

HEWLETT-PACKARD

# Introduction to the HP-87



## CASH FLOW ANALYSIS

YEAR:

3

4

5

SHIP OF PROPERTY INCOME: TAXABLE INCOME

Total Gross	9600	105600	140553.6
- Operating	25000	27500	02.5
Net Operating	71000	78100	1
- Interest	33827	33388	865
- Depreciation	20000	20000	000

Tax	2471		1
CAS			

	85910	94501	103951.1
	38652	38652	38652
Cash	47258	55849	65299.1
- Inc	13195.2	16833.6	20834.44
Cash Flo	34062.8	39015.4	44464.66

## INT. OF RETURN

Sale Proceeds After Tax:  
Discount Rate:

Cash Flow Aft. Tax (Init. Invest. in Year 0)	-100000	25478.8	29563.2
Net Present Value	-77844.5	-55490.5	-330
IRR (Percent)	-74.5212	-31.41	





# **Introduction to the HP-87**

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# Contents

<b>Section 1: Your HP-87 Computing System</b>	<b>5</b>
Introduction	5
Owner's Documentation	6
The HP-87's Features: An Overview	6
<b>Section 2: Owner's Information</b>	<b>9</b>
Inspection Procedure	9
Physical Specifications	10
Rear Panel	10
Power Cords, Voltage, and Fuses	11
Power Requirements	11
AC Line Voltage	11
Line Frequency	11
Power Consumption	11
Power Cords	11
Grounding Requirements	12
Fuses	12
For 110/117 Vac Operation	12
For 220/240 Vac Operation	12
Initial Set-Up Instructions	12
Installing Plug-In Modules	13
General Module Installation and Removal	14
Installing and Removing ROMs	15
Selecting a Workspace	16
<b>Section 3: Connecting Peripherals</b>	<b>19</b>
Introduction	19
Preparations	19
The Interface Select Code	20
Setting Peripheral Device Addresses	20
Connecting HP-IB Peripherals	21
Connecting Non-HP-IB Peripherals	23
<b>Section 4: Getting Started</b>	<b>25</b>
Power On	25
The <b>(END LINE)</b> Key	26
The <b>(SHIFT)</b> Key	26
Manual Problem Solving	27
Error and Warning Messages	28
Display Editing	29
Variables	30
Typing Aids	31
Addressing Peripheral Devices	31
Accessing the Printer	31
Accessing Mass Storage	32
Programming with the HP-87	33
Erasing Program Memory	33
Entering a BASIC Program	33
Running the Program	33
Storing Programs	34
Initializing a Flexible Disc	34
The <b>STORE</b> Command	34
Generating a Graphics Display	35
Storing and Retrieving a Graphics Display	37
Retrieving Programs	37
Listing a Program	40
Halting Program Execution	40

<b>Appendix A: The HP-IB Interface</b>	<b>43</b>
Introduction	43
Plug-In ROMs	43
Peripheral Load	43
Accessory Cables	44
Connecting Peripherals	44
Disconnecting Peripherals	45
The HP-IB Switch	46
The Select Code	46
Peripheral Addressing	47
Talk/Listen Address Switches	47
System Controller Switch	48
Parallel Poll Rotary Switch	49
HP-IB Control Registers	49
Control Registers 0 Through 3	49
Registers 16 Through 23: The End-of-Line Registers	50
Register 16	50
Registers 17 through 23	50
HP-IB Errors	50
<b>Appendix B: Compatibility With Other HP Series 80 Products</b>	<b>53</b>
Compatibility of Optional Plug-In Modules	53
Translating HP-83/85 Programs	53
Translating HP-83/85 Programs That Use Binary Programs	54
Troubleshooting: Sources of Possible Errors	55
Extended-Type Files	56
Printer and Display Formats	56
<b>HP-IB Interface Errors</b>	<b>Inside Back Cover</b>



# Your HP-87 Computing System

## Introduction

If you've just purchased your HP-87 or if you've never had the opportunity to operate a Hewlett-Packard Series 80 Personal Computer, you should read all or portions of this manual before you start reading the operating and programming manual. The *Introduction to the HP-87* manual has been written to provide you with step-by-step instructions for setting up your computer system and to present an overview of the HP-87's powerful features.

Sections 2 and 3 include the information you need to properly set up the computer, install various optional modules, and connect peripheral devices. If you are responsible for setting up or altering the configuration of your system, please read sections 2 and 3, carefully following all instructions. As you perform the set-up procedures, pay particular attention to cautions and warnings; they've been provided to protect you and your new computing system from possible harm.

Once your system has been set up, you'll be ready to start learning about the HP-87 by using it. Section 4, Getting Started, is intended to give you "hands on" experience in performing calculations, entering and running programs, and accessing peripheral devices. You'll also have the opportunity to load and run a program provided on the demonstration disc packaged with the computer. Since the HP-87 cannot be harmed by any keyboard operation, you can become familiar with the computer by doing, rather than by merely reading. In some cases, the computer will be your best teacher, informing you when you've made an error and even providing hints on how to remedy your mistake.

After you've completed section 4, you'll be ready for the more in-depth discussion of the HP-87 presented in the operating and programming manual. Make sure you read the preface of that manual—it includes valuable hints for using the rest of the manual efficiently.

Appendix A of this manual describes the computer's integrated HP-IB interface. Refer to appendix A if you need to know more about using the interface to connect peripheral devices than is explained in section 3. The *HP-IB Interface Owner's Manual* is included with your owner's documentation to provide a detailed description of the interface. Refer to that manual when using the interface for applications other than accessing printers, plotters, and disc drive units.

Appendix B covers compatibility of the HP-87 with other HP Series 80 products. Read appendix B if you will be using the HP-87 to run programs written for the HP-83/85 computers or if you have questions about the compatibility of accessories such as ROMs and plug-in modules.

## Owner's Documentation

The following literature has been packaged with your HP-87:

- *Introduction to the HP-87 manual.*
- Operating and programming manual.
- Pocket guide.
- *HP-IB Interface Owner's Manual.*
- *Fuse Instruction Card.*
- *HP Series 80 Warranty Statement.*
- *Basic Exchange* and Users' Library literature.
- Informational brochures.

Please take the time now to fill out your Basic Exchange form. The form provides us with a mailing address to which we can send your copies of the users' newsletter *Basic Exchange* and is a source of information that enables us to better serve our customers.

Also examine the Users' Library literature. As the owner of an HP Series 80 Personal Computer, you have the opportunity to gain access to a large number of programs and programming ideas by purchasing programs from the library.

## The HP-87's Features: An Overview

Most of your owner's documentation is devoted to discussing the computing and programming capabilities of your HP-87. If you are somewhat experienced in programming, however, you might appreciate this list of some of the HP-87's features:

- An 80-column alphanumeric display with variable page size (16 or 24 lines per screen) and inverse video characters.
- Approximately 124K usable bytes of computer memory expandable in increments of 32K, 64K, and 128K bytes to a maximum of approximately 636K bytes. Programs can contain up to 99999 lines.
- Easy-to-use display editing.
- Four variable types: simple numeric, simple string, numeric array, and string array. Arrays can be one- or two-dimensional.
- Three numeric precisions: `INTEGER`, `SHORT`, and `REAL` (full).
- Multicharacter variable names and statement labels.
- Multiparameter user-defined functions.
- Fourteen user-defined keys used to provide program control and typing aids.
- Multiple binary programs: a maximum of five binary programs can be present simultaneously in computer memory.
- The ability to address and drive a peripheral printer and disc-based mass storage system.
- An integrated HP-IB (Hewlett-Packard Interface Bus) interface for connecting devices such as printers, plotters, and disc drive units to the computer.

- Four ports used to add additional interfaces and enhancement features to the system.
- A high-resolution graphics display with variable apportionment of alpha/graphics display memory.
- Powerful program trace operations for debugging, including an immediate execute key for initiating or cancelling a trace operation while a program is running.





## Owner's Information

This section covers information you should know about your HP-87 computer before you begin setting up your computing system.

**Note:** You should become thoroughly familiar with the information in this section before you proceed to operate your HP-87 or to connect peripheral devices to the computer.

Section 2 covers:

- Unpacking and inspection.
- Power supply information.
- Description of the computer's rear panel.
- Initial set-up instructions.
- Installation of plug-in modules.
- Selecting a workspace.

After you have read the material in this section, you'll be ready to connect your peripheral devices to the computer and get your system working for you. Section 3, *Connecting Peripherals*, gives you step-by-step instructions for connecting your peripheral printer, disc drive unit, and other devices.

### Inspection Procedure

Your HP-87 computer was thoroughly inspected before it was shipped and should be ready to operate as soon as you've completed the set-up procedure. Carefully check the computer for any signs of physical damage sustained during shipment. Do not turn on the power if the CRT display shows any cracks. Notify your dealer and file a claim with any carriers involved if you discover any damage to the computer.

Please check to ensure that you have received all of the standard items included with the HP-87:

- Owner's documentation (refer to page 6 for a list of items).
- Demonstration disc.
- Power cord.
- Fuses and fuse cap holders.
- Series 80 three-ring binder and dividers.
- HP-IB accessory cable (1 meter length, part number HP 10833A).

If any items are missing, please contact the dealer from whom you purchased the computer. If the computer was purchased directly from Hewlett-Packard, please contact the sales and service facility through which you placed your order.

## Physical Specifications

### Dimensions:

Width	42 cm (16.5 in.).
Depth	45 cm (18 in.).
Height	20 cm (7.8 in.).

### Weight:

9.75 kg (21.5 lb.).

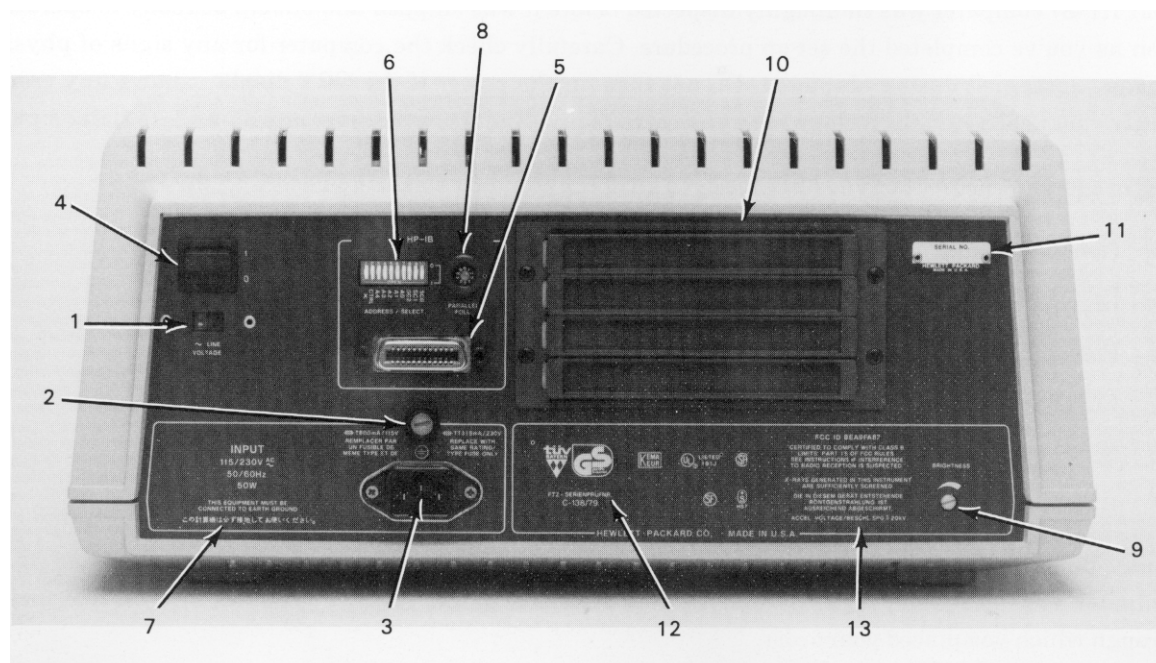
### Temperature Ranges:

Operating	0° to 55°C (32° to 131°F).
Storage	-40° to 55°C (-40° to 131°F).

## Rear Panel

An understanding of the rear panel layout and features of your HP-87 is essential for safe and efficient operation. Use the photograph below to locate the following features:

1. Line Voltage Selector Switch.
2. Fuse Receptacle.
3. Power Cord Receptacle.
4. ON-OFF Switch.
5. HP-IB Cable Connector.
6. HP-IB Switch.
7. Ground Information.
8. HP-IB Parallel Poll Rotary Switch.
9. Display Brightness Control.
10. Module Ports and Covers.
11. Serial Number Plate.
12. Worldwide Safety Approved Nomenclature.
13. RFI (Radio Frequency Interference) Compliance Statement (applicable in U.S.A. only).



## Power Cords, Voltage, and Fuses

The following information relates to the computer's power supply.

### Power Requirements

The HP-87 has the following power requirements:

#### AC Line Voltage

115 Vac Setting	110/117 Vac Nominal
230 Vac Setting	220/240 Vac Nominal

#### Line Frequency

50 to 60 Hz

#### Power Consumption

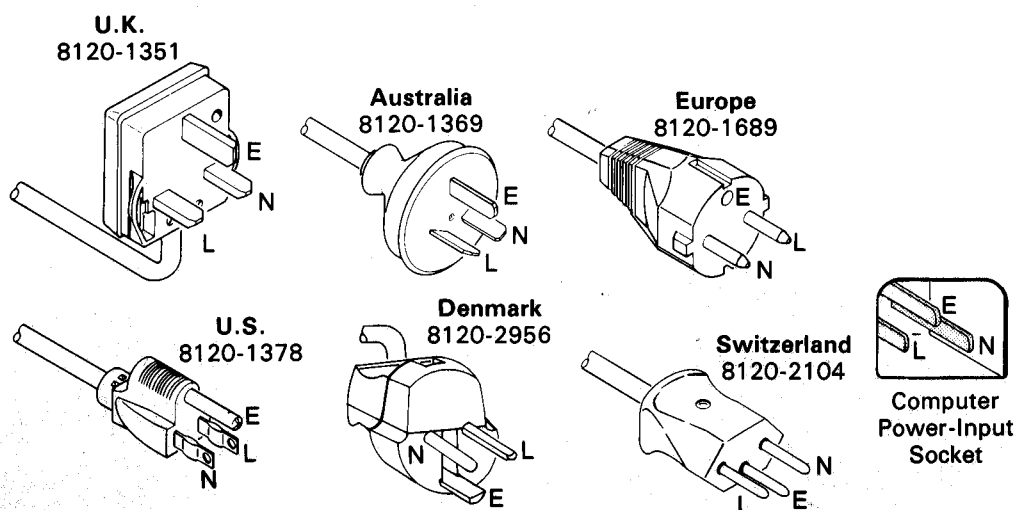
40 Watts Nominal

### Power Cords

Power cords supplied by HP have polarities matched to the power-input socket on the machine, as shown below.

- L = Line or Active Conductor (also called "line" or "hot").
- N = Neutral or Identified Conductor.
- E = Earth Ground.

Power cords with different plugs are available for the HP-87. The part number of each cord is shown below. Refer to appendix A of the operating and programming manual for ordering information.



Each plug has a ground connector. The cord packaged with the machine depends upon where the machine was delivered. If your equipment has the wrong power cord for your area, please contact your local authorized HP Series 80 dealer or HP sales and service facility for information on obtaining the proper cord.



## Grounding Requirements

To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that all class 1 equipment be properly grounded. The HP-87 is equipped with a three-conductor power cable which, when connected to an appropriate power receptacle, grounds the machine. To preserve this protection feature, do not operate the machine from a power outlet that has no earth ground connection.

## Fuses

### For 110/117 Vac Operation

When the voltage selector switch is set to 115V, use a T800mA fuse.

### For 220/240 Vac Operation

When the voltage selector switch is set to 230V, use a TT315mA fuse.

Additional fuses can be ordered from Hewlett Packard.

T800mA      part number HP 2110-0020

T315mA      part number HP 2110-0639

## Initial Set-Up Instructions

If you have not already done so, please read the preceding pages of this section before continuing.

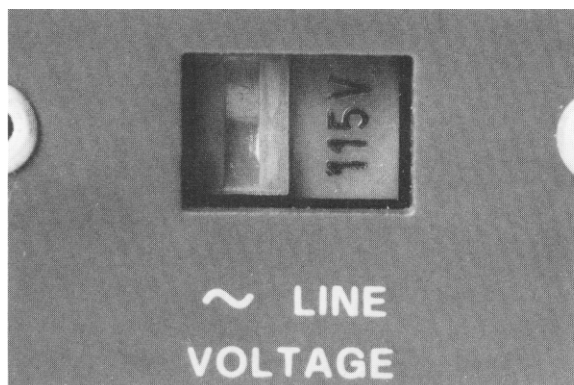
1. Make sure the power cord is disconnected and that the ON/OFF switch is set to OFF (setting 0).

### WARNING

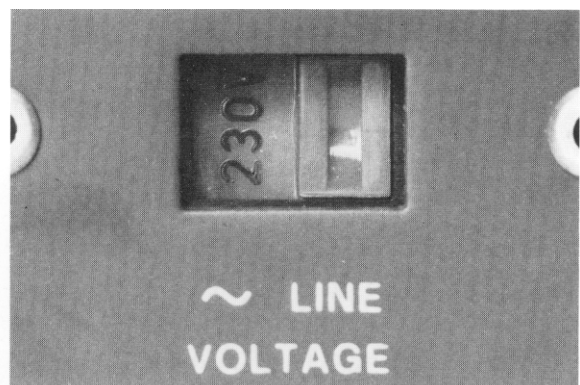
Check the voltage selector switch before applying power. Damage to the computer will occur if the selector switch is set to 115 volts ac and 230 volts ac is applied to the power receptacle.

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

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



Voltage selector switch in 115V position.



Voltage selector switch in 230V position.

**WARNING**

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

3. Install the appropriate fuse. A T800mA fuse is required for 115 Vac operation; a T315mA fuse is required for 230 Vac operation. To install or replace the fuse, first disconnect the power cord from the machine. Insert the proper fuse in the fuse cap holder; either end of the fuse can be inserted into the cap. Now, install the fuse and fuse cap into the fuse receptacle by pressing the cap inward and then turning it clockwise until it locks in place.

**WARNING**

Use only the HP-87 power cord specified by Hewlett-Packard for your area. If it is necessary to replace the power cord, the replacement cord must have the same polarity as the original. Otherwise, a safety hazard from electrical shock might exist, and the equipment could be extensively damaged.

4. Connect the power cord to the power input receptacle on the back of the computer. Plug the other end of the cord into an ac power outlet.
5. Set the computer ON/OFF switch to ON (setting 1). Within 12 seconds, a cursor (rectangular block) should appear in the upper left corner of the CRT display. When the cursor appears on the screen, the HP-87 is ready for use. If the cursor is too pale or too bright, use a screwdriver to adjust the display intensity control on the rear of the computer.

Each time the power is turned on, the system performs a self-test. Should the cursor not appear, or if the CRT displays **Error 23 : SELF TEST**, turn the machine off, then on again. If the problem persists, contact your local authorized HP-87 dealer or the nearest HP sales and service facility.

If you will be using your HP-87 without any optional plug-in modules, then you are now ready to begin connecting peripheral devices, following the instructions in section 3. However, if your system includes any plug-in modules (e.g., memory modules, ROM Drawer, interface modules), read the remaining material in this section.

## Installing Plug-In Modules

The four module ports on the rear of the computer are designed to accept a number of plug-in modules, including:

- The HP 82936A ROM Drawer.
- The 32K, 64K, and 128K Memory Modules (model numbers HP 82907A, HP 82908A, and HP 82909A).
- Any of the available HP Series 80 Interface Modules.

The ports are numbered 1 through 4 from top to bottom. Before shipping, each port is covered with a removable protective cover. It is recommended that ports not in use be kept covered.

**WARNING**

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

## General Module Installation and Removal

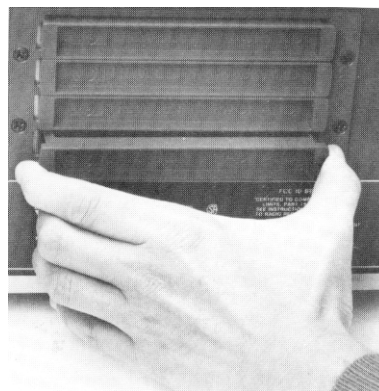
Plug-in modules can be installed or removed as often as you'd like.

It is important that you read all the documentation accompanying each module for instructions, warnings, and any limitations. Make sure you have thoroughly read the installation procedures before starting the installation process.

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

**Note:** Most plug-in modules can be inserted into any of the four ports. However, examine the documentation included with each module for any instructions regarding the use of a specific plug-in port. If it is intended that a module fit into a particular port, it must be inserted into that port. If your system includes more than one interface, each interface must have its own unique select code.

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



**Note:** The length of time required by the computer to complete the power-on self-test depends on the amount of user-available memory present. For example, with four HP 82929A 128K Memory Modules installed, the cursor appears approximately 45 seconds after the power is turned on.

### CAUTION

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

- Always switch off the computer and all peripherals before inserting or removing modules. Use only plug-in modules designed by Hewlett-Packard for the HP-87.
- Do not force a module into a port. The port tracks are keyed to prevent the module from being inserted upside down. Forcing an upside down module into a port could result in damage to the module or to the computer.

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



To remove a plug-in module:

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



## Installing and Removing ROMs

The ROM drawer contains six rectangular slots for individual plug-in ROMs. Each slot is fitted with its own protective cap.

Any HP-87 ROM will fit into any of the six positions in the ROM drawer. Before installing a ROM into the drawer, please read the documentation accompanying each plug-in ROM for user instructions, warnings, and any limitations.

**Note:** Never install duplicate ROMs into the ROM drawer. Duplicate ROMs will not increase your computing power and may create error conditions. The ROM drawer will physically accept both HP-83/85 and HP-87 ROMs. However, the presence of an HP-83/85 ROM causes the HP-87 to return a warning when the power is switched on, and may cause improper computer operation.



To insert a ROM into the ROM drawer:

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



#### CAUTION

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

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



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

## Selecting a Workspace

The computer is designed to operate on a flat, hard surface such as a desk or table top. Any workspace you choose should allow the following minimum clearance for adequate air circulation.

Both sides:	15 cm (6 in.).
Rear panel:	15 cm (6 in.).
Overhead:	15 cm (6 in.).

#### CAUTION

Always keep the top of the computer free of books, papers, and other materials to avoid obstructing the air circulation vents built into the cover.





## Connecting Peripherals

### Introduction

If your computing system includes peripheral devices such as a printer, disc drive unit, and plotter, then you'll want to connect those devices to the computer before you proceed to perform calculations and run programs.

This section explains how to:

- Connect peripheral devices using the computer's integrated HP-IB interface or other interface modules.
- Establish unique addresses for your peripherals which the HP-87 then uses in communicating with these devices.

You may at times need to refer to the documentation accompanying your peripherals or to appendix A, The HP-IB Interface, for additional information.

### Preparations

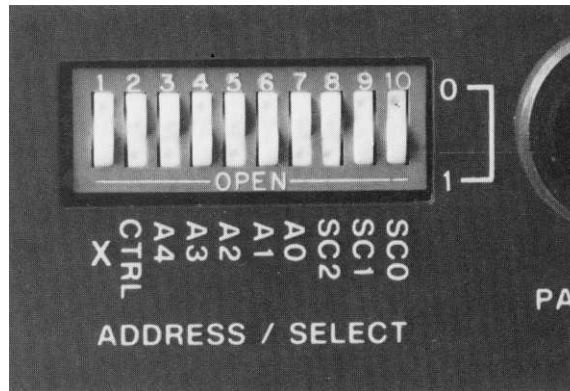
Before you start connecting peripheral devices to the computer, you must:

- Plug the computer and each peripheral device into a grounded (three-wire) ac outlet. (Read section 2, Owner's Information, before applying power to the computer.)
- Turn off the computer and all peripheral devices.
- Using the instructions provided in section 2, install any interface module to be used (in addition to the computer's integrated HP-IB interface) into a plug-in port on the rear of the computer. This step is unnecessary if you'll be using only the computer's integrated HP-IB interface.
- Read the rules for cable length on page 44 if you'll be using individual HP-IB accessory cables longer than 2 meters or if you'll be connecting more than 10 peripheral devices.



## The Interface Select Code

This manual assumes that the interface select code of the computer's integrated HP-IB interface is set to 7, the factory preset value. Check to see that the select code is properly set. The interface select code is set using segments SC2, SC1, and SC0 of the HP-IB switch located on the rear of the HP-87. If these segments are not set as shown below, please reset them to match the photograph. Also check to see that the other switch segments are set properly.



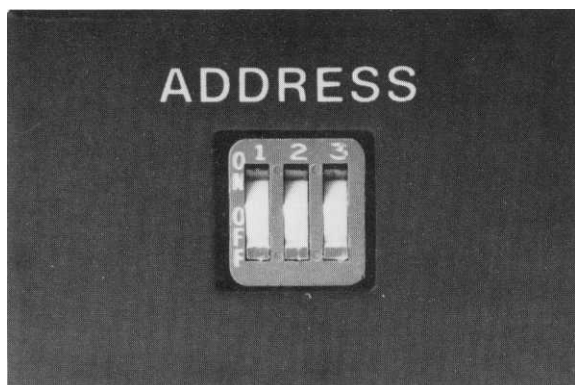
## Setting Peripheral Device Addresses

Each peripheral device connected to the computer via the HP-IB interface must have a unique two-digit device address. (An exception is disc drive add-on units, which have the same address as the master units to which they are connected.)

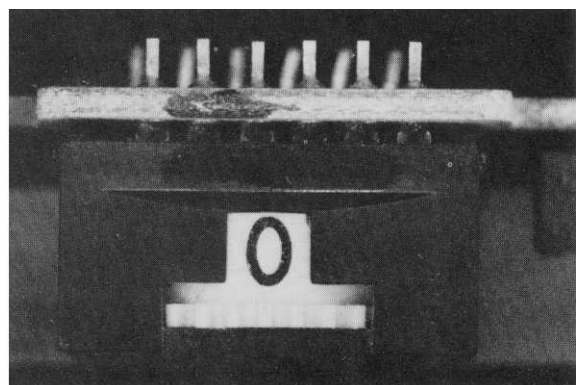
The device address is set by a switch usually located on the rear panel of the instrument. Refer to documentation accompanying the peripheral device for information on the device address switch.

This manual assumes that you have peripheral devices set to the addresses listed below. The accompanying photographs show device address switches of several devices and the positions of the switch elements when the address is set as specified. If necessary, reset the switch to match the photograph. If your system includes devices other than the ones shown below, consult the documentation accompanying those devices for further instructions.

### Master disc drive unit—Set device address to 0.

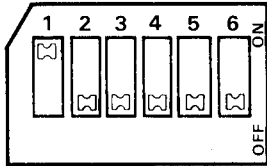


Device address switch of HP 82901M Flexible Disc Drive.

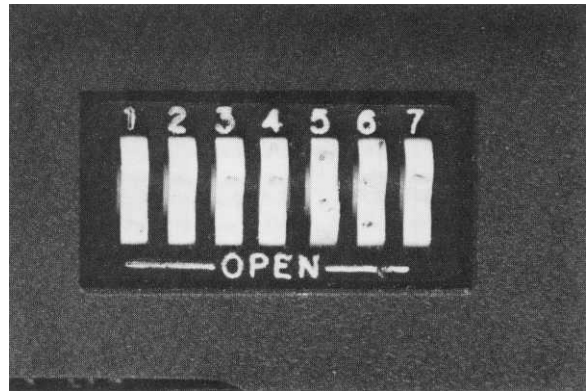


Device address switch of HP 9895A Flexible Disc Drive.

**Printer—Set device address to 1.**

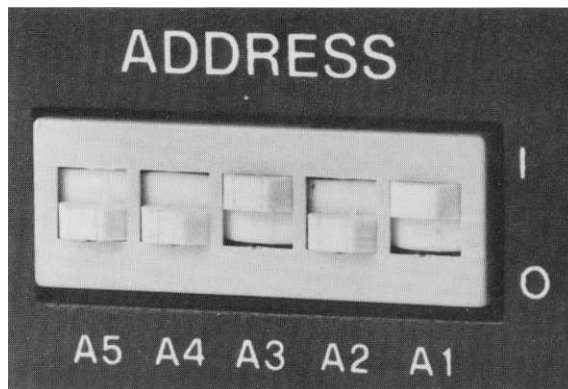


Device address switch of HP 82905 Printer



Device address switch of HP 2671 Printer.

**Plotter—Set device address to 5.**



Device address switch of HP 7225A Plotter.

If you are connecting other peripherals to the HP-IB interface, set them to any unused device address except 21 (the computer's preset address).

## Connecting HP-IB Peripherals

### WARNING

The computer and peripheral devices must be properly grounded and switched to power OFF before you start the connecting process. Make sure the computer and each peripheral are plugged into grounded (three-wire) ac outlets, and that the power switch on each device is set to OFF. Failure to follow these instructions could result in a shock hazard.

Examine figure 3.1 on page 22. Then, follow this sequence of instructions for connecting your peripherals. The illustration and photographs are numbered to match the instructions. If you need additional information, refer to appendix A and to the documentation accompanying your peripheral devices.

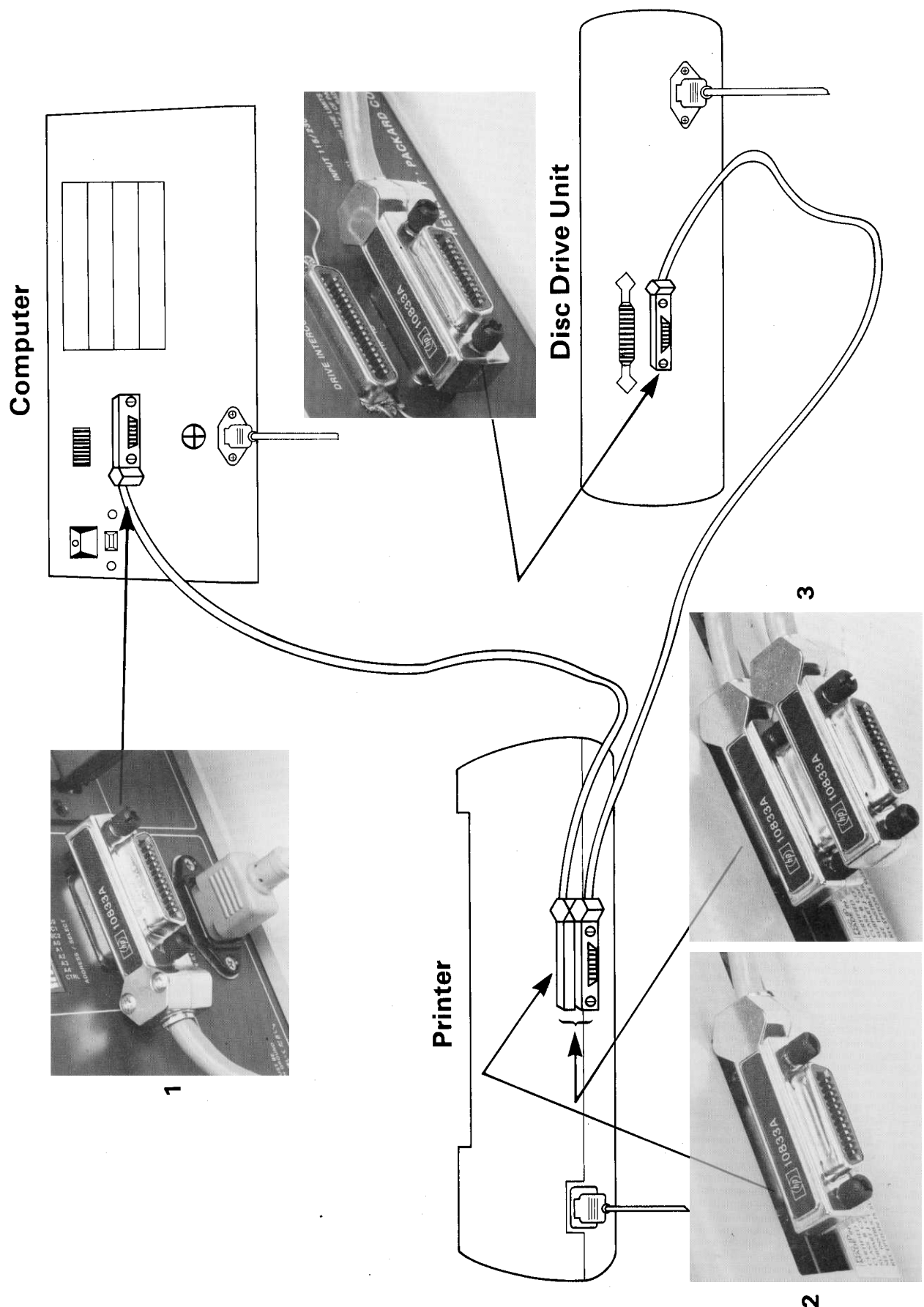


Figure 3.1 Connecting HP-IB Peripheral Devices

1. Attach and fasten an HP-IB accessory cable to the HP-IB cable receptacle on the rear of the HP-87. The cable connector fits onto the receptacle only when the connector is oriented properly. Hand tighten the two mounting fasteners on the cable housing.
2. Attach the other end of the cable to the HP-IB receptacle on your first peripheral device. (Peripherals can be connected in any order.)

For each additional peripheral device:

3. Attach one end of an HP-IB accessory cable in piggy-back fashion to the connector of any previously connected cable. To avoid mechanical strain, refrain from stacking more than three piggy-back connectors on the same receptacle.
4. Attach the other end of the accessory cable to the HP-IB receptacle on the peripheral device.

## Connecting Non-HP-IB Peripherals

If your system includes any plug-in interface modules, connect the peripherals requiring those modules. Refer to the documentation accompanying both the interface module(s) and the peripheral device(s) for set-up procedures and the preset interface select code.



## Getting Started

Now that you've installed any plug-in modules and connected your peripheral devices, you are ready to start learning how to put the HP-87 to work for you.

This section is designed to provide you with an overview of the HP-87. In order to get you "up and running" in a few hours, the section introduces a number of topics in relatively few pages. If you key in the examples as shown, you will, by the time you're finished, have acquired some experience in:

- Performing arithmetic calculations from the HP-87 keyboard; that is, using the HP-87 as a desktop calculator.
- Assigning values to variables.
- Editing the contents of the computer display.
- Entering, running, and halting programs.
- Storing programs onto a flexible disc.
- Generating, storing, and retrieving a graphics display.
- Retrieving and running a prerecorded program provided on the demonstration disc.

Detailed discussions of the HP-87's functions, commands, statements, and other features are presented in the operating and programming manual.

Discussions throughout this section assume that you've set the device addresses of the disc drive unit and peripheral printer as described in section 3.

### Power On

If your system includes a disc drive unit, it should be switched on before you turn on the computer. If your system includes more than one disc drive unit, turn on the unit having the lowest device address.

After you've switched on the disc drive unit, set the power switch on the rear panel of the computer to ON. The amber power light below the keyboard indicates that power is on. If the computer is not receiving power, check the power connection and the fuse as described in section 2.

When the cursor (rectangular block) appears in the upper left corner of the display (the *home* position), the computer is ready to use. If your system includes a disc drive unit and if a flexible disc is present in DRIVE 0, the system will automatically search for a program file named *Autost* (*automatic start*). The automatic start feature enables the computer to load and run a program on its own when power is turned on.

The computer performs a self-test when the power is switched on. If it discovers a problem in its circuitry, the computer informs you it has failed the self-test by beeping and displaying:

```
Error 23 : SELF TEST
```

Failure to pass the self-test indicates the system is not operating properly. Contact your local authorized dealer or your nearest HP sales and service facility (addresses provided in the back of the operating and programming manual).

The computer also checks to determine whether any installed ROM modules are incompatible with the HP-87. If an incompatible ROM has been installed, the computer informs you by displaying the message:

```
Warning 27 : 85 ROM IGNORED
```

Incompatible ROMs should be removed to prevent possible improper operation of the computer.

#### CAUTION

If you must remove a ROM module, carefully follow the procedure for removing ROMs explained in section 2. Failure to follow the proper procedure could cause damage to equipment.

If the power light is on but the display remains blank, hold down the **(SHIFT)** key and press **(RESET)**. (This key has both an unshifted and shifted operation associated with it. Like the number keys on a typewriter, shifted operations are shown on the upper half of the key, unshifted operations on the lower half.) This operation resets the computer to a ready state.

If the cursor has not appeared, or if it is too pale or too bright, adjust the display brightness control on the rear panel of the computer. If the display remains blank, turn the computer off and call the nearest Series 80 dealer or HP sales and service facility for further assistance.

## The **(END LINE)** Key

Before you start performing calculations and entering programs, you need to understand the purpose of the **(END LINE)** key.

When you press **(END LINE)**, the line on which the cursor is located is entered into the computer, where the line is first checked to see that you made no errors in formulating the information to be processed. If the line begins with a line number, the computer interprets the line as a program statement and enters the line into program memory. If the line has no line number, the computer immediately performs the operation. Operations performed immediately "from the keyboard" rather than by running programs are called *calculator-mode* operations.

If the cursor is positioned on an empty line when you press **(END LINE)**, the cursor moves to the first column of the next line.

## The **(SHIFT)** Key

Before you start entering information, make sure the **(CAPS LOCK)** key is level with the other keys in its row. With **(CAPS LOCK)** in this position, the HP-87 keyboard produces unshifted uppercase letters and shifted lowercase letters. The rest of the keyboard operates like a typewriter in that unshifted keys access the character or operation printed on the lower portion of the key; shifted keys (holding down **(SHIFT)** while you press the key) access the character or operation printed on the upper portion of the key.

## Manual Problem Solving

Type in the following lines exactly as shown, pressing **END LINE** to obtain the answer on the line below the input. The number keys and arithmetic symbol keys are located both on the typewriter and numeric keypad parts of the keyboard and can be used interchangeably.

**Note:** Spacing between numbers and symbols is arbitrary.

If you make a typing mistake, press **BACK SPACE** to erase incorrect characters and then retype the correct information.

5+6  
11

Enter this expression.

The computer returns this answer, indented one space for the sign.

9\*8  
72

Enter this expression (\* indicates multiplication).

The computer returns this answer.

2^9  
512

The ^ symbol indicates exponentiation.

The computer returns this answer, 2<sup>9</sup>.

SQR(16)  
4

SQR is the square root function.

The computer returns this answer,  $\sqrt{16}$ .

SIN(4)  
-.756802495308

SIN is the sine function. At power-on, the

computer is in *radians* mode. The computer returns the sine of 4 radians.

8.8E12/2.2E10  
400

Scientific notation;  $(8.8 \times 10^{12}) / (2.2 \times 10^{10})$ .

The computer returns this answer.

1234567\*12345678  
1.52415666514E13

Enter this expression.

The computer displays very large and very small numbers in scientific notation.

Arithmetic expressions are typed algebraically. Parentheses are used to enclose the argument(s) on which a function operates. Parentheses are also used to enclose parts of the expression to change the order in which the computer performs arithmetic operations. (The arithmetic hierarchy, which establishes the order in which algebraic operations are performed, is discussed on page 32 of the operating and programming manual.)

For example, the expression:

$$.938 (50 \sin .646) - \frac{(32)(.938)^2}{4(.5)}$$

is evaluated by typing and entering the expression:

Parentheses enclose argument of SIN function.

Exponentiation performed before multiplication.

Multiplication performed before division.

.938\*50\*SIN(.646)-32\*.938^2/(4\*.5) **END LINE**  
14.156166441



## Error and Warning Messages

No keyboard operation is capable of damaging your computer system. The computer will return an error or warning message if you attempt an improper operation.

If you attempt to enter a line that contains an improperly constructed expression, statement, or command, the computer beeps and displays the word `Error` followed by a number and short description. Errors received when you attempt to enter a line, called *syntax* errors, are usually easily remedied; simply correct the error using the computer's editing features and enter the corrected line. Display editing is covered on pages 29 and 30.


If, after receiving an error message, you desire additional information about the nature of the error, refer to the list of error messages in appendix F of the operating and programming manual.

**Example:** Attempt to enter the expression:

```
3*(5-2
```

The expression is incomplete because the right parenthesis is missing. Since the computer cannot interpret the expression, it returns an error message and moves the cursor to the position in the expression where it first detected the error—in this case, the `*` symbol.

```
3*(5-2
Error 88 : BAD STMT
```

To correct the line, use the  key to move the cursor past the `2` and type a right parenthesis. Then, enter the line; the line beneath the expression is cleared before the result is displayed. If you'd rather not correct the line, you can move the cursor to a new line and enter another expression.

Certain math calculations, though properly constructed, cannot be evaluated (for example, expressions that generate answers too large or too small for the computer to handle). For errors numbered 1 through 8, the computer displays a warning message and automatically provides a default value for the answer.

**Example:**

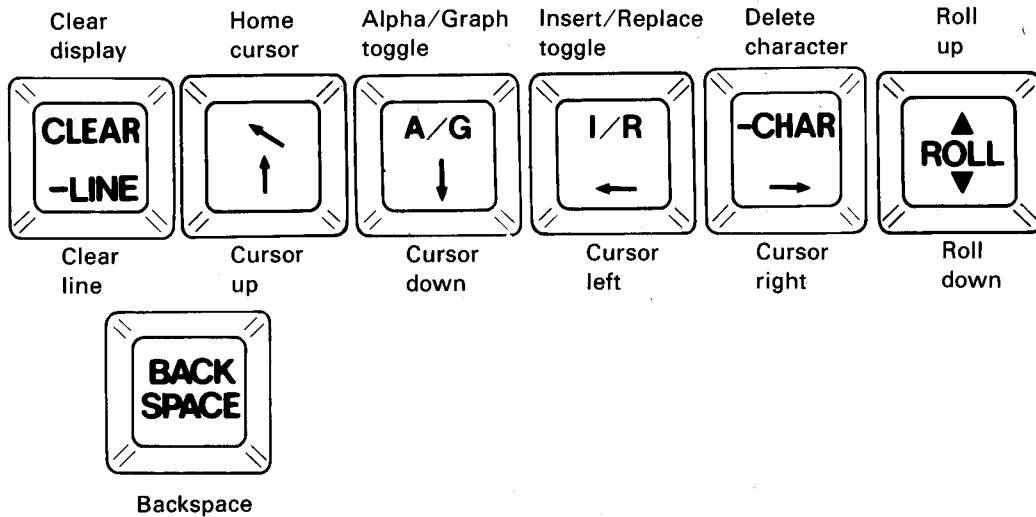
```
5/0
Warning 8 : /ZERO
9.999999999999E499
```

Attempt to divide by zero.  
Computer displays warning message  
and the default value.

If you'd prefer to receive error messages for errors 1 through 8, you can change the computer's method for handling math errors (discussed on page 82 of the operating and programming manual).

## Display Editing

In addition to **BACK SPACE**, the HP-87 provides a set of display editing keys located on the upper right part of the keyboard.



Suppose you'd like to edit a previously entered expression:

Original expression:

```
.938*50*SIN(.646)-32*.938^2/(4*.5)
```

Changes:

Change .646 to .7

Change 50 to 55.67

First, the cursor must be positioned on the line in which the expression appears. The **↑** and **↓** keys move the cursor up and down without changing the contents of the screen. If the previously entered expression has rolled up out of view, use the **ROLL** key to bring the expression back down onto the screen. (**SHIFT ROLL** rolls the screen contents upwards.)

Now that the cursor is on the proper line, use the **←** or **→** key to position the cursor over the first change:

```
.938*50*SIN(.█46)-32*.938^2/(4*.5)
```

Type **7** over the first digit of .646. Then, when the cursor is positioned over the **4**, press the **-CHAR** (delete character) key twice. The **46** will be deleted, and characters to the right will move to the left to fill the gap. The expression should now be:

```
.938*50*SIN(.7█-32*.938^2/(4*.5)
```

Next, position the cursor over the **0** in 50 and type **5** over the **0**. To make room for the next two digits, you'll need to place the keyboard into insert mode by pressing **I/R** (insert/replace). When you press **I/R**, the cursor doubles in width.

```
.938*55█SIN(.7)-32*.938^2/(4*.5)
```

Characters typed in are inserted between the two characters highlighted by the cursor. When you've typed in the characters `.67`, press `(I/R)` again to return the display to replace mode. Then press `(END LINE)` to compute the answer.

```
.938*55.67*SIN(.7)-32*.938^2/(4*.5)
19.5625515323
```

Now, suppose you'd like to evaluate the expression `.938*55.67*SIN(.7)`. You could place the cursor over the minus sign and hold down the `(-CHAR)` key until the rest of the line was deleted. An easier way is to use the `(-LINE)` key to clear the line from the cursor position to the end of the line. Position the cursor over the minus sign and press `(-LINE)`. Then press `(END LINE)` to evaluate the expression.

```
.938*55.67*SIN(.7)
33.6400555323
```

The `(CLEAR)` (shifted) key clears the display and returns the cursor to the home position (upper left corner). You can home the cursor at any time without erasing the display using the `(↵)` (shifted) key.

## Variables

So far, the examples have evaluated expressions composed of numbers. In many applications, it is preferable to evaluate expressions using variables. A variable specifies a location in computer memory where information is stored. Each variable is given a unique name which is used to access or alter the stored information.

The HP-87 provides four types of variables:

- Simple numeric.
- Simple string.
- Numeric array (subscripted).
- String array (subscripted).

Each variable name can be up to 31 characters long. Names can contain any combination of letters, digits, and the underscore character, with the following constraints:

- The first character of any variable name must be a letter.
- The last character of any string variable name, simple or array, must be the character `$`.
- Uppercase and lowercase letters are not interchangeable. For example, `LENGTH`, `Length`, and `length` are each unique variable names.
- Variable names cannot be BASIC keywords (for example, `PRINT`, `RUN`).

### Example:

```
LENGTH=5
WIDTH=2
AREA=LENGTH*WIDTH
AREA
10
```

```
Assigns value 5 to numeric variable LENGTH.
Assigns value 2 to numeric variable WIDTH.
Evaluates LENGTH*WIDTH and assigns value to AREA.
Directs computer to fetch and display value of AREA.
```

## Typing Aids

Keys (k1) through (k14) operate in calculator mode (when no program is running) as typing aids for certain BASIC keywords. To view the typing aid assignments, press (SHIFT) (KEY LABEL). The *key labels* for all 14 keys will appear in seven inverse video boxes at the bottom of the screen.

TRACE VAR	CRT IS	PRINTER IS	INITIALIZE	SCRATCH	LOADBIN	STOREBIN
AUTO	DISP	PRINT	MASS STORA	DELETE	LOAD	STORE

Pressing unshifted ((k1) through (k7)) or shifted ((k8) through (k14)) keys displays the assigned BASIC keyword or sequence of keywords at the current cursor position. You'll have an opportunity to use the typing aids later in this section.

## Addressing Peripheral Devices

If your system includes a peripheral printer and disc drive device, you must supply the computer with certain information before it can access those devices. It is assumed you've read section 3 of this manual, and that each device is set to the device address specified in section 3.

To access a peripheral plotter your system must include an HP-87 Plotter ROM (part number 00087-15002). Refer to documentation accompanying the Plotter ROM for information on addressing your plotter. Graphics output is automatically directed to the display when no peripheral plotter has been addressed.

### Accessing the Printer

At power-on, the computer assumes that the printer address is 1, the address of the CRT. If your system doesn't include a printer, output ordinarily printed is directed to the CRT.

If your system includes a printer, a `PRINTER IS` statement must be executed to establish an address to which printed output is routed.

Turn your printer on and set it to ON-LINE.

If the printer is connected via the HP-IB interface, press (k10) to display `PRINTER IS` and then type in the rest of the line:

```
PRINTER IS 701,80
```

If you prefer, you can type  
`PRINTER IS` instead of using the  
typing aid.

If your printer is connected using a different interface, then enter the appropriate statement:

```
PRINTER IS 8,80
PRINTER IS 10,80
```

HP 82949A (Parallel) Printer Interface  
HP 82939A Serial Interface

Now, test your system by entering this statement:

```
PRINT "THIS IS A TEST!"
```

Your printer should print the text that is enclosed in quotes. If it doesn't, make certain the printer is on and ON-LINE and that its device address has been properly set.

## Accessing Mass Storage

If you turned on your disc drive unit before you turned on the computer, the computer will automatically access DRIVE 0 for all operations involving mass storage. If you didn't turn on the disc drive unit first, enter the statement:

```
MASS STORAGE IS ":D700"
```

Now, install the demonstration disc provided with the computer into DRIVE 0. As illustrated below, the disc must be oriented label side up, with the label in the right hand corner nearest you.



### CAUTION

Attempting to force the drive latch closed when the flexible disc is improperly aligned in the drive could cause damage to the disc.

Close the drive latch to secure the disc in the drive.

To test your mass storage system, obtain a *directory*, or *catalog*, of the contents of the disc by executing the CAT statement.

```
CAT
```

The drive light will come on while the computer accesses the directory. The directory heading is then displayed,

```
[ Volume ]: DEMO
Name      Type  Bytes  Recs
```

followed by an entry for each file stored on the disc. Directory listings are discussed in section 20 of the operating and programming manual.

Later in this section, you'll use your mass storage system to store and retrieve programs.

## Programming With the HP-87

Programming, like performing keyboard calculations, is a problem-solving process. When you run a computer program, you are directing the computer to perform a series of operations in a particular order. Programs can direct the computer to make decisions and request, obtain, manipulate, and provide information.

The BASIC language consists of a number of functions, statements, and commands that provide you with a “vocabulary” the computer understands. You’ve already seen some examples of functions—`SIN` and `SQR`. You’ve also already directed the computer to perform, or execute, the `PRINTER IS` and `CAT` statements. In the next few pages, you’ll be briefly introduced to a number of other statements and commands as you enter and run two programs.

### Erasing Program Memory

Programs are stored in the computer in program memory. Before you enter a program, you should erase, or scratch, any current contents of program memory.

To erase program memory, execute the `SCRATCH` command. You can type the word `SCRATCH`, or use the typing aid `(k12)`.

`SCRATCH`

`SCRATCH` is categorized as a command, rather than a statement, because it cannot be executed in a program.

### Entering a Basic Program

The following BASIC program requests you to input the length and width of a rectangle and prints the data you input. It then computes the area and prints the answer.

Before you start entering the program, you may wish to clear the display by pressing `(CLEAR)` (a shifted key).

Now, enter the following short program by typing one line at a time. When you’ve finished typing each line, press `(END LINE)` to enter the line into program memory.

```
10 REM *****THIS PROGRAM COMPUTES THE AREA OF A RECTANGLE*****
20 DISP "ENTER LENGTH"
30 INPUT LENGTH ! Enter LENGTH.
40 PRINT "LENGTH =";LENGTH
50 DISP "ENTER WIDTH"
60 INPUT WIDTH ! Enter WIDTH.
70 PRINT "WIDTH =";WIDTH
80 AREA=LENGTH*WIDTH ! Compute AREA.
90 PRINT "AREA =";AREA
100 END
```

### Running the Program

To run the program, press `(RUN)`. As long as the program is running, the power light will blink on and off.

The following chart shows the information you must input from the keyboard and the program’s output to the display and printer. Each time the program requests data, program execution temporarily halts until you’ve entered the required information. However, the power light continues to blink. After you type in the requested information and press `(END LINE)`, program execution resumes.

Statement(s) Being Executed	Key in This Information	Output to Display	Output to Printer
	Press <b>RUN</b>		
20,30		ENTER LENGTH ?	
30	5		
40			LENGTH = 5
50,60		ENTER WIDTH ?	
60	2		
70			WIDTH = 2
90			AREA = 10

## Storing Programs

If your system includes a disc drive unit, you can store the program onto a flexible disc. You may use the demonstration disc or a new, empty disc.

If you choose to use an empty disc, you must first prepare the disc by a process called *initialization*, discussed next. If you'll be using the demonstration disc, you must first remove the write-protect tab. (Refer to page 305 of the *HP-86/87 Operating and BASIC Programming Manual*. Then, skip the discussion Initializing a Flexible Disc and go on to The Store Command.)

## Initializing a Flexible Disc

Before you use an empty disc for the first time, it must be initialized. Initializing the disc prepares it to accept information from the computer. During the initialization process, any previously stored information is erased; therefore, **never** initialize a disc that contains information you may later wish to access.

**Note:** The initialization process erases any previous contents of the disc. Make sure you have removed the demonstration disc from DRIVE 0 before you execute the **INITIALIZE** statement.

If you intend to store the program you've just entered, remove the demonstration disc from DRIVE 0 of your disc drive unit and place an empty disc in DRIVE 0. After securing the drive latch, execute the **INITIALIZE** statement. You can type the statement or use the typing aid provided on **(k11)**.

**INITIALIZE**

Initialization takes approximately three minutes. When the drive light goes out, the disc is initialized and ready to use. Use the **CAT** statement to display the empty disc directory.

```
[ Volume 1:
Name      Type  Bytes  Recs
```

## The STORE Command

To store the program in computer memory onto the flexible disc, execute a **STORE** command. The name you wish to assign to the file is enclosed in quotation marks.

```
STORE "RECTANGLE"
```

The file name can be up to 10 characters long; you can use any characters except quotation marks ("), colon (:), or period (.).

The drive light for DRIVE 0 will be on while the program is being stored. Now, obtain a directory listing to see the new entry for the program (PROC) file you've just created.

```
[ Volume ]:
Name      Type  Bytes  Recs
RECTANGLE  PROC   256    2
```

## Generating a Graphics Display

This next program introduces you to the HP-87's graphics capabilities. Before you enter the program, you should erase the previous program from memory using the `SCRATCH` command.

To make entering the program easier, the HP-87 provides automatic line numbering when you execute the `AUTO` command. You can type in the word or use the typing aid on (k1).

```
AUTO
```

The first line number, 10, is displayed and the cursor is positioned on the line, awaiting the statement you'll enter.

```
AUTO
10 ■
```

After you've typed in and entered the statement, the computer automatically displays the next line number, 20, on the following line. Each time a statement is entered, the computer automatically increments the line number by 10. (You can change the starting line number and increment value using optional parameters with the `AUTO` command. This feature is discussed in section 5 of the operating and programming manual.)

Now, enter the following program:

```
10 PLOTTER IS 1
20 GCLEAR
30 SCALE 0,99,0,99
40 GRID 3,3
50 LOCATE 28,RATIO *100-28,15,85
60 PEN -1
70 GRID 3,3
80 PEN 1
90 FRAME
100 SHOW -80,80,-50,50
110 MOVE 50,0
120 DEG
130 FOR ANGLE=0 TO 360 STEP 10
140 DRAW 50*COS (ANGLE),50*SIN (ANGLE)
150 NEXT ANGLE
160 CSIZE 8,.5,0
170 MOVE -30,25 @ LABEL "WELCOME TO"
180 CSIZE 12,1,30
190 MOVE -48,-5 @ LABEL "GRAPH"
200 CSIZE 8,.5,0
210 MOVE -12,-30 @ LABEL "MODE"
220 END
```

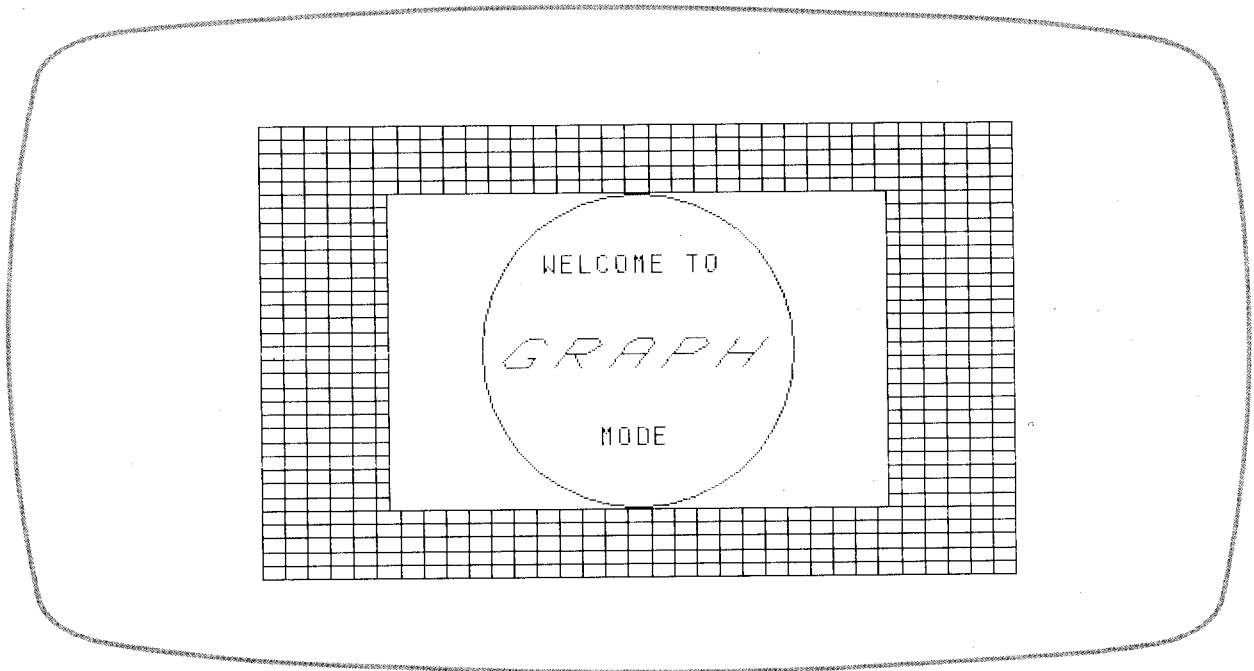


When you've entered statement 220, the computer displays 230 on the next line. To stop automatic numbering, backspace over 230 and execute the `NORMAL` statement.

```
220 END
NORMAL
```

Now, press **(RUN)**. The display enters *graph* mode as the program produces graphics output, and you will be viewing the computer's graphics display. (The display you are viewing when you perform calculations and enter programs is called the alpha display.)

When the computer has finished executing the program (the power light will stop blinking), the graphics display will contain a greeting.



Press the **(A/G)** (*alpha/graphics*) toggle key to return the display to *alpha* mode. To view the display again, press the **(A/G)** toggle once again.

**Note:** Actually, when the HP-87 is in *graph* mode, pressing almost any key causes the display to revert to *alpha* mode.

If you'd like to preserve the program for future use, switch to *alpha* mode and execute:

```
STORE "GREETING"
```

Your directory listing should now contain two entries by you:

[ VOLUME ]:			
Name	Type	Bytes	Recs
RECTANGLE	PROC	256	2
GREETING	PROC	256	2

## Storing and Retrieving a Graphics Display

There may be times when you want to access a graphics display without having to run the program that originally generated the display. The HP-87 allows you to store the contents of the graphics display onto a disc and to retrieve the stored display.

To store the display, execute the `GSTORE` statement:

```
GSTORE "PICTURE"
```

The display switches to *graph* mode when you execute `GSTORE`. When the operation is completed (in approximately 15 seconds), press **(A/G)** to return the display to *alpha* mode. Then, use the `CAT` statement to display the updated file directory containing the graphics (`GRAF`) file.

[ Volume ]:			
Name	Type	Bytes	Recs
RECTANGLE	PROG	256	2
GREETING	PROG	256	2
PICTURE	GRAF	256	47

Now that you've preserved your graphics "picture," you can clear the graphics display by executing:

```
GCLEAR
```

The computer will switch to *graph* mode, and the display will be erased from top to bottom. When the graphics display has been `GCLEAR`d, use the **(A/G)** toggle to return to *alpha* mode.

To retrieve the contents of the `GRAF` file, execute a `GLOAD` statement:

```
GLOAD "PICTURE"
```

The display enters *graph* mode as the contents of the file is entered into the graphics display.

## Retrieving Programs

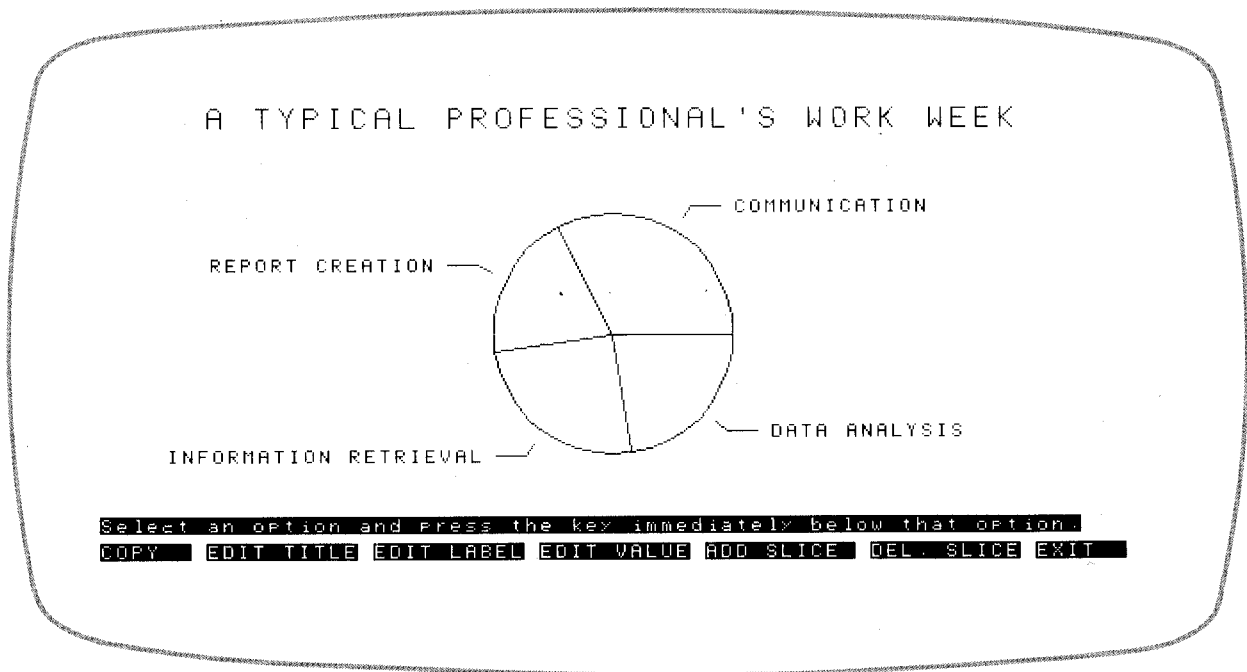
A stored or prerecorded program is retrieved into computer memory by executing the `LOAD` command.

With the demonstration disc in `DRIVE 0`, execute:

```
LOAD "PIE"
```

to load the prerecorded program named `PIE` into the computer. When the drive light goes off, press **(RUN)** to start the program.

The program displays a key label for each of the languages in which data can be displayed. Press the appropriate key. The drive light goes on while the program loads a binary program and data from files on the demonstration disc. The program then draws and labels a pie chart illustrating the proportion of time devoted to various tasks during a 40-hour work week.

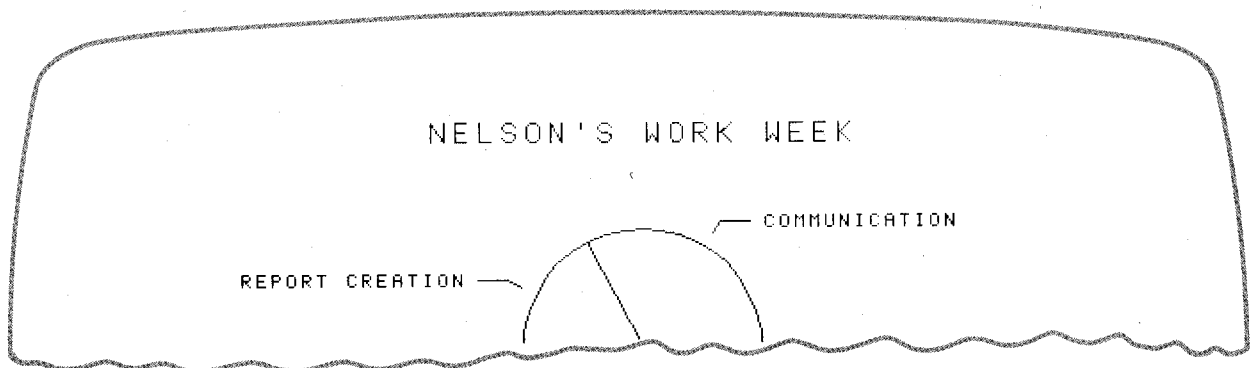


The inverse video boxes at the bottom of the screen are key labels for keys (k1) through (k7). The program allows you to edit the chart's title and labels. You can also change the relative size of the pie slices and increase or decrease the number of slices. If you enter any changes that alter the size of the slices (keys (k4), (k5), and (k6)), the program calculates the new value for the total area (currently 40 hours) and computes the proportional size of each slice.

**Example:** To change the chart's title, press (k2). Type the new title; it will be displayed beside the question mark.

```
New title? (40 characters maximum)
?NELSON'S WORK WEEK
```

Press (END LINE) to enter and draw the new title.



The pie chart must be edited further. Nelson actually works a 42 hour week. Two of the hours currently included in the COMMUNICATION slice and an additional two hours on Thursday evening are spent reviewing literature produced by his department.

To subtract 2 hours from the **COMMUNICATION** slice, press **(k4)**. The program numbers the 4 slices and requests the number of the slice to be changed:

```
Enter the number of the slice to be edited.
?1
```

The program displays the current value of slice #1 and the total value. Enter the new value.

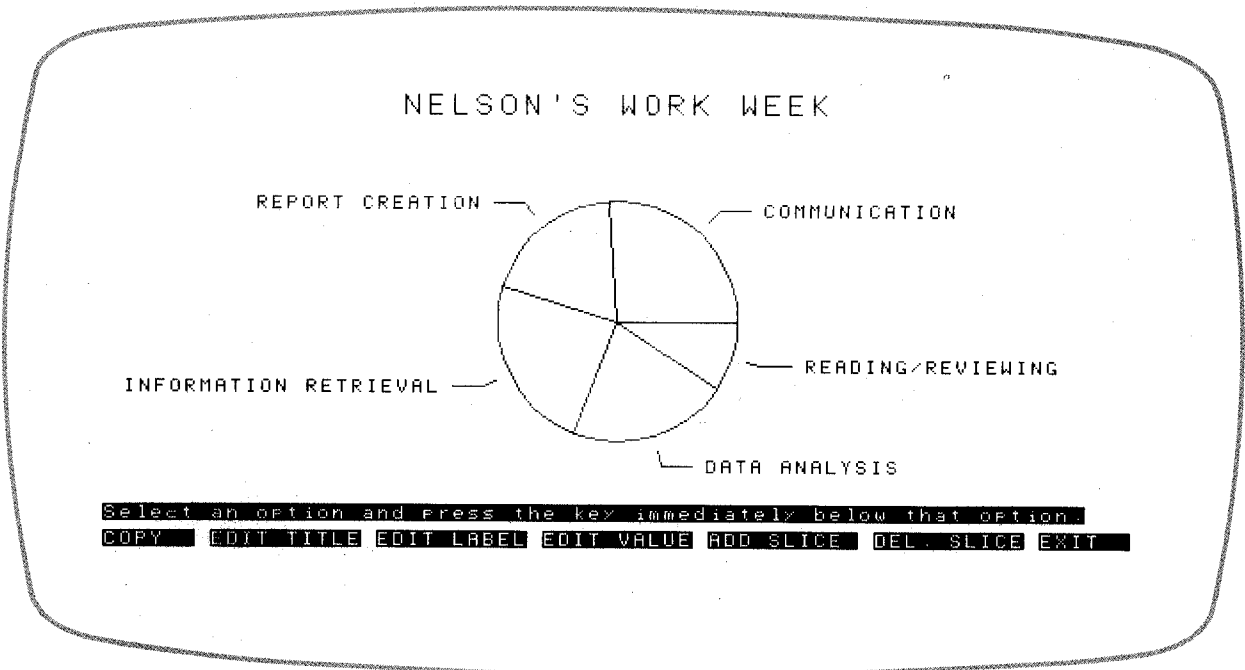
```
New value?      COMMUNICATION      Current value: 13
?11             Current total: 40
```

When the program has drawn the new pie chart, press **(k5)** to add a slice. Enter the new label and value.

```
New label? (21 characters maximum)
?READING/REVIEWING
```

```
New value?      READING/REVIEWING    Current total: 38
?4
```

The final pie chart should look like this:



Press **(k7)** to halt the program and erase the display.

## Listing a Program

The **LIST** key allows you to obtain a listing of the program currently in program memory. When you press **LIST**, the first 15 lines of the program are displayed on the CRT. If the program is longer than 15 lines, pressing **LIST** repeatedly displays 15-line program segments. When the last statement has been listed, the computer displays a number indicating the number of bytes of unused computer memory.

To obtain a printed listing of the entire program, press **PLST**.

## Halting Program Execution

The **PAUSE** key is used to halt a running program at any time, returning control of the computer from the program to the keyboard user. When you press **PAUSE** while a program is running, the computer beeps and the power light stops blinking.

Pressing almost any other key during program execution halts the program and causes the computer to perform the key's indicated function.

To resume (*continue*) program execution from the point at which the program was halted, press **CONT**.





## The HP-IB Interface

### Introduction

The HP-IB (Hewlett-Packard Interface Bus) interface contained within the HP-87 allows the computer to communicate with and control a large variety of peripheral devices. The interface conforms to IEEE\* Standard 488-1978.

This section covers the information you need to use the integrated HP-IB interface to communicate with peripheral devices such as printers, disc drive units, and plotters. If you intend to use the interface with the I/O ROM or if you desire further information on the theory of operation of the interface, refer to relevant portions of the *HP-IB Interface Owner's Manual* provided with your HP-87 owner's documentation.

### Plug-In ROMs

The computer is designed to perform a number of input and output operations involving disc drive units and peripheral printers. For some applications, however, you will need one of the following ROMs.

- HP-87 Plotter ROM (part number 00087-15002).
- HP-87 I/O ROM (part number 00087-15003).

The Plotter ROM allows the HP-87 to output graphics to a peripheral plotter. The I/O ROM is a general purpose ROM used to greatly enhance the input/output flexibility of your HP-87 computing system.

The ROMs are installed into a ROM drawer which is then installed into any of the four module ports on the back of the computer.

### Peripheral Load

The HP-IB interface can support up to 14 peripheral devices. If your system exceeds these limitations, an additional HP 82937A HP-IB Interface Module can be installed into one of the computer's four module ports.

In order for the system to operate properly, at least half the devices connected to the interface must be switched to ON. (The computer counts as one device.)

---

\*Institute of Electrical and Electronics Engineers



## Accessory Cables

### WARNING

Do not attempt to install any of the accessory cables until you've read the installation instructions on pages 44 and 45. Failure to follow installation instructions could result in a shock hazard.

Accessory cables are used to connect peripheral devices to the HP-87. They are available in a variety of lengths:

Length	Model Number
0.5 meter	HP 10833D
1 meter	HP 10833A
2 meters	HP 10833B
4 meters	HP 10833C

To insure proper operation of the interface, two rules regarding cable length must be observed:

1. The total length of cable permitted for all peripherals connected via the interface must be less than or equal to 2 meters times the number of devices. (The computer is counted as one device.) For example, if you intend to have a printer, disc drive unit, and plotter connected to the HP-IB, the total length of the cables must not exceed 8 meters.
2. Regardless of the number of peripheral devices, the total length of cable must not exceed 20 meters.

## Connecting Peripherals

It is extremely important that you read through and understand the installation instructions before you start the installation process. Failure to follow proper installation procedures could result in a safety hazard or temporary unpredictable equipment performance.

### SAFETY PRECAUTION

Manufacturers of peripherals do not all use the same grounding technique. Often, earth ground and logic ground of the peripheral and computer are at different voltage levels. In some instances, this is a deliberate effort to reduce ground return interference with digital signals.

When an accessory cable is attached to the computer, its ground is connected to earth ground and to logic ground. Thus, if the earth and logic ground levels of a peripheral are different, either by design or due to a defect, the potential for a hazardous shock exists unless installation procedures are strictly followed.

A peripheral is properly grounded if it uses a three-prong power plug and if it is plugged into an outlet with matching configuration. Use of a three-prong to two-prong adapter does not provide adequate grounding, since the grounding may be interrupted or nonexistent.

1. Set the power switches on the computer and all peripherals to the OFF position. However, make sure the computer power cord is plugged into a grounded (three-wire) ac outlet.

**WARNING**

Always turn off the computer and all peripheral devices to be connected or already connected to the computer before connecting the accessory cable to or disconnecting the cable from the computer cable receptacle. Failure to do this could result in a shock hazard.

2. Attach an accessory cable to the cable receptacle on the rear of the computer. The cable must be oriented such that the threads of the mounting fastener screws face in towards the computer. Tighten the screws by hand to ensure a firm connection.
3. Attach the other end of the accessory cable to the peripheral device and tighten the mounting fasteners. On some peripherals, the connectors will not be compatible. If this is the case, an HP 10834A Adapter is required.

**Note:** Accessory cables are supplied with mounting fasteners having metric threads. If your peripheral device requires National Coarse (American) threads, you will need to replace the mounting fasteners on the accessory cable. A metric conversion kit is available (part number 5060-0138) to supply the necessary fasteners. Refer to appendix A of the operating and programming manual for ordering information.

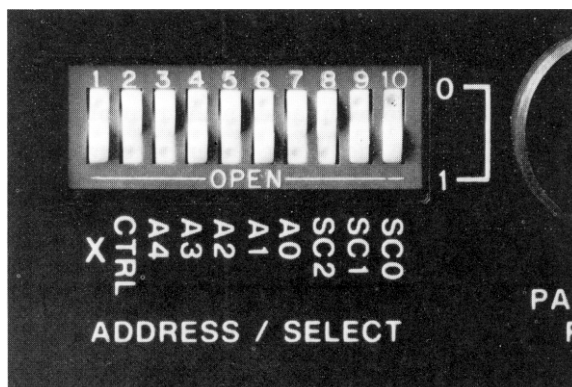
4. Additional peripherals are connected by attaching and fastening one end of an accessory cable to the peripheral and stacking the other end in piggy-back fashion onto a previously attached accessory cable. There are no restrictions on how many connectors can be stacked together. However, to avoid mechanical strain, it is recommended that no more than three connectors be stacked together on one device.
5. After all the peripherals are connected, set the power switch of each of the peripherals to be operational on the interface to the ON position. At least half the devices connected to the HP-IB interface must have their power switches turned to ON in order for the interface to operate properly. The HP-87 is counted as one device. For example, if there are three peripheral devices on the interface, two must have their power on.
6. Set the power switch on the HP-87 to ON.

## Disconnecting Peripherals

1. Set the power switch on all peripherals connected to the HP-IB interface to the OFF position. If you intend to detach the cable connected to the computer HP-IB cable receptacle, turn off the computer and all peripheral devices.
2. Disconnect the HP-IB cable from each peripheral to be removed from the interface.
3. To disconnect all devices using the HP-IB interface, detach the cable connected to the computer HP-IB receptacle.

## The HP-IB Switch

The HP-IB switch located on the back of the computer above the HP-IB connector consists of 10 elements serving three functions.



- Segments 8, 9, AND 10 (SC0, SC1, and SC2) are used to set the interface select code for the HP-IB interface.
- Segments 3 through 7 (A0, A1, A2, A3, and A4) are used to set the computer's talk/listen address.
- Segment 2 (CTRL) is used to change the computer's normal status as system controller.
- Segment 1 is not used.

The rocker switch segments are set to 0 or 1 by pressing the switch towards the desired setting. For example, a switch segment is set to 1 when the depressed part of the rocker is set to 1 with the raised part at the 0 position.

## The Select Code

Since the HP-IB interface can support more than one peripheral device, and because the computer can use more than one HP-IB interface at a time, an addressing system is necessary to ensure that data output by a peripheral or the computer reaches its proper destination.

Each interface module used with your HP-87 must have assigned to it a unique interface select code. The select code is an integer ranging from 3 through 10. Segments SC0, SC1 and SC2 are used to change the interface select code of the integrated HP-IB interface.

Select Code	Segment 8 (SC2)	Segment 9 (SC1)	Segment 10 (SC0)
3	0	0	0
4	0	0	1
5	0	1	0
6	0	1	1
PRESET → 7	1	0	0
8	1	0	1
9	1	1	0
10	1	1	1

The select code of the HP-IB interface is factory preset to 7.

## Peripheral Addressing

Since the HP-IB can support up to 14 peripheral devices, each device on the interface must be assigned a unique device address. The device address is a two-digit number assigned to a peripheral device by setting its device address switch. Refer to the documentation accompanying the device for additional information on setting the device address.

The computer uses several types of DEVICE IS statements to identify the location of peripherals:

```
CRT IS device selector
PLOTTER IS device selector
PRINTER IS device selector
MASS STORAGE IS mass storage unit specifier
```

The device selector has the form:

```
interface select code [device address]
                        (two digits)
```

The mass storage unit specifier has the form:

```
" :D interface select code  device address drive number "
                        (one digit)
```

The device selector is a valid interface select code or combination of interface select code and device address. (An interface select code alone is sufficient to define the computer display, and to locate devices attached to interfaces which can support only one peripheral device at a time.)

### Examples:

```
CRT IS 1
PRINTER IS 701
PLOTTER IS 705
MASS STORAGE IS ":D700"
```

## Talk/Listen Address Switches

The HP-87 has its own device address on the HP-IB interface, called its *talk/listen address*. The I/O ROM uses this address to specify the computer as either the *talker* (output device) or the *listener* (input device) during certain types of input/output operations.

The talk/listen address need not be changed unless two or more computers that have the same preset talk/listen address have been connected to the same HP-IB interface. Then, one of the talk/listen addresses must be changed, since every device on the interface must have a unique device address.

Talk/Listen Address	Segment 3 (A4)	Segment 4 (A3)	Segment 5 (A2)	Segment 6 (A1)	Segment 7 (A0)
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
PRESET → 21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

The talk/listen address is factory preset to 21. Because the interface requires all addresses to be unique, never set the address of a peripheral to the computer's talk/listen address.

## System Controller Switch

Switch segment 2 (CTRL) is factory preset to 1 to establish the HP-87 as system controller. The system controller switch need not be changed unless two or more computers are connected to the interface. There can be only one system controller on the HP-IB interface at a time.

Controller Status	Segment 2 (CTRL)
PRESET → HP-87 is system controller	1
HP-87 is not system controller	0

## Parallel Poll Rotary Switch

The parallel poll rotary switch is used only in configurations with the HP-87 I/O ROM installed in which the HP-87 is not the active controller. Do not change this setting unless you are familiar with the theory of operation of the HP-IB interface.

The switch allows you to change the parallel poll response line. When the switch is set to 1, the computer responds to a parallel poll using data line DIO1 as the parallel poll response line. The dial can be reset to provide response on other lines.

	Switch Setting	DIO Line
	0	None
PRESET →	1	DIO1
	2	DIO2
	3	DIO3
	4	DIO4
	5	DIO5
	6	DIO6
	7	DIO7
	8	DIO8
	9	None

To change the parallel poll response line, use a small screwdriver to rotate the switch until the round notch is positioned at the proper setting.

## HP-IB Control Registers

In many situations the HP-IB interface exchanges information between the computer and peripheral devices with a minimum of intervention from the programmer. However, the interface is extremely versatile, and it can be adapted somewhat to meet particular user needs by changing the contents of its control registers. One common use of this capability is changing the instructions sent by the computer to the peripheral printer at the end of a line (the *end-of-line sequence*).

The HP-IB interface has 12 *control* (write-only) registers, numbered 0 through 3 and 16 through 23. The registers are not numbered consecutively in order to provide numbering compatibility with other HP Series 80 interfaces.

The `SET I/O` statement discussed in section 10 of the operating and programming manual provides the ability to write to the interface control registers.

### Control Registers 0 Through 3

Registers 0 through 3 are involved in regulating the transfer of information through the interface. They should not be accessed unless you have an HP-87 I/O ROM and you are familiar with how those registers affect operation of the interface.

For additional information about registers 0 through 3, refer to the *HP-IB Interface Owner's Manual*.

**CAUTION**

Do not write to control registers 0 through 3 unless you have an I/O ROM and you are completely familiar with the function of these registers. In particular, control registers 2 and 3 provide direct access to the HP-IB control and data lines. Access to these lines must be performed with care, and only by persons aware of HP-IB protocols. It is possible to cause a bus malfunction or device damage by improper use of these registers.

**Registers 16 Through 23: The End-of-Line Registers****Register 16**

Bits 0 through 2 of register 16 contain the number of instructions in the EOL (end-of-line) sequence. Normally this is 2 (carriage return and line feed) but may be any integer from 0 through 7. Bits 3 through 6 are not used.

Bit 7 should be used only when the system includes an I/O ROM. When set, bit 7 causes the HP-IB control line EOI (*end-or-identify*) to be asserted with the last byte of a data transfer. If the EOL count is non-zero, EOI is asserted with the last character of the EOL sequence. If the EOL count is zero, EOI is asserted with the last character of the data list being output.

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
EOI Enable	X	X	X	X	Number of EOL Characters (default = 2)		

**Registers 17 Through 23**

Registers 17 through 23 contain the decimal code for each character sent as an EOL instruction. The default contents of registers 17 through 23 are:

Register Number	Contents	Meaning
17	13	Carriage return.
18	10	Line feed.
19 through 23	0	Null—no action.

**HP-IB Errors**

Certain errors are generated by interfaces. To determine whether an error originated from an interface, execute the ERRSC function (discussed on page 156 of the operating and programming manual). If ERRSC returns the select code of the integrated HP-IB interface, consult the table of HP-IB errors on the inside back cover of this manual for a description of the error condition.

If ERRSC returns any other non-zero number, refer to the documentation accompanying the interface assigned that select code.







## Compatibility with Other HP Series 80 Products

As a member of the HP Series 80 family of computer products, your HP-87 has been designed to provide maximum compatibility with other HP Series 80 Personal Computers, peripherals, and software. However, you need to be aware of the differences between the HP-87 and other HP Series 80 models before you can reliably run HP-83/85 programs on the HP-87. If you have access to an HP-83/85-based system, you may also want information regarding the compatibility of certain optional plug-in modules.

### Compatibility of Optional Plug-In Modules

- All existing HP Series 80 interface modules are compatible with the HP-87. When adding an optional interface module to your system, however, make sure there is no duplication of select codes among the system's interfaces.
- The HP 82936A ROM Drawer, HP 82928A System Monitor, and HP 82929A Programmable ROM Module are designed for use with all existing HP Series 80 Personal Computers.
- You cannot use an HP 82903A 16K Memory Module (designed for the HP-83/85 computers) with your HP-87.
- HP-83/85 ROMs are not compatible with the HP-87. At power-on, the HP-87 searches for incompatible ROMs and returns a warning if an HP-83/85 ROM is present. The presence of HP-83/85 ROMs may interfere with proper operation of the HP-87.

### Translating HP-83/85 Programs

When a BASIC program written for and stored using an HP-83/85 is loaded into an HP-87, the program is automatically translated into a form executable by the HP-87. The translated version cannot be loaded into an HP-83/85.

**Note:** HP-83/85 BASIC programs that use a binary program cannot be translated by the following procedure. Refer to the discussion of binary programs on page 54 for instructions on translating these programs.

To load an HP-83/85 program into the HP-87, execute:

```
LOAD "file specifier"
```

The computer automatically recognizes that the program originated on an HP-83/85 and begins translation, displaying the message:

```
PLEASE WAIT
```

The power light blinks during translation. Translation time depends on the length of the program, and may take up to several minutes. When translation is complete, the power light stops blinking; the computer beeps and displays:

```
DONE
```

You can now store the translated program under the same name to overwrite the HP-83/85 version or under a new file name to preserve both versions.

During translation, program statements not recognized by the HP-87 are converted into comment lines. The HP-85's `CTAPE`, `ERASETAPE`, `REWIND`, and `COPY` statements are not recognized, and will be listed as shown below:

```
240 ! COPY
```

If the unrecognized statement is part of a multistatement line, the entire line becomes a comment. For example, in the program line shown below, `GCLEAR` is not executable:

```
240 ! GCLEAR @ COPY
```

Programs written with the HP-83/85 Plotter/Printer ROM, the HP-83/85 Mass Storage ROM, or with no optional ROMs can be translated. However, if the program used other HP-83/85 ROMs (e.g., Matrix, I/O), then the corresponding HP-87 ROM must be installed in order to translate the program.

When an HP-83/85 program is chained into an HP-87, the program is translated and then automatically executed.

## Translating HP-83/85 Programs That Use Binary Programs

The following procedure will translate an HP-83/85 BASIC program that uses a binary program:

1. List the HP-83/85 program on an HP-83/85 computer. Convert all lines containing binary statements to comment lines by inserting a comment delimiter, `!`, after the line number and then entering the line.
2. Store the edited program.
3. `LOAD` the edited program into the HP-87. The program will be translated.
4. `LOADBIN` the appropriate HP-87 binary program into the HP-87.

**Note:** HP-87 BASIC programs and translated HP-83/85 programs return an error if they attempt to access an HP-83/85 binary program. You must obtain a copy of the appropriate HP-87 binary program.

5. List the program. On each line containing binary statements, delete the comment delimiter. Then, enter the edited line.
6. To avoid repeating the translation process, store the translated BASIC program.

## Troubleshooting: Sources of Possible Errors

If a translated HP-83/85 program generates an unexpected error, the cause may be related to differences between the HP-83/85 and the HP-87 operating systems.

- Before running a translated program, list the program to check for untranslated statements converted to comments. This step is particularly important if the program includes multistatement lines.
- If the program returns a string overflow error while accessing a single-line user-defined string function, check to see whether the string expression returned by the function exceeds the allowable maximum length of 18 characters. The HP-83/85 permits longer strings returned by single-line user-defined string functions.
- The HP-87 character set differs from the HP-83/85 character set for certain decimal codes. The following table lists decimal codes to which different characters have been assigned.

Decimal Code	HP-83/85 Characters	HP-87 Characters
6	Γ	Σ
7	Π	Δ
8	Δ	+
15	⊥	π
17	Ω	Æ
18	δ	œ
27	Æ	†
28	œ	
29	z	—
31	⊗	+
123	π	(
125	→	)
126	Σ	~
127	†	⊗

When a translated HP-83/85 program is listed on an HP-87, HP-83/85 characters with these decimal codes are displayed as corresponding HP-87 characters having the same decimal code.

- Control characters (characters with decimal codes 0 through 31) in program listings are suppressed by the HP-87 during PLISTing. The HP-83/85 computers do not suppress PLISTed control characters.
- The HP-87 stores all programs deallocated. The HP-83/85 stores all programs allocated unless they contain common variables (declared with a COM statement) or allocation errors.
- The HP-87 allocates uninitialized programs dynamically—in other words, during program execution. The RUN command and **RUN** key do not allocate program variables before execution begins. The HP-83/85 allocates programs statically; the RUN command and **RUN** key allocate all program variables before execution begins.

- Certain long HP-83/85 statements may return `Error 88 : BAD STMT` when you attempt to enter them into an HP-87. If this happens, the statement must be broken into separate, shorter operations.
- The HP-87 performs certain graphics operations more rapidly than the HP-83/85. Translated graphics programs may require insertion of `WAIT` statements to slow the action on the screen.
- Because the HP-87 CRT is larger than the HP-83/85 CRT, translated programs that use the graphics display may require editing of boundary and scaling statements.
- Because the HP-87 CRT is larger than the HP-83/85 CRT, translated programs that use the graphics display may require editing of boundary and scaling statements and `CSIZE` parameters.
- On the HP-87, `BPLOT`ing can begin at any dot position. The HP-83/85 requires `BPLOT`s to begin at dot positions that are multiples of 4.

## Extended-Type Files

Extended files include all file types except `PROG`, `DATA`, `NULL`, and `BPGM`. All HP-83/85 extended files appear as type `****` in a directory listing obtained on an HP-87. Likewise, HP-87 extended files appear as type `****` in a directory listing obtained using an HP-83/85.

The HP-87 cannot access HP-85 extended files. For instance, graphics files `GSTOREd` by an HP-83/85 cannot be retrieved into an HP-87.

## Printer and Display Formats

If a translated HP-83/85 program is designed to print or display information formatted for 32 columns, you may choose to adapt the program to format the output for 80 columns. If you'd prefer, you can specify 32-column output by executing the appropriate `PRINTER IS` and/or `CRT IS` statements.

### Examples:

```
PRINTER IS 701,32
CRT IS 1,32
```





# Index

## A

Accessing peripheral devices, 31-32  
Accessory cables for HP-IB interface, 44  
Accessories, standard, 9  
Addresses of peripheral devices, 47  
A/G key, 36  
*Alpha* mode, 36-37  
Arithmetic expressions, 27  
AUTO command, 35  
Automatic line numbering, 35-36  
Autostart programs, 25

## B

*Basic Exchange* newsletter, 6  
BASIC language programming, 33-37  
Binary programs, 54  
Brightness of display, 26

## C

Cable length of accessory cables, 44  
*Calculator* mode, 26  
CAPS LOCK key, 26  
CAT statement, 32  
Catalog of disc, 32  
Character set, 55  
CLEAR key, 30  
Clearance for operation, 16  
Clearing the display, 30  
Compatibility of Series 80 BASIC programs, 54-55  
CONT key, 40  
Continuing a program, 40  
Control characters, 55  
Control registers of HP-IB interface, 49-50  
CRT address, 31  
CRT IS statement, 47  
Cursor, 25  
Cursor control keys, 29

## D

Deleting characters, 29, 30  
Deleting lines, 30  
Device addresses, 20-21, 47  
Device selector, 47  
Dimensions of computer, 10  
Disc directory, 32  
Disconnecting peripheral devices, 45  
Display brightness control, 10, 26  
Display editing, 29-30  
Documentation, 6

## E

Editing the display, 29-30  
Electrical specifications, 11  
END LINE key, 26  
End-of-line sequence, 49-50  
End-or-identify assertion, 50  
Entering programs, 33  
EOI assertion, 50  
Erasing program memory, 33  
Error messages, 28  
ERRSC function, 50  
Extended files, 56

## F

Fuses, 10-13  
    Fuse installation, 13  
    Fuse receptacle, 10  
    Fuse specifications, 12, 13

## G

GLOAD statement, 37  
GRAF files, 56  
*Graph* mode, 36-37  
Graphics display, 35-37  
Graphics files, 56  
Ground information, 10, 11  
GSTORE statement, 37

## H

Halting program execution, 40  
HP-IB cable connectors, 10, 45  
HP-IB cable receptacle, 23  
HP-IB cables, 44  
HP-IB control registers, 49-50  
HP-IB interface, 43-50  
HP-IB switch, 10, 20, 46-48  
HP-IB talk/listen address, 47-48

## I

Initializing a disc, 34  
*Insert* mode, 29  
Inspection procedure, 9  
Installation procedures, 13-16, 44-45  
    Installing modules, 13-15  
    Installing peripheral devices, 44-45  
    Installing ROMs, 15-16  
Interface errors, 50, inside back cover  
Interface modules, 53  
Interface select code, 20  
I/O ports, 13-14  
I/R key, 29-30

## K

KEY LABEL key, 31

## L

Line frequency, 11  
Line numbers, 26  
Line voltage selector switch, 10  
LIST key, 40  
Listing a program, 40  
LOAD command, 37

## M

Mass storage address, 32  
MASS STORAGE IS statement, 47  
Mass storage unit specifier, 47  
Mathematical errors, 28  
Memory modules, 13, 53  
Metric conversion kit for HP-IB cables, 45  
Modules, 13-15, 53  
    Module installation, 13-15  
Module ports, 10

## N

Numeric variables, 30



**O**

ON-OFF switch, 10  
 Operating environment, 10, 16  
 Owner's documentation, 6

**P**

Parallel poll rotary switch, 10, 49  
 Parentheses, 27  
 Pausing a program, 40  
 Peripheral devices, 19-23, 31-32, 43-47  
   Connecting peripheral devices, 19-23  
   Peripheral device addresses, 20-21, 31-32, 47  
   Peripheral load on HP-IB interface, 43  
 Physical specifications, 10  
 PLOTTER IS statement, 47  
 Plug-in modules, 13-15, 53  
 Ports, 13-14  
 Power cord receptacle, 10, 11  
 Power cords, 11  
 Power light, 25, 33, 40  
 Power requirements, 11  
 Power-on procedure, 25-26  
 PRINT statement, 31  
 Printer addressing, 31  
 PRINTER IS statement, 31  
 Programs, 26, 33-37, 40  
   Program line numbers, 26  
   Program listings, 40

**R**

Radio frequency interference compliance, 10  
 Rear panel, 10  
 Replace mode, 30  
 Retrieving graphics, 37  
 Retrieving programs, 37  
 ROLL key, 29  
 ROM drawer, 13, 15-16  
 ROMs, 15-16, 53  
   Installation of ROMs, 15-16  
   Removing ROMs, 16  
 RUN command, 55  
 RUN key, 33, 55  
 Running programs, 33

**S**

SCRATCH command, 33  
 Select code, 20, 46  
 Self-test, 13, 25-26  
 Serial number, 10  
 Set-up instructions, 12-16  
 SHIFT key, 26  
 Specifications, 10-11  
   Electrical specifications, 11  
   Physical specifications, 10  
 Standard accessories, 9  
 STORE command, 34-35  
 Storing graphics, 37  
 Storing programs, 34-35  
 String variables, 30  
 System controller status, 48

**T**

Talk/listen address, 47-48  
 Temperature specifications, 10  
 Translating HP-83/85 programs, 53-54  
 Typing aids, 31

**U**

Users' Library, 6

**V**

Variables, 30  
   Variable names, 30  
   Variable types, 30  
 Voltage selector switch, 12  
 Voltage settings, 11

**W**

Warning messages, 28  
 Workspace, 16

## HP-IB Interface Errors

Error Number	Message	Error Condition
110	I/O CARD	The interface assembly failed the self-test or failed after interrupting the computer; the interface requires servicing.
111	IOP	An illegal operation, statement, or command has been sent to the interface. For example, a SET I/O statement was executed specifying a non-valid register number.
112		A plug-in ROM module failed the self-test (this error originates in the ROM module).
Errors 113 through 122 are dependent on the type of interface generating the error, and thus display no message. It is unlikely that errors 113, 114, and 115 would be generated without an I/O ROM. If you have an I/O ROM, please refer to the list of error conditions in the documentation accompanying that ROM.		
Errors 113 through 117 may be generated by the HP-IB interface by the following error conditions:		
113		Not system controller. The statement executed requires that the computer be system controller.
114		Not active controller. The statement executed requires that the computer be active controller.
115		Not active talker. The statement executed requires that the computer be addressed to talk.  A possible cause for this error is directing print output to an HP-IB PRINTER IS device for which the device selector does not include the device address.
116		Not active listener. The statement executed requires that HP-IB be addressed to listen.  A possible cause for this error is that the computer has not been addressed to listen (but has been previously addressed to talk with a PRINTER IS statement) when a PLOTTER IS statement is executed with the device selector equal to the select code. The device selector must include the device address to specify the currently active talker and listener.
117		Interface is active controller. The statement executed requires the computer to be non-controller.



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