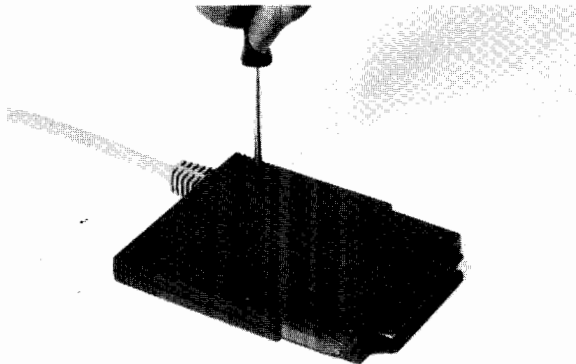
Because of the common construction of all interfaces, the following basic techniques apply to disassembling and reassembling any module.

To disassemble a module:

1. Remove the screws holding the top and bottom case together.
2. Lift off the bottom case.

top case.

4. If there is a cable attached to the PCA, unplug the cable socket from the cable plug on the logic PCA.
5. Remove the locknuts from the cable clamp using a ¼-inch nut driver.
6. Remove the top clamp.
7. Separate the PCA and cable assembly.
8. If there is a second cable assembly, repeat steps 4-7.

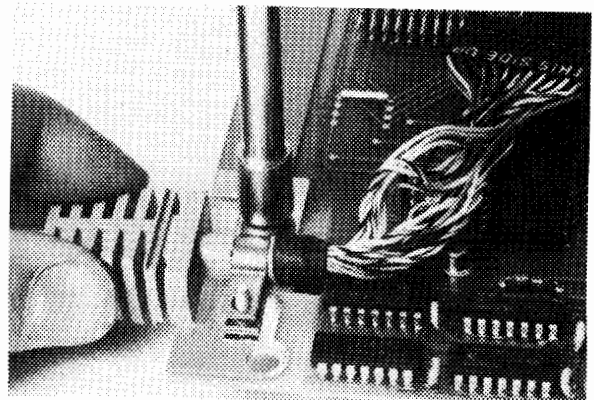


1. Ensure that the bottom cable clamp is in place on the PCA. (The bottom clamp has a larger loop than the top clamp.)
2. Place the cable assembly onto the bottom clamp. Keep the insulation cutout facing away from (but aligned with) the bottom clamp.
3. Fasten the cable in place using the top cable clamp and two locknuts. (The top clamp has a smaller loop than the bottom clamp.) The top clamp fits into the insulation cutout and contacts the cable shield.

CAUTION!

Be sure the printed label on the cable socket faces up. Otherwise, components may be damaged.

4. Plug the cable socket into the connector on the PCA. Be sure the label faces up.
5. Check the labels inside the case halves. These labels serve as electrical insulators. If either label is damaged, replace the case.
6. Place the PCA into the top case. Keep the edge of the case between the first and second ribs of the strain relief. Be sure the larger screw holes in the PCA fit around the posts. The components should face into the top case.
7. Place the ground contact onto the edge of the PCA. The contact should lay along the outside edge of the top case.
8. Place the bottom case onto the top case and PCA.
9. Install the screws. Be sure that the ground contact remains snug against the side of the top case.



Module Disassembly

Setting Internal Switches

Every interface must have a distinct select code to differentiate it from other interfaces. The following list summarizes the factory preset default select codes for the Series 80 interfaces. Each of the interfaces has at least 3 switch segments dedicated to setting the select code. For more information about how to set switches, refer to the Service Manual or the Interface Owner's Manual.

Interface	Factory Preset Select Code
HP-IL	9
BCD	3
GPIO	4
Printer	8
Data Link	10
HP-IB	7
Serial	10
Modem	10
Speech Synthesis	10

When you run the diagnostic programs, remember that select code 7 has been set aside for the internal disc/printer or HP-IB interface, and you cannot use this as a select code for either a test or reference interface.

There are additional switches in the BCD, GPIO, data link, HP-IB, and serial interfaces. These switches control default operational parameters such as Baud rate for the serial interface, and 8-bit or 16-bit operation for the GPIO interface. Most of the diagnostic programs require that these switches be preset to specific values. Be sure to read the test procedures in the Service Manuals in regards to setting both the select code switches and the default switches.



Table 7-1. Accessories for the HP 86.

Module Part Number	Product	Test Connector	Reference Interface
Interface Modules			
82937A	HP-IB Interface		Yes
82938A	HP-IL Interface		
	Serial Interface (RS-232-C)		
82939A	Female Connector	82944-60001	
82939A Opt 001	Male Connector	82944-60001	
82939A Opt 002	Current Loop	82947-60001	
82940A	GPIO (16-bit) Interface	82945-69901	
82941A	BCD Interface	82946-69901	
82949A	Printer Interface	82949-60002	
82966A	Data Link Interface	82966-60902	Yes
82950A	Modem		Yes
82967A	Speech Synthesis System	(1)	
Enhancement Modules			
82929A	Programmable ROM Module	(2)	
82928A	System Monitor	(3)	
82900A	CP/M System		
	HP 86/87 ROMs		
82908A	64K Memory Module		
82909A	128K Memory Module		

(1) Requires external speaker.

(2) Requires service EPROMs (P/N 82929-60903).

(3) Requires Programmable ROM Module with service EPROMs (P/N 82929-60903)

Optional Tools and Equipment

To troubleshoot accessory modules, you need:

- A #1 Pozidriv screwdriver.
- A ¼-inch nut driver.
- An HP 86 Computer.
- An HP 82912A 9-inch or HP 82913A 12-inch Monitor.
- An HP Flexible Disc Drive.
- An HP 82936A ROM Drawer.
- An HP 00087-15003 HP 86/87 I/O ROM.
- An HP 00087-60914 HP 86/87 I/O Exerciser Disc.
- An HP 00085-60958 Port Extender.
- An HP 0960-0062 Continuity Tester or a multimeter such as the HP 3449B Multimeter.
- The test connector for the interface being serviced (refer to Table 7-1 on previous page).
- A “yes” entry in column 4 of Table 7-1 indicates that testing requires a known-good reference module of the same type. For instance, testing the HP-IB interface requires that you have both the interface to be tested and an additional HP-IB interface that you know is working properly. If you are testing with an HP 86B, the internal HP-IB interface may be used as the reference.

Safety Precautions

Make sure you read and understand the precautions in the following paragraphs before you connect or disconnect an interface or peripheral.

Manufacturers of peripheral devices do not all use the same grounding technique. Often, earth ground and logic ground are at different voltage levels. In some instances, this is deliberate in an effort to reduce ground return interference with digital signals. Be aware that this potential may be high enough to be hazardous unless peripherals are connected in an exacting manner.

If you don't know the grounding technique used on a peripheral, check with the manufacturer of the device. After verifying that suitable grounding techniques have been used on the peripheral, follow the installation guidelines below.

WARNING!

To avoid personal injury and equipment damage, read and understand the preceding safety precautions and follow the guidelines below.

Follow these guidelines when connecting or disconnecting the interface or peripheral:

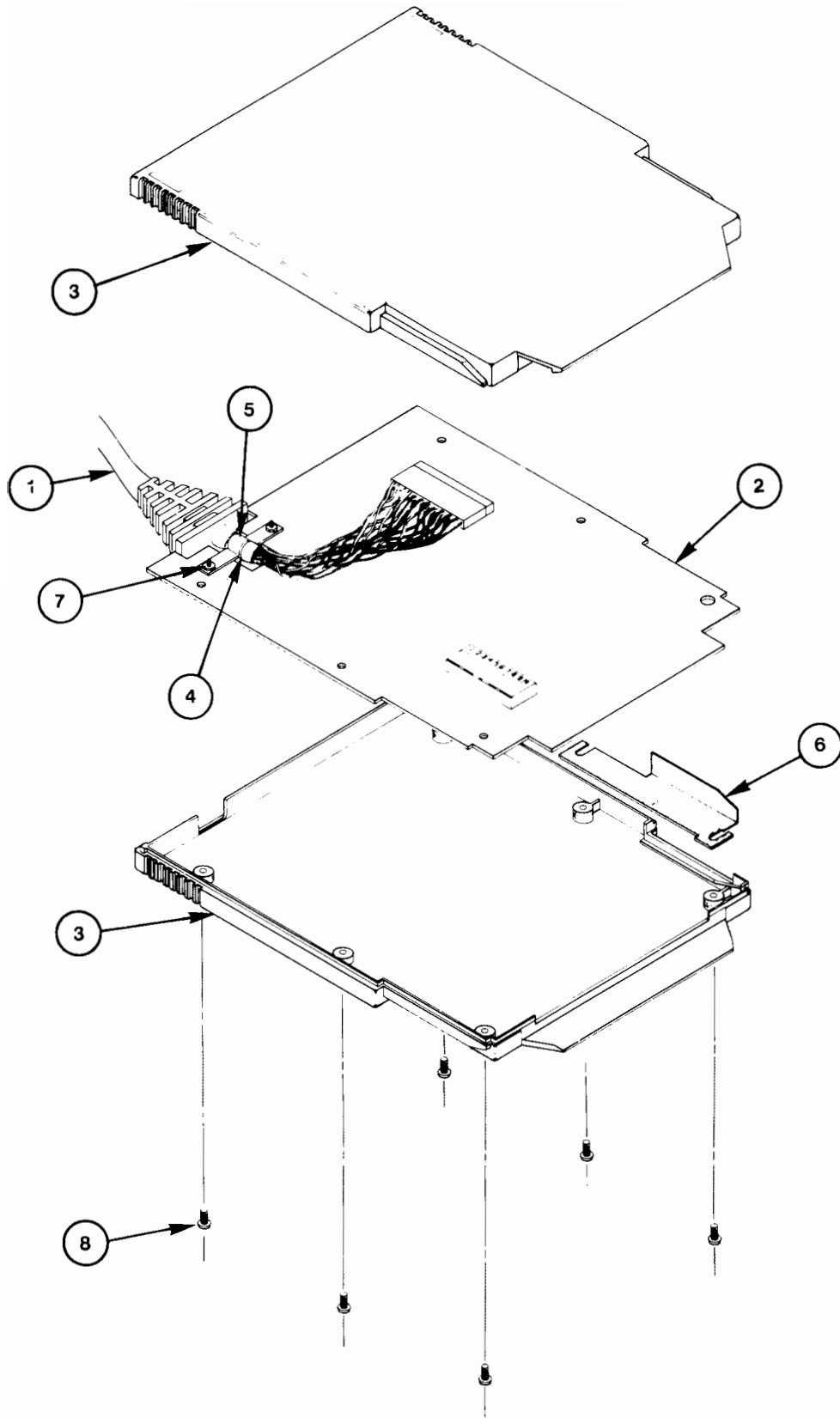
- a. Always turn off the computer and all peripherals before installing or removing the interface or any peripherals.
- b. Be sure the computer is plugged into a grounded (three-wire) outlet.
- c. Always have the interface module installed in the computer whenever any peripherals are being connected to or removed from the interface.
- d. Be sure that accessory cables remain connected to the interface module as long as peripherals are connected to them.
- e. Turn on the computer and peripherals only after all connections are made.

General Description

All of the Series 80 interfaces have similar design characteristics: each interface has a top and bottom case; a logic PCA; and one or two cable assemblies. Other than physical damage requiring complete replacement, the repair of interfaces is narrowed down to isolating and replacing one of two failed components, the logic PCA or the cable assembly.

The figures following and on page A-9 illustrate the replaceable parts of an HP-IB interface listed below:

1. Cable assembly.
2. Printed-circuit assembly.
3. Top case and bottom case.
4. Bottom cable clamp.
5. Top cable clamp.
6. Ground contact.
7. Locking nut.
8. Screw.



HP 82937A HP-IB Interface Exploded View

Running the Diagnostic Test Procedures

Troubleshooting and testing of Series 80 interfaces is simplified with the use of the diagnostic programs on the I/O Exerciser Disc. These programs were designed at the factory for component repair of each interface. If you are doing assembly level repair of the interface, then you need not concern yourself with the detail provided by the error messages other than to recognize when to immediately replace the PCA or cable, or whether to conduct further tests.

The following diagnostic routines are currently available on the I/O Exerciser Disc:

- HP 82900A CP/M System Test
- HP 82937A HP-IB Exerciser
- HP 82938A HP-IL Exerciser
- HP 82939A Serial Exerciser
- HP 82940A GPIO Exerciser
- HP 82941A BCD Exerciser
- HP 82949A Parallel Printer Interface Exerciser
- HP 82950A Modem Exerciser
- HP 82966A Data Link Exerciser
- HP 82967A Speech Synthesis Exerciser Module

To use the diagnostic programs:

1. Prepare the computer and interface for testing.
2. Insert the exercise disc into the disc drive.
3. Cycle power on the computer to autostart the supervisor program.
4. Optional: Set printer address, and select "print on" to record all error messages (especially useful when running repeated test cycles).
5. Press the softkey to select the diagnostic program for the interface being tested.
6. Compare the error message, if any, to the table in the appropriate Service Manual. Replace the PCA or perform further testing as necessary.

7. Insert the I/O Exerciser Disc into the disc drive. Load and run the supervisor program.
8. Select the appropriate diagnostic test and run it one or more times.
9. Locate any error message in the error table in the Service Manual and follow the recommended repair procedure—either replace the cable assembly, the logic PCA, or the entire unit.
10. Return any modified switches to the customer's setting recorded in Step 2.

Troubleshooting Guidelines

To troubleshoot Series 80 interface modules you will need a complete system consisting of a computer, display, mass storage device, ROM drawer, and I/O ROM. Then, with the aid of the I/O Exerciser Disc, you can use the computer to automatically test the interface.

The diagnostic programs test the interface by outputting commands and data to the interface and then reading back the new status of the interface to see if the expected result has occurred. If not, the interface needs repair.

To provide for looping signals back to the computer, test connectors have been designed to fit in place of cable assemblies on most of the interfaces. For the HP-IL interface no test connector is used; instead, the HP-IL connector that comes with the interface is simply looped back into the receiver connector. For the HP-IB and modem interfaces, the interface being tested is connected to a known-good reference interface; no special connector or cables are needed.

Briefly, troubleshooting includes the following steps:

1. Note the customer's concern. If the customer has changed the wiring configuration of the interface cable (especially RS-232-C, BCD, or GPIO modules), substitute a cable that is wired in the configuration in which the interface was shipped.
2. Disassemble the interface module. Record the customer's switch settings. Set the switches as required by the testing procedure.
3. Attach the appropriate test connector and test cables. (For HP-IB, the modem, and data link interface, install a known-good reference interface into an I/O port.)
4. Insert the test interface into a port extender. (For the HP-IB, the modem, and the data link interface, connect the test interface to the reference interface.)
5. Install the port extender (with the test interface installed) into an I/O port.
6. Install the ROM Drawer with an HP 86/87 I/O ROM.

HP 82939A Serial Interface (RS-232-C)

The HP 82939A Serial Interface provides bidirectional, asynchronous data communication between Series 80 computers and terminals or printers. The serial interface is also used in applications where two computers are communicating, such as remote data acquisition. This interface supports operation with the Series 80 mainframe acting as the computer or as the peripheral; an I/O ROM is required.

The serial interface can be ordered with one of three cable termination options: 1) a female connector (standard), 2) a male connector (Option 001) or, 3) current loop (Option 002). The PCA for each of these options is the same—the only differences are in the cables; e.g. installing an Option 002 cable assembly in a Standard Serial Interface changes the interface to current loop operation.

Customers frequently adapt the serial interface cable for their own applications, and this can often be the cause of improper operation. However, the Serial Interface diagnostic program is run with the cable assembly removed and a loop-back connector installed in its place. Malfunctions in the cable must be located with a continuity tester or by substitution of the cable assembly.

To run the Serial Interface diagnostic test:

- Set up the HP 86 test system with monitor, disc drive, I/O Exerciser disc, ROM drawer, and I/O ROM.
- Disassemble the module.
- Set the interface select code to a value other than 7 (the HP 86 internal interface select code.)

- Set the default switch to the factory setting.
- Remove the cable assembly.
- Install the test connector (there are two—one for standard and Option 1, and one for Option 3).
- Install the test interface into an I/O port using the port extender.
- Run either the short test, the long test, or both.

HP 82940A GPIO Interface

The HP 82940A GPIO Interface connects the computer to a variety of peripheral devices. It is a general-purpose interface which provides 16-bit or 8-bit data exchange between the computer and a peripheral device. The interface can transfer data in a half-duplex mode, which requires either an input or output handshake. The hardware and software characteristics of the interface are very flexible. Data exchange timing and logic can be configured to meet a wide variety of peripheral requirements; an I/O ROM is required.

Customers frequently adapt the GPIO interface cable for their own applications, and this can often be the cause of improper operation. However, the GPIO Interface diagnostic program is run with the cable assembly removed and a loop-back connector installed in its place. Malfunctions in the cable must be located with a continuity tester or by substitution of the cable assembly.

To run the GPIO Interface diagnostic test:

- Set up the HP 86 test system with monitor, disc drive, I/O Exerciser disc, ROM drawer, and I/O ROM.
- Disassemble the module.
- Set the interface select code to a value other than 7 (the HP 86 select code).
- Set the default switch as prescribed in the GPIO Service Manual.
- Remove both cable assemblies.
- Install the test connectors in place of the two cables.
- Install the test interface into an I/O port using the port extender.
- Run the diagnostic test.

HP 82941A BCD Interface

The HP 82941A BCD Interface supports interfacing with BCD (Binary Coded Decimal) instrumentation. These BCD instruments present all the digits of their operation at one time on a set of parallel lines. Common instruments with a BCD interface include voltmeters, multimeters, medical equipment, and weighing systems; an I/O ROM is required. The hardware and software characteristics of the interface are very flexible.

Customers frequently adapt the BCD interface cable for their own applications, and this can often be the cause of improper operation. However, the BCD Interface diagnostic program is run with the cable assembly removed and a loop-back connector installed in its place. Malfunctions in the cable must be located with a continuity tester or by substitution of the cable assembly.

To run the BCD Interface Test follow the same procedure as for the GPIO interface, but select the switch settings, test connectors, and diagnostic routine that are specific to the BCD interface.

HP 82949A Printer Interface

The HP 82949A Printer Interface connects Series 80 computers to a printer requiring a standard parallel printer interface. The interface provides uni-directional communication from the HP 86 to the printer. One printer at a time can be connected to the computer via the interface. (Since the HP 86A has a built-in printer interface, it is unlikely to see this interface being used with an HP 86A.)

To run the Printer Interface Test, follow the same procedure as for the GPIO interface, but select the switch settings, test connector, and diagnostic routine that are specific to the printer interface. The test connector for a parallel printer interface test differs from the BCD and GPIO connectors in that it has loop-back plugs to attach the standard interface cable to.

HP 82938A HP-IL Interface

The HP 82938A HP-IL Interface connects Series 80 computers to a number of low-power instruments, some battery-powered. Up to 30 devices can be connected on one loop. Connectors on the interface accept the cables required to form the interface loop.

To test the HP-IL Interface:

- Set up the HP 86 test system with monitor, disc drive, I/O Exerciser disc, ROM drawer, and I/O ROM.

- Set or verify the interface select code of the interface as specified in the HP-IL Service Manual.
- Set the default switches of the interface as prescribed in the HP-IL Service Manual.
- Connect the interface ports to each other using an HP-IL cable.
- Run the diagnostic test.

HP 82950A Modem

The HP 82950A Modem provides HP Series 80 computers with the ability to use the public telephone network for data communications operations. It features:

- Standard Baud rate of 300—lower Baud rates are software selectable.
- Bell 101/113 compatible.
- Full-duplex, asynchronous operation.
- Automatic or manual originate and answer.
- Automatic dialing of voice calls.
- Direct connection to the public telephone network.

The modem is larger in profile than most of the other plug-in modules. When it is inserted into a port, it partially blocks the port above it. However, the modem can be inserted a port with the ROM drawer placed in the port above the modem.

To test the modem:

- Set up the HP 86 test system with monitor, disc drive, I/O exerciser disc, ROM drawer, I/O ROM, and a known-good reference modem.
- Set the interface select code of the test interface and reference interface, as specified in the *Modem Service Manual*.
- Set the default switches of the test interface and reference interface as prescribed in the *Modem Service Manual*.
- Connect the test and reference interfaces to each other using the modular plug telephone cables.
- Run the diagnostic test.

HP 82967A Speech Synthesis Module

The HP 82967A Speech Synthesis Module provides speech generation for Series 80 computers. The system uses a parametric coding scheme known as LPC (line predictive coding) to generate high-quality speech at moderately low data transfer rates. It is exclusively a voice synthesis system; it is not capable of performing voice recognition.

To test the Speech Synthesis Module:

- Set up the HP 86 test system with monitor, disc drive, I/O Exerciser disc, ROM drawer, and I/O ROM.
- Set or verify the select code of the interface as specified in the *Speech Synthesis Module Service Manual*.
- Attach an 8-ohm speaker.
- Run the speech synthesis module diagnostic test.

HP 82966A Data Link Interface

The HP 82966A Data Link Interface allows Series 80 Personal Computers to function effectively in data communications networks hosted by HP 1000 and HP 3000 computers. The interface uses the I/O ROM and handles data link protocol. An HP 3074A Data Link Adapter is required to make the electrical connection to the link.

The interface is designed to be used as part of a Distributed Systems Network/Data Link (DSN/DL), consisting of several computer systems interconnected by one or more Data Comm lines.

To test the Data Link Interface:

- Set up the HP 86 test system with monitor, disc drive, I/O Exerciser disc, ROM drawer, I/O ROM, and a known-good reference data link interface.
- Set the interface select code of the test interface and reference interface as specified in the *Data Link Service Manual*.
- Set the default switches of the test interface and reference interface as prescribed in the *Data Link Service Manual*.

- For the short test, plug the labelled end of the test cable into the test interface.
- Run the short test.
- For the long test, install the reference interface, and connect the test cable from the test interface to the reference interface (change switch settings as specified in the Service Manual).
- Run the long test.

HP 82907/8/9A Memory Modules

The above memory modules add 32K, 64K, and 128K (respectively) of memory to the HP 86. When a module is installed, the additional memory automatically becomes accessible for storing data and BASIC programs. Any combination of modules can be installed at one time.

The external RAM test included in the service ROMs provides for testing the memory modules.

HP 82929A Programmable ROM Module

The HP 82929A Programmable ROM Module allows standard ROMs to be used with Series 80 computers. Assembly language programs developed using the HP 86 Assembler ROM and HP 82928A System Monitor can be used to program standard EPROMs, which are installed into the computer using the programmable ROM module.

To test the Programmable ROM Module:

- Set up the HP 86 test system with a monitor.
- Disassemble the programmable ROM module.
- Set the address switches as specified in the Service Manual.
- Install the test EPROMs.
- Using a port extender, install the module into an I/O port.
- Turn on the computer and run the test program in the service EPROMs.

HP 82928A System Monitor

The HP 82928A System Monitor simplifies developing and debugging assembly language programs for Series 80 computers. It allows the user to set breakpoints and to single-step through programs. When the system monitor is used with the HP 86/87 Assembler ROM, programs can be executed in real time and halted at predetermined points. While the program is halted, the user can modify register and memory locations, select a new breakpoint, and continue execution until the next breakpoint. Registers and memory locations can also be modified during single stepping.

To test the System Monitor:

- Set up the HP 86 test system with a monitor.
- Install the service EPROMs in a programmable ROM module, and install in an I/O port.
- Install the system monitor in another I/O port.
- Turn on the computer and run the test program in the service EPROMs.

HP 82936A ROM Drawer and Enhancement ROMs

The HP 82936A ROM Drawer contains six slots for enhancement ROMs. Enhancement ROMs expand the capabilities of the HP 86 by providing additional BASIC statements, functions, and commands. ROMs are installed into the ROM drawer, which in turn is inserted into an I/O port.

The External ROM Test included in the service ROMs provides for testing enhancement ROMs. The ROMs are not serviceable. If one fails, it is simply replaced.

HP 82900A CP/M System

The HP 82900A CP/M System extends the HP 86 system by adding a Z-80 processor and 64K bytes of dedicated RAM (CP/M user memory). With the CP/M operating system loaded from the disc, the HP 86 will accept software written under the CP/M operating system. The CP/M system plugs into one of the I/O ports of the HP 86.

To test the CP/M system:

- Set up the HP 86 test system with monitor, disc drive, and I/O Exerciser disc.
- Install the CP/M system in an I/O port.
- Turn the computer on and run the CP/M diagnostic test from the I/O Exerciser disc.

HP-IB Interface

The HP 82937A HP-IB Interface Module permits bidirectional, asynchronous communication among a wide variety of instruments and peripherals. It implements the IEEE 488-1978 Standard Digital Interface for Programmable Instrumentation, and allows the computer to communicate with as many as 14 HP-IB compatible devices per interface, with a total of up to 20 meters of cable.

The HP-IB interface can be used with disc drives, plotters, and printers with the commands available with the built-in ROMs, but to make full use of this interface to control instruments requires the HP 86/87 I/O ROM (P/N 00087-15003).

The HP-IB interface module connects to the mainframe by plugging into one of the I/O ports on the backplane. The connector on the end of the interface cable plugs into the HP-IB receptacle on the peripheral device. Accessory cables are used to connect additional peripherals.

To learn more about the HP-IB interface, and to learn repair skills that apply to all the interfaces, do the following lab.

STOP!

Complete Optional Lab Project 8 now—Troubleshooting the HP-IB.

Optional Lab Project 8

Troubleshooting the HP-IB Interface

In this exercise you will learn both disassembly and assembly techniques, as well as how to set up for the interface test programs, how to set interface switches, how to test for continuity in the HP-IB cable, and how to run the test programs.

Equipment Required:

- HP 86 Personal Computer, 5¼-inch disc drive, and video monitor.
- Printer (for optional printing of test messages).
- HP 82936A ROM Drawer and 00087-15003 I/O ROM.
- 2 HP 82937A HP-IB Interface Modules, when using an HP 86A; one is sufficient with an HP 86B.
- HP 00085-60958 Port Extender.
- #1 Pozidriv screwdriver.
- ¼-inch nut driver.
- Ohmmeter and small probes.

Start now!

- _____ 1. In order to test an HP-IB interface you will need the help of an HP 86 Computer System, with a ROM drawer and HP 86/87 I/O ROM (provides BASIC I/O control statements used by test programs), a video monitor (displays test messages), a 5¼-inch disc drive (to load test programs, and a known-good HP-IB interface. When using an HP 86B, either the internal or external HP-IB interface may be tested.

Assemble these items now. Label one HP-IB interface as the GOOD interface, and the other as the TEST interface.

- _____ 2. Use the following procedure to prepare the GOOD interface for the tests that follow:*
- a. Using a #1 Pozidriv screwdriver, remove the seven screws holding the bottom case.
 - b. Lift off the bottom case.
 - c. Lift the PCA and ground contact out of the top case.
 - d. The operation of the interface depends upon the settings of the HP-IB switch S1. This 10-segment switch is located on the PCA inside the interface module. The segments are preset at the factory, but they may have been reset by the customer to a different setting.

Set the switch segments of the GOOD interface to nonactive controller, talk listen address 20, and select code 6 (segments 2-10 set to 010100011).

If the switch is the slide type, the slides should be pushed toward the 0 or 1 printed on the PC board next to the switch. If the switch is the rocker type, the rockers should be pressed down at the end toward the desired setting.
 - e. The HP-IB interface responds to a parallel poll command by pulling one of the DIO lines low. The line is selected by a jumper wire on the PCA. The jumper is initially installed between E1 and E2 and selects DIO1 as the response line.

What is the parallel poll jumper set to for this card?

***Note:** When preparing the internal HP-IB interface of the HP 86B for use as either the GOOD or the TEST interface, move the top cover of the HP 86B and locate the HP-IB dip switch behind the I/O ports on the logic PCA rear edge.

It may then be set just as the HP 82937A HP-IB Interface (described later).

Although the S1 switch must be set as described above in order to run the HP-IB interface test programs, it does not matter how the parallel poll jumper has been set.

Should you need to change the parallel poll response line, first disconnect the interface from all devices, then unplug the cable connector from the PCA connector by prying them apart. Unsolder and remove the jumper from the PCA. Install and solder the jumper in the two holes corresponding to the chosen DIO line. Reconnect the cable connector. Be sure the printed label on the connector is facing up.

- e. Place the PCA into the top case. Keep the edge of the case between the first edge of the strain relief. Be sure the larger screw holes in the PCA fit around the posts. The components should face into the top case.
 - f. Place the ground contact onto the edge of the PCA. The contact should lie along the outside edge of the top case.
 - g. Place the bottom case onto the top case and PCA.
 - h. Install the six screws. Be sure that the ground contact remains snug against the side of the top case.
- 3. Separate the case of the TEST interface by removing the six screws as described in Step 3 above (unless the TEST interface is internal to the HP 86B, in which case the computer's top case must be removed).
- 4. Separate the cable assembly from the PCA as follows:
- a. Unplug the cable plug from the cable connector on the PCA connector by prying them apart. Do not pull on the wires.
 - b. Remove the two locknuts from the cable clamp using a ¼-inch nut driver.
 - c. Separate the PCA and cable assembly. Leave the bottom cable clamp in place on the PCA; the bottom clamp has a larger loop than the top clamp.
- 5. Check for continuity from the HP-IB connector to the J1 connector: (delete this step for the HP 86B internal interface).

HP-IB Signal	HP-IB Connector	J1 Connector	Continuity?
DIO1	1	22	
DIO2	2	23	
DIO3	3	1	
DIO4	4	24	
EOI	5	21	
DAV	6	11	
NRFD	7	10	
NDAC	8	12	
IFC	9	9	
SRQ	10	7	
ATN	11	6	
SHIELD	SHIELD	20	
DIO5	13	2	
DIO6	14	3	
DIO7	15	4	
DIO8	16	5	
REN	17	8	
GRND	18	14	
GRND	19	15	
GRND	20	13	
GRND	21	16	
GRND	22	18	
GRND	23	19	
GRND	24	17	

- ___ 6. Reinstall the cable assembly:
 - a. Place the cable assembly onto the bottom cable clamp. Keep the insulation facing away from, but aligned with, the bottom clamp.
 - b. Fasten the cable in place using the top cable clamp and two locknuts; the top clamp has a smaller loop than the bottom clamp.

CAUTION!

Be sure the printed label THIS SIDE UP on the cable connector faces up. Otherwise components may be damaged.

- ___ c. Plug the socket into the connector on the PCA. Be sure the label faces up.
- ___ 7. Record the setting of the HP-IB switch in the TEST interface:

Set the switch to active controller, talk/listen address 21, and select code 5. Set segments 2-10 to 110101010.
- ___ 8. Turn off the HP 86 and all peripherals. Be sure to observe the precautions and guidelines described above when installing the HP-IB interfaces.
- ___ 9. Use* a port extender (00085-60958) to install the TEST HP-IB interface into any I/O port. Or, if no port extender is available, reassemble the TEST Interface, and install as a complete unit. The upper port is recommended so that the port extender can be easily used.
- ___ 10. Install the GOOD HP-IB interface into any other I/O port.
- ___ 11. Install an HP 86/87 I/O ROM (00087-15003) and ROM drawer into any other I/O port.
- ___ 12. Connect the two HP-IB cables together.
- ___ 13. Insert the disc containing the test programs into the disc drive.
- ___ 14. Turn on the monitor. Turn on the computer. Wait for the system to autostart the I/O exerciser program.
- ___ 15. Press the softkey that selects the HP-IB test.
- ___ 16. Select the short test. If you receive an immediate error message to the effect that the HP-IB switches are not set correctly, go back and check the S1 switch settings to both interfaces; it's very easy to confuse ones and zeroes when setting this switch, be sure to check the markings on the PC board.
- ___ 17. What two messages are displayed for the short test? (This test cycles two times.)

- ___ 18. Run the long test. What further messages are displayed? Attach a printout if you'd like. (This test also cycles two times.)

*This step is not necessary if the HP 86B internal interface is used as the TEST interface.

___ 19 Disconnect the two HP-IB cables and run the short test again. What error messages are displayed? Run the long test.

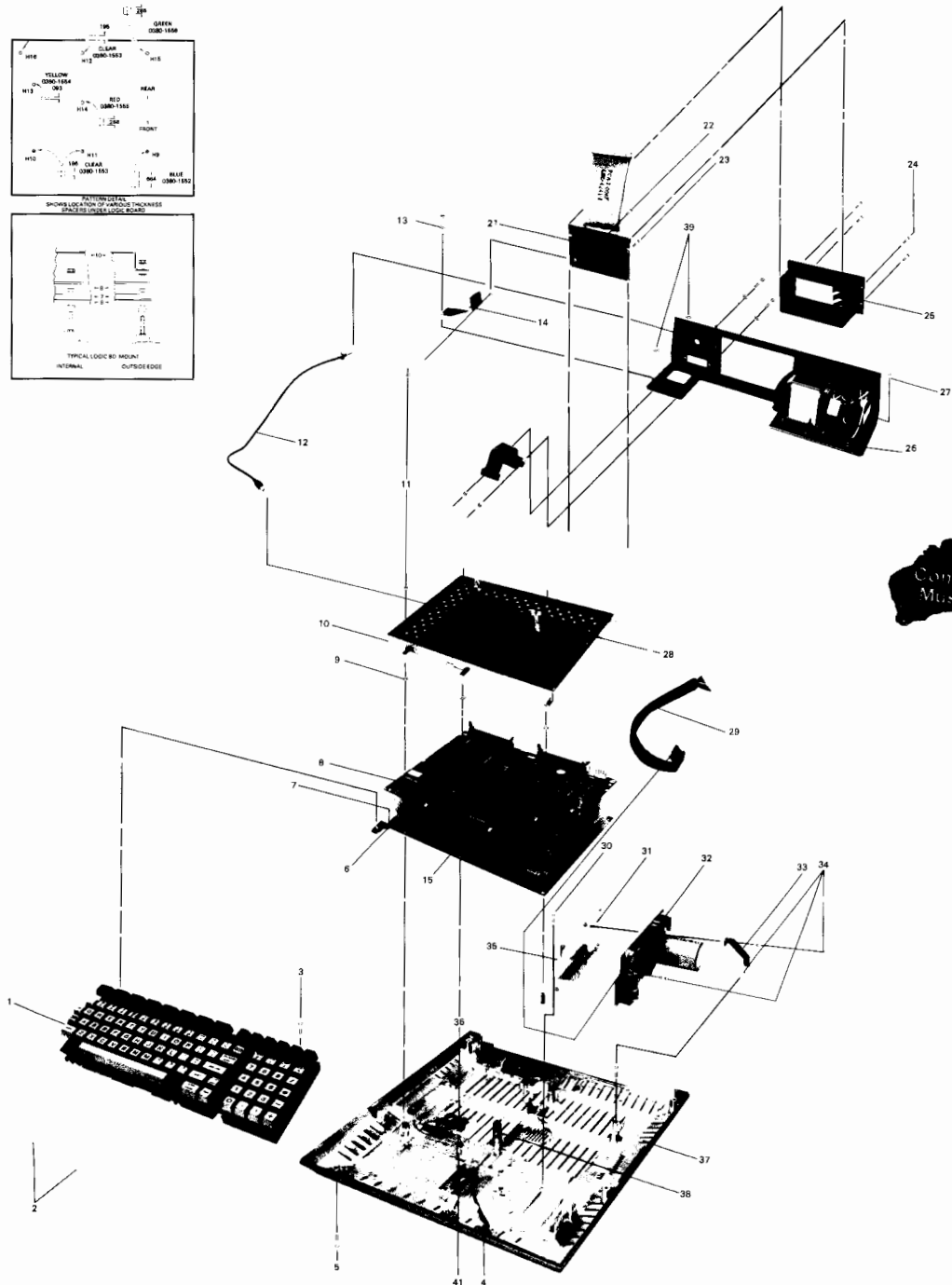
What error messages are displayed? Assuming the cables were actually connected, what is your diagnosis? How would you repair this interface?

___ 20. Power-off the computer, pull out the port extender, and reassemble the TEST module.

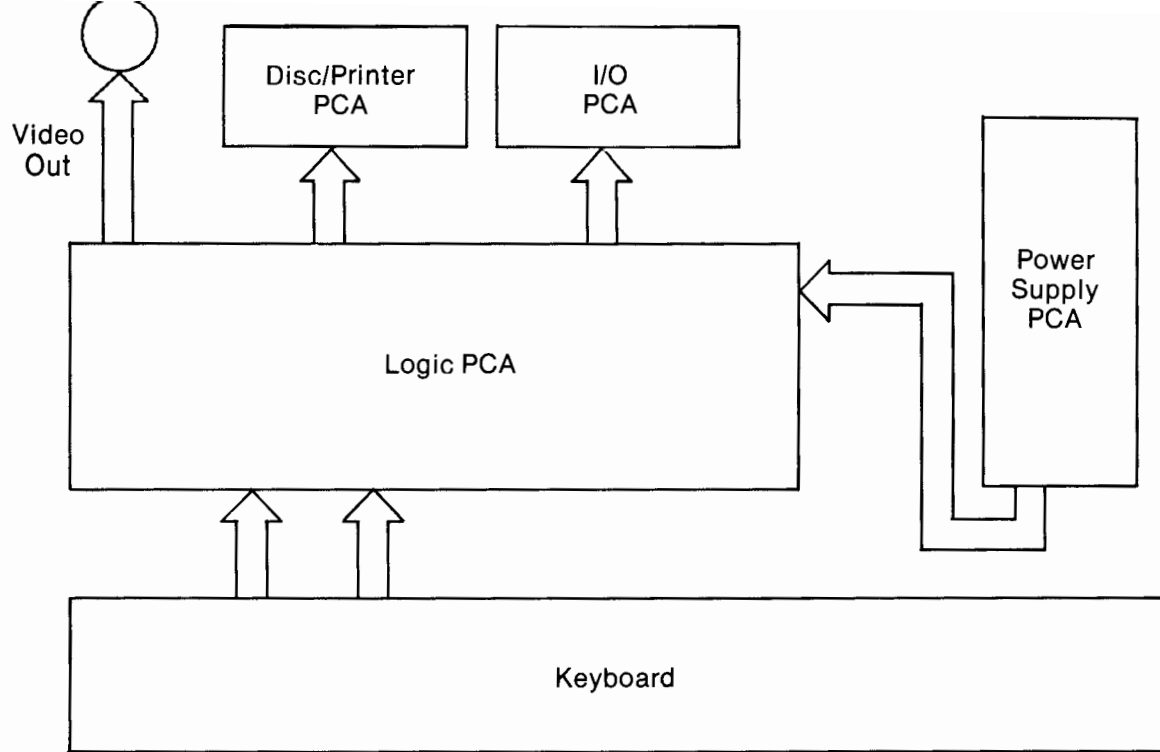
- a. Check the labels inside the case halves. These labels serve as electrical insulators. If either label is damaged, replace the case.
- b. Reset the S1 switch to the setting recorded at Step 7. The customer may be upset if the setting is different after servicing is completed!
- c. Place the PCA into the top case. Keep the edge of the case between the first and second ribs of the strain relief. Be sure the larger screw holes in the PCA fit around the posts. The components should face into the top case.
- d. Place the ground contact onto the edge of the PCA. The contact should lie along the outside edge of the top case.
- e. Place the bottom case onto the top case and PCA.
- f. Install the seven screws. Be sure that the ground contact is snug against the side of the top case.

Diagrams

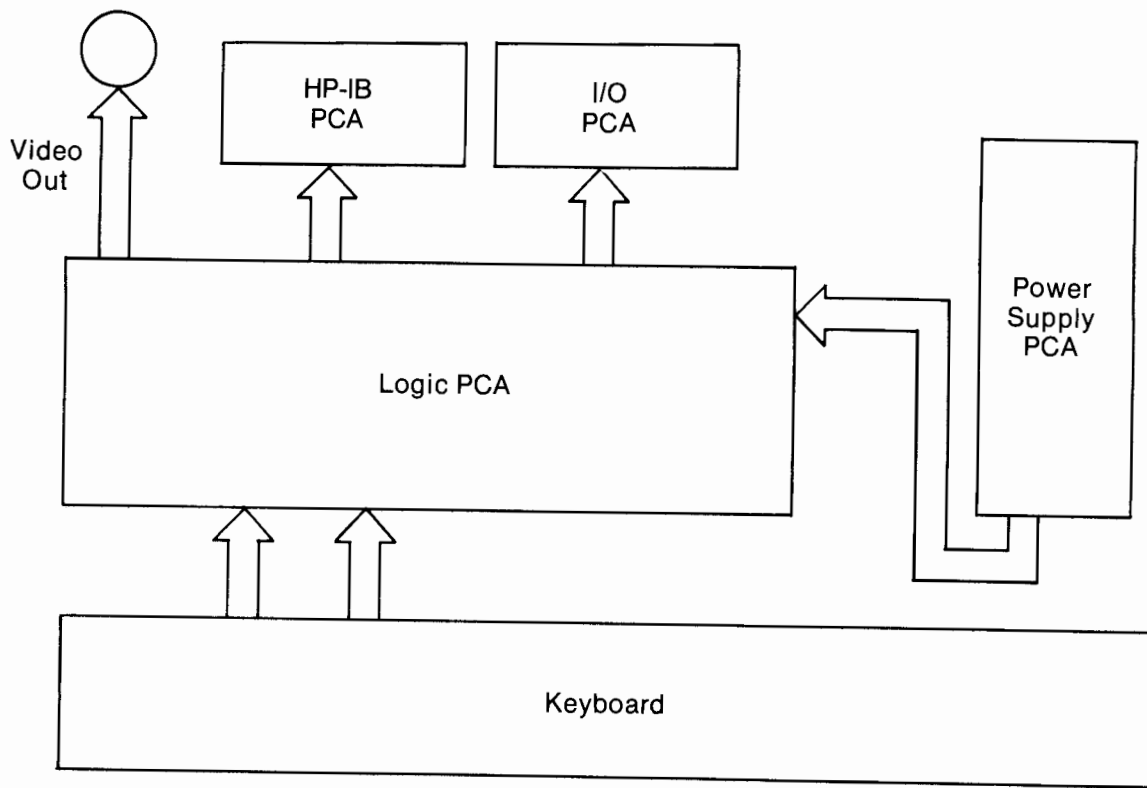
Appendix A



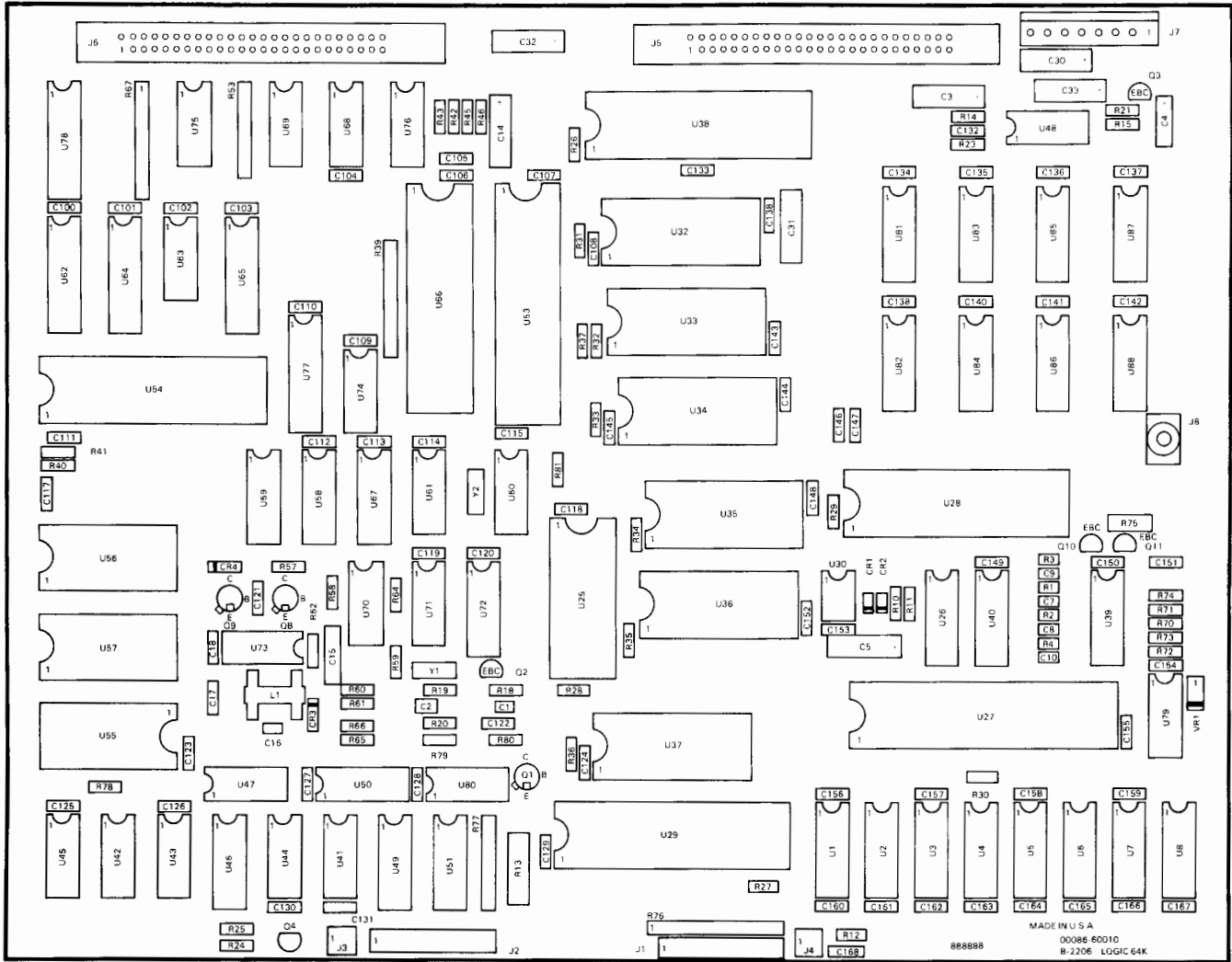
HP 86 Exploded View



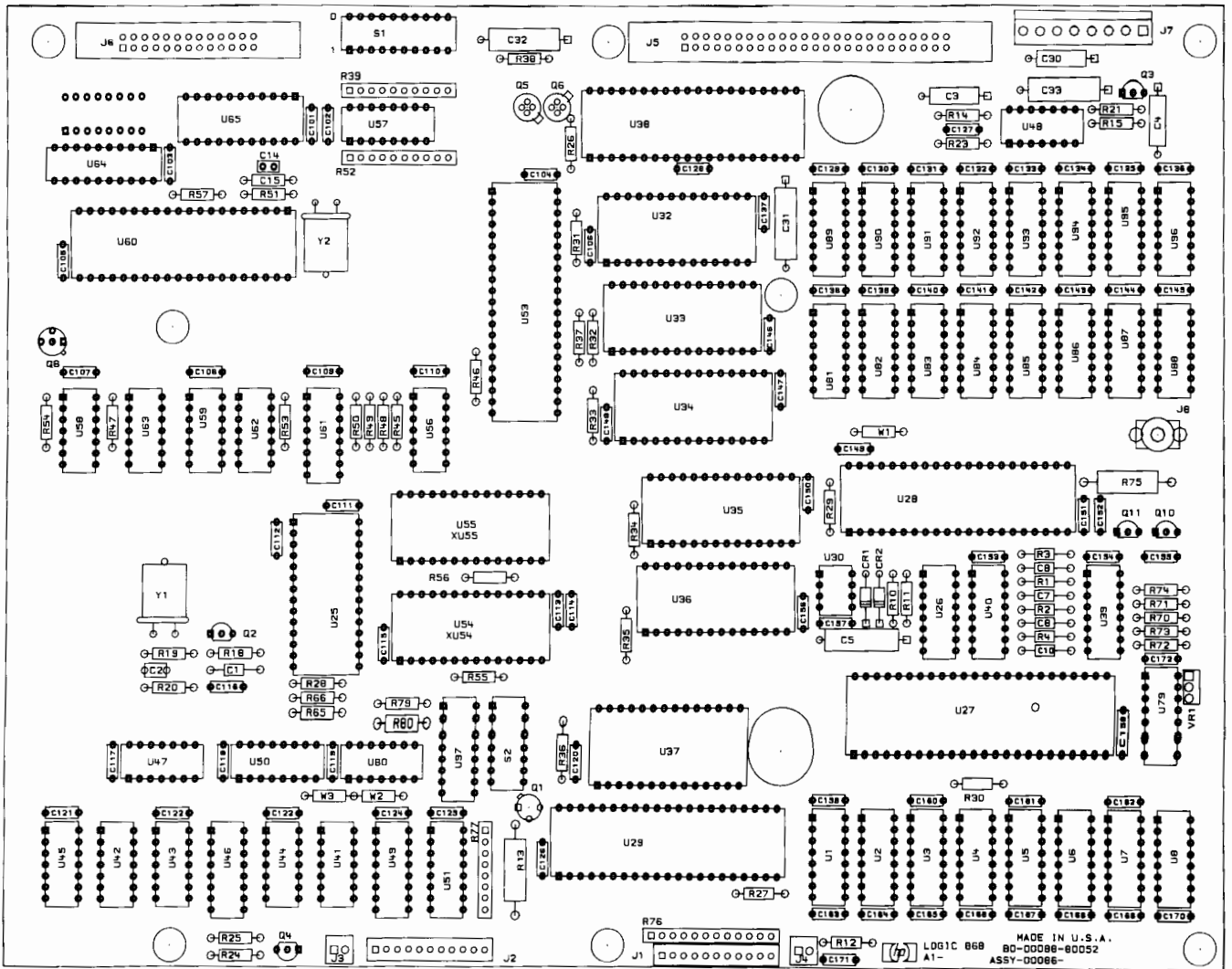
HP 86A Basic Block Diagram



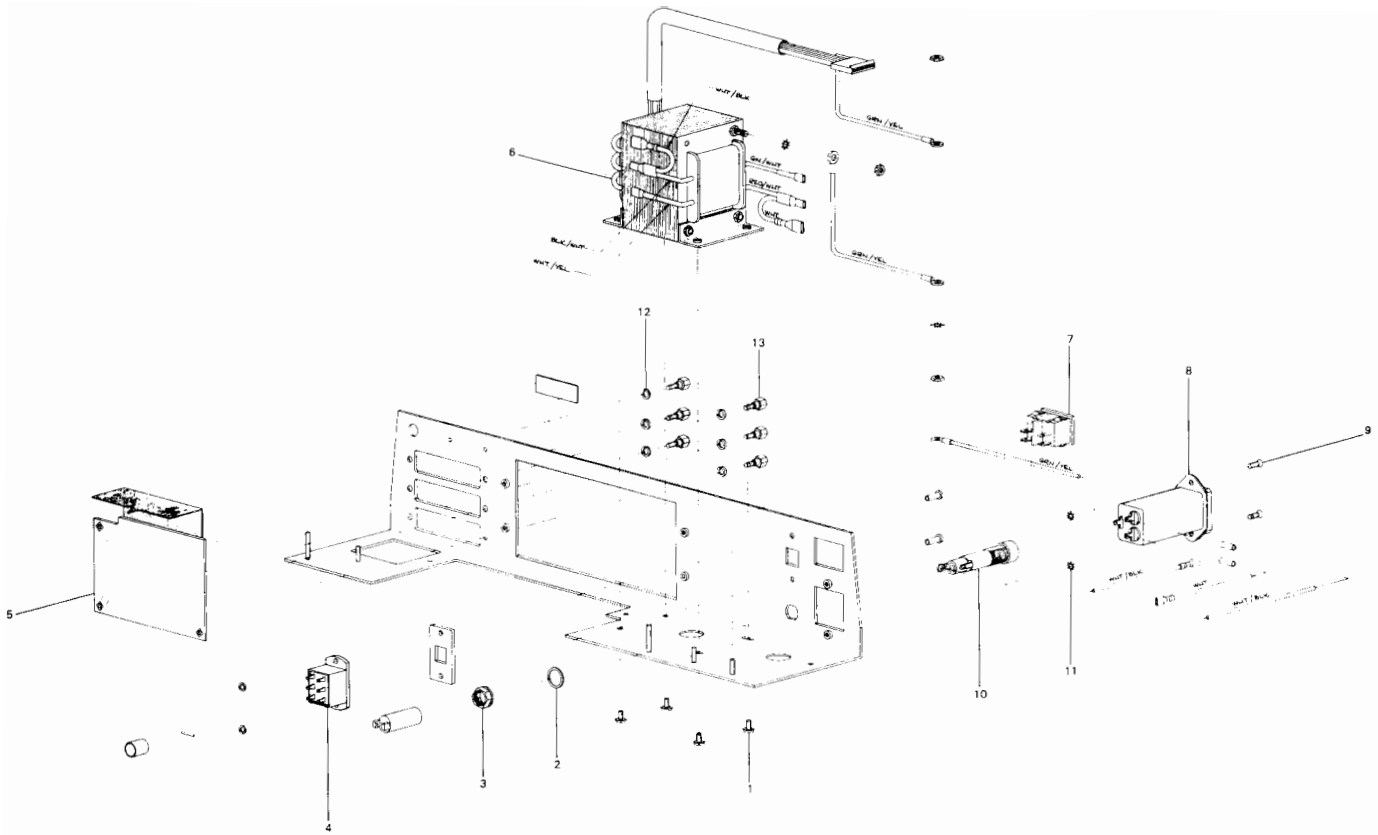
HP 86B Basic Block Diagram



HP 86A Logic PCA Component Location Diagram

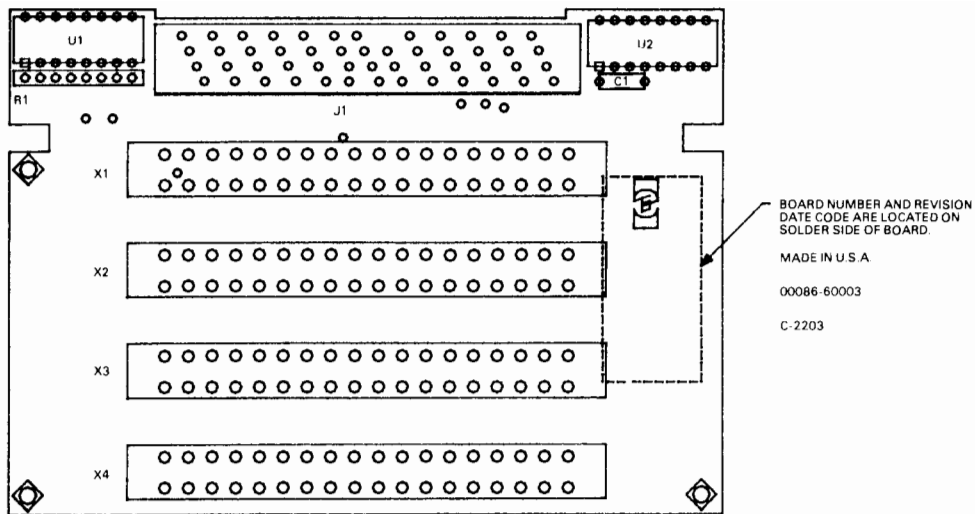


HP 86B Logic PCA Component Location Diagram

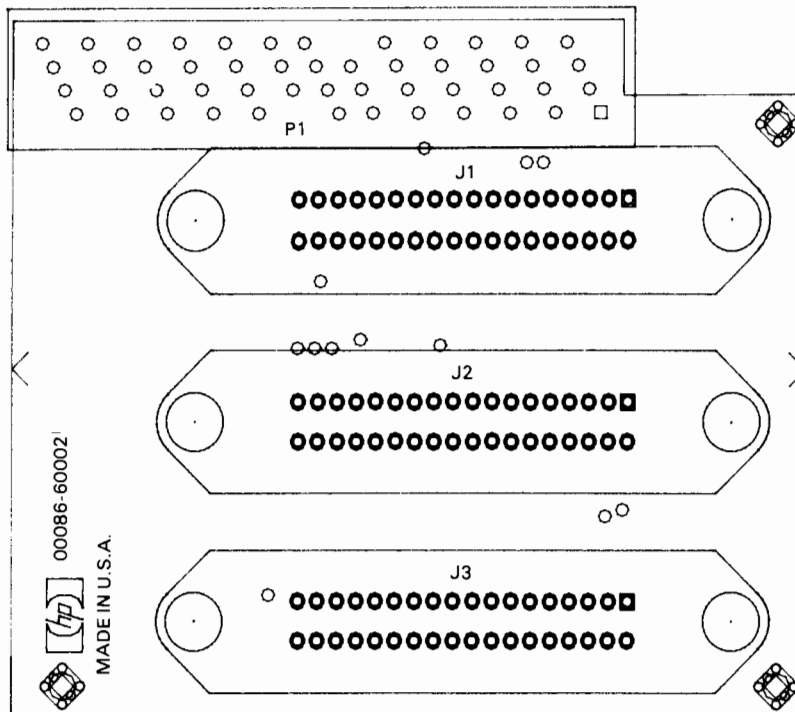


HP 86A* Back Panel Exploded View Diagram

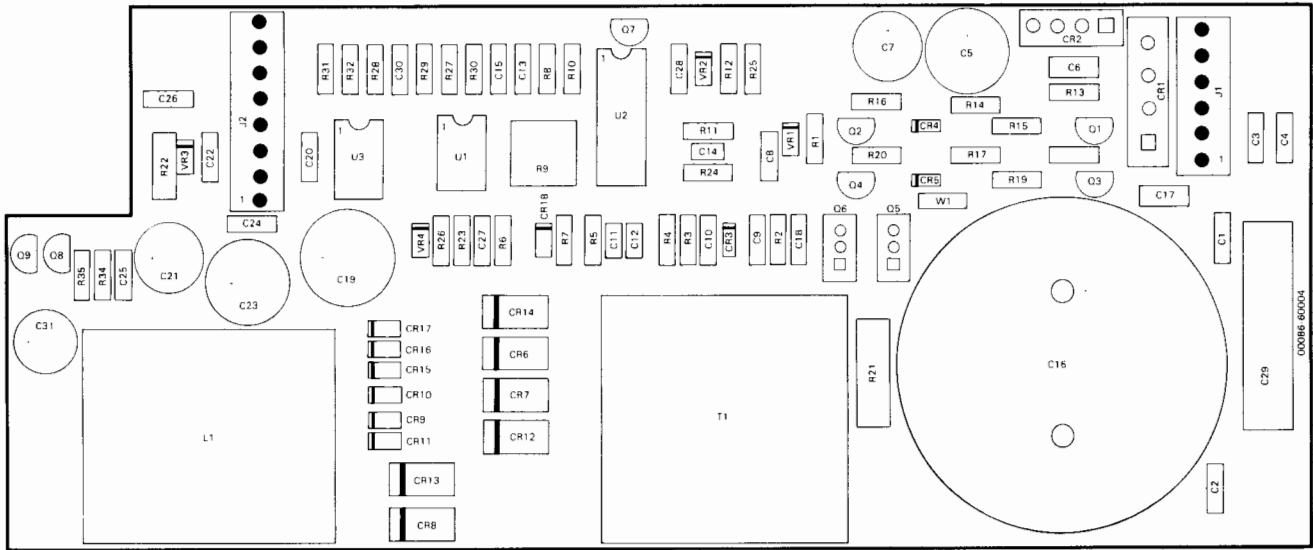
*The HP 86B Back Panel has an HP-IB connector instead of the disc drive and printer interfaces shown here.



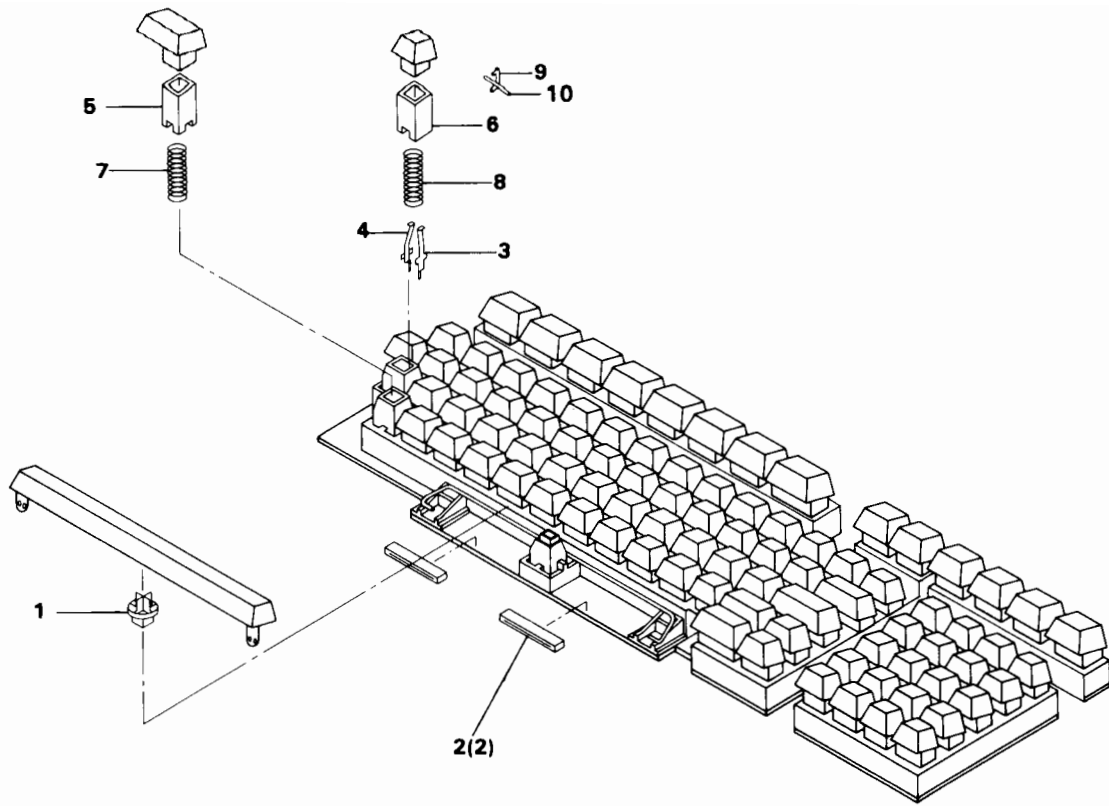
I/O PCA Component Location Diagram



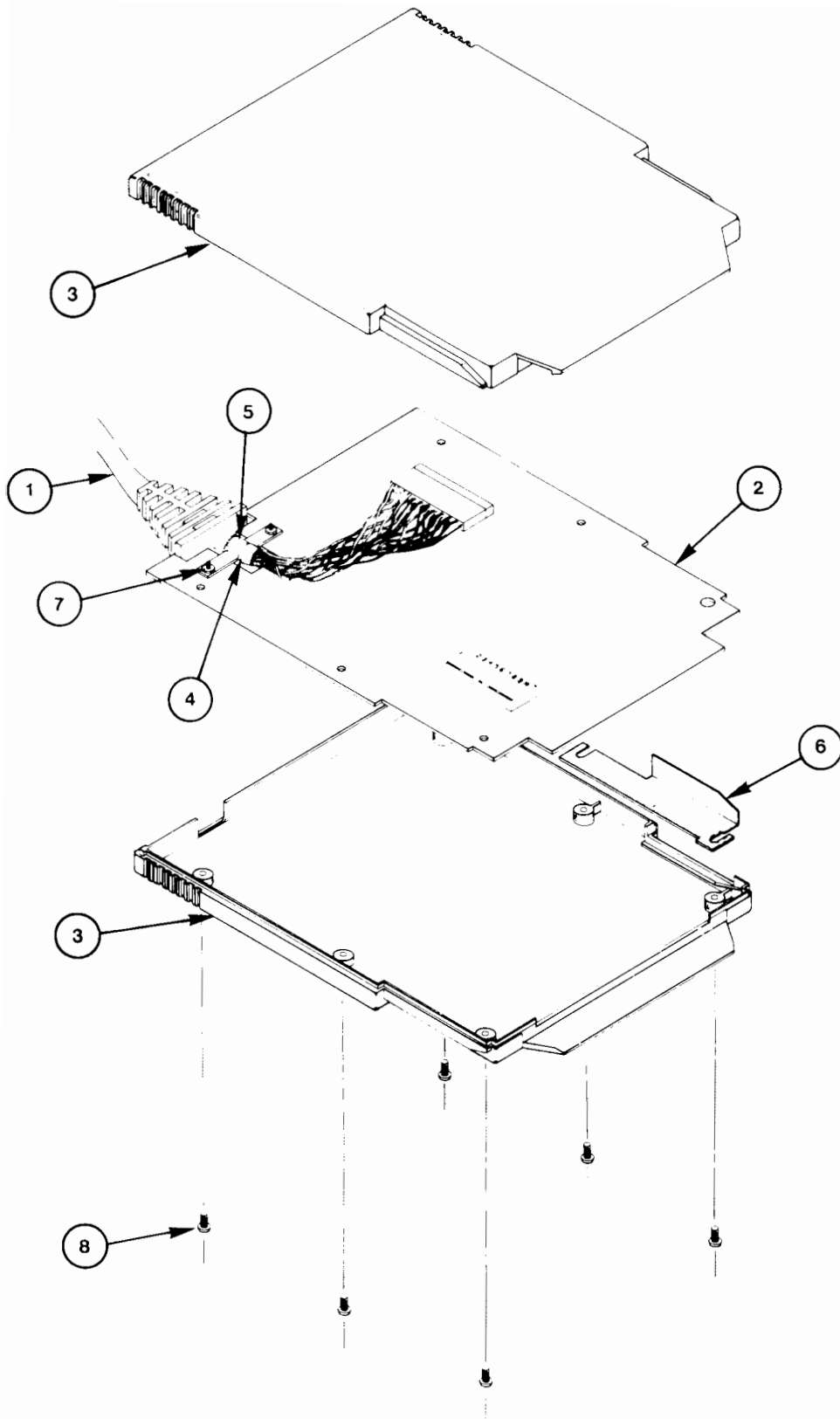
Disc/Printer PCA Component Location Diagram
(HP 86A)



Power Supply PCA Component Location Diagram



Keyboard Assembly Exploded View



HP 82937A HP-IB Interface Exploded View

Service ROM Self-Test

Appendix B

Test	Key	Command
System	A	SYSTEM
CPU	B	CPU
RAM	C	RAM
ROM	D	ROM
Beeper	E	BEEPER
CRT	F	DISPLAY
Timer	J	TIMER
Key	K	KBD
External RAM	L	XRAM
External ROM	M	XROM
Heat	N	HEAT X
Focus Pattern	O	FOCUS
Pincushion Pattern	P	PATTERN
QA	Q	QA X
Raster Screen	R	
Cycle	V	CYCLE

The Disc/Printer Interface ROM contains two tests:

Test	Key	Command
Printer	H	PRINTERTEST
Disc	I	DISC

The HP-IB Interface Service ROM contains two tests:

Test	Key	Command
Short HP-IB	H	HPIBx*
Long HP-IB	I	HPIBy

*For these tests "x" must be an odd integer, "y" must be even.

Problem Chart

Appendix

C

Quiz Answers

Appendix D

Quiz 1

1. Printer
9130 disc drives
I/O interfaces
2. Keyboard
Logic
Power supply
I/O PCA
Disc/printer PCA
3. True
4. All go to Logic PCA.
5. False
6. False
7. False
8. 7
9. False
10. 4

Quiz 2

1. True
2. **CAUTIONS:** inform you of potential for damage to equipment.
WARNINGS: inform you of potential danger to personnel.
3. False
4. False
5. OFF
6. 75 Ohms
7. Performs a self-test.
8. False
9. False
10. 4

Course Completion Summary

Appendix **E**

Section	Date Completed	Time Required
General Theory	_____	_____
Initial Set-Up	_____	_____
Test Procedures	_____	_____
Disassembly/Reassembly	_____	_____
Troubleshooting	_____	_____
How To Keep It Running	_____	_____
Interfaces and Enhancements	_____	_____

Student's Signature

Manager's Signature

Date

Date

Please complete this course summary and the evaluation form
on the reverse side and mail them to:

Hewlett-Packard, Computer Support Division
Attention: Training Program Engineering Manager
19320 Pruneridge Avenue
Cupertino, California 95014

Course Evaluation Form

HP 86 Self-Paced Hardware Maintenance Study

Student Name: _____ Date: _____

Company: _____

Address: _____

Service Manager: _____

	Yes	No
Do you feel the course objectives were met?	<input type="checkbox"/>	<input type="checkbox"/>
Did you find the course easy to read and understand?	<input type="checkbox"/>	<input type="checkbox"/>
Do you feel you need additional training on this subject?	<input type="checkbox"/>	<input type="checkbox"/>
Would you purchase another self-paced course?	<input type="checkbox"/>	<input type="checkbox"/>

How would you rate the following:

(check one)	Excellent	Very Good	Good	Acceptable	Poor
Quality of quizzes and exercises?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quality of information provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quantity of information provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Self-paced learning guide?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Service manuals provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Diagnostic tests?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quality of troubleshooting labs?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overall rating of the course?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Was the level of the course? too trivial about right too technical

Would you recommend this program to other people in your organization? Yes No

Why? _____

Additional Comments: _____

Mail to: Hewlett-Packard, Computer Support Division
Attention: Training Program Engineering Manager
Hewlett-Packard Computer Support Division
19320 Pruneridge Avenue
Cupertino, CA 95014

Glossary

Appendix **F**

AC= alternating current.

Bus lines= lines used by the computer for transmitting data, instructions, and addresses between parts of the computer system.

CPU= the central processing unit that handles the computer arithmetic and logical operations, addressing, and instruction operations.

CRT= the computer display screen (cathode ray tube).

EMI= electromagnetic interference.

Keyboard= the module containing the typewriter keys, numeric keypad, and editing keys.

IC= integrated circuit.

I/O= input/output operations whereby the computer transmits information to the user or to other devices.

PCA= printed circuit assembly.

Pincushioning= a condition of the CRT where supposedly straight lines are displayed bent.

PWO= power-on circuitry that ensures that ICs are not enabled until the power supply and system clocks have reached their proper states.

RAM= random access (read/write) computer memory used for temporary storage of programs and data.

ROM= read-only memory used to store the computer operating system.

Skew= a condition of the CRT where straight lines are displayed straight, but rotated from the angle at which they should appear.

Bibliography

Appendix G

	HP Part Number
Introduction to the HP 86	00086-90014
HP 87 Operating and BASIC Programming Manual	00087-90017
HP 86A Assembly Level Service Manual	00086-90038
HP 86B Assembly Level Service Manual	00086-90080
HP 82928A System Monitor Installation Sheet	82928-90001
HP 82928A System Monitor Service Manual	82928-90002
HP 82929A Programmable ROM Module Instruction Sheet	82929-90012
HP 82939A Programmable ROM Module Service Manual	82929-90002
HP 82937A HP-IB Interface Owner's Manual	82937-90017
HP 82937A HP-IB Interface Service Manual	82937-90013
HP 82938A HP-IL Interface Owner's Manual	82938-90001
HP 82938A HP-IL Interface Service Manual	82938-90002
HP 82939A Serial Interface Owner's Manual	82939-90012
HP 82939A Serial Interface Service Manual	82939-90008
HP 82940A GPIO Interface Owner's Manual	82940-90011
HP 82940A GPIO Interface Service Manual	82940-90007
HP 82941A BCD Interface Owner's Manual	82941-90011
HP 82941A BCD Interface Service Manual	82941-90007
HP 82949A Printer Interface Owner's Manual	82949-90001
HP 82949A Printer Interface Service Manual	82949-90002
HP 82950A Modem Owner's Manual	82950-90001
HP 82950A Modem Supplement	82950-90006
HP 82900A CP/M System Owner's Manual	82900-90001
HP 82900A CP/M System Service Manual	82900-90002
HP 82907/8/9A Memory Module Instruction Sheet	5955-9414

