HP 110 Portable Computer

HEWLETT PACKARD

Self-Paced Hardware Training Guide

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HP 110 Portable Computer

Self-Paced Hardware Training Guide

First Edition, 1984

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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. A vertical bar in the margin indicates the changes on each 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.) The manual part number changes when extensive technical changes are incorporated.

First Edition ..... June 1984

Contents

Introduction

Purpose

This self-paced program has been designed to make the most of the learning experience for the student using a minimum of special tools and equipment required for the support of the HP 110.

To successfully complete this program you should have:

- A good understanding of digital electronics.
- At least one year of experience in digital electronic repair or have direct supervision of each course lesson by a person with more than one year of experience in computer repair.

Materials Needed to Take This Course

- A working HP 110 computer for the entire program.
- A working HP 9114 Disc Drive for the troubleshooting lesson.
- The *HP 110 Portable Computer Owner's Manual* (00090-90004).
- The *HP 110 Self-Paced Hardware Training Guide* (00110+49A-90001).
- The HP 110 Service Documentation (00090-60909), which includes:
  - The *HP 110 Portable Computer Service Manual.*
  - The HP110 Diagnostic Disc.
- The Final Review Envelope (00110+49A-90003).
- The standard repair tools listed below.
- The expensed tool package (00090-67801) listed on the next page.

Standard Repair Tools

- T-10 Torx screw driver (8710-1422).*
- T-8 Torx screw driver (8710-1418).*
- 10mm Hex driver (8710-1590).
- 5.5mm Hex driver (8710-1220).
- HP 3435A Digital Voltmeter (or equivalent).
- Oscilloscope — recommend 100 MHz (optional).
- Signature Analyzer — HP 5005A/B (optional).
- A 25 Vdc power supply.
- Soldering iron.
- Pace Desoldering Station
  Model #SX-301-HPS, available from:
  Tech-Ser
  1931 Old Middlefield Way, Suite F
  Moutain View, CA 94043

  Phone: (415) 969-9020
  HP Contact: Judd Shutts
  Estimated Cost: $615 + tax
- Double-sided Tape (00090-80033).

*Use bits with handle 8710-1413 and extension 8710-1425.

Expensed Tool Package

- Keyboard extension cable (00090-60910).
- Battery cable assembly (00090-60915).
- Diagnostic Module (00090-60904).
- One HP-IL cable (HP 82167A).
- 9-pin "D" test connector 1 (00090-60914).
- SVC EPROM assembly (00090-60908).

Other Useful Tools

- PAK-X-TRAC desoldering tool for 28-pin DIP (8960-0344).

Course Description

Products Covered

All HP 110 computers as of this printing are covered in this guide.

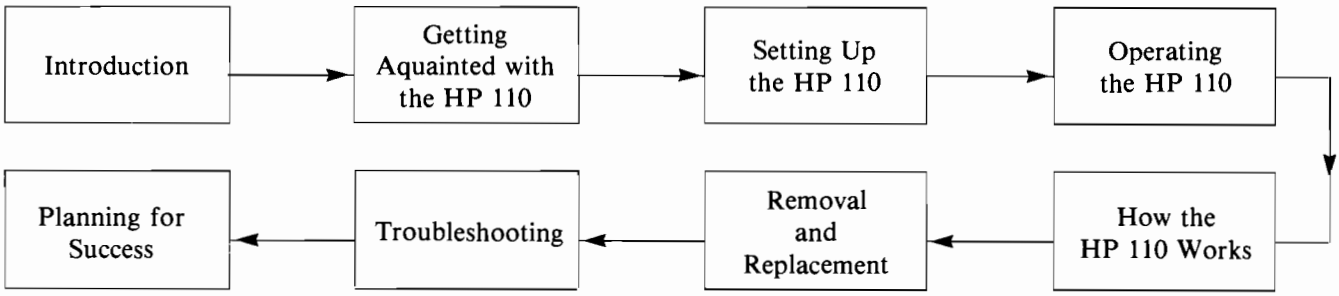
How to Take this Course

1. Give the sealed Final Review Envelope to your course coordinator.
2. Read each lesson in sequence.
3. Observe all warning notes before attempting the defined procedures.
4. Follow the instructions given in each lesson (for example, *Do Quiz 1-1 Now*).
5. Do the quizzes, assignments, and labs in each lesson. You can refer to the lesson material to answer questions.
6. If you answer all of the questions correctly, continue with the course. If you don't answer all questions correctly, go back and review the material covered by that question before continuing.

After completing the course, take the Final Review examination and correct it. (The final examination is open book.) If you answered any questions incorrectly, go back and review the material covered by those questions, and then answer those questions again. Study the material until you are able to answer all questions correctly.

Course Structure

The elements of the following flowchart are the major points to be covered to repair the HP 110 to the module/component level. This guide does not intend to develop good electronics technicians. It is designed to teach a good technician to repair the HP 110 computer to the module/component level.



Course Objectives

The primary goal of this guide is to train a qualified technician, using the HP 110 service manual, to repair the HP 110 in the most direct and efficient manner through an understanding of the normal operation of an HP 110.

The objectives to meet this goal are:

- To teach a technician efficient troubleshooting techniques by successfully completing the exercises and labs in the lesson on troubleshooting.
- To enhance the technician's knowledge of the HP 110 by performing labs and exercises and by reading the HP 110 owner's manual and HP 110 service manual.
- To train engineers or technicians, through labs and exercises using the HP 110 service manual, to service the HP 110. The labs provide hands-on testing and experimenting.
- To enhance the repair person's technical knowledge and enable the individual to reap greater benefits from product training and/or system 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 assembly level. Hewlett-Packard has used this approach in designing the HP 110.

This self-paced hardware training guide supplies the basic information for learning assembly-level and component-level repair of the HP 110 using the HP 110 service manual. Operator errors, installation configuration problems, program coding problems, and external data communication problems are not covered in detail and are part of other training programs available through customer training. Consult your local training catalog for more information.

All the material and information needed to repair the HP 110 are included in the HP 110 service manual.

There are various flags used throughout this course that must be followed to ensure your safety and the safety of the product. Be sure to pay special attention to the following symbols and text:

WARNING!

The WARNING symbol will be used above text where potential danger to an individual may occur.

CAUTION!

The CAUTION symbol will be used above text where potential danger to equipment may occur.

Notice

The NOTICE symbol will be used above text where attention to special instructions appear.

The STOP symbol will be used above text where student involvement occurs.

Course Completion Checklist

HP 110 Self-Paced Learning Guide

Lesson Title	Date Completed	Time Required	Supervisor's Initials
1. Getting Acquainted With the HP 110			
2. Setting Up the HP 110			
3. Operating the HP 110			
4. How the HP 110 Works			
5. Removal and Replacement			
6. Troubleshooting			
7. Planning for Success			

Program Completion Date _____

Student's Signature _____

Company Name _____

Address _____

_____

_____

Final Review Administered By: _____ Date: _____

Getting Acquainted With The HP 110

Lesson 1

Overview

This lesson gives an overview of the HP 110. It will help you become familiar with the main features and specifications of the HP 110.

Learning Objectives

You will be given reference information that provides an overview of the major components and specifications of the HP 110. You will be expected to correctly answer all questions covering:

- Major modules and assemblies of the HP 110.
- HP 110 memory.
- Display characteristics.
- Interface ports.
- Power requirements.

Product Features

Before going on with this lesson, take a few minutes to read chapter 1, "Getting Started" in the HP 110 owner's manual. It describes how to turn the HP 110 on and off, and shows you how to use the keyboard.

Interfaces

The HP 110 has three interface connections. They are located on the back of the computer. The three interfaces are:

- Hewlett-Packard Interface Loop (HP-IL).
- Serial.
- Modem.

The interfaces provide the HP 110 access to peripheral devices, such as printers and disc drives, and to other computers, such as the HP 3000.

The HP-IL interface enables the HP 110 to control up to 30 devices. All devices are connected in a loop by cables that are keyed to IN and OUT receptacles. For the loop to operate, all devices must be connected and turned on.

The serial interface can be connected to one device at a time, such as a printer or a modem. The serial connector on the back of the HP 110 is not standard, but the serial cable supplied with the HP 110 establishes a standard connection (RS-232).

The modem interface connects to a telephone line using a modular telephone connector. The modem enables the HP 110 to communicate with other computers over a phone line.

Memory

The HP 110 has 272K bytes of random-access memory (RAM) and 392K bytes of read-only memory (ROM). An "electronic disc" can occupy up to 176 bytes of RAM. You can store files and data on electronic disc as if it were an external disc drive. The portability of the HP 110 is enhanced by electronic disc because an external disc drive is not always needed when performing disc operations.

HP 110 Components

The HP 110 has seven major assemblies that are connected by cable as shown in the illustration below.

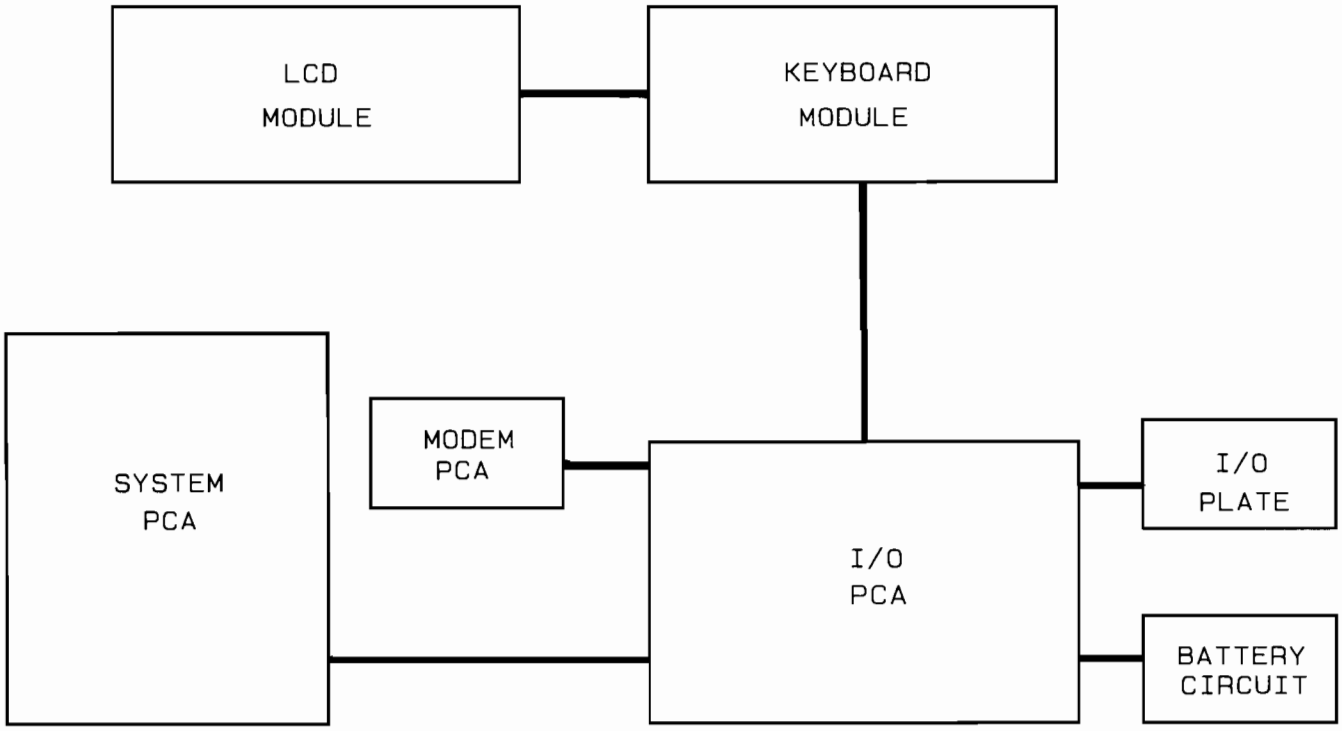


Figure 1-1. Major HP 110 Assemblies

Study the above figure; lines between assemblies represent cable connectors. The keyboard module consists of the keyboard printed circuit assembly (PCA) and keyboard assembly. The liquid crystal display (LCD) module consists of the LCD PCA and the liquid crystal display.

Read section 1 of the HP 110 service manual.

Stop! Do Quiz 1-1 now!

Quiz 1-1
HP 110 Specifications

1. List the seven major assemblies and modules of the HP 110.

2. What test do you use first when you begin to service the HP 110?

3. How many lines of text fit on an HP 110 display?

4. How many characters can fit across an HP 110 dipslay?

5. List the three interfaces on the HP 110.

6. How many bytes of Random-Access Memory (RAM) does the HP 110 have?

7. How many bytes of Read-Only Memory (ROM) does the HP 110 have?

8. List the following power specifications of the HP 110:
   - Battery type.
   - Battery capacity.
   - Battery recharging time.
   - Power consumption.

9. For the following serial number, list the sequence number, manufacturing location, week manufactured, and year manufactured: 2436A19865.

Correct Quiz 1-1 now using the answers given on the following page.

Quiz 1-1 Answers

1. System PCA, I/O PCA, Modem PCA, LCD Module, Keyboard, I/O Plate, Battery Circuit.
2. Built-in diagnostic test.
3. 16.
4. 80.
5. HP-IL, Serial (RS-232), Modem.
6. 272K bytes.
7. 392K bytes.
8. Battery type: 6-volt, sealed, 3-celled, lead-acid.
   Battery capacity: 2½ ampere-hours.
   Battery recharging time: 95 percent charged in 12 hours if turned off; 20 hours if turned on.
   Power consumption: 160mA typical (power-up, running); 280μA typical (power-down).
9. Sequence number: 19865
   Manufacturing location: United States
   Week manufactured: 36
   Year manufactured: 1984.

Setting Up the HP 110

Lesson 2

Overview

This lesson describes how to set up the HP 110 for testing and servicing.

If a service problem involves a configuration of the HP 110 that includes peripheral devices, refer to the documentation accompanying those devices for additional information.

Learning Objectives

The goal of this lesson is to familiarize you with the procedures for setting up the HP 110 and verifying its proper operation. The following objectives will enable you to meet that goal:

- You will be asked to read reference information about setting up the HP 110. You will then be expected to correctly answer all questions in a quiz that covers the power requirements and interface specifications of the HP 110.
- You will be given reference information on how to verify proper operation of the HP 110. You will then be asked to do a lab that covers how to verify the proper operation of the HP 110, doing the exercises successfully and answering all questions correctly.
- You will be given instructions for properly configuring the HP 110 for diagnostic testing. You will be expected to perform the excercises successfully and answer all questions correctly.

Initial Setup

Installation is not required to operate the HP 110. If the battery has insufficient power to operate the HP 110, plug the recharger in a 110-volt ac outlet, then connect it to the recharger outlet on the HP 110. The HP 110 can be used while the battery is recharging.

You can turn on the display be pressing any key except [Shift], [CTRL], or [Extend char]. When you first turn on the HP 110, the Personal Application Manager (PAM) screen is displayed. In the upper right of the screen is an indicator that tells the percentage of battery power remaining. From this you can tell approximately how long the HP 110 can run without being connected to power. (Refer to the HP 110 owner's manual for more information about the battery level indicator.)

If you are using any peripherals, you can connect them to the HP 110 using the interface ports on the back of the computer. (The labs in this lesson tell you when to connect and disconnect peripherals.) You can connect one device at a time to the serial interface port and up to 30 devices at a time to the HP-IL interface.

Read part 2.1, "Preparation" and 2.2, "Installation" in the HP 110 service manual. Then take the following quiz.

Stop! Do Quiz 2 now!

Quiz 2-1

1. Can the battery be recharged while you are operating the HP 110?

   _____

2. The FCC has required procedures for installing and operating equipment interconnected to public communications lines.

   _____ True

   _____ False

3. How many devices can be connected to the serial port?

   _____

4. What cables are required for connecting HP-IL and serial devices?

   _____

   _____

5. A telephone line can be connected to what receptacle?

   _____

6. What kind of telephone jack can be used?

   _____

Correct this quiz using the answers given on the following page!

Quiz 2-1 Answers

1. Yes.

2. True.

3. One.

4. One HP-IL cable is required for the HP 110 and each device on the loop. One serial interface cable is required.

5. Direct-connect modem receptacle.

6. Standard modular telephone plug.

Lab 2-1
Verifying Proper Operation

The HP 110 contains a set of built-in diagnostic tests that enable a user to find out if a problem exists, and if so, its type and location. Additionally, the HP 110 is shipped with a disc containing several utilities, including some added diagnostic programs. All of the diagnostics that are built-in or on the utilities disc are also included on the service disc.

When you receive a description of the problem that a user has identified on the HP 110, the problem statement might also include the results of a diagnostic test the user ran. You should run that test and verify the results that the user obtained before troubleshooting the computer.

This lab describes how to run the built-in and the user's disc-based diagnostic tests. Before you start this lab, disconnect any peripherals that you might have connected to the HP 110.

Read part 2.3, "Functional Verification," in the service manual, then do this lab. After answering each question, correct that question using the answers given after this lab. If you answer a question correctly, continue. If you answer a question incorrectly, redo that step of the lab and answer the question again before continuing.

1. Ensure that the HP 110 display is turned off. (You can do this by pressing [f8] in the main P.A.M. screen or by resetting the computer—pressing the contrast key for 15 seconds.) To start the built-in diagnostic test, press and hold [Shift] and [Extend char] simultaneously, then press [f8].

   Look at the self-test menu. What can you test?

   _____

2. Press [f1]. What is initially displayed?

   _____

   How does the test indicate that no problem was found?

   _____

   If you answered this question incorrectly, press [f1] again to view the result of the test. (The result is displayed momentarily.)

3. Connect an HP-IL cable to the two HP-IL receptacles at the back of the HP 110 so that the cable loops back to the HP 110. Now press [f3] to display screen for the HP-IL test.

   What choices does the menu display?

   _____

   Press [f1] and note the result of the test. What two things did this test indicate?

   _____

   _____

4. Now disconnect the HP-IL cable from the HP 110 and run the HP-IL test again. Press [f1] to select "No devices on the loop."

   What does the test indicate?

   _____

5. Now connect your HP 9114 Disc Drive to the HP 110, turn on the drive and run the HP-IL test again. This time, select [f2], "One or more devices on the loop."

   What three things does this test indicate?

   _____

   _____

   _____

6. Turn off the disc drive and run the "One or more devices on the loop" test again.

   What is the result of the test?

   _____

   Remember that when you operate HP-IL, all devices must be connected and turned on. Otherwise the loop won't operate, and the results of your HP-IL tests will not be valid.

7. To exit the built-in diagnostic program, press [f5] when the program's main menu is displayed. Now connect your HP 9114 Disc Drive to the HP 110 and turn it on. Insert the service disc and type

   C:STEST [Return]

   to run the diagnostic test. This program displays a menu of 15 tests.

8. This set of diagnostic tests is similar to that given the user on the *utilities* disc. Since the user might include the results of one of these common tests with the description of the problem, you should know how to run these tests so that you can verify the customer's test results.

   Now press [f6] to run the keyboard test. Read the displayed instructions and press the top row keys from left to right in sequence.

   What does the display show after you press a key?

   _____

   What happens if you press a key out of sequence?

   _____

   _____

   What happens if you don't press any keys?

   _____

   _____

   The number you get with the error message is called a "failure code." The meaning of failure codes is listed in the "Diagnostic Test Results" table in section 7 of the service manual.

   What is the significance of the failure code?

   _____

   _____

9. After completing the keyboard test, press [f5] to select the LCD test.

   What does the test tell you about what it's going to do?

   _____

   The test is divided into two parts:
   - Testing the LCD itself.
   - Testing display memory.

   When testing the LCD, what does the program tell you about each test?

   _____

   _____

10. The testing of display memory isn't interactive. What appears on the display during this test?

You might want to practice on other tests to get a feel for how they work and what results to expect if the HP 110 tests OK. After testing the HP 110, press [Shift] [f8] to return to the P.A.M. screen.

Lab 2-1 Answers

1. ROM, RAM, HP-IL.

2. ROM test. The HP 110 displays the message ROM TEST—OK.

3. f1: No devices on the loop.
   f2: One or more devices on the loop.
   f3: Exit.

   Loop path OK.
   HP-IL chip controller function OK.

4. Broken loop.

5. Loop path OK.
   Number of devices on the loop = 01.
   HP-IL chip controller function OK.

6. Broken loop.

8. A layout of the keyboard. The next key to press flashes on and off.

   Displays the message "Wrong key."

   The test ends and a failure code is displayed. The failure code is a number you use in table 4-2 of the service manual to find out what components and assemblies might need to be replaced.

9. "The following test should show 3 patterns scrolling onto the LCD."

10. Several different test patterns.

Lab 2-2
Configuring the HP 110

To start this lab, you need a working, charged HP 110. You might also want to review chapter 1, "Getting Started" in the *HP 110 Portable Computer Owner's Manual.*

After you perform each step in this lab, correct your answers. If you answered any questions incorrectly, redo that step before continuing.

1. Turn your HP 110 on. (If your HP 110 is already on, turn it off, then turn it back on again.) The HP 110 displays the Personal Applications Manager screen.

   Where is the battery level indicated?

   _____

   Where is the date indicated?

   _____

   Where is the time indicated?

   _____

2. The contrast key at the lower right of the keyboard is used to set the display contrast and to reset the computer. The contrast you observe on the screen depends on the contrast setting and the viewing angle. You might need to adjust the contrast for the viewing angle you are using.

   To increase the display contrast, press the contrast key several times.

   To decrease the contrast, press [Shift] contrast key several times.

3. You can also use the contrast key to reset the computer. To do this, press and hold the contrast key until the computer turns off (about 10 seconds). Turn the HP 110 back on by pressing any key. The main P.A.M. screen will be displayed.

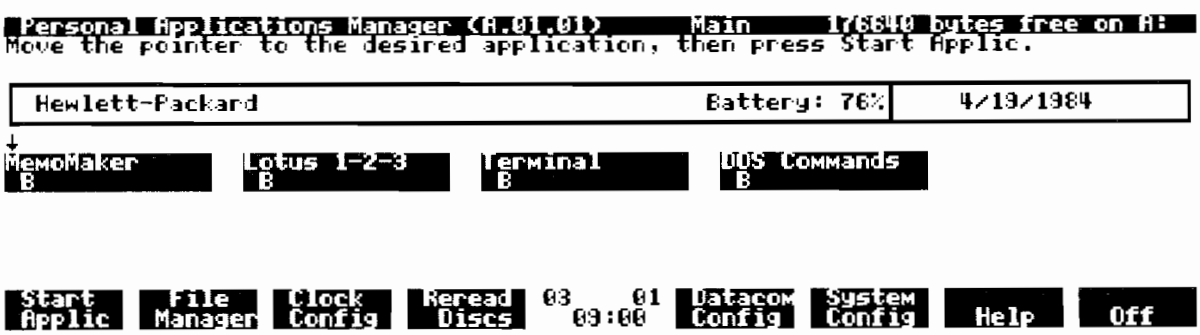


Figure 2-1. The Main P.A.M. Screen

4. After setting the display contrast, you might want to set the time and date. With the main P.A.M. screen displayed, press [f3] to activate the Clock configuration menu. Each item in the menu has several possible settings, one of which is active at a time. To alter the setting of an item, use the tab key to select that item, then press [f3] (next choice) or [f4] (previous choice) to set one of the possible values. (Refer to the owner's manual for more information about setting the time and date.)

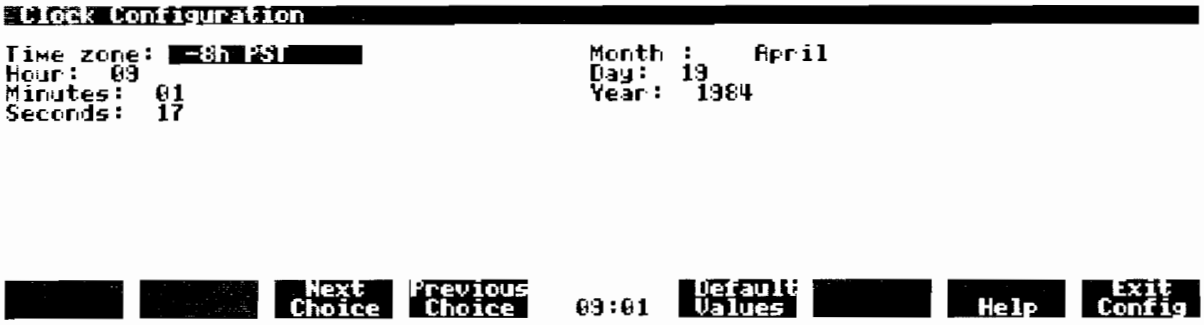


Figure 2-2. The Clock Configuration Menu

After setting the time and date, press [f8] to exit back to the P.A.M. menu.

After you have selected the settings in the System Configuration Menu, press [f8] to return to the P.A.M. screen.

5. In the manner that you set options in the Clock configuration, you can set options in the System and Data Communications configurations.

   If you use disc-based diagnostic tests, you will need to configure the HP 110 to accommodate an external disc drive. After exiting the Clock configuration, select the System configuration. When the System configuration menu is displayed, use the tab key to select "External disc drives," then using [f3] or [f4] set the number of external drives to 1. This enables you to use the HP 9114 Disc Drive.

   Using the tab key, select the item "cursor." What options are available for the cursor?

   Using the tab key again, select "Display Timeout." Using the Next Choice ([f3]) and Previous Choice ([f4]) keys, select 20 minutes as the display timeout.

   Press [f8] to return to the main P.A.M. screen.

6. With the P.A.M. screen displayed, press Data Communications ([f5]) to display the "Datacom Configuration" screen.

   Using the tab key, select the item "Serial Port," then using the [Next Choice] and [Previous Choice] keys, select "RS-232-C."

   Next, use the tab key to select the item "HP 82164A baud rate." Using the [Next Choice] and [Previous Choice] keys, select "9600."

   After setting the baud rate, press [f8] to return to the P.A.M. screen. Turn the HP 110 off by pressing [f8].

Lab 2-2 Answers

1. Right, upper-middle of the display.

   Upper right of the display.

   On the bottom center of the display.

5. Box and underscore.

Operating the HP 110

Lesson 3

Overview

You will learn how to service the HP 110, you should develop some skills at operating the product. This will enable you to better determine if an HP 110 that you are servicing is operating properly.

Learning Objectives

The goal of this lesson is to familiarize you with the operations of the HP 110.

To successfully complete this lesson:

- You will be given reference information on how to use the Personal Applications Manager (P.A.M.). Using this information, you will be expected to complete an assignment by correctly answering all questions concerning the functions and uses of P.A.M. Using an HP 110, you will also be expected to do a lab, performing each step so that you get the results that are indicated, and answer all questions correctly.

- You will be given reference information on using the HP 9114 Disc Drive and handling discs. You will be expected to use the reference information to successfully perform all steps and correctly answer all questions in a lab that covers disc operations. You will be connecting and operating an HP 9114 Disc Drive.

- Using information given to you in the *HP 110 Portable Computer Owner's Manual,* you will be expected to correctly answer all questions in an assignment that covers files and another assignment that covers applications.

P.A.M.—Personal Applications Manager

When you first turn on the HP 110 the Personal Applications Manager (P.A.M.) screen is displayed. From this screen you can:

- Select an application program to run.
- Select a function to perform from one of the function keys.
- Execute Disc Operating System (MS-DOS) commands.

Applications

The following applications are installed in the basic P.A.M.:

- Lotus 1-2-3.*
- Memomaker.
- Terminal Emulator.
- MS-DOS Commands.

*Lotus and 1-2-3 are trademarks of Lotus Development Corporation

The Lotus 1-2-3 program turns the HP 110 into an electronic spreadsheet for accounting and bookkeeping. Also, it can be used for financial forecasting and planning.

Memomaker is a text editor that enables you to write not only memos, but reports as well. The Terminal Emulator turns your HP 110 into a remote terminal for a host computer. You can communicate with a host computer through a telephone line using the built-in modem or through a direct connection to the host through the built-in serial interface.

Function Keys

The function keys are labeled along the bottom of the P.A.M. screen. The function keys are:

- **Start Application.** Using the [Tab] key you can move the pointer to an application, then run that application by pressing this key.
- **File Manager.** You can use the file manager to copy files, rename files, obtain a file directory, and delete files. You can also use this to make a back-up copy of the service disc.
- **Clock Configuration.** You can use this to set the time and date.
- **Reread Discs.** This instructs the computer to read all internal and external disc drives, searching for installed applications.
- **Datacom Configuration.** This enables you to configure the serial interface for data communications.
- **System Configuration.** This enables you to set the amount of memory used for electronic disc, set the number of external disc drives, set the keyboard characteristics, and define printer and plotter characteristics.
- **Help.** This gives you information about using P.A.M.
- **Off.** This key turns the HP 110 off.

P.A.M. is an easy-to-understand facility designed to help the user execute commands. The following assignment will help you learn more about what P.A.M. is, what its capabilities are, and how to access and use it.

Assignment 3-1
P.A.M.

Read chapter 2 of the owner's manual (review the parts you've already read) and answer the following questions.

1. Which of the following things can P.A.M. do?
   - Start an application program.
   - Set the date and time on the HP 110 clock.
   - Cook a pizza.
   - Tell you what devices you have connected to HP-IL.
   - Give simple explanations of P.A.M. functions.
2. How do you tell P.A.M. to start an application?

   _____

   _____
3. How do you tell P.A.M. to set the date and time on the clock?

   _____

   _____
4. How do you tell P.A.M. to list all available application programs?

   _____
5. How do you ask P.A.M. for help?

   _____
6. What is the File Manager? How do you access the File Manager?

   _____

   _____

   _____
7. What capabilities does the File Manager have?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

Turn to the next page and correct Assignment 3-1 using the answers given.

Assignment 3-1 Answers

1. Start an application program.

   Set the data and time on the HP 110 clock.

   Help you by giving some simple explanations.

2. To start an application select the application you want to run and then press [f1] (Start Application).

3. You set the time and date using the Clock configuration screen.

4. Press "Reread discs."

5. Press "Help."

6. The File Manager is a feature that helps you use the most common MS-DOS commands. To access the File Manager, press the "File Manager" key when the P.A.M. screen is displayed.

7. The File Manager allows you to:
   - List files in a directory.
   - Print a file or directory.
   - Delete a file or directory from a disc.
   - Make a new directory on a disc.
   - "Browse" through the contents of a file.
   - Make a copy of a file on a disc.
   - Rename a file on a disc.

Lab 3-1
Using P.A.M.

The purpose of this lab is to give you a chance to implement some of what you learned in Assignment 3-1. After each step of the lab, correct any questions using the answers on the next page before going on to the next step. If you answered any questions incorrectly, review that step until you can answer the questions correctly, then go on to the next step. Otherwise, go on to the next step.

1. Turn on your HP 110. The P.A.M. screen should appear on the display.
   What applications are available?

   _____

2. Access the File Manager. What function key labels are displayed?

   _____

   _____

   _____

3. Exit the File Manager.

4. From P.A.M., how would you configure the HP 110 to operate as a terminal? Go ahead and do it.

   _____

   _____

   _____

5. Now, how would you get back to the main P.A.M. screen? Go ahead and do it.

   _____

Lab 3-1 Answers

1. MemoMaker, Lotus 1-2-3, Terminal, DOS Commands.

2.

[f1]	[f2]	[f3]	[f4]	[f5]	[f6]	[f7]	[f8]
Print File/Dir	Delete File/Dir	Make Dir	Choose Dir	Format	Copy File	Rename File	Exit File Mgr

4. Select the terminal application. It prompts you to enter a configuration file name (either one that exists or one to create) and press [Return]. After pressing [Return], you would press [f5] to configure the terminal.

5. To go back to the main P.A.M. screen, press [f8] twice.

Lab 3-2
Using the HP 9114 Disc Drive

In this lab you will learn how to use the HP 9114 Disc Drive to aid you in servicing an HP 110. You will also learn the proper care of discs.

Before starting this lab, review chapter 1, "Getting Started," and then read chapter 2 "Using the HP 110 With Peripherals" and "Disc Handling and Care" in appendix A of the *HP 110 Portable Computer Owner's Manual.*

1. Before using the HP 9114 Disc Drive with the HP 110, you might need to alter the system configuration to accommodate the disc drive. This is described in Lab 2-2. Also, if you use any new discs, they need to be formatted before they can be used. (This lab requires you to use the service disc only.) to access the disc in this drive, use drive identifier C.

2. Connect the HP 9114 Disc Drive to the HP 110 using HP-IL cables. If the disc drive battery power is low, you might need to connect an ac adapter/recharger to the drive before you use it.

3. Insert the service disc in the disc drive.

4. Turn on the HP 110 and from the P.A.M. screen type:

   DIR C: [Return]

   The red LED on the disc drive will light up as the disc is being accessed. The HP 110 should display the directory of files on the disc. After viewing the directory, return to the P.A.M. screen by pressing any key.

5. What does it mean when a 3.5″ disc drive's light starts to blink and it starts to make a clicking noise?

   _____

6. When this condition occurs, what must be done?

   _____

7. List three things the owner's manual says to avoid to keep discs operating properly.

   _____

8. What must be done to a new disc before it can be used for the first time?

   _____

9. How should you clean your discs?

   _____

Lab 3-2 Answers

5. The disc is almost worn out.

6. The disc's contents should be copied to a new disc.

7. Avoid extremes of temperatures, contamination, and magnetic fields.

8. The disc must be formatted before it can be used for the first time.

9. You should never attempt to clean your discs. They are self-cleaning. Attempting to clean them could damage them.

Files

The next assignment covers some of the basics of creating files.

Assignment 3-2
Files

Read "Using the File Manager" in chapter 2 of the *HP 110 Portable Computer Owner's Manual* and then answer the following questions.

1. How many letters can a valid file name contain? What characters cannot be used in a valid file name? (Refer to page 2-12 of the owner's manual.)

   _____

   _____

2. What file names are used by MS-DOS and the HP 110 and therefore should not be used for new file names?

   _____

   _____

   You do not need to memorize all these names. You should simply be familiar with the file names that should not be used.

3. What is a file extension? What restrictions are there on file extensions?

   _____

   _____

   _____

4. What file extensions are used by MS-DOS or applications and therefore should not be used for new files?

   _____

   _____

   _____

Correct Assignment 3-2 using the answers on the next page.

Assignment 3-2 Answers

1. A valid file name consists of one to eight characters other than a . [ ] ? \ = * : ; - < and > .

2. File names used by either MS-DOS or HP are AUX, CON, NUL, PRN, PLT, LPT1, LPT2, and PAM.

3. A file extension is an addition to the file name that further identifies the file. A file extention is a period followed by three letters added to a file name. The same restrictions that apply to file names apply to file extensions.

4. File extensions used by either MS-DOS or HP are .BAR, .COM, .DIF, .EXE, .HLP, .IN$, .LIN, .LNK, .RM$, .TXT, .PIE, .VC, .MNU, .MSG, .WKS, .PIC, and .PRN.

Assignment 3-3
Applications

This assignment will help you learn about what applications are, how to install them, and how to remove them. Information for this assignment can be found under "Starting an Application Program" and under "Installing Application Programs in P.A.M." in chapter 2 of the owner's manual.

1. What are application programs? What disc can you install application programs on?

2. What do you do to install an application program from a disc?

3. What do you do to remove an application from the P.A.M. screen?

Correct Assignment 3-3 using the answers given on the next page.

Assignment 3-3 Answers

1. Applications are purchased programs that have been designed to generically cover certain situations such as accounting, word processing, or graphic charting.

2. For each disc that contains applications, you must have a file named PAM.MNU that contains information about the programs to be installed.

3. To remove an application, you simply remove the information about it in the file PAM.MNU on its disc.

MS-DOS Commands

MS-DOS is the system that manages files on the disc. (The File Manager is able to do some of the operations that you can do with MS-DOS commands.) MS-DOS commands are normally used by the advanced HP 110 user. MS-DOS commands can be typed from the P.A.M. screen, or you can select the DOS Commands application to put you into MS-DOS mode.

At times you might want to obtain a directory of files on a disc (internal or external). To do this, you can type:

DIR [d:] [Return]

from the P.A.M. screen, where [d:] is the optional drive identifier (followed by a colon). For example, if you want to know what files are stored on the disc in the HP 9114 Disc Drive, insert the disc in the drive and type:

DIR C: [Return]

Quiz 3-1

1. What four applications are installed in the basic P.A.M. screen?

   _____

2. Which application contains disc operating system commands?

   _____

3. From the P.A.M., what function key enables you to copy files, rename files, and delete files?

   _____

4. From the P.A.M. screen, which function key allows you to allocate electronic disc memory?

   _____

5. A drive identifier is a single letter that the HP 110 associates with an internal (electronic disc) or external disc drive. For example, drive A is the internal RAM disc. When you attach external disc drives, the HP 110 automatically assigns each drive an identifier, beginning with the letter C. If you have a single external disc drive attached, what identifier would you use to access it?

   _____

6. Which of the following are valid file names that you can freely use?

   FILE1 WORK:ORD FILENAME1 EASYAS.PIE %TEMPLAT.TAB 2DCHAPTR.EXT

   _____

7. What MS-DOS command would you use to obtain a directory of files on a disc?

   _____

Correct Quiz 3-1 using the answers on the next page.

Quiz 3-1 Answers

1. Lotus 1-2-3, MemoMaker, Terminal Emulator, MS-DOS commands.
2. MS-DOS.
3. [f2] (File Manager).
4. (f6] (System Configuration).
5. A single external disc drive would be C.
6. FILE1, 2DCHAPTR.EXT, %TEMPLAT.TAB.
7. The DIR command.

How the HP 110 Works

Lesson 4

Overview

You will be introduced to the circuits in the HP 110 in this lesson and provided optional assignments on the function of each circuit.

Learning Objectives

The goal of this lesson is to provide you with an overview of the circuits in the HP 110. If you desire to know more of how each circuit works, you can work through the optional assignments in this lesson.

The following objectives will enable you to meet this goal:

- You will be given reference information with diagrams. You will be expected to correctly answer all questions in a quiz covering the CPU circuits, and the role of the CPU in transmitting information from one circuit to another.

- Optionally, you will be given information with diagrams on the function of each of the HP 110 circuits. You will be expected to correctly answer all questions in the assignments and the quizzes.

HP 110 Circuits

The HP 110 consists of 15 basic circuits. These circuits are connected according to the block diagram shown in figure 4-1 (below). This diagram is the same as figure 4-1 in the service manual. In this diagram, the wide bars and arrows represent data and address buses. An address bus typically contains 16 lines of information. A data bus typically contains 8 lines of information. The CPU bus transfers both address and data information.

A solid arrow indicates that information is passed serially from one circuit to another. A dashed arrow indicates that one or more control signals are passed from one circuit to another.

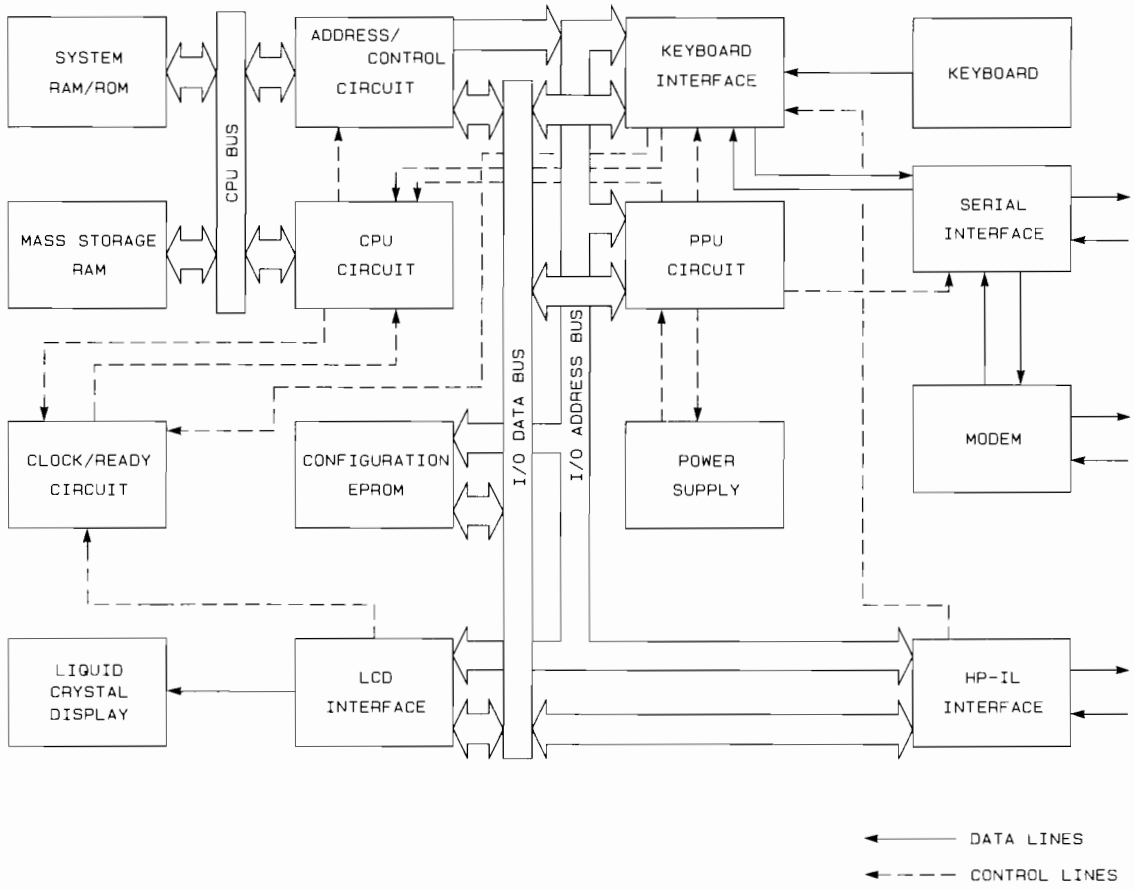


Figure 4-1. HP 110 Block Diagram

Three circuits in the upper left corner of the diagram, the CPU, Mass Storage RAM, and System RAM/ROM, make up the system PCA. All other circuits are on the I/O PCA, with the following exceptions:

- Part of the Modem circuit is on the Modem PCA, which is connected to the I/O PCA.
- The Keyboard circuit is on the Keyboard module.
- The Liquid-Crystal Display is on the LCD module.

Flow of Information

The central processor unit (CPU) is the heart of the HP 110. It directs the flow of data, controls the other circuits, and is the calculator within the computer. The peripheral processor unit (PPU) regulates the flow of information among the CPU, the keyboard, and the interfaces. The PPU performs its operations in response to commands from the CPU.

Information is transmitted from one circuit to another over a *data bus*. The CPU bus is a combined data address bus. Information and addresses are transferred between the CPU circuit and the Mass Storage Ram, System RAM/ROM, and Address/Control circuits using the CPU bus.

All other circuits transmit information over the I/O Data bus. They also receive addresses over the I/O Address bus.

As an introduction to some of the operations of these circuits, let's look at an operation in which, when the HP 110 turns on, the CPU reads character and display data from the Configuration EPROM and stores it in the display memory. This procedure contains eight steps. The procedure is repeated for each word (two bytes) of data to be transferred.

When you turn on the HP 110, the CPU reads information from the configuration EPROM. It reads one byte at a time and transfers it to LCD RAM. To read the information, it first sends an address out on the CPU bus and sets the appropriate control lines so that the Address/Control Circuit forwards this address to the EPROM circuit on the I/O Address bus. (The use of control lines is described in the *HP 110 Service Manual* under the first part of "Functional Description" up to "Configuration EPROM.") By sending the address, the CPU selects a specified section of the EPROM from which it will read two bytes of information. Figure 4-2 below indicates the path of the address information.

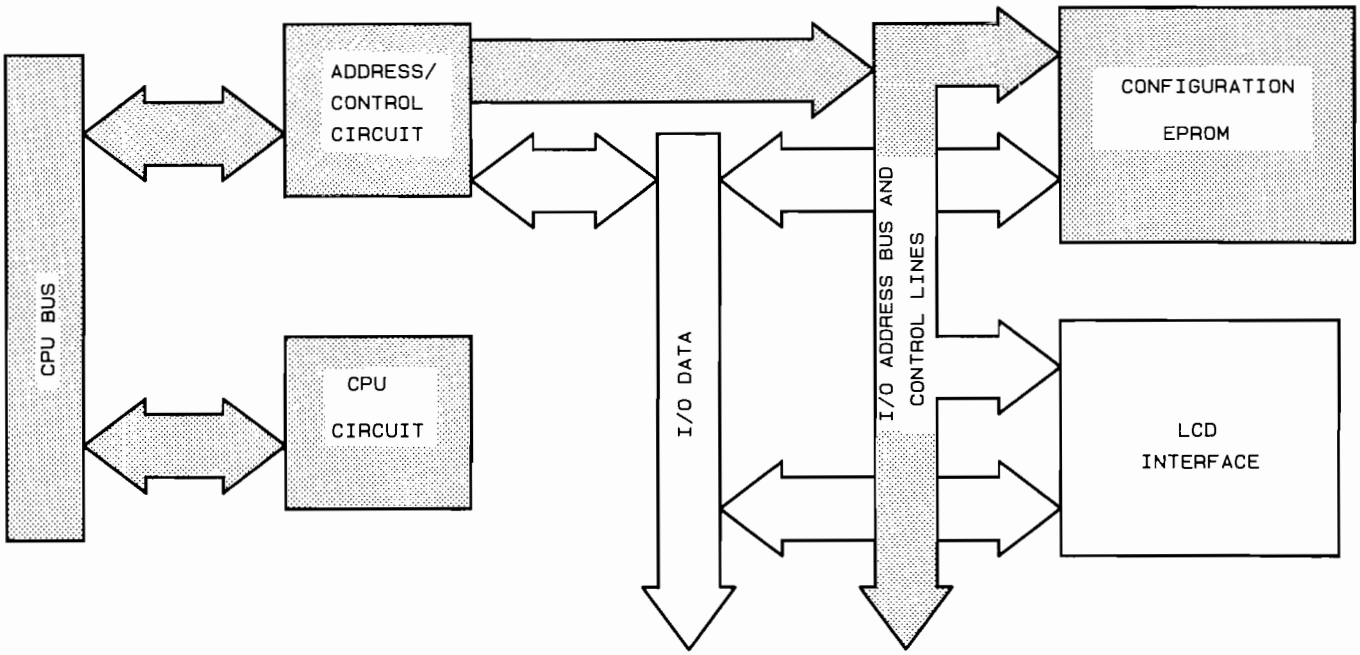


Figure 4-2. Addressing the EPROM

After the CPU places the address for the EPROM on the CPU bus, the address is maintained (latched) at the Address/Control circuit, shown in figure 4-3 below.

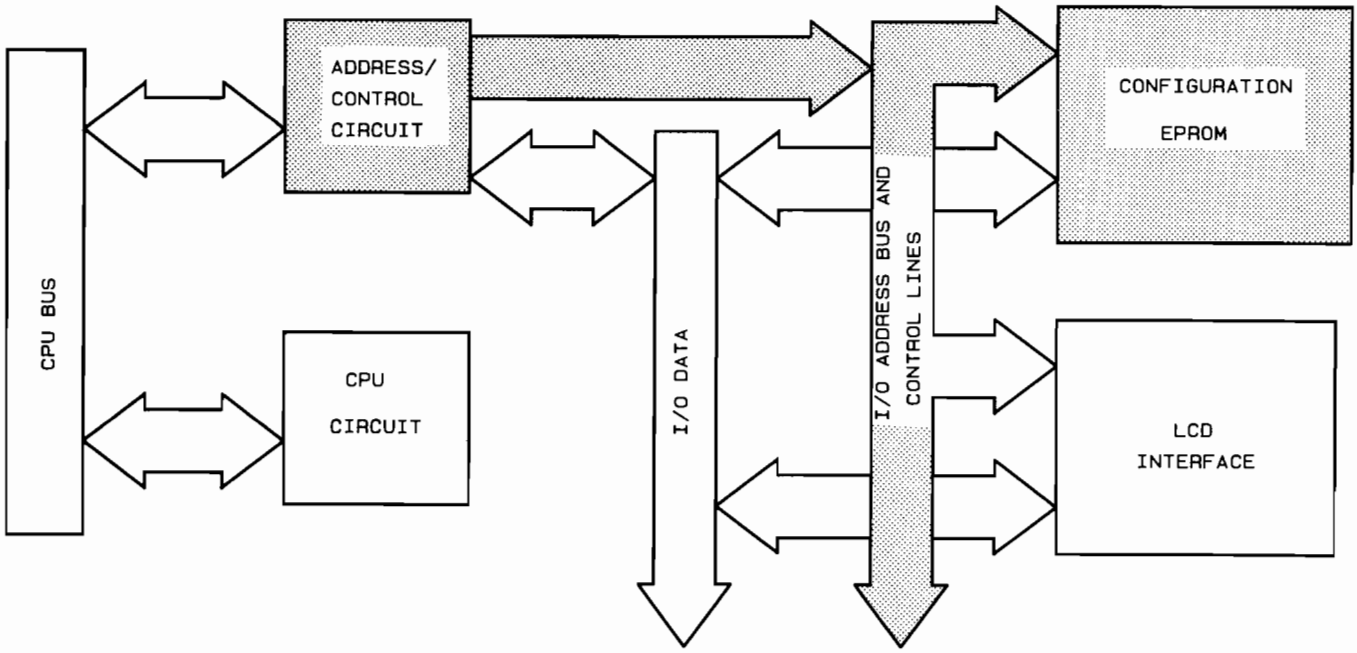


Figure 4-3. Latching the Address

With the address latched, the CPU sets a read signal that causes the EPROM to send two bytes of information over the I/O Data bus, which the Address/Control circuit in turn sends to the CPU on the CPU bus. (Figure 4-4 below.) These two bytes are stored in a CPU register until they are written to the LCD.

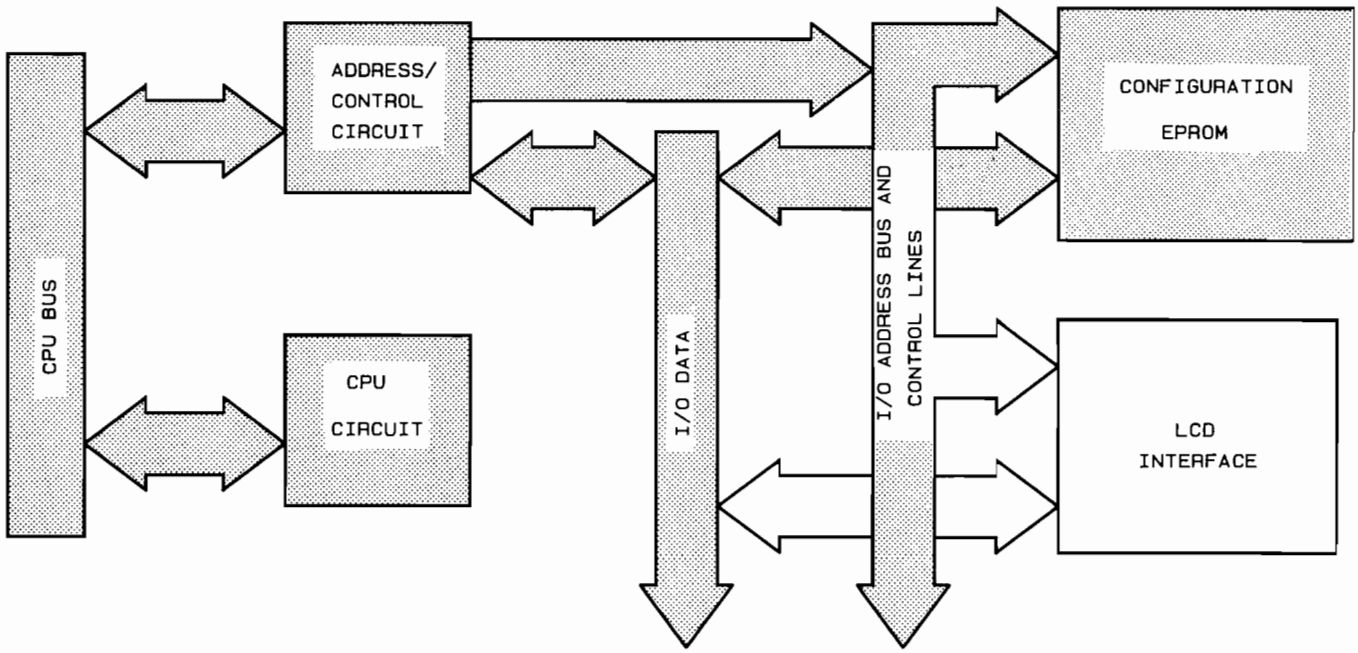


Figure 4-4. Retrieving Two Bytes From the EPROM

The CPU now addresses the LCD interface and enables it to receive information by setting the appropriate control lines. (Shown in figure 4-5 below.)

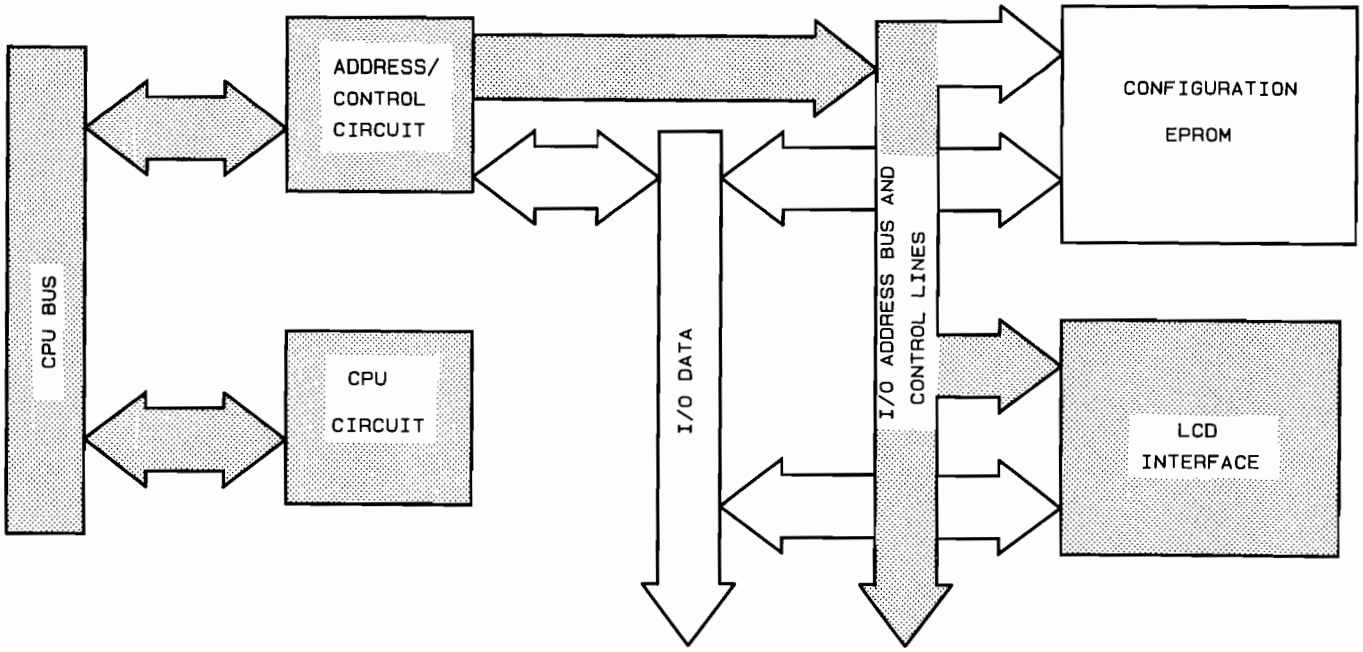


Figure 4-5. Addressing the LCD Interface Circuit

When the address is latched at the Address/Control circuit, the CPU then prepares the CPU bus for another operation, as shown in figure 4-6 below.

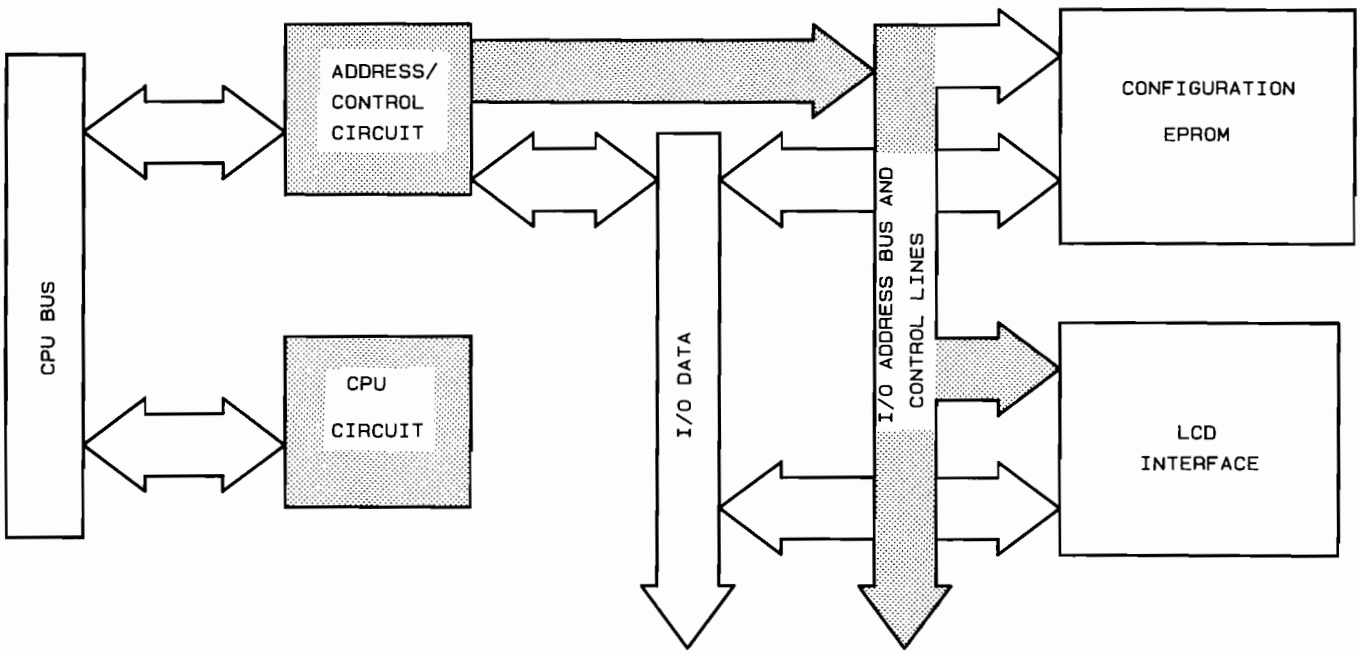


Figure 4-6. Preparing the CPU Bus

After the bus is cleared, the LCD Interface is enabled to received the information from the CPU, as shown in figure 4-7 below. The information is transmitted on the CPU bus to the Address/Control circuit, which in turn forwards it to the LCD Interface circuit over the I/O Data bus.

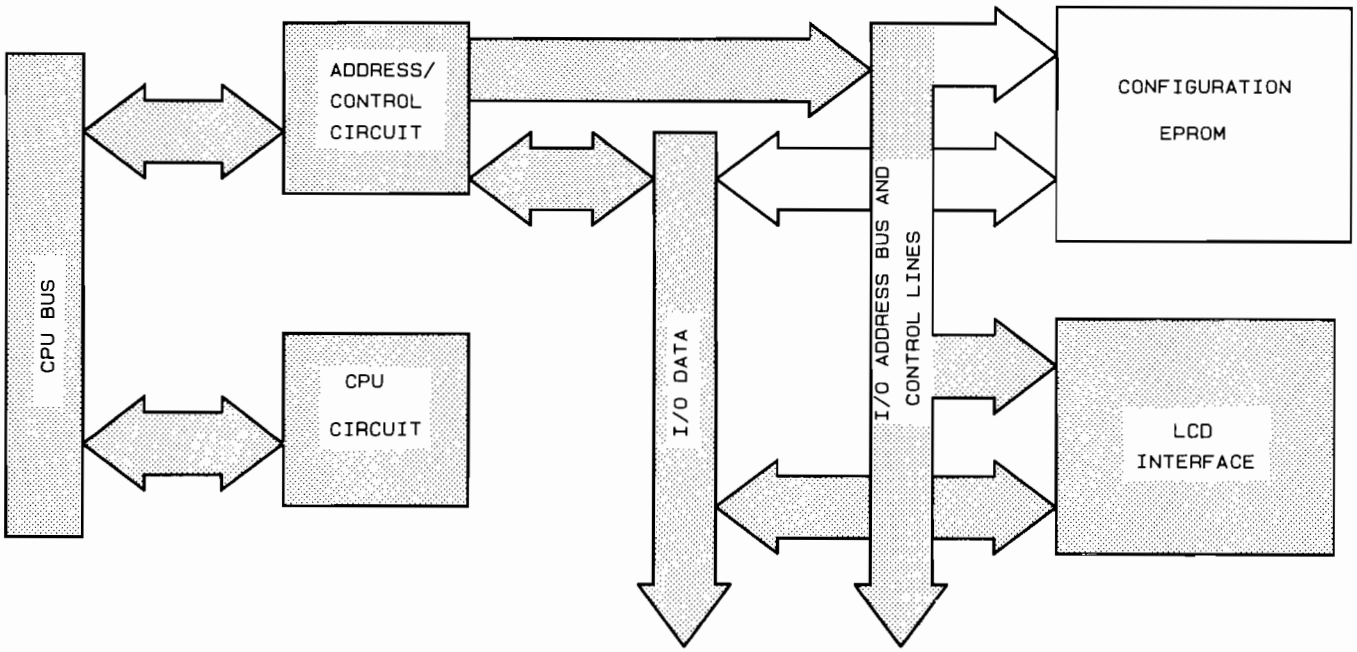


Figure 4-7. Sending Information to the LCD Interface Circuit

After the LCD Interface circuit receives the information, all buses are cleared, as shown in figure 4-8 below. The LCD Interface circuit stores the information in LCD RAM.

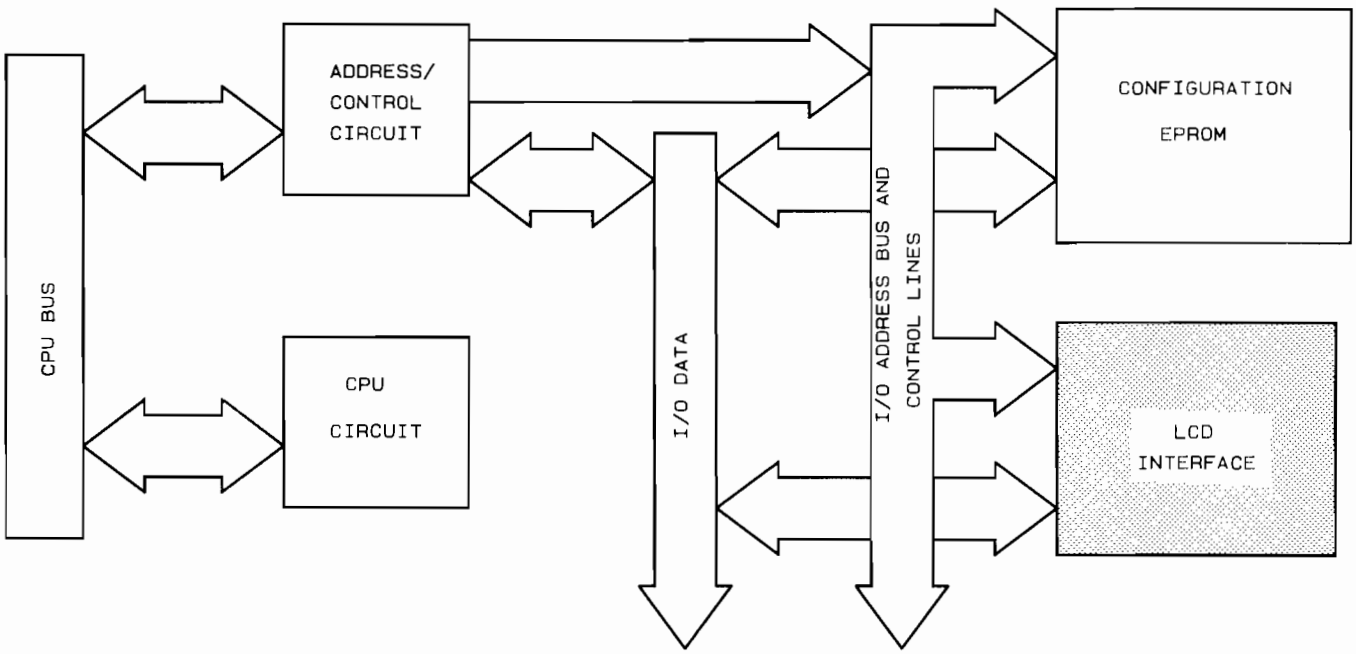


Figure 4-8. Clearing the Buses

The HP 110 repeats this operation for every word of information until all the necessary display data from the Configuration EPROM is stored in the Display RAM.

Read sections 3.1 through 3.3 in the service manual, then take the following quiz.

Quiz 4-1

1. What three circuits make up the System PCA?

2. What circuits are connected to the CPU bus?

3. What is the reference designation for the System PCA? For the I/O PCA?

4. What does the CPU do before it reads or writes information to another circuit?

5. Does the CPU bus carry both data and addresses?

6. On which PCA is the component A2U20 located?

Correct Quiz 4-1 using the answers on the next page.

Quiz 4-1 Answers

1. The three circuits of the PCA are: CPU, System RAM/ROM, and Mass Storage RAM.

2. The circuits connected to the CPU bus are: CPU, System RAM/ROM, Mass Storage RAM, and Address/Control Circuit.

3. The reference designation for the System PCA is A1. The reference designation for the I/O PCA is A2.

4. Before the CPU reads or writes information to another circuit it selects that circuit by setting an address on the CPU bus.

5. Yes.

6. The I/O PCA.

How To Do the Optional Assignments in This Lesson

The optional assignments in this lesson show you how the circuits in the HP 110 operate. The circuits are not all described in the same detail. These assignments will show the major data paths between circuits. They will also describe some of the control circuitry, but you should use section 3, "Functional Description" in the HP 110 service manual for information to complete these assignments.

Assignment 4-1
The System PCA Circuits

This assignment will introduce you to the function of each circuit on the System PCA, to show you the data paths through each one.

Introduction

The system PCA has three major circuits.

- CPU circuit.
- Mass Storage RAM circuit.
- System RAM/ROM circuit.

These circuits are connected by the CPU bus. The CPU bus transfers address and data information between the CPU and the memory circuits.

The CPU Circuit

As shown in figure 4-9 below, the CPU circuit contains:

- The CPU chip.
- A buffer.
- An address latch.
- The RAM Select circuit.
- The ROM Select circuit.
- The Bus Select circuit.

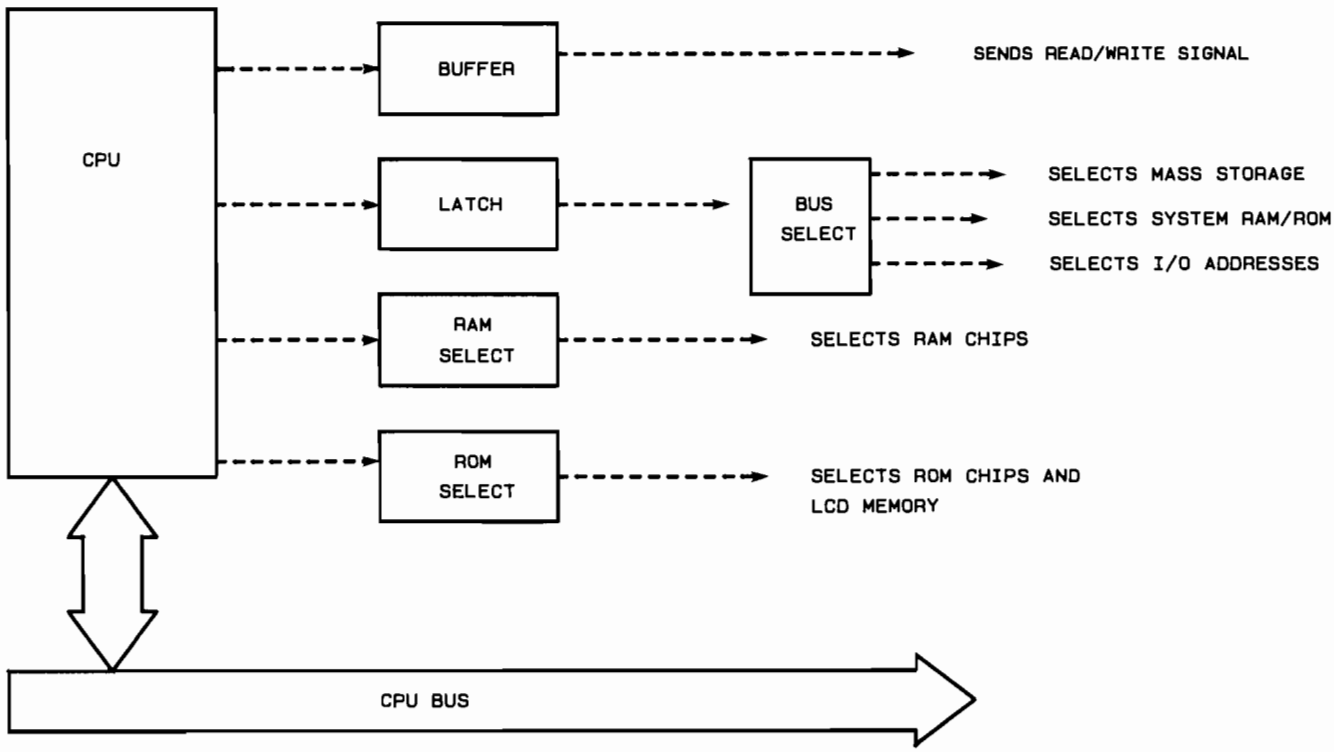


Figure 4-9. The CPU Circuit

The CPU sends addresses and data over the CPU bus. When the CPU wants to send information to a circuit, it sends a *read* or *write* signal which is buffered to the appropriate circuit. This lets the circuit know that it will be receiving or sending information.

To select a memory device, the CPU sends a signal to the address latch, which selects one of the other three circuits connected to the CPU bus. Any information sent between the CPU and circuits other than the System RAM/ROM and the Mass Storage RAM goes through the Address/Control circuit.

The RAM Select circuit enables specific RAM chips to be read from or written to. Similarly, the ROM Select circuit selects specific ROM chips to be read from.

Reread part 3.2, "CPU Circuit" in the service manual and answer the following questions:

1. What type of processor is the CPU?

   _____

2. What are the three primary functions of the CPU?

   _____

   _____

   _____

The System RAM/ROM Circuit

The System RAM/ROM circuit contains:

- An Address/Control circuit.
- RAM chips.
- ROM chips.
- An address bus (shown with control lines).
- A data bus.

Figure 4-10 below shows the organization of the System RAM/ROM circuit. Note that the Address/Control circuit transfers address information from the CPU bus to the address bus within the circuit, and transfers data between the CPU bus and the internal data bus. Note also that in all the circuits, address information always flows from the CPU to the appropriate circuit, but data flows both ways between the CPU and other circuits.

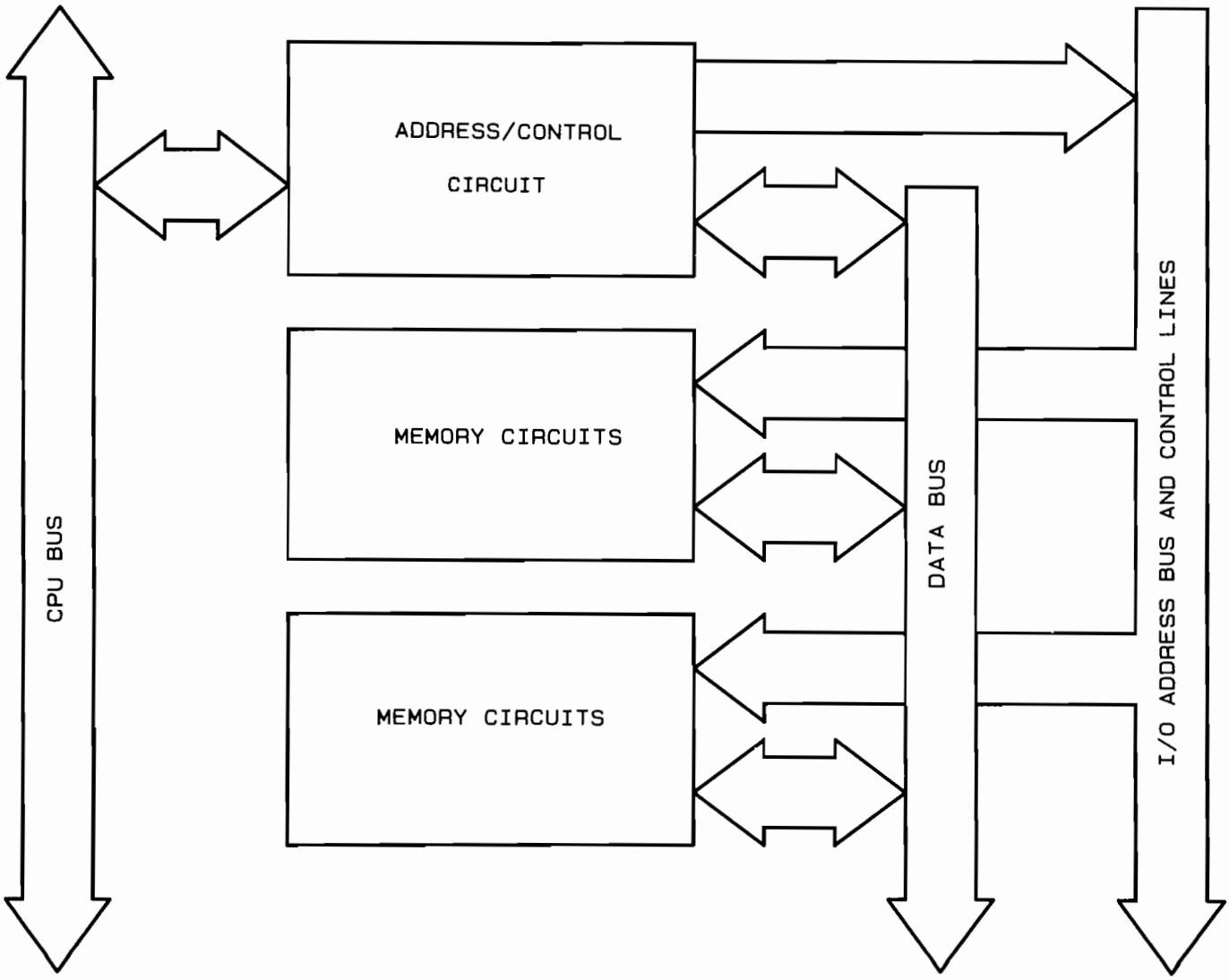


Figure 4-10. The System RAM/ROM Circuit

Any information that is transferred between circuits other than the CPU (for example, between ROM and RAM), goes through the CPU one word (two bytes) at a time.

Mass Storage RAM

The Mass Storage RAM circuit operates similarly to the System RAM/ROM circuit. The circuits have the same structure, except that the Mass Storage RAM circuit doesn't have any ROM chips.

In the service manual, refer to part 3.3, "System RAM/ROM" and read part 3.4, "Mass Storage RAM" and then answer the following questions:

1. What components does the ROM/Display RAM Select Circuit consist of?

2. Which RAM ICs contain the upper byte of a 16-bit word? Which contain the lower byte?

3. List the components of the mass storage RAM circuit.

Correct Assignment 4-1 using the answers on the next page.

Assignment 4-1 Answers

The CPU Circuit

1. The CPU is an 80C86, a CMOS version of the 8086.

2. The three primary functions of the CPU are to:
   - Control the operation of all the circuits.
   - Direct the transfer of information on the CPU bus and the I/O buses.
   - Respond to interrupts from the PPU and the Keyboard Interface circuit.

Mass Storage RAM

1. One 3-to-8 decoder (A1U12).

2. Odd-numbered RAM ICs contain the upper byte and even numbered RAM ICs contain the lower byte of a word.

3. The Mass Storage RAM circuit consists of: 26 RAM ICs, 2 address latch ICs, and 2 data transceiver ICs.

Assignment 4-2
The I/O PCA Circuits

This assignment will teach you which circuits make up the I/O PCA and supporting modules, and to offer an overview of their functions. As you work through each part of this assignment, answer the questions at each step, and correct them using the answer key at the end of the assignment before going on to the next step. If you answer any questions incorrectly, go back and review until you can answer them correctly. Then go.

Address/Control Circuit

The Address/Control circuit operates in the same manner as the Address/Control circuit in the System RAM/ROM and Mass Storage RAM circuits. This circuit latches addresses selected by the CPU, providing an interface between the CPU and circuits not on the CPU bus. The Address/Control circuit also buffers data between the CPU and these circuits.

The decoders select circuits on the I/O buses to send and receive data from the CPU. The DT signal from the CPU sets the direction that the data travels.

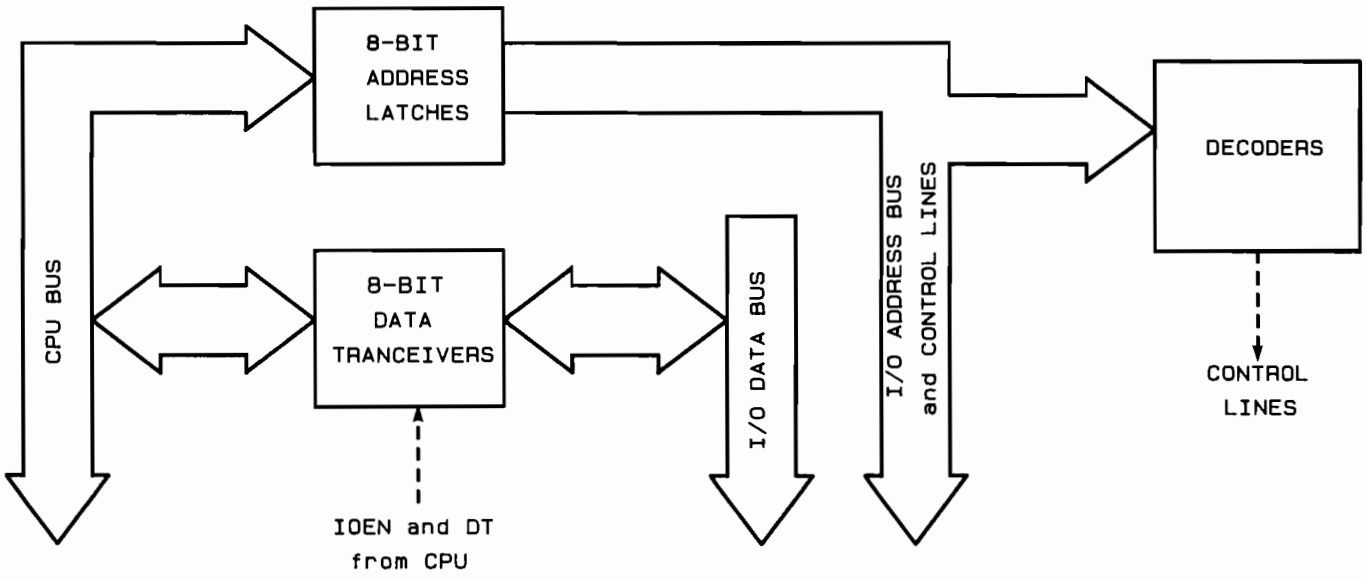


Figure 4-11. The Address/Control Circuit

Read part 3.5, "Address/Control Circuit" in the service manual, and answer the following questions.

1. In what memory space are the circuits selected by the Address/Control circuit?

   _____

2. What is the function of the Address/Control circuit?

   _____

   _____

Configuration EPROM

The Configuration EPROM (erasable/programmable read-only memory) is a memory circuit that contains HP 110 operating information. This operating information is read by the CPU when the computer powers up. The Configuration EPROM also carries unique information that identifies the computer. It contains ROM IDs, a serial number, and a checksum of all ROMs.

The checksum contained in the EPROM is the sum of all byte values in the ROM ICs. When the HP 110 first turns on, it computes the byte values of all ROM ICs, sums them, and compares that sum with the checksum stored in the EPROM. If the checksums don't match, an error is indicated by the HP 110.

Read part 3.6, "The Configuration EPROM" in the service manual, and answer the following questions:

1. What signal selects the EPROM?

   _____

2. Where does the signal come from?

   _____

3. Which signal causes the EPROM to send data?

   _____

The PPU Circuit

The peripheral processor unit (PPU) circuit operates under the direction of the CPU, and controls the operation of several system functions. A simplified block diagram of the PPU circuit is shown in figure 4-12 below.

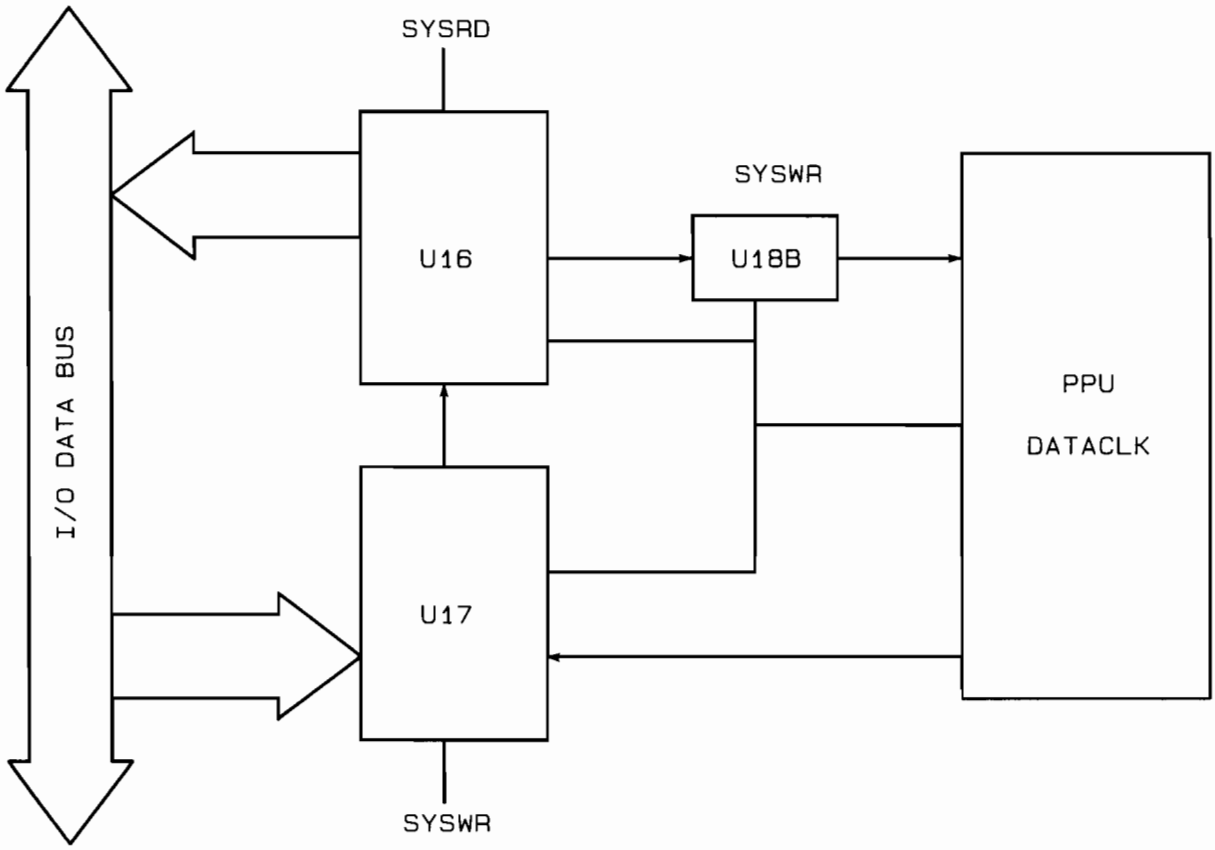


Figure 4-12. The PPU Circuit

In figure 4-12 above, you can see that the PPU microprocessor is buffered from the I/O Data bus by the PPU Interface. The PPU Interface consists of a A2U1, A2U16, A2U17, and A2U18. The PPU Interface translates data between the parallel bus and the serial lines of the PPU microprocessor.

The PPU Interface has its own clock mechanism to control the conversion between serial and parallel data. This is different from the real-time clock of the PPU circuit. The three chips of the PPU interface act as a 17-bit shift register in CPU memory space.

Read part 3.7, "The PPU Circuit" in the service manual, and answer the following questions:

1. What are the reference designations for the PPU ICs?

2. List the seven functions of the PPU circuit.

3. How does the CPU determine the PPU busy status?

4. How does the PPU interrupt the CPU?

5. For what events does the PPU interrupt the CPU?

The Keyboard Interface and Keyboard

The heart of the keyboard interface is the multicontroller. Among other things, the multicontroller is responsible for polling the keyboard for any pressed keys. A simplified block diagram of the Keyboard Interface circuit is shown in figure 4-13 below.

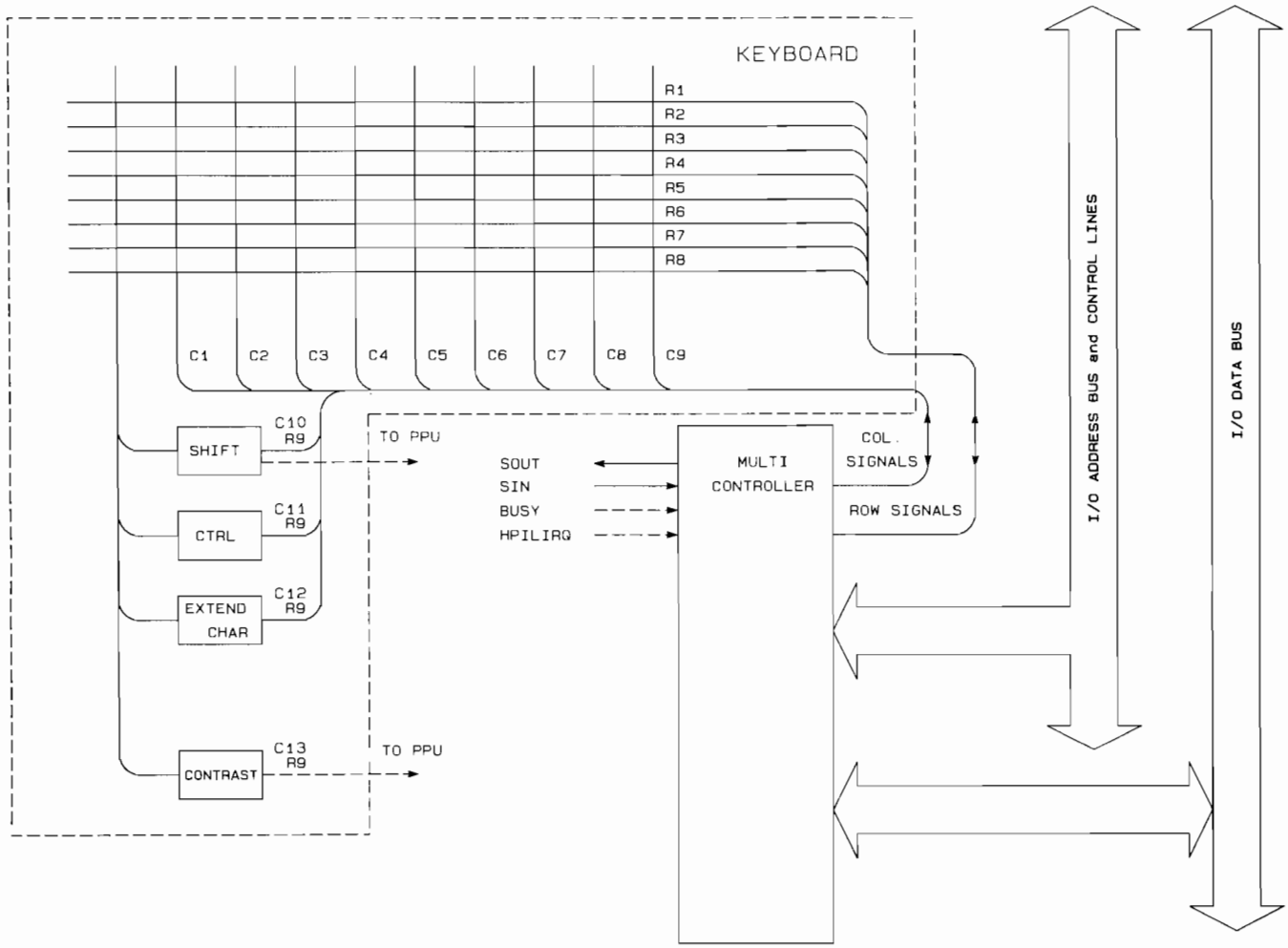


Figure 4-13. The Keyboard Interface

From figure 4-13 you can see that the [Shift], [Extend Char], [Cntl], and [Contrast] keys have individual column numbers and are all on row 9, which is always grounded. The [Contrast] key is connected to the PPU, not the multicontroller as the other keys are. (It is not "polled" by the multicontroller.)

Read part 3.8, "The Keyboard Interface" and 3.9 "The Keyboard" in the service manual, and then answer the following questions:

1. List the five functions of the Keyboard Interface.

2. What key is not polled by the multicontroller?

3. How does the CPU control the multicontroller?

The LCD Interface

The LCD Interface circuit processes information received on the I/O Data bus and sends it, as appropriate, to the display. The display is controlled by the LCD Controller chip. The display is divided into four quadrants, enabling it to be updated quickly. Figure 4-14 below is a simplified block diagram of the LCD Interface circuit.

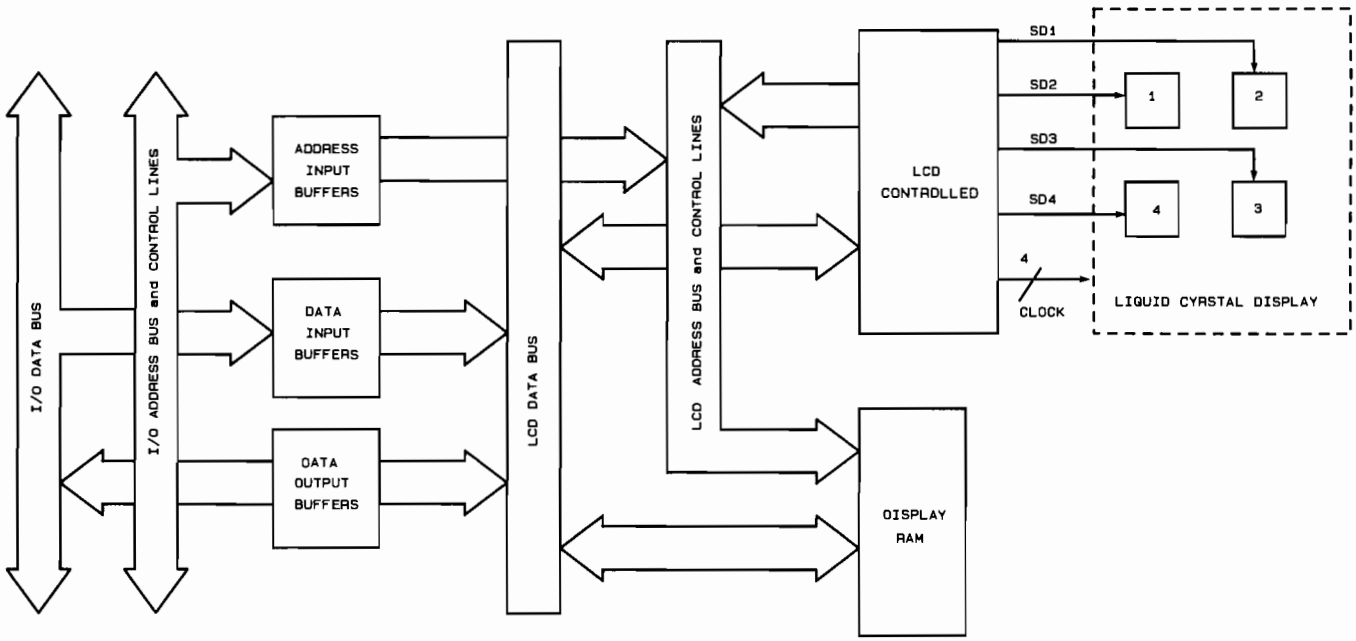


Figure 4-14. The LCD Interface

The LCD Interface has its own address and data bus, buffered from the I/O Address and Data buses by Address Input buffers, Data Input buffers, and Data Output buffers. The LCD buses enable the LCD Controller to control the LCD RAM and operate the display independent of any operations on the I/O Address and Data buses.

Read part 3.10, "LCD Interface" and part 3.11, "Liquid-Crystal Display" in the service manual, and answer the following questions:

1. What are the four functions of the LCD Controller?

2. What is the size, in bytes, of the display RAM?

3. Which voltage supply controls the display contrast?

The Clock/Ready Circuit

Read part 3.12, "The Clock/Ready Circuit" in the service manual, and answer the following questions:

1. What are the two functions of the Clock/Ready circuit?

2. Where is the real-time clock located?

3. What signals are provided by dividing the 16-MHz oscillator into two signals and gating one signal with LCDEN and the other with MODEMEN?

The HP-IL Interface

The HP-IL Interface consists of an HP-IL chip that provides an interface between HP-IL lines and the I/O Data and Address buses. A simplified block diagram of the HP-IL Interface circuit is shown in figure 4-15 below.

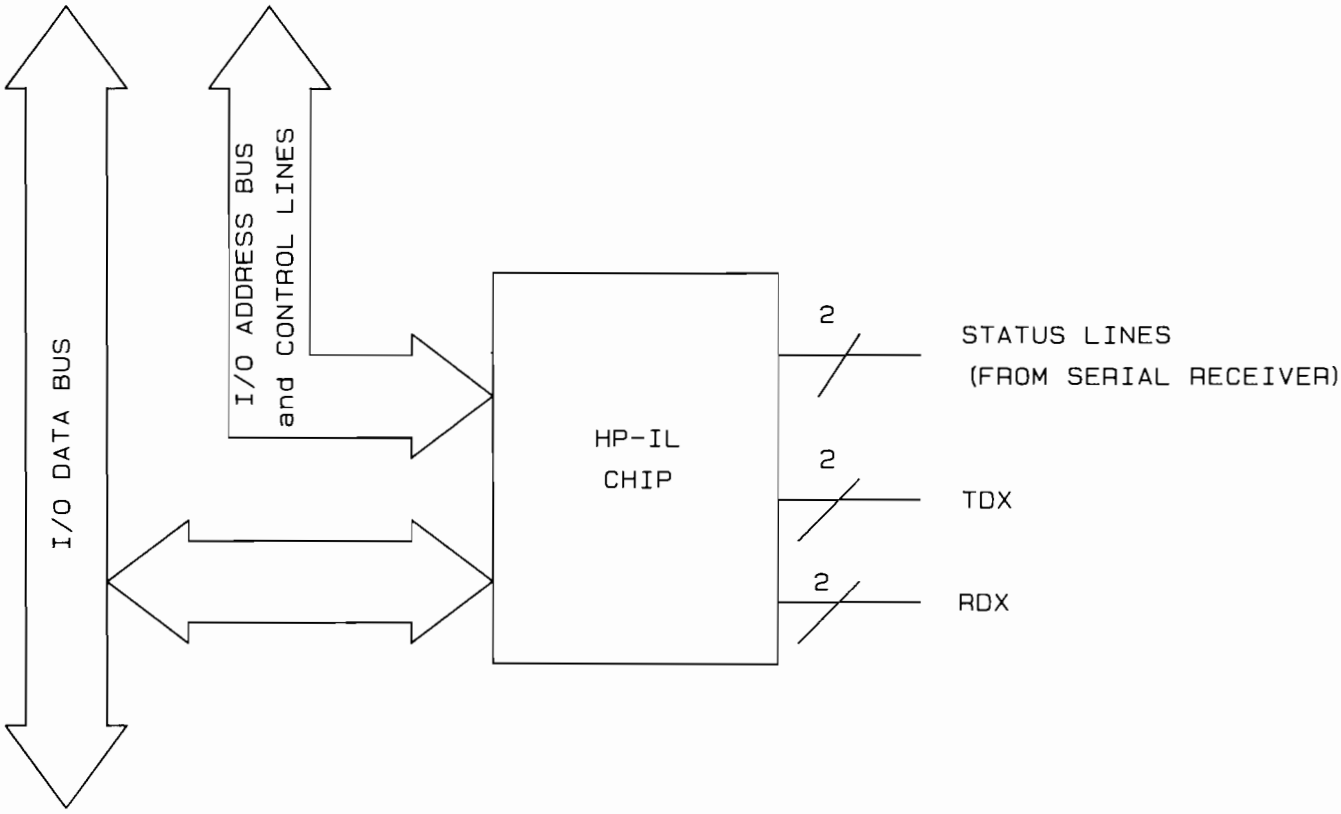


Figure 4-15. The HP-IL Interface Circuit

In addition to supporting HP-IL operations, the HP-IL chip has a register that is used by the Serial Interface circuit as a status register that is read by the CPU. This serial status register is not used for HP-IL operations.

Read part 3.13, "HP-IL Interface" in the service manual, and answer the following questions:

1. What are the two functions of the HP-IL Interface circuit?

   _____

   _____

2. What are the names of the two lines that come from the Serial Interface circuit?

   _____

3. What line does the CPU use to select the HP-IL Interface? At what state does the CPU set the line?

   _____

4. What signal provides timing for the HP-IL Interface circuit?

   _____

Serial Interface and Modem Circuits

The Serial Interface and the Modem circuits use some of the same circuitry, and therefore only one of the circuits can be operating at any given time. The simplified block diagram in figure 4-16 below shows the data paths through the serial and modem circuits.

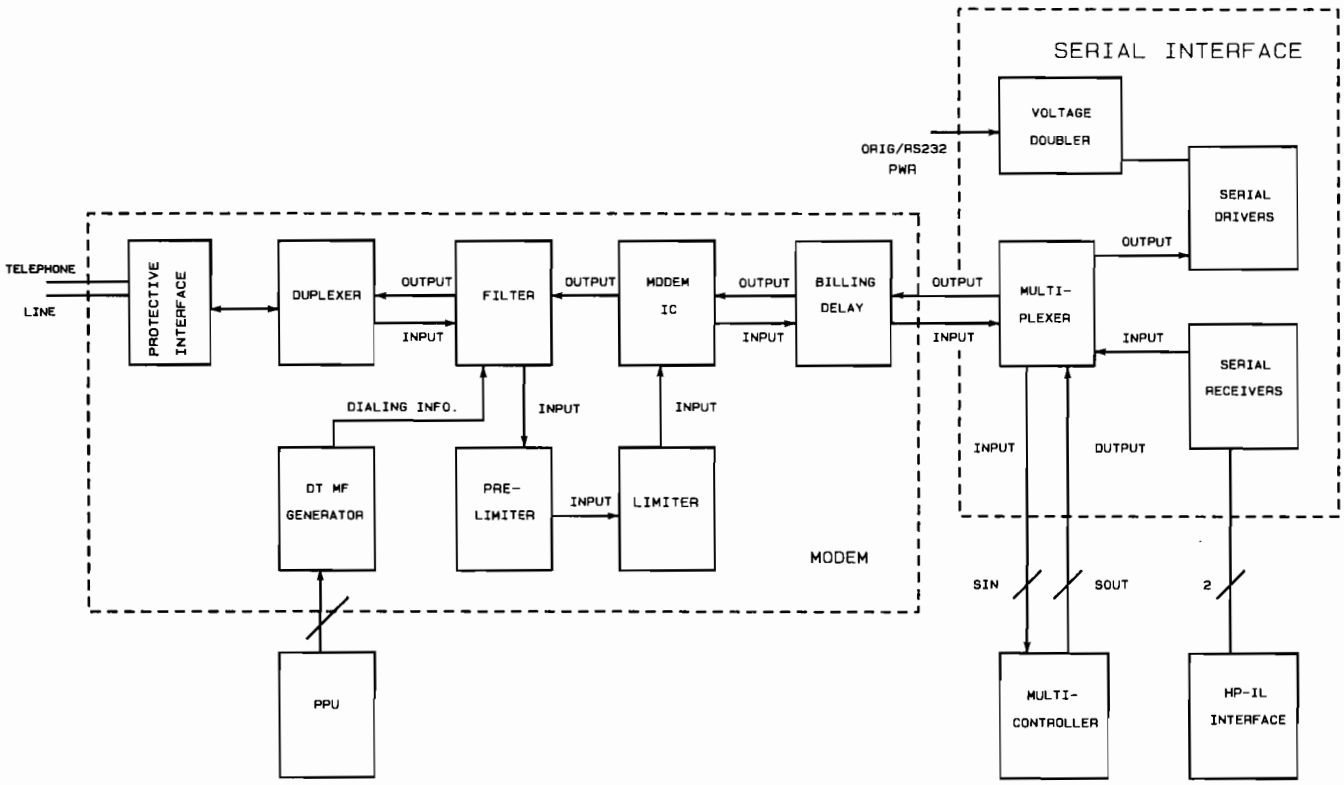


Figure 4-16. Serial Interface and Modem

The serial interface and the modem are controlled by the PPU circuit. The PPU circuit controls the flow of data through the interface, and controls the dialing function of the modem.

Study figure 4-16 and read part 3.14, "Serial Interface" and part 3.15, "Direct-Connect Modem" in the service manual, then answer the following questions:

1. What circuit processes information before it is transmitted over the serial interface?

   _____

2. What do the multiplexers do?

   _____

3. From what circuit does the modem receive information to be transmitted over the telephone line?

   _____

4. What is the function of the protective interface?

   _____

Power Supply

Read part 3.16, "Power Supply" and part 3.17, "Power-Up Routine" in the service manual, and then answer the following questions:

1. List the six functions of the power supply.

2. How many regulated power supplies does the regulator produce?

3. What circuits continue to operate when the HP 110 is "turned off?"

4. What circuit directs the power-up sequence?

Correct Assignment 4-2 using the answers on the next page.

Assignment 4-2 Answers

Address/Control Circuit

1. I/O memory space.
2. To latch addresses and pass information between the CPU and circuits in the CPU's I/O memory space.

Configuration EPROM

1. The $\overline{\text{ROMCS}}$ signal.
2. The signal comes from the Address/Control circuit.
3. The $\overline{\text{RD3}}$ signal causes the EPROM to send data.

The PPU Circuit

1. The PPU ICs are A2U16, A2U17, and A2U18.
2. The seven functions of the PPU circuit are to:
   - Control the power-down and power-up status of the system.
   - Maintain a real-time clock.
   - Interrupt the CPU at certain enabled events.
   - Control negative LCD supply voltage.
   - Compute reserve battery power and control recharging.
   - Control the operation of the serial interface and modem.
   - Control the beeper.
3. The CPU reads a status register in the multi-controller.
4. The PPU interrupts the CPU by setting $\overline{\text{KEYIRQ}}$ low.
5. Power-down required.

The Keyboard Interface and Keyboard

1. The five functions of the Keyboard interface are to:
   - Buffer row and column information from the keyboard.
   - Interrupt the CPU when certain enabled events occur.
   - Send and receive serial data from the serial interface and modem.
   - Store the busy status of the PPU for access by the CPU.
   - Provide interval timing for keyboard operations.
2. The contrast key.
3. By reading and writing to 16 registers in the multi-controller.

The LCD Interface

1. The four functions of the LCD Controller are to:
   - Read the current display data from the display RAM.
   - Provide all timing and data signals to drive the liquid-crystal display.
   - Implement four display modes.
   - Control CPU access to the display RAM.
2. Display RAM has 8K bytes.
3. The LCDNEG voltage supply controls the display contrast.

The Clock/Ready Circuit

1. The Clock/Ready circuit performs the following functions:
   - Provides timing signals for the CPU, the multi-controller, the LCD controller, the HP-IL interface, the modem, and the ready circuit.
   - Synchronizes access by the CPU to other circuits.
2. The real-time clock is in the PPU.
3. The two signals are HPILCLK (2 MHz) and MODEMEN (1 MHz).

The HP-IL Interface

1. The HP-IL interace performs the following two functions:
   - Provides the link between the CPU and HP-IL devices.
   - Transfers control information from the serial interface to the CPU.
2. The two lines from the serial interface are DSR and CTS.
3. The CPU sets $\overline{\text{HPILCS}}$ low to select the HP-IL interface.
4. The HPILCKL signal.

Serial Interface and Modem Circuits

1. The multi-controller.
2. They switch between the serial interface and modem circuits.
3. The multi-controller.
4. It isolates and protects the modem and the telephone circuitry from damage by spurious electrical signals.

Power Supply

1. The power supply performs the following six functions:
   - Provides battery power.
   - Provides the regulated supply voltage (VCC1).
   - Provides the switched supply voltage (VCC2).
   - Indicates the battery-voltage level.
   - Provides the selectable LCD supply voltage (LCDNEG).
2. Two—VCC1 and VCC2.
3. The PPU and the multi-controller.
4. The PPU.

Stop! Do Quiz 4-2 now!

Quiz 4-2

1. What are the three primary functions of the CPU?

2. What are the five major components of the CPU circuit?

3. The PPU does not control the HP-IL Interface.

   _____ True

   _____ False

4. List the seven main functions of the PPU.

5. What are the four major components of the System RAM/ROM circuit?

6. List the three major components in the Mass Storage RAM circuit.

Correct Quiz 4-2 using the answers on the next page.

Quiz 4-2 Answers

1. The CPU performs the following functions:
   - Controls the operation of circuits according to programs and data.
   - Directs the transfer of data on the CPU and I/O buses.
   - Responds to interrupts from the PPU.

2. The five major components of the CPU are:
   - CPU microprocessor.
   - CPU buffers.
   - Bus select circuits.
   - RAM select circuits.
   - ROM/Display RAM select.

3. True.

4. The PPU performs the following seven functions:
   - Controls the power-down and power-up status of the computer.
   - Maintains the real-time clock.
   - Interrupts the CPU for certain enabled events.
   - Controls the LCD contrast.
   - Computes reserve battery power and controls recharging.
   - Controls the operation of the modem and the serial interface.
   - Controls the beeper.

5. The four major components of the System RAM/ROM circuit: RAM ICs, ROM ICs, data transceivers, and address latches.

6. The three major components of the Mass Storage RAM circuit are: RAM ICs, data transceivers, and address latches.

Removal and Replacement

Lesson 5

Overview

This lesson will teach the student to properly remove and replace all HP 110 field replaceable components and assemblies. Proper handling of components and assemblies along with information on parts and removal/replacement procedures will be covered.

Learning Objectives

For this lesson, you will be provided reference reading, equipment, and tools.

- You will remove and replace an HP 110 battery and separate, then reassemble the case. You will be successful when the HP 110 successfully passes the diagnostic tests.
- You will remove and replace the system PCA. Successful completion will be indicated by proper operation of the HP 110.
- You will remove and replace the display module, noting the precautions. Successful completion will be indicated by proper operation of the display.

Handling Precautions

All nonconductive materials are capable of storing a static charge. The charge is generated whenever two nonconductive materials are separated from each other. Whenever a nonconductive and a conductive material come in contact with each other a discharge occurs.

The HP 110, like most modern electronic equipment, is susceptible to damage from electrostatic discharge (ESD), especially when the case has been removed. To prevent damage to the unit while it is being serviced, you must follow approved anti-static procedures and be aware of the following misconceptions:

- "If I don't feel a static zap, then it didn't happen."

  Not true. You cannot feel a static discharge of less than about 4000 volts, but most modern integrated circuits (and some passive components) can be damaged by discharges of 4000 volts or less.

- "Static is only a problem in low-humidity areas."

  Not true. Static is **more** of a problem in low-humidity areas because the charge can build up much higher before it leaks off the surface, but it is also very much a problem in high-humidity areas. You just cannot feel the discharges as often.

- "Static-sensitive parts are 'safe' when they are mounted in their assemblies."

  Not true. A static-sensitive part is never safe. The assembly may minimize the risk to the part through the part's external connections, but it may increase the risk to the part by providing a channel for the charge into the chip from elsewhere on the assembly. Also, it does nothing to protect the part from induced charges, perhaps through the metal lid on the part.

- "Only MOS parts are static-sensitive."

  Not true. Most common parts (MOS, LS-TTL, LINEAR) can be damaged by discharges that are common in normal operations.

- "Static damage will be apparent — the machine will fail."

  Not necessarily. Many times, a static discharge will degrade a chip to the point that it still works, but will fail much sooner than normal.

Remember, ESD can cause two types of failures:

1. Immediate catastrophic failure.
2. Intermittent failures.

   The intermittent failure is, of course, the greatest concern, as it can make troubleshooting very difficult.

Static damage can and should be prevented during the course of repair. Following the suggestions below will help you prevent further failure of the product you are repairing.

- Use a static-safe workstation. At a repair bench, this may consist of a grounded, conductive work surface, a grounded wrist or heel strap, a grounded soldering iron, and an ionized air blower directed over the workstation. At an on-site location this may consist of a folding conductive mat, a ground cable, and a wrist strap. Keep all insulators (coffee cups, paperwork, packing material, etc.) far away from the static-sensitive devices; they are notorious static generators.

- Keep all assemblies and components in their conductive packages until needed. This will bleed off any static charge before it can cause damage. When the part is needed unpack it only at a static safe workstation and only while you are grounded. If you must set the part somewhere, place it only on the conductive mat.

- Handle PC boards by the edges. **Do not touch** any component, trace, or connector.

- Keep your clothing away from static-sensitive parts, even when using heel and wrist straps, as charge on clothing is often not bled away.

- Do not use erasers to clean contacts (they generate lots of static and also tend to rub off the gold).

- Connect the chassis of the instrument you are working on to the grounded mat so that it will remain grounded even when you remove the power cord for service. The ground jumper should have a 1 Mohm resistor built into it to protect you in case of a ground fault in the instrument.

The key to avoiding ESD damage is to prevent the buildup of static and to provide a discharge path away from static-sensitive parts. Both are accomplished through use of wrist and heel straps, as well as conductive mats.

If you follow these precautions, you and the machine parts you are using will all be at the same potential and there will be no damage caused by static discharge.

Removal and Replacement

This part will cover the procedures for removing and replacing the field-replaceable components and assemblies. In order to complete the following labs, you will be using the procedures described in section 5, "Removal and Replacement" in the HP 110 service manual. The beginning of it will reference specific parts of the service manual to use to complete the lab. Be sure to read the procedures completely before attempting to remove or replace any component, part, or assembly in the HP 110. If you have any problems while doing the labs or the HP 110 does not perform as expected, contact the class mentor.

Lab 5-1
Removing the Battery and Separating the Case

The purpose of this lab is to give you hands-on experience removing and replacing the battery and separating the case. Use the procedures described in part 5.2, "Removing the Battery" and part 5.3, "Separating the Case" in the HP 110 service manual.

Remove the cover to the battery compartment.

Refer to the last paragraph in part 3.7.1, "PPU" in the service manual to learn what the button on the terminal block PCA does.

Now remove the battery.

1. Replace the battery. Be sure you take note of the polarity of the battery as you are replacing it.
2. Turn the HP 110 on to ensure that you have replaced the battery properly. If the HP 110 doesn't turn on, remove and replace the battery again, making sure to follow the instructions in the service manual.
3. Remove the battery again and follow the instructions in the service manual for separating the case.

Notice

If you are going to immediately proceed to the next lab, you can skip the last two steps of this lab.

4. Reassemble the case. (You don't need to put the battery back in if you are going on to the next lab.)
5. Check the HP 110 to make sure you reassembled the case properly by opening and closing the HP 110 several times. If the screen tilts freely and the latches operate normally, good job! If the display assembly seems to stick when tilting it or the latches seem to stick, you will need to separate and reassemble the case again, carefully following the instructions in the service manual.

Lab 5-2
Replacing the PCAs

The purpose of this lab is to learn how to remove and replace HP 110 PCAs. Be sure you follow the instructions in part 5.4, "Replacing the PCAs" and part 5.5, "Removing the Keyboard Module" in the service manual.

1. Follow the instructions in the service manual for removing the I/O PCA and the EMI shield.

   What do you think will happen if the EMI shield is pierced or damaged?

   For reassembly, what do you think will happen if the leads on the back of the PCA are not trimmed properly?

2. Remove the System PCA.

   Locate the CPU. Using section 6, "Replaceable Parts" in the service manual, find the part number of the CPU. What is it?

   Suppose you wanted to replace a transceiver IC on this PCA. What part number would you use to order a new one?

   ---

3. Using the instructions in the service manual, remove the keyboard module.

4. Assemble the HP 110, replacing the keyboard and the PCAs, assembling the case and reinstalling the battery.

5. Turn on the HP 110 and type your name to verify that the circuits and the keyboard are operating properly.

Correct Lab 5-2 using the answers on the next page.

Lab 5-2 Answers

1. EMI protection may be reduced, and the shield could ground some circuits.

   If the leads are not trimmed properly, they could pierce the EMI shield.

2. 1820-3533, 1820-3330.

Lab 5-3
Removing the Display Module

The purpose of this lab is to learn how to remove and replace the display module. To do this lab, use the instructions in part 5.7, "Removing the Display Module" in the service manual.

WARNING!

Avoid touching, swallowing, or breathing material from a broken display module.

CAUTION!

Take precautions against physical and electrostatic damage to the display module:

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

Be careful NOT to exert pressure on the display module. The LCD display and its PCA can become misaligned, causing damage that can't be repaired.

Don't touch the front surface of the display module. Body oils or other contamination can damage the optical properties of the polarizer.

1. Follow the instructions in the service manual for removing the display module.

2. Install the display module.

3. After reassembling the case and installing the battery, turn the HP 110 on and when the P.A.M. screen is displayed type DIR and press [Return].

   Does the display operate properly? If so, good job!

   If the display does not operate properly, do this lab again being careful to do exactly as instructed in the service manual.

Troubleshooting

Lesson 6

Overview

This lesson teaches the correct procedures for troubleshooting and repairing the HP 110. You'll use these procedures to test the HP 110 operation, to find the cause of a problem, and to restore the HP 110 to proper operation.

The lab projects in this lesson will give you practice in using the troubleshooting procedures.

Learning Objectives

You will be given equipment, reference material, and tools.

- You will be expected to correctly answer all questions in an assignment that covers the diagnostic tools available to the repair person.
- You will be expected to correctly answer all questions in an assignment that covers the main troubleshooting procedure. The troubleshooting procedures are given in the service manual.
- You will test a good HP 110 to observe the responses for a unit that has no problems. Success is indicated by following the testing procedures and noting the responses of the tests. The tests should indicate that the unit is working properly.
- You will be expected to correctly answer all questions in an assignment that covers repair procedures.
- In a lab, you will install malfunctions in a working HP 110, then use the troubleshooting procedures in the service manual to diagnose the malfunction down to the component level. You will be successful when you diagnose the problem that was installed.
- You will correctly answer all questions in an assignment and perform all procedures in a lab that covers burning a configuration EPROM and testing the recharger. You will be successful when you install a new configuration EPROM and the HP 110 passes the diagnostic tests.
- In a lab, you will be given a diagnostic module and an HP 110. Using a procedure described in the service manual, you will be expected to connect the diagnostic module to the HP 110. You will be successful when you can run the diagnostic tests from the diagnostic module.

Troubleshooting Overview

The user of an HP 110 is able to perform two types of diagnostic tests similar to the ones that you'll use for troubleshooting the HP 110:

- **Built-in diagnostic tests.** These diagnostic routines are contained in system ROM and can be executed without connecting external equipment. They can test a limited number of HP 110 functions.

- **"Utilities" disc-based diagnostic tests.** These diagnostic routines are contained on the "Utilities" disc provided with the HP 110. They must be loaded from an external disc drive. They can test many of the HP 110 functions, but not as many as the service routines can test.

The fundamental tools for servicing the HP 110 are the built-in diagnostic tests, the service disc, and the diagnostic module. These tools provide additional diagnostic tests:

- **Service disc-based diagnostic tests.** These diagnostic routines are contained on the service disc. They must be loaded from an external disc drive. They can test almost all HP 110 functions. Many of the tests are the same as the "Utilities" disc-based tests. The service disc also contains a routine that "burns" a configuration EPROM using the diagnostic module.

- **Service EPROM diagnostic tests.** These diagnostic routines are contained in EPROM in the diagnostic module. They can be executed by connecting only the diagnostic module. These routines can test many of the HP 110 functions. In addition, the EPROM contains routines for performing signature analysis.

Service Philosophy

The HP 110 is constructed with a modular design that enables you to disassemble and repair it using basic hand tools. About 60 percent of the repair will be at the component level and 40 percent at the assembly level. On-site repair will typically be at the assembly level. All components are soldered except ROMs containing firmware, which are socketed.

Component level troubleshooting is supported by theory, schematics, component location diagrams, and a parts list in the HP 110 service manual.

The diagnostic procedure in the service manual uses a step-by-step approach, telling you when to perform each test. The diagram on the next page illustrates an overview of the troubleshooting process. You will be instructed by the service manual at each step.

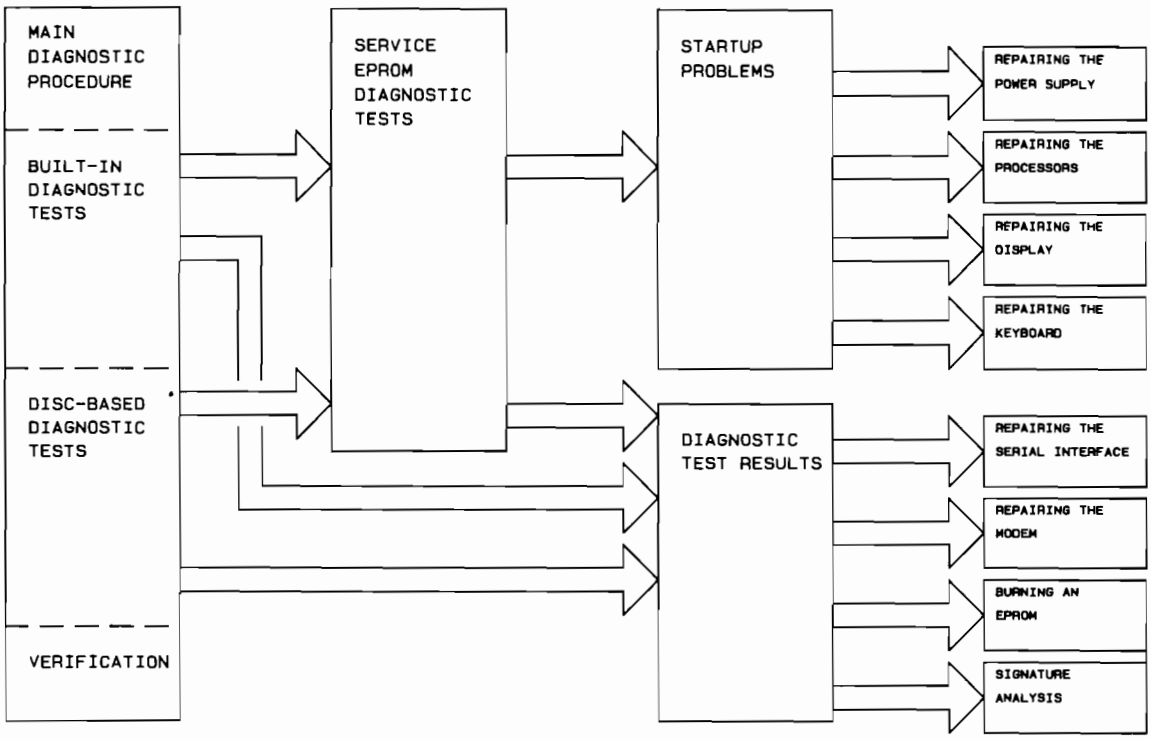


Figure 6-1. Service Overview

The above diagram indicates the process you go through when servicing an HP 110. Starting at the top of the far-left box, proceed to run the built-in or disc-based tests. If the tests won't run, use the service EPROM diagnostic tests. If those tests won't run, then you have a start-up problem. If the diagnostic tests do run, then read and interpret the diagnostic test results. After that, repair the indicated components.

Assignment 6-1
Troubleshooting Overview

At this time, read the "Overview" part of section 4 in the service manual. This gives an overview of the troubleshooting tests and procedures. Then answer the following questions.

1. What diagnostic tools are available to the customer with an HP 110?

2. What additional diagnostic tools are available to service personnel?

3. Which of the above diagnostic tools are used in the "main diagnostic procedure" as described in the service manual (section 4)?

4. Which of the diagnostic tools exist on discs? How do they differ? Which one of these is used by service personnel?

5. How do the assembly-level troubleshooting tests compare to the component-level troubleshooting tests?

Correct Assignment 6-1 using the answers on the next page.

Assignment 6-1 Answers

1. The diagnostic tools available to the customer are:
   - The built-in diagnostic tests.
   - The disc-based diagnostic test program on the "Utilities" disc.

2. The additional tools available to service personnel are:
   - The disc-based diagnostic test program on the service disc.
   - The diagnostic tests available in the diagnostic module. (EPROM tests.)

3. The main diagnostic procedure uses:
   - The built-in diagnostic tests.
   - The disc-based diagnostic test program on the service disc.

4. Diagnostic tools that exist on discs are:
   - The "Utilities" disc-based diagnostic program.
   - The service disc-based diagnostic program. The service disc-based program contains routines that test more HP 110 functions that the "Utilities" program tests. Service uses the service disc-based diagnostic program.

5. The assembly-level and component-level troubleshooting tests are the same; the indicated assembly or component is replaced according to the level at which you are repairing the HP 110.

Main Troubleshooting Procedure

The main troubleshooting procedure for the HP 110 is presented in the "Main Diagnostic Procedure" part of section 4 of the service manual. The main procedure makes use of the built-in diagnostic tests and the service disc-based diagnostic tests.

The main procedure supports both assembly-level and component-level repair. The action that you are directed to take for the outcome of a diagnostic test depends upon the level of repair you're performing.

Assignment 6-2
Main Troubleshooting Procedure

At this time, read the introduction under "Troubleshooting Procedures" and the "Main diagnostic Procedure" part of section 4 in the service manual (including table 4-2). They describe how to perform the main procedure and interpret its results. Then answer the following questions:

1. What precaution should you take before opening the HP 110 case to make a repair?

2. List the main functional parts of the HP 110 that can be tested by the built-in tests. Which is the one built-in test that you might use in the main diagnostic procedure? In what situation would you use it?

3. What equipment is required to load the service disc-based diagnostic test program?

4. List the functional parts of the HP 110 that can be tested by the service disc-based diagnostic program.

5. What service disc-based tests require you to make special preparations before executing the tests?

6. How do you verify that a repaired unit is good?

7. In general, the battery in a unit is neither fully charged nor fully discharged. But if power was disconnected from the unit, the battery "gauge" will read either 0 or 99 percent. How should you bring the battery level up to the level of the "gauge"?

8. If you receive an HP 110 that is completely unresponsive (no display at all) to each step in the main procedure, where does the main procedure direct you?

9. If you receive an HP 110 and an HP 9114 Disc Drive with an explanation from the customer that he can't get the disc drive to work, where in the main procedure would you determine which unit is at fault? What might happen if the HP 110 (specifically, its HP-IL function) were at fault?

10. According to the "Diagnostic Test Results" table (table 4-2 in the service manual), why must the configuration EPROM match the system ROMs installed in the system PCA?

Correct Assignment 6-2 using the answers on the next page.

Assignment 6-2 Answers

1. Before opening the HP 110, you must take precautions against damage by electrostatic discharge: put on a grounded wrist strap and work at a bench that is grounded.

2. Functional parts tested by the built-in tests: ROM, RAM, and HP-IL. The main diagnostic procedure uses the HP-IL test when the indicated problem involves the HP-IL function (such as an HP-IL peripheral problem).

3. Equipment needed in addition to the HP 110: HP 9114 Disc Drive, two HP-IL cables, and the service disc.

4. Functional parts tested by the service disc-based tests: CPU, ROM, RAM, LCD (display), keyboard, HP-IL, modem, RS-232 (serial interface), beeper, timer, sleep.

5. Special preparations required for: HP-IL test, RS-232 test, modem test, and the system test (which performs the previous three tests).

6. Verify repair by performing the service disc-based system test.

7. Match battery and "gauge" by charging battery for at least 12 hours, bringing both near the 99 percent level.

8. For an unresponsive unit, failure to start the built-in test (in step 5 of the main procedure) would lead you to the "Service EPROM Diagnostic Tests" procedure (table 4-3 in the service manual).

9. For a disc drive problem, the built-in HP-IL test would help determine which unit is at fault (steps 6 through 8 in the main procedure). If the HP 110 were at fault, it would fail the "no devices" or the "devices" part of the HP-IL test (in step 7 or 8).

10. According to the "Diagnostic Test Results" table footnote, the configuration EPROM contains ROM checksums that must correspond to the system ROMs installed in the system PCA.

Lab 6-1
Main Diagnostic Procedure

In this lab you'll follow the main diagnostic procedure for an HP 110 that has no problems. This gives you a chance to observe the responses for a good unit. Knowing how a good unit responds will assist you in determining when a problem may exist.

Follow the "Main Diagnostic Procedure" in section 4 of the service manual using a good HP 110.

1. For the Problem Analysis part, assume that no information is available. Proceed to the next part.

2. For the Built-in Diagnostic Test portion, check the HP-IL function. Use the HP 9114 Disc Drive as a peripheral (as though the customer had included it with the HP 110).

   List any errors or faults, if any, that occurred. Note whether they were caused by a faulty unit or by an operational problem.

   _____

   _____

3. For the Disc-Based Diagnostic Test portion, use the system test to check each function.

   List any errors or faults, if any, that occurred. Note whether they were caused by a faulty unit or by an operational problem.

   _____

   _____

4. For the Verification portion, if you never replaced any parts and have already checked all functions, you need not repeat the system test. Set the time using the clock configuration menu. (You can skip recharging the battery at this time since you'll be disassembling the unit in later labs.)

Repair Procedures

If the diagnostic tests in the main procedure can't indicate the problem with a unit, that procedure will direct you to one or more of the repair procedures. The repair procedures involve disassembling the HP 110 so that you can use the diagnostic module or measure signals within the HP 110.

The following repair procedures are provided:

- Service EPROM Diagnostic Tests.
- Startup Problems.
- Repairing the Power Supply.
- Repairing the Processors.
- Repairing the Display.
- Repairing the Keyboard.
- Repairing the Serial Interface (RS-232).
- Repairing the Modem.

The "Service EPROM Diagnostic Tests" table enables you to check a system that won't respond to the built-in tests or the disc-based tests. The program code exits in EPROM in the diagnostic module (which is connected as part of the system). The program can be executed with only a small part of the main system being operative.

Each of the other repair procedures focuses on one type of problem. Each one is presented in a table that starts with a flowchart. The flowchart gives an overview of the procedure—the procedure itself is described in the body of the table.

Assignment 6-3
Repair Procedures

At this time, look through the "Repair Procedures" part of section 4 in the service manual. This describes how to perform the procedures that you'll be directed to by the main diagnostic procedure. Then answer the following questions:

1. While connecting the diagnostic module to the HP 110 PCAs (to use the EPROM diagnostic tests — or at other times), what two kinds of actions must you perform carefully to prevent physical damage to the unit? (These are in addition to using electrostatic protection.)

2. In order to perform the EPROM diagnostic tests, how must you place the two-pin jumper in the diagnostic module?

3. Where in the HP 110 system do you install the diagnostic module?

4. In order to perform the EPROM diagnostic tests, how do you provide power to the HP 110?

5. After connecting the diagnostic module to the HP 110 system, what must you do to bring up the main test menu?

6. If the HP 110 has startup problems (it doesn't turn on and none of the diagnostic tests will operate), in what order should you check the following circuits: display, CPU, battery, power supply, keyboard?

7. For a startup problem, you'll measure certain voltages. What are the acceptable *ranges* for the following voltages while the unit is turned on: VBAT, VCC1, VCC2, LCDNEG?

8. For a processor problem (for which you're referred to the "Repairing the Processors" table), in what order will you check the two processors? Which internal buses will you also check?

9. What main clock signal is required for the display circuit to operate? What four clock signals are output to the display module?

10. What main clock signal is used by the keyboard circuit while the system is turned on?

Correct your answers to Assignment 6-3 using Appendix A.

Assignment 6-3 Answers

1. Connect and disconnect internal cables carefully since no strain relief is provided. Align connectors carefully while installing them.

2. The two-pin jumper must connect the two pins in order to perform the EPROM diagnostic tests. The jumper must be connected at the end of the diagnostic module nearest the I/O PCA.

3. The diagnostic module is inserted between the two main PCAs (system PCA and I/O PCA).

4. You can provide power for the EPROM diagnostic tests by connecting either a recharger or a service battery assembly.

5. The main EPROM menu normally appears when power is applied. (Occasionally, you might have to press any key.)

6. The startup problem procedure directs you to check circuits in this order: battery, power supply, CPU, display, keyboard.

7. Acceptable voltage ranges while the unit is turned on: VBAT (6.2 Vdc or above), VCC1 (4.7 to 5.3 Vdc), VCC2 (4.7 to 5.3 Vdc), LCDNEG (-7 to -12 Vdc).

8. The processor repair procedure directs you to check the PPU signals first, then the CPU signals. You should check the CPU (address/data) bus and the system ROM (address and data) buses.

9. The KEYCLK signal is required by the display circuit. The M, CL2, CL1, and FLM clock signals are output to the display module. (These signals are checked in the display repair procedure.)

10. The KEYCLK signal is used by the keyboard circuit. (This signal is checked in the keyboard repair procedure.)

Lab 6-2
Troubleshooting Procedures

In this lab you'll use the main diagnostic procedure and repair procedures to find HP 110 problems.

This lab directs you to install individual malfunctions in an HP 110. Using the troubleshooting procedures in the service manual, you're directed to find and repair the fault, then verify the HP 110 operation.

CAUTION!

Disconnect all power from the HP 110 before installing any of the malfunctions for this lab.

To install some of the malfunctions, you'll have to open the HP 110 case. In these situations, connect the keyboard to the I/O PCA using a keyboard extension cable. *Be sure the top case and base assemblies are in their normal orientation when joining them with the extension cable.* If the fronts of both assemblies aren't facing the same direction, components could be damaged.

1. With power disconnected, install one of the following malfunctions in the HP 110:
   - Disconnect the I/O plate connector from the I/O PCA.
   - Substitute a new (unburned) configuration EPROM (part number 00090-60908) for the original configuration EPROM (A2U28) on the I/O PCA.
   - Deliberately avoid pressing one particular key (such as the Q key) during the keyboard test (to simulate a bad keyswitch).
   - Leave the RS-232 test connector off while testing the serial interface (to simulate a bad signal path).
   - Disconnect the battery cable at the terminal block PCA. (When reconnecting the plug, be sure the red wire is next to the RED label.)
   - Mark and swap two ROMs on the system PCA. (This may be convenient only if you've already removed the PCAs from the case.)

2. Use the troubleshooting procedures in section 4 to test the HP 110 and to locate the cause of the malfunction. *While you're checking the unit, observe the symptoms that it shows — try to relate them to the fault that you find.* Stop testing when you're directed to replace the component that's been disabled. Instead, restore the disabled component — then continue to verify that the problem has been corrected.

3. Repeat steps 1 and 2 with other malfunctions installed — one at a time. For additional practice, explain the locations of components and connectors to a technically competent person, and then leave the room while that person installs one of the malfunctions for you. *Be sure to remove power from the unit and take precautions against electrostatic damage* before leaving the room.

4. At certain points in the diagnostic procedure, the service manual directs you to connect the diagnostic module to the HP 110 and then run diagnostic tests. In this step, you'll get some practice connecting the diagnostic module.

   Connect the diagnostic module to the HP 110 using the procedure in steps 1 through 4 of table 4-3 in the service manual.

5. Run the diagnostic tests using the procedure described in step 5 of table 4-3 in the service manual.

You can leave the HP 110 disassembled and the diagnostic module connected. The next lab requires that the HP 110 be disassembled and the diagnostic module connected.

Other Service Procedures

Section 4 of the service manual contains two additional procedures for troubleshooting and repairing the HP 110:

- **Burning an EPROM.** Any time the configuration EPROM is bad, or any time you install a set of ROMs that have a different revision from the original set, you must burn and install a new configuration EPROM on the I/O PCA. The configuration EPROM contains the checksum values of all system ROMs that are used for the diagnostic tests. The EPROM also contains the serial number of the unit.

- **Testing the Recharger.** If the customer's recharger is suspected as the cause of the problem, you should test it according to the recharger procedure.

Assignment 6-4
Other Service Procedures

At this time, read the "Burning an EPROM" and "Testing the Recharger" parts of section 4 in the service manual. They describe how to perform these two procedures. Then answer the following questions:

1. In order to burn a configuration EPROM, how must you place the two-pin jumper in the diagnostic module?

2. What is the nominal voltage that must be supplied to the diagnostic module in order to burn an EPROM? What is the allowable range for this supply?

3. When burning a configuration EPROM, what must be installed in the configuration EPROM socket on the I/O PCA? In the configuration EPROM socket in the diagnostic module?

4. What load resistance is used when checking a recharger under load?

Correct Assignment 6-4 using the answers on the next page.

Assignment 6-4 Answers

1. The two-pin jumper must **not** connect the two pins while burning a configuration EPROM.

2. You must provide a +25 Vdc supply. It must be adjusted between 24.8 and 30 Vdc.

3. Any usable configuration EPROM must be installed in the socket on the I/O PCA. The EPROM to be burned must be installed in the socket in the diagnostic module.

   You must supply the serial number when burning a configuration EPROM. Get the number from the bottom case of the unit. The number contains 10 characters (two year, two week, one location, five sequence) according to reference in section 1.

4. A 12-ohm load resistance is applied to a recharger.

Lab 6-3
Other Service Procedures

In this lab you'll perform the procedure for burning a configuration EPROM for the HP 110.

1. Follow the "Burning an EPROM" procedure in section 4 of the service manual. Use a new (unburned) configuration EPROM (part number 00090-60908). Enter the serial number from the HP 110 that you're using. (The EPROM that you use can be burned only once.)

2. Reassemble the HP 110 and verify its operation according to the main diagnostic procedure in the service manual.

3. If necessary, complete the main diagnostic procedure by setting the time and charging the battery.

Stop! Do Quiz 6-1 now!

Quiz 6-1

1. List the three built-in diagnostic tests.

2. List the two fundamental tools for servicing the HP 110.

3. List the two cases where a new EPROM must be burned.

4. Disc-based diagnostics do not test HP-IL.

   _____ True

   _____ False

5. The service manual shows the menus for both the disc-based and EPROM-based diagnostic tests. List the seven tests common to both the diagnostic disc and the diagnostic module (EPROM).

Correct this quiz using the answers on the next page.

Quiz 6-1 Answers

1. RAM, ROM, and HP-IL.
2. The diagnostic disc and the diagnostic module.
3. The configuration EPROM is bad or new versions of ROMs are installed.
4. False.
5. CPU, SYSTEM, ROM, RAM, LCD, TIMER, BEEPER.

Product Support Considerations

Lesson 7

Planning for Success

Up to this point in the training program, you have focused on understanding and repairing the HP 110 Portable Computer. Your progress through this program has been measured by your ability to understand the material presented and your troubleshooting expertise. While these are important aspects of product repair, your true success can only be measured by 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 IC—isolating the problem quickly is of little value if you do not have a spare IC. Having a large quantity of the wrong IC 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 3 major elements:

- Determining Need.
- Evaluating Resources.
- Planned Maintenance.

1. Determining Need

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.

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 normal working 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 process be inoperable?
  It is important to establish alternate plans for critical times. Suggest alternatives for the user: back-up procedures, etc.

The User Requirements Worksheet on page 7-6 will help answer some of these questions and should be completed for each site and product that you will support.

For this course, 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 users, you should make several copies before you complete the form.)

Complete Steps 1 through 6 of the User Requirements Worksheet located on page 7-6.

Product Design

The Hewlett-Packard HP 110 Portable Computer 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? Is it subjected to high/low termperature extremes, power fluctuation, dirt, caustic atmopshere, 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.

Complete Section III of the Resource Analysis Worksheet on page 7-14.

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

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 user's 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 normal working hours, weekends and holidays.

Response Time

Response time is a measure of the efficiency of the disptaching 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. Poor communication can mean long delays in responding to service requests or worse, missed service requests. Consider:

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

Availability of Service Personnel

You must understand what procedures your organization follows to best utilize its service personnel. For example:

- How are service requests assigned?
- Can you leave immediately?
- What happens if you can't go immediately?
- Do you have a back-up plan?
- What happens after normal working 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 normal hours, weekends, and holidays? Valuable time can be wasted if parts are stored miles away from your current location.

User's Location

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

- Distance from support personnel.
- Geographic territory (mountains, etc.)
- Travel time consideration (traffic, etc.)
- Travel method (airplane, 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?

Complete Section I of the Resource Analysis Worksheet on page 7-8.

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?

Complete Section II of the Resource Analysis Worksheet on page 7-12.

3. Planned Maintenance

The first portion of this lesson described the preventive maintenance (PM) procedures for the HP 110. 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.

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 unimportant which definition or formula is used. However, once the criteria have been established, it is important that they remain unchanged.

The general formula for uptime calculations is:

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

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 8-1 shows PPM for typical applications.

Hours of Service Coverage/day	No. of days covered/week 5	6	7
8	174	208	242
12	261	312	363
16	348	416	484
24	522	624	728

Table 8-1

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.

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

$$\text{Monthly Uptime \%} = \frac{174\text{-}6}{174} \text{ X } 100$$

$$\text{Monthly Uptime \%} = 96.6$$

The uptime graphs provided on page 7-15 and 7-16 can be used to record graphically the uptime results for both the site and service person.

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

You have completed this product's self-paced hardware training course. You must now apply your new theory, practical knowledge, troubleshooting techniques, and then "think beyond the fix." You have been introduced to the key elements for providing a successful support program.

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: S M T W TH F S)

Hours: From: _____ to: _____ Days of month: _____ Months of the year: _____

Other: _____

6. Maximum Downtime/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 hours/day_____ 12 hours/day_____ 24 hours/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 Hours Phone # _____	HP After Hours 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

Availability of Service Personnel

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 back-up plan? ☐ No ☐ Yes: What is it?

   _____

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

B. After 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 back-up 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 back-up plan? ☐ No ☐ Yes: What is it?

   _____

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

Parts/Tools Availability

A. Normal Working 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 pickup 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 pickup 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 pickup 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 pickup 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 pickup 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 pickup parts and tools: _____hours

Estimated travel time: _____hours

Estimated time delay for security access to site: _____hours

Total Response Hours: _____hours

Resource Analysis Worksheet

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 # _____

b. Estimated amount of time to contact technical back-up: _____hours

c. Is management assistance available? ☐ Yes ☐ No

Name _____

Location _____

Phone # _____

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 # _____

b. Estimated amount of time to contact technical back-up: _____hours

c. Is management assistance available? ☐ Yes ☐ No

Name _____

Location _____

Phone # _____

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 # _____

b. Estimated amount of time to contact technical back-up: _____hours

c. Is management assistance available? ☐ Yes ☐ No

Name _____

Location _____

Phone # _____

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 to? ☐ Industrial Manufacturing
   ☐ Office Area ☐ Computer Room ☐ Other _____
2. What temperatures will the 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 set-up 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_____

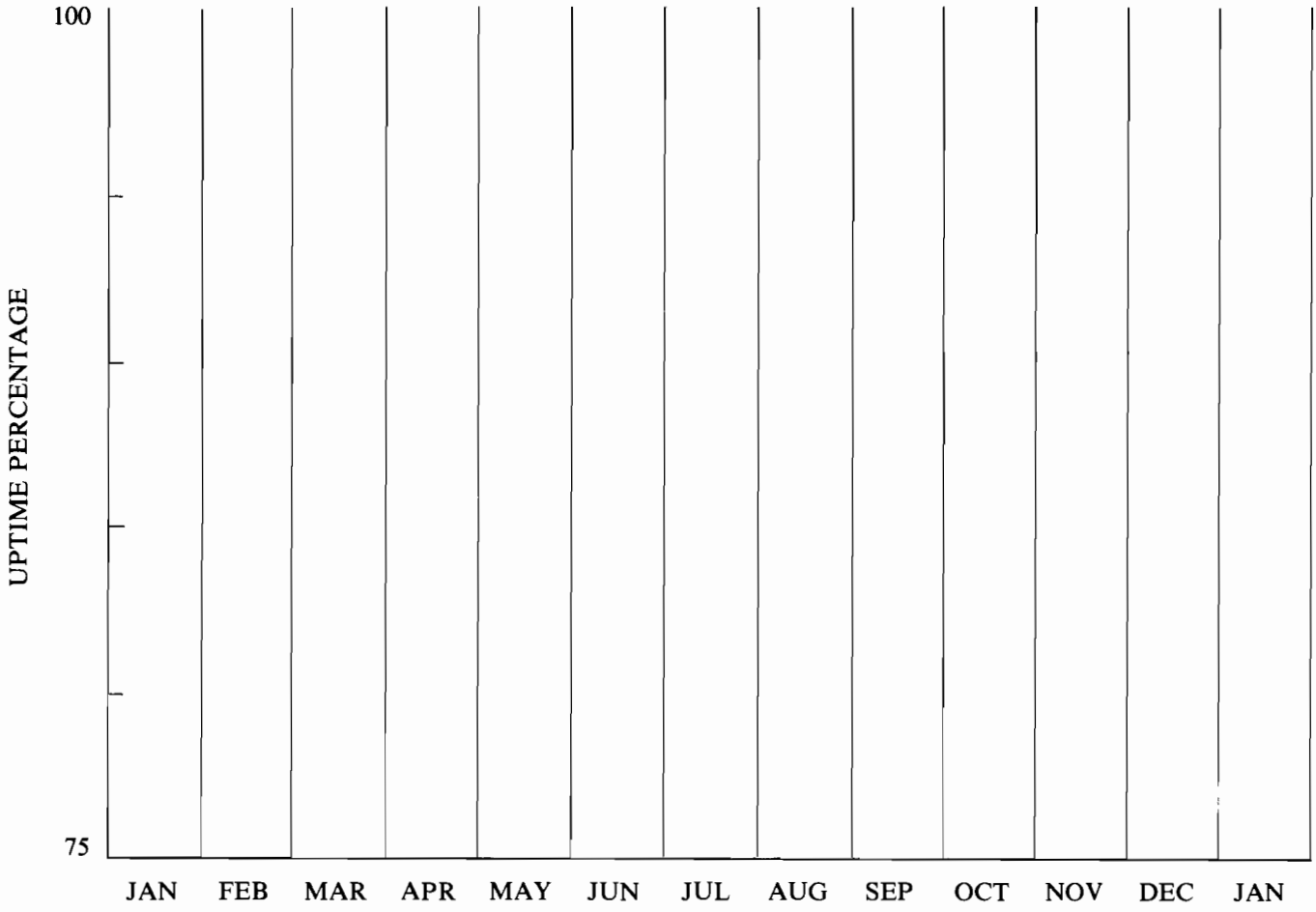
Uptime Graph
Final Site Plan

Service Person _____

Name _____

Number of Products _____

Product Types _____



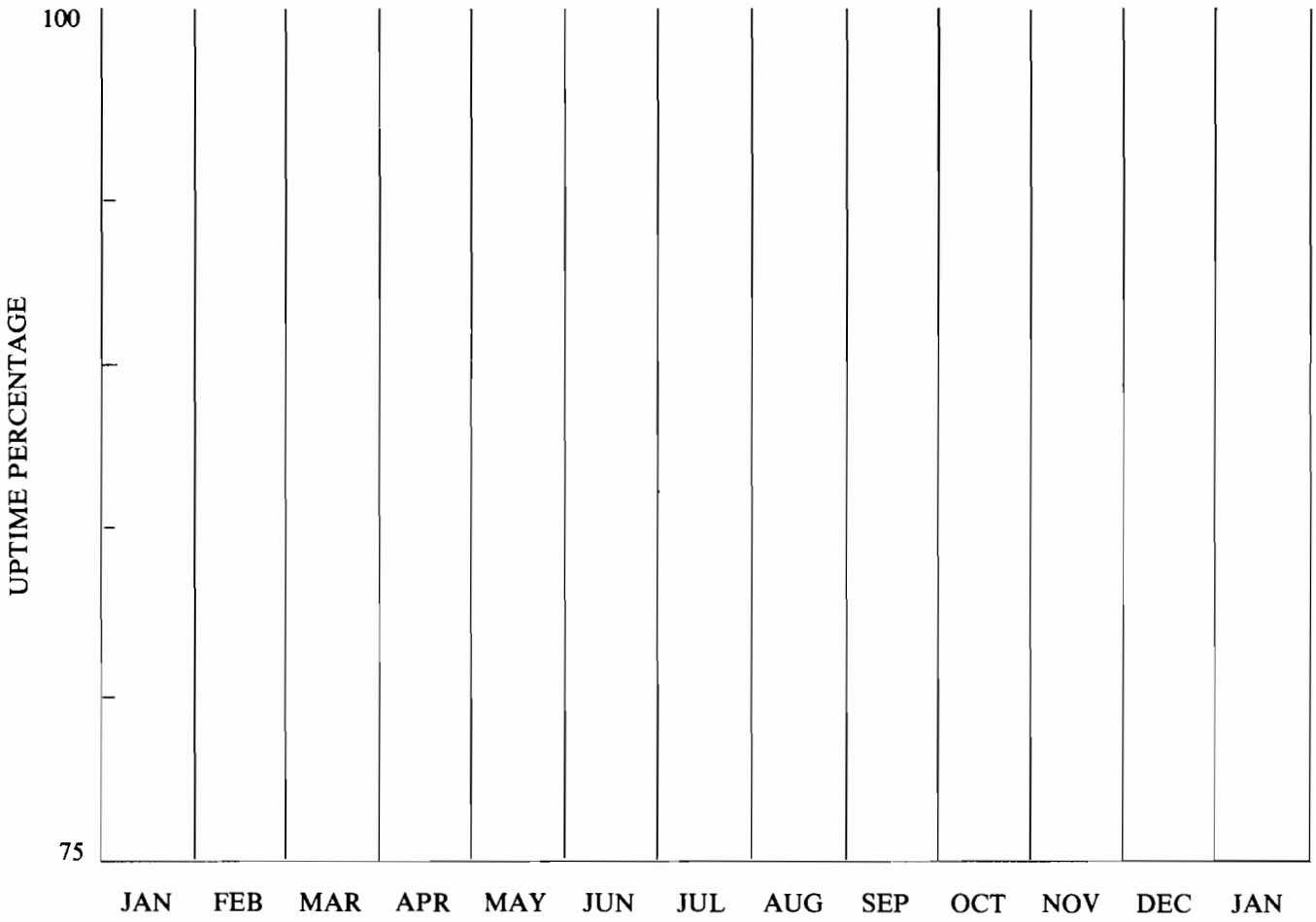
Uptime Graph
Work Sheet

User Name _____

Product Type _____

Serial # _____

Service Person: _____



Course Completion Summary

HP 110 Portable Computer
Self-Paced Hardware Training Guide

Lesson	Date Completed	Time Required
1. Getting Acquainted with the HP 110	_____	_____
2. Setting Up	_____	_____
3. Operating the HP 110	_____	_____
4. How the HP 110 Works	_____	_____
5. Removal and Replacement	_____	_____
6. Troubelshooting	_____	_____
7. Planning for Success	_____	_____

_____
Student's Signature

_____
Date

_____
Manager's Signature

_____
Date

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