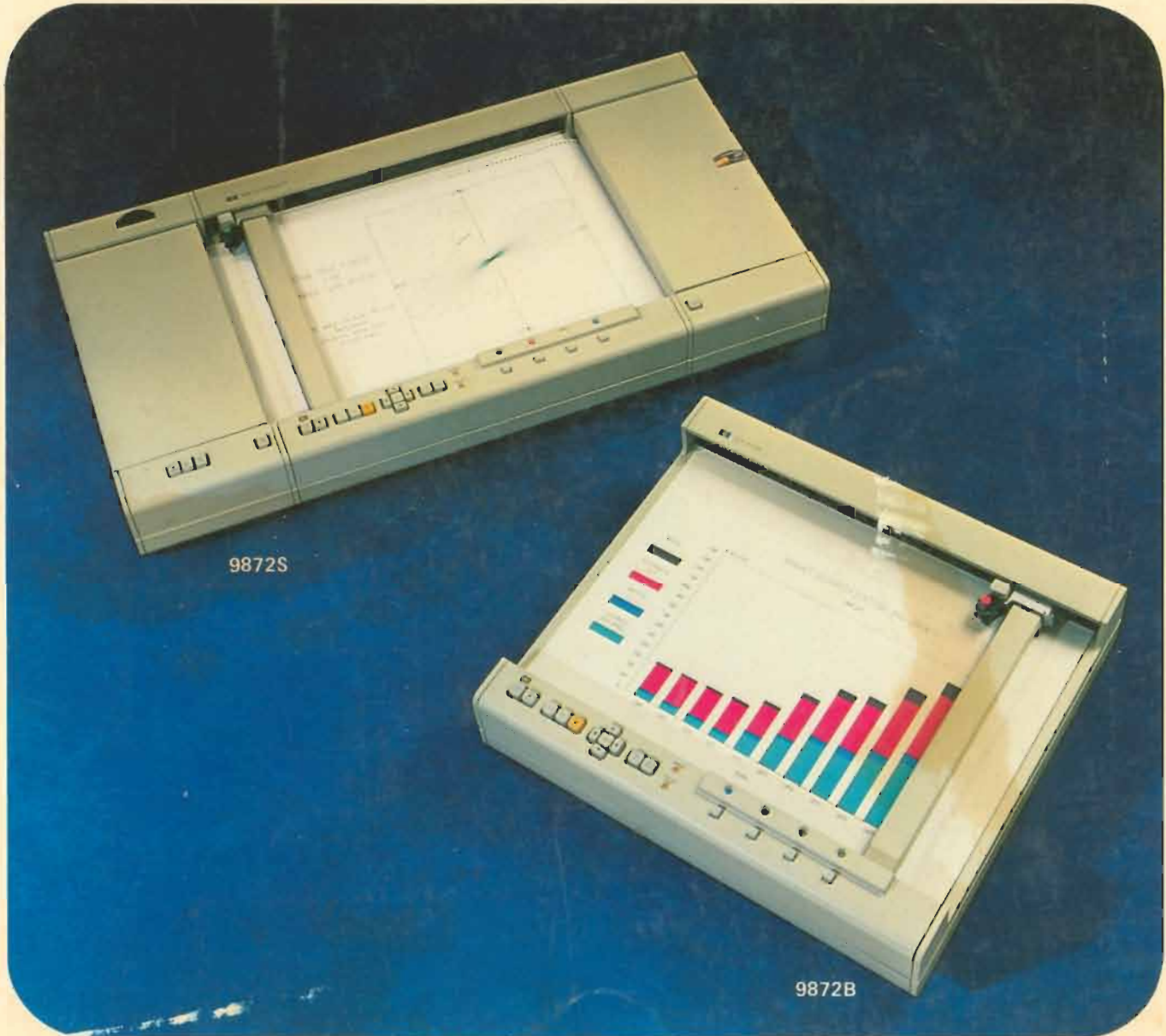


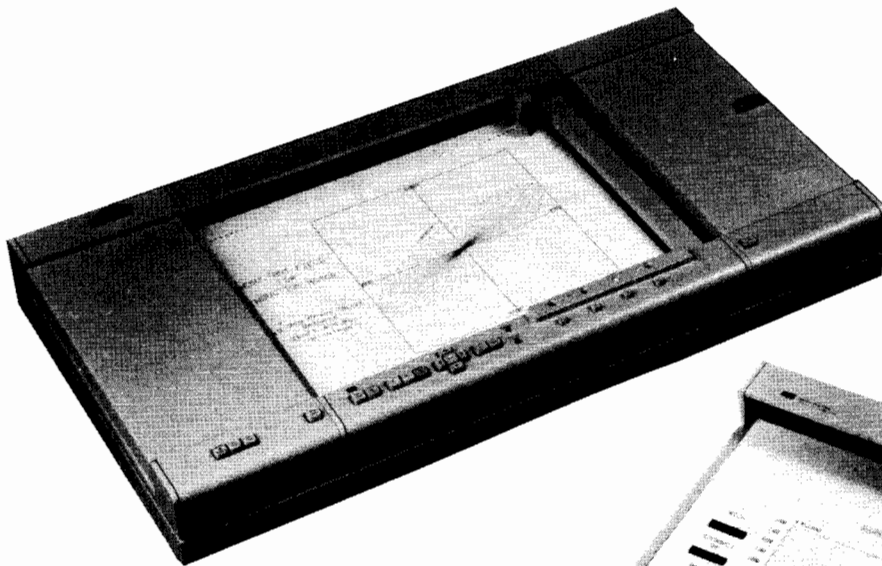
Hewlett-Packard 9872B and 9872S Graphics Plotters  
Operating and Programming Manual  
Using HP-GL Instructions



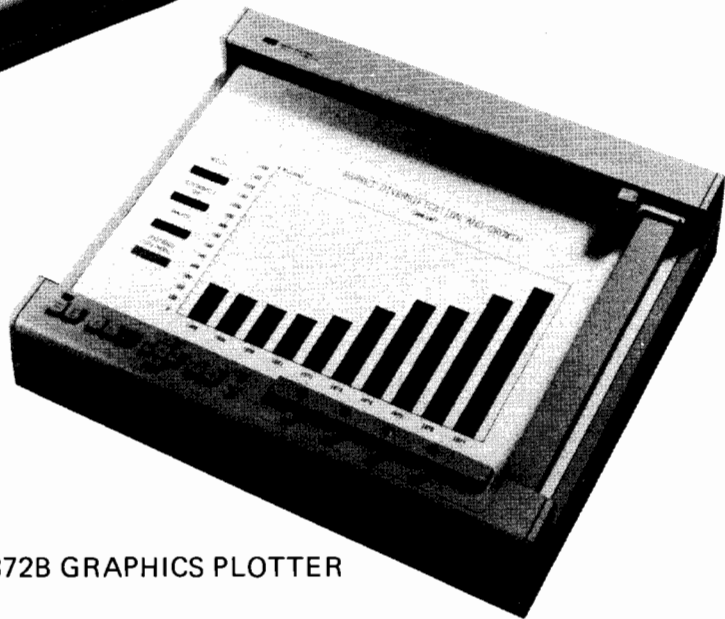
9872S

9872B

9872B Graphics Plotter and  
9872S Graphics Plotter  
Operating and Programming  
Using HP-GL Instructions



HP 9872S GRAPHICS PLOTTER



HP 9872B GRAPHICS PLOTTER

Hewlett-Packard  
16399 W. Bernardo Drive, San Diego, California 92127  
(For World-wide Sales and Services Offices see appendix)  
Copyright© by Hewlett-Packard Company 1979

Revised  
February 1980

# Manual Summary

## Chapter 1: General Information

Information about setting up the plotter, maintenance, and the methods of addressing, sending, and receiving data over the Hewlett-Packard Interface Bus.

## Chapter 2: Plotting

Describes the instructions used in plotting.

## Chapter 3: Lettering

Describes the instructions used in lettering. Included are instructions to vary the size, width, and slant of the characters.

## Chapter 4: Graph Enhancement

Describes the instructions used to enhance the plot.

## Chapter 5: Digitizing

Describes the instructions used to digitize with the plotter and perform interactive digitizing communication with the controller.

## Chapter 6: Additional Plotter Control

Describes the additional plotter control instructions for pen control, character control, plotter configuration and status, and external plotter commands.

## Chapter 7: Scaling

Describes the instructions for locating the scaling points, establishing user units, and includes some scaling examples.

## Chapter 8: Automatic Paper Advance

Describes the instructions for the 9872S which advance and cut the paper.

**HP Computer Museum**  
**[www.hpmuseum.net](http://www.hpmuseum.net)**

**For research and education purposes only.**

## Table of Contents

<b>Chapter 1: General Information</b> .....	1
Introduction .....	1
Description .....	2
Unpacking and Inspection .....	3
Accessories .....	4
Grounding Requirements .....	6
Power Requirements .....	6
Power Cords .....	6
Fuses .....	8
Line Voltage Selection .....	8
Operator Maintenance .....	9
General Cleaning .....	9
Electrostatic Paper Hold-down Surface Cleaning .....	9
Air Filter Cleaning .....	10
Shipment .....	11
Controls and Indicators .....	13
Confidence Test .....	17
The Plotter Address Code .....	18
Listen Only Mode .....	20
Setting Up the Plotter .....	20
Turning the Power On .....	20
Loading Pens .....	20
Loading Sheet Paper .....	22
Loading Roll Paper .....	23
Setting the Scaling Points .....	25
Bus Command Statements .....	26
Addressing the 9872 as a Talker or Listener .....	27
Sending and Receiving Data .....	29
Controller-to-Plotter .....	29
Plotter-to-Controller .....	31
The 9872 Instruction Set .....	32
Suggested Programming Practices .....	35
 <b>Chapter 2: Plotting</b> .....	 37
The Plotter Unit .....	37
The Plot Absolute Instruction PA .....	38
The Plot Relative Instruction PR .....	42
The Pen Instructions PU and PD .....	44
Plotting With Variables .....	45

<b>Chapter 3: Lettering</b> .....	47
The Label Instruction LB .....	47
The Absolute Direction Instruction DI .....	49
The Relative Direction Instruction DR .....	50
The Absolute Character Size Instruction SI .....	53
The Relative Character Size Instruction SR .....	54
Spacing Between Characters and the Character Grid .....	56
The Character Slant Instruction SL .....	57
The Character Plot Instruction CP .....	58
<b>Chapter 4: Graph Enhancement</b> .....	61
The Tick Instructions XT and YT .....	61
The Tick Length Instruction TL .....	62
The Pen Select Instruction SP .....	64
The Symbol Mode Instruction SM .....	64
The Line Type Instruction LT .....	67
<b>Chapter 5: Digitizing</b> .....	69
The Digitize Point Instruction DP .....	69
The Digitize Clear Instruction DC .....	69
The Output Digitized Point and Pen Status Instruction OD .....	70
Digitizing With the 9872 .....	71
<b>Chapter 6: Additional Plotter Control</b> .....	73
Pen Control Instructions .....	74
The Automatic Pen Pickup Instruction AP .....	74
The Velocity Select Instruction VS .....	74
The Adaptive Pen Velocity Instruction VA .....	75
The Normal Velocity Instruction VN .....	76
Character Control Instructions .....	76
Character Sets .....	76
The Designate Standard Character Set Instruction CS .....	77
The Designate Alternate Character Set Instruction CA .....	78
The Select Standard Set Instruction SS .....	78
The Select Alternate Set Instruction SA .....	79
The User Defined Character Instruction UC .....	79
Plotter Configuration and Status Instructions .....	82
The Input Mask Instruction IM .....	82
The Input Window Instruction IW .....	84
The Default Instruction DF .....	88
The Initialize Instruction IN .....	89

<b>Chapter 6: Additional Plotter Control (Continued)</b>	
The Output Actual Position and Pen Status Instruction OA . . . . .	90
The Output Commanded Position and Pen Status Instruction OC . . . . .	91
The Output Error Instruction OE . . . . .	91
The Output Status Instruction OS . . . . .	92
The Output Factors Instruction OF . . . . .	93
The Output Identification Instruction OI . . . . .	94
The Output Options Instruction OO . . . . .	94
External Plotter Commands . . . . .	96
Plotter Reaction to Bus Clear Commands DCL, SDC, and IFC . . . . .	96
Serial and Parallel Polling . . . . .	96
The Serial Poll . . . . .	96
The Parallel Poll . . . . .	97
<b>Chapter 7: Scaling</b> . . . . .	99
The Input P1 and P2 Instruction IP . . . . .	99
The Output P1 and P2 Instruction OP . . . . .	101
The Scale Instruction SC . . . . .	102
<b>Chapter 8: Automatic Paper Advance (9872S)</b> . . . . .	117
The Advance Full Page Instruction AF . . . . .	117
The Advance Half Page Instruction AH . . . . .	118
The Enable Cutter Instruction EC . . . . .	118
<b>Appendix</b> . . . . .	119
Binary Coding and Conversions . . . . .	119
Binary-Decimal Conversions . . . . .	119
The HP Interface Bus . . . . .	120
The HP-IB Lines and Operations . . . . .	120
Interface Functions . . . . .	123
HP 9872 HP-IB Implementation . . . . .	125
Plotter Default Conditions . . . . .	126
Error Messages . . . . .	127
Syntax and Formulas . . . . .	128
ASCII Character Codes . . . . .	138
Sales and Service Offices . . . . .	142
<b>Subject Index</b> . . . . .	146





Chapter **1****General Information****Introduction**

This manual contains operating and programming information for the Hewlett-Packard 9872B and 9872S Graphics Plotters. The manual is organized into eight chapters and an appendix as follows:

- Chapter 1 – General Information
- Chapter 2 – Plotting
- Chapter 3 – Lettering
- Chapter 4 – Graph Enhancement
- Chapter 5 – Digitizing
- Chapter 6 – Additional Plotter Control
- Chapter 7 – Scaling
- Chapter 8 – Automatic Paper Advance (9872S)
- Appendix

Before using this manual, you should be thoroughly familiar with the controller and its programming language. The 9872B and 9872S are interfaced through the Hewlett-Packard Interface Bus (HP-IB conforms to IEEE 488-1975). Using the appropriate interface cable, you can connect the plotter to your HP-IB compatible desktop computer, computer, or other controller.

The following conventions apply to the syntax used within this manual:

References to the 9872 plotter include both the 9872B and 9872S. When 9872 is followed by a letter, reference is being made to that model only.

**Command Syntax**

- `DOT MATRIX` – All items in dot matrix are required exactly as shown.
- `nec parameter` – All typeset items are required parameters.
- `( )` – All items in parenthesis are optional.
- `[: or LF]` – Required terminator.

## 2 General Information

Most examples in this manual were programmed on an HP 9835 desktop computer. However, with minimal changes in addressing procedure, the programs can be accepted by other computers.

### Description

The Hewlett-Packard 9872B and 9872S are microprocessor-based HP-IB plotters that produce high quality, multi-color graphic plots up to 285 x 400 mm (11.2 x 15.75 in.). The plotters are identical except for the automatic paper advance features of the 9872S.

Both the 9872B and 9872S accommodate chart paper up to ISOA3 (297 x 420 mm) and 280 x 432 mm (11 x 17 in.). In addition, the 9872S accommodates roll paper perforated at either ISOA3 or 11 in. width. The 9872S allows programmable or manually controlled full or half page paper advance. Since the paper cutter can be enabled or disabled programmatically or with a front panel switch, paper can be cut into ISOA3 or ISOA4 and 11 x 17 in. or 8½ x 11 in. sizes, or can be left uncut.

There are 43 different Hewlett-Packard Graphics Language (HP-GL) instructions built in to equip the plotter with such capabilities as point digitizing, labeling, character sizing, window plotting, and scaling. In addition, the 9872S recognizes three more instructions which control the automatic paper advance features. Using this easily understood HP-GL language you can start plotting with a minimum of programming experience.

Trace identification is enhanced by the automatic selection of any of four pens through either program control or front panel pushbuttons. Seven different dashed-line fonts, symbol mode plotting, and user-defined characters provide additional trace identification capabilities.

Fast, high quality plotting is another contribution of the 9872 plotter. Pen velocity is programmable to any one of 36 speeds from 10 mm/s to 360 mm/s (0.4 to 14.2 in./s), so quality graphics can be produced not only on standard paper but also on other media.

Annotation can be easily done using any of five character sets, including three European sets. Text can be written in any direction, with or without character slant, and in varying sizes. You can even design your own characters.

The 9872 family is engineered to be especially useful in the areas of business graphics, statistics, medicine, numerical control, surveying, and engineering design. An optional overhead transparency kit enables you to produce high quality graphic transparencies from your plotting programs. Project the details as you present economic trends, engineering or scientific data, marketing plans, profit data or sales forecasts.

The 9872S, with software controlled paper advance and cutting, is designed to allow unattended operation in a laboratory or computer environment. This plotter is ideal for repetitive production of engineering test system output, mainframe computer room output, and production of multiple copies of four-color presentation graphs.

Whether data are tabulated, measured, or computed, the 9872 enables you to prepare multi-colored plots of excellent line quality and high resolution.

## Unpacking and Inspection

---

### WARNING

The 9872S is a large, heavy device (weight 65 lbs.). Do not attempt to unpack it or move it to a different location alone.

---

The 9872S plotter should be moved or unpacked by two people, one positioned at each end of the plotter. Each person should grasp the lower support bars of the plotter near the rubber feet and lift.

The individual parts of your plotter were thoroughly inspected before the unit was shipped to you, and the instrument should be in good operating order. Carefully inspect the plotter and accessories for any physical damage sustained in transit. Notify the nearest HP sales and service office and file a claim with the carrier if the unit is received in a damaged condition.

Please check to ensure that you have received all of the items that should accompany the plotter. Refer to the table of Accessories Supplied and check that all accessories are present.

#### 4 General Information

If you have any difficulties with the plotter, if it is not operating properly, or if accessories are missing, contact the nearest HP Sales and Service Office; addresses are supplied at the back of this manual.

Retain the original packing materials and carton. If the plotter must be shipped, this will save having to order new packing materials and a carton from HP.

### Accessories Supplied

The following items are supplied with each 9872 plotter:

ITEM	QUANTITY	PART NUMBER
Operating and Programming Manual	1	09872-90008
Pocket Guide	1	09872-90009
Accessory Kit - includes the following items:	1	09872-60070
Four Color Pen Pack	4 pkg. of 4	5060-6810
Digitizing Sight	1	09872-60066
Chart Paper (pkg. of 10 sheets) 10 x 15 in. grid area	1	9270-1004
Chart Paper (pkg. of 10 sheets) 250 x 380 mm grid area	1	9270-1024
Power Cord (appropriate cord supplied, based on origin of sales order)	1	
Dust Cover 9872B	1	9222-0564
or		
Dust Cover 9872S		9222-0681
Roll Paper 9872S (English) or	1 Roll	9280-0493
(Metric)	1 Roll	9280-0494
Paper Tray 9872S	1	17072-60023

## Accessories Available


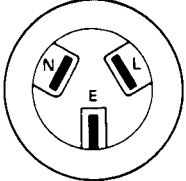
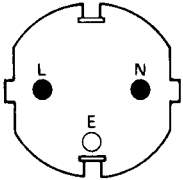
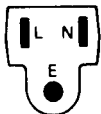
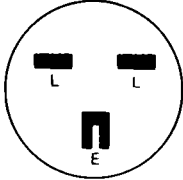
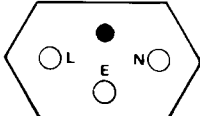
1

The following items are available and can be purchased using the appropriate part number:

ITEM	PART NUMBER
<b>Plotter Pens</b>	
Package of 5 red pens	5060-6784
Package of 5 blue pens	5060-6785
Package of 5 green pens	5060-6786
Package of 5 black pens	5060-6787
4-color pack (red, blue, green, black)	5060-6810
<b>Plotter Paper</b>	
10 x 15 in. grid area, 10 grids/in., 100 sheets	9270-1004
7 x 10 in. grid area, 10 grids/in., 100 sheets	9270-1006
250 x 380 mm grid area, 1 grid/mm, 100 sheets	9270-1024
180 x 250 mm grid area, 1 grid/mm, 100 sheets	9270-1023
<b>Semi-log:</b>	
10 in. x 2 cycle plot area, 100 sheets	9280-0159
10 in. x 3 cycle plot area, 100 sheets	9280-0160
2 cycle x 15 in. plot area, 100 sheets	9280-0169
3 cycle x 15 in. plot area, 100 sheets	9280-0168
<b>Log-log:</b>	
2 cycle x 3 cycle plot area, 100 sheets	9280-0167
3 cycle x 2 cycle plot area, 100 sheets	9280-0165
3 cycle x 4 cycle plot area, 100 sheets	9280-0171
Blank, 100 sheets 11 x 16½ in.	9280-0180
Pad: 50 sheets gridless 8½ x 11 in.	9280-0475
50 sheets gridless ISOA4	9280-0476
Roll: English 200 ft. (61 m)	9280-0493
Metric 61 m (200 ft.)	9280-0494
<b>Overhead Transparency Kit (includes)</b>	
4 pens (black, red, blue, green) 0.25 mm tip	5060-6818
4 pens (black, red, blue, green) 0.7 mm tip	5060-6819
4 pens (black, orange, brown, violet) 0.25 mm tip	5060-6834
4 pens (black, orange, brown, violet) 0.7 mm tip	5060-6835
Solvent 29.6 ml (1 fl. oz.)	5060-6828
100 sheets transparency film (kit includes 2 packages)	9270-0639
Carrying Case 9872B only (not suitable for shipping)	1540-0480
Interface Cables, ROMs, and Software (see your HP sales representative)	
Service Manual 9872B	09872-90006
Service Manual Supplement 9872S	09872-90007



Option Number

<p>BS 1363A</p> 	<p>HP Part Number 8120-1351; 250V, 13A, 1<math>\phi</math> plug rating. (Furnished for use in the United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore)</p>	<p>900</p>
<p>AS C112</p> 	<p>HP Part Number 8120-1369; 250V, 10A, 1<math>\phi</math> plug rating. (For use in Australia, New Zealand)</p>	<p>901</p>
<p>CEE 7-VII</p> 	<p>HP Part Number 8120-2857; 250V, 10/16A, 1<math>\phi</math> plug rating. (Furnished for use in East and West Europe, Saudi Arabia, Egypt).</p>	<p>902</p>
<p>NEMA 5-15P</p> 	<p>HP Part Number 8120-1378; 125V, 15A, 1<math>\phi</math> plug rating. (UL approved; for use in United States, Canada, Japan, Mexico, Philippines, Taiwan)</p>	<p>903</p>
<p>NEMA 6-15P</p> 	<p>HP Part Number 8120-0698; 250V, 15A, 1<math>\phi</math> plug rating. (UL approved; for use in United States)</p>	<p>904</p>
<p>SEV 1011</p> 	<p>HP Part Number 8120-2104; 250V, 10A, 1<math>\phi</math> plug rating. (For use in Switzerland)</p>	<p>906</p>

NOTE: All plugs are viewed from connector end.

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

## Fuses

### CAUTION

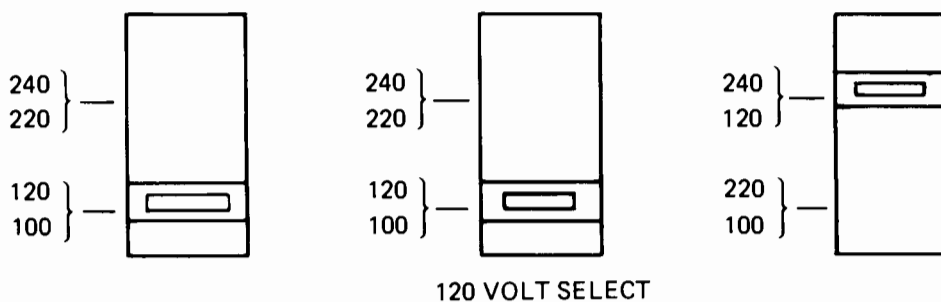
To prevent damage to the plotter make the line voltage selection and install a fuse of the correct amperage and type **BEFORE** connecting the line power. Also ensure the line power cord is connected to a line power socket that is provided with a protective earth contact.

The 9872 is factory equipped with fuses appropriate to the factory-set line voltage. To change or inspect a fuse, turn the desired fuseholder on the rear panel in the direction of the arrow (counterclockwise) until the fuseholder releases. Remove the fuseholder and insert a slo-blo fuse which matches the voltage setting. Place the fuseholder back into the plotter, and turn the fuseholder clockwise, while pressing it, until the threads engage and the fuse remains flush with its casing. Fuse values are marked on the rear panel and appear below.

Voltage	Lower Fuse	Upper Fuse
100V or 120V	3A	500 mA
220V or 240V	1.5A	250 mA

## Line Voltage Selection

The 9872 is shipped from the factory with the line voltage set to the nominal value for the specified area. The line voltage can be changed by moving the three switches on the rear panel to the desired line voltage setting. The four settings have been marked, each in a different color. The setting for 120V is illustrated below.





## Operator Maintenance

Maintenance of the plotter is limited to a periodic cleaning of the external surfaces, electrostatic paper hold-down surface, and air filter. Cleaning intervals are determined by the type of operation, local air contamination, and climatic conditions.

---

### WARNING

Disconnect the plotter from the power source prior to performing any maintenance. When cleaning, apply water using only a lint-free wipe, such as Kimwipe®. DO NOT allow water to run onto electrical components and circuits or through openings in the enclosure as it may create a shock hazard.

Scratches or punctures in the electrostatic paper hold-down surface may expose high voltage conductors. Plotters damaged in this manner should not be operated.

---

## General Cleaning

Clean the outer surfaces as follows:

- a. Blow away dust accumulation with compressed air.
- b. Clean the outer surface of the instrument with a damp sponge or cloth. Use a mild soap and water solution if necessary. Wipe dry after cleaning.

## Electrostatic Paper Hold-down Surface Cleaning

Dust and other contaminants will lower the paper holding capability. Although recording ink will not affect hold-down performance, it may be desirable to remove ink stains as well.

## 10 General Information

Cleaning moderate contamination can be accomplished as follows:

1. Prepare a mixture of 50% isopropyl alcohol and 50% water by volume.
2. Apply the alcohol/water mixture to the surface using a Kimwipe® or equivalent. Immediately wipe any moisture from the surface. Never let any liquid stand on surface as it may become permanently damaged.

If the surface cannot be easily cleaned with the alcohol/water mixture, cleaning can be accomplished as follows:

1. Select a clean, lint-free cloth that will not scratch the surface.
2. Remove transparency ink with solvent (HP 5060-6828) and continue cleaning process.
3. Dampen the cloth with warm water or alcohol and apply a light amount of cleanser such as Ajax® or Comet®.
4. Wipe the surface until it is clean, then rinse the cloth and wipe any remaining cleanser from the surface. Immediately wipe any moisture from the surface.

### Air Filter Cleaning

The air filter should be cleaned approximately every three months or when dirt becomes visible on the filter surface, whichever happens first. Remove the filter and either hold it under running water, or wash it in warm, soapy water, followed by a rinse in clean water. Dry the filter thoroughly before replacing it.

## Shipment

**1**

When the plotter is to be shipped, it is essential that the original packing materials and carton be used. If not available, packing materials and a carton may be ordered through the local Hewlett-Packard Sales and Service Office.

If the plotter is being returned to Hewlett-Packard for any reason, contact the local Hewlett-Packard Sales and Service Office for shipping instructions. Attach a tag to the instrument including the following information:

1. Your company name
2. Address
3. Telephone number
4. Name of person who can be contacted
5. Description of problem and desired service
6. Model number and full serial number.

Do not include the power cord or other operating accessories if returning the instrument to HP.

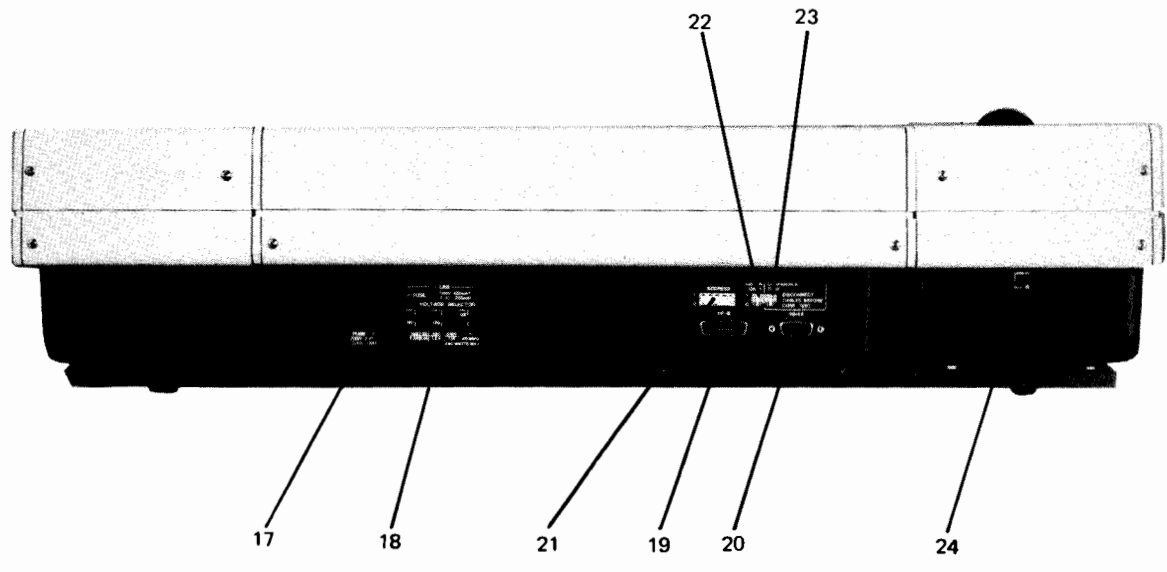
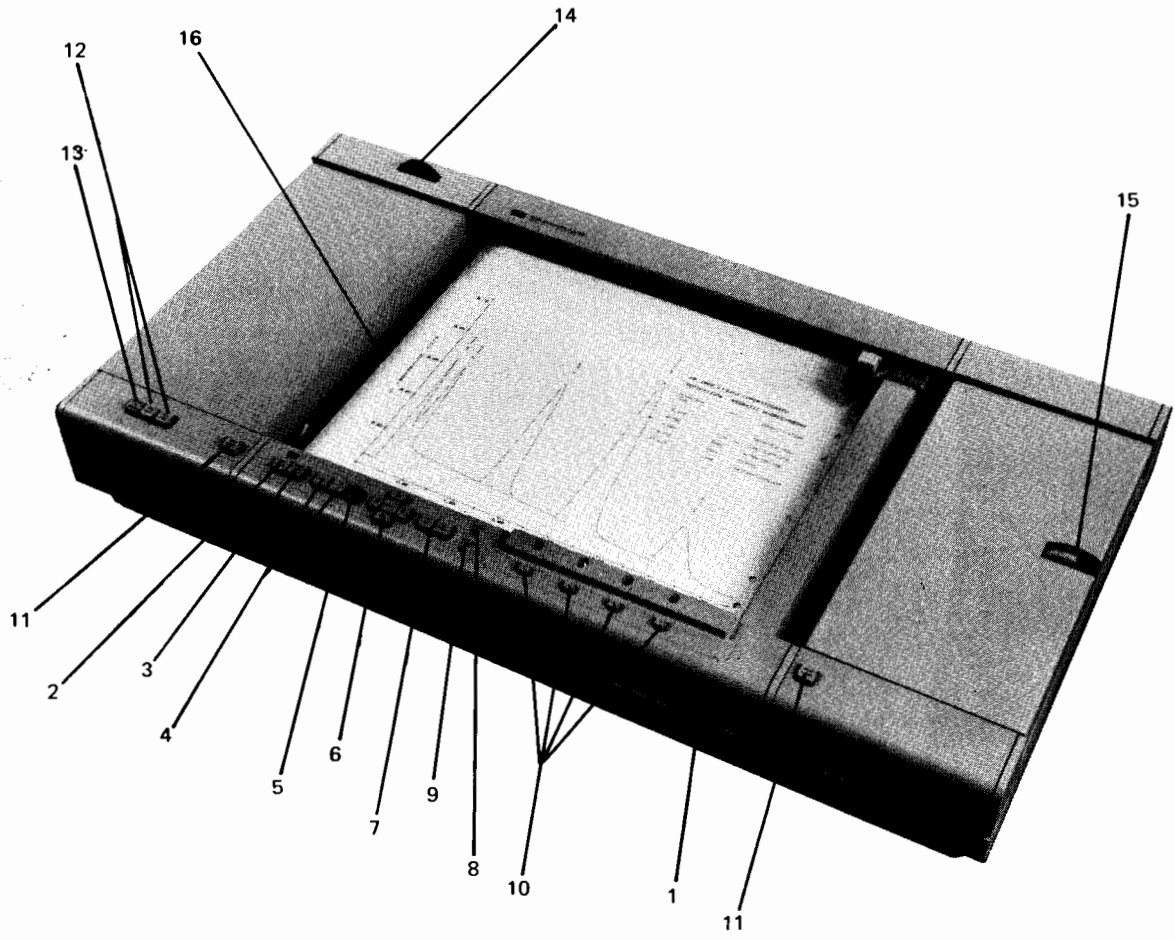
---

**CAUTION**

Before shipping remove all pens.

---

12 General Information



9872S Plotter Controls and Indicators

## Controls and Indicators

1

A brief description of the 9872 controls and indicators, including their functions, follows. Those which apply to both the 9872B and 9872S are given first, followed by those that apply to the 9872S only.

---

### WARNING

To avoid the possibility of injured fingers, always keep your hands away from the pen stable and plotter arm when operating the panel controls.



---



### FRONT BASE

1.





A pushbutton switch that controls application of power to the plotter. Power is on when depressed (set to ) and off when extended (set to ) .

### FRONT PANEL

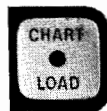
2.



A pushbutton that activates electrostatic paper hold-down when sheet paper is used, and turns off the  lamp. Cannot be activated when using roll paper on the 9872S.

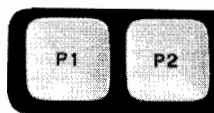
When pressed after pressing the  the plotter is initialized.






3.



Pressing this pushbutton causes pen to move to upper right-hand corner of platen, turns on lamp, and deactivates the paper hold-down.

4.


















Pressing  or  raises the pen and moves it to the corresponding physical point, P1 or P2, on the platen. Pressing , followed by  or  defines the current pen location as the scaling point P1 or P2. See Setting The Scaling Points (Chapter 1).

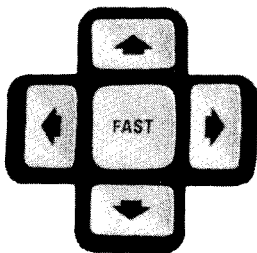
5.




A multi-purpose pushbutton with a lamp. It is used as follows:

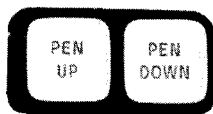
- a). Pushed before  to initialize plotter.  lamp blinks until  is pushed.
- b). Used with  and  to establish scaling points.  lamp blinks until  or  is pushed.
- c). Used to enter a point in digitizing mode.  lamp is on steady from receipt of digitize point command until  button is pushed.
- d).  lamp can be turned off by pushing any of the , , , or  pushbuttons.
- e). Used with the pen select buttons to store a pen.


6.








Pushbuttons to move pen within the plotting area in the direction of the arrows at 4 mm/s. Two adjacent pushbuttons move pen diagonally in the indicated directions. When an arrow pushbutton is pressed together with , pen moves at approximately 60 mm/s. May halt program and draw unwanted lines if pressed during program execution.

7.



These pushbuttons raise or lower the pen. When held down during program execution, they override programmed pen control until released.  with

, , , , or  can be used to draw lines.

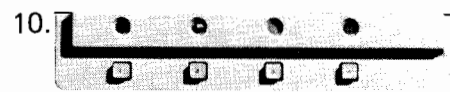


ERROR lamp lights when an error occurs if error mask has been set to flag that error. See Input Mask Instruction (Chapter 6).

Lamp also lights at end of confidence test until confidence test switch is turned off.



OUT OF LIMIT lamp lights when plotter is requested to plot outside window area or beyond limits of platen area. Lamp blinks if commanded position puts plotter in "lost" state. See Plot Absolute (Chapter 1) and Input Window (Chapter 6).



Pen select buttons for manual control of pen selection. Can be used to change a pen during program execution. The pen change is made after execution of the current instruction. Note pen color is visible through round holes located above the pushbuttons.

**9872S ONLY**



Pushbuttons to release cover on right and left paper supply module.



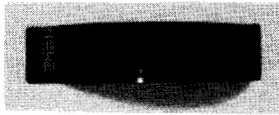
Pushbuttons to advance paper one full page or one half page from left margin of platen. Will interrupt plotting and advance paper if pushed during program execution.



Pushbutton switch to enable/disable cutter. Lamp is on when cutter is enabled and off when disabled.

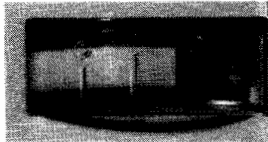
## 16 General Information

14.



Paper advance thumbwheel to adjust tension on newly loaded roll paper or to advance paper manually.

15.



Paper gauge calibrated in quarters of a roll.

### PLATEN AREA

16.



Paper stop. Should be recessed while roll paper is in use and raised when using sheet paper. Pushing upper part with a pencil point will raise stop.

### REAR PANEL 9872B AND 9872S

17.



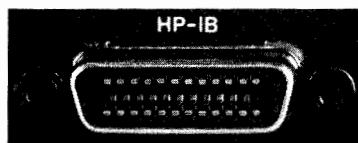
Fuseholders. See Fuses (Chapter 1).

18.



Voltage selection switches factory set according to geographic area. See Voltage Selection (Chapter 1).

19.



24-pin HP-IB interface connection for cable from computer or other HP-IB device.



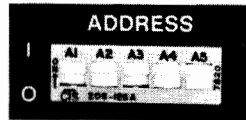
20.



14-pin interface connection for the HP 9815A desktop computer.

1

21.

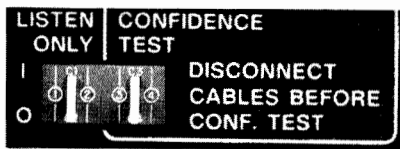


Plotter address switches set at HP-IB address for plotter. Set at 5 at factory. See Plotter Address Code (Chapter 1).

22.

&amp;

23.

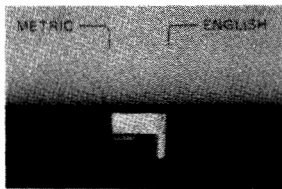


22). Listen only switch set to 0 for talk and listen mode and 1 for listen only mode.

23). Confidence test switch. See Confidence Test (Chapter 1).

### 9872S ONLY

24.

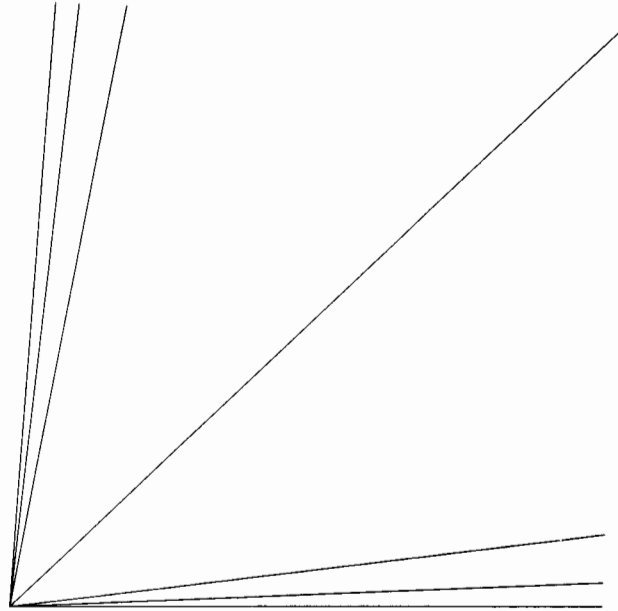


Metric/English paper switch to control length of paper advance and settings of scaling point P1 and P2 at power-up and initialization.

## Confidence Test

The confidence test verifies mechanical and electronic functions of the 9872 plotter and draws the following test plot. Perform the test in the following manner.

1. With the plotter turned off, disconnect all interface cables. Set listen only switch to zero. If a trace is desired, be sure a pen is mounted in the penholder on plotter arm.
2. Turn the plotter on by depressing line switch.
3. Move the confidence test switch on the rear panel to 1.
4. At the completion of the test plot, all lamps on front panel will be turned on and the pen will come to rest in the lower left corner of the platen. Now set the confidence test switch to 0. The pen will move to the lower right corner of the platen.



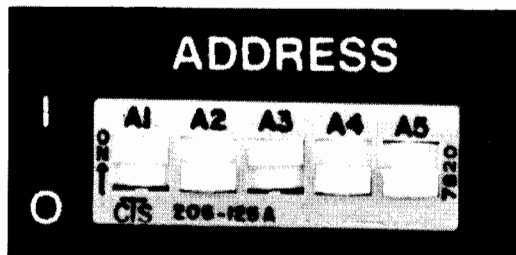
A plotter which does not complete the confidence test as illustrated above should be serviced.

## The Plotter Address Code

Since each HP-IB interface can have as many as 14 devices connected to it, each device must be set to a specific address code.

The plotter can be set to any one of 31 HP-IB addresses ranging from 0 through 30. Each address can be selected by setting the switches on the plotter back panel to the appropriate binary bit positions for the particular address value desired. Switch A1 is the low order bit.

The plotter is set to an address code of 05 at the factory. This corresponds to a listen character of % and a talk character of E. Check your plotter for the proper switch positions shown below.



Plotter Address Switches

The following table lists the switch positions for each address value. Note switches are in reverse order on the back panel of the plotter.

**Address Switch Positions**

Address Characters		Address Switch Settings					Address Codes	
Listen	Talk	A5	A4	A3	A2	A1	decimal	octal
SP	@	0	0	0	0	0	0	0
!	A	0	0	0	0	1	1	1
"	B	0	0	0	1	0	2	2
#	C	0	0	0	1	1	3	3
\$	D	0	0	1	0	0	4	4
&	F	0	0	1	1	0	6	6
'	G	0	0	1	1	1	7	7
(	H	0	1	0	0	0	8	10
)	I	0	1	0	0	1	9	11
*	J	0	1	0	1	0	10	12
+	K	0	1	0	1	1	11	13
,	L	0	1	1	0	0	12	14
-	M	0	1	1	0	1	13	15
.	N	0	1	1	1	0	14	16
/	O	0	1	1	1	1	15	17
0	P	1	0	0	0	0	16	20
1	Q	1	0	0	0	1	17	21
2	R	1	0	0	1	0	18	22
3	S	1	0	0	1	1	19	23
4	T	1	0	1	0	0	20	24
5	U	1	0	1	0	1	21	25
6	V	1	0	1	1	0	22	26
7	W	1	0	1	1	1	23	27
8	X	1	1	0	0	0	24	30
9	Y	1	1	0	0	1	25	31
:	Z	1	1	0	1	0	26	32
;	[	1	1	0	1	1	27	33
<	\	1	1	1	0	0	28	34
=	]	1	1	1	0	1	29	35
>	^	1	1	1	1	0	30	36

Address Restricted to These Codes When Using Parallel Poll Capability

## Listen-Only Mode

The HP 9872B and HP 9872S graphic plotters are capable of operating in listen-only mode. The plotter is set to listen-only mode by setting the listen-only switch on the rear of the plotter to 1. When in listen-only mode the plotter can only receive data. It cannot talk. Therefore, output instructions should not be used. While output instructions will not work, they will not turn on the error light. The controller may then fail to respond to further commands. No digitizing can be done. No responses to a serial poll are possible. However positive responses to a parallel poll can occur. The confidence test cannot be executed.

Listen-only mode is included to make bare plotting as simple as possible. In this mode it is possible to plot large quantities of data directly from a storage device if the data has been stored with the necessary plot commands. It is also possible to plot directly from an intelligent measuring device (i.e., one that can send the alphabetic plot instructions with the data).

## Setting Up the Plotter

### Turning the Power On

After observing the proper power and grounding requirements and precautions previously specified, set the LINE switch to 1 (on). The following will then occur:

- a. Pen is raised.
- b. Pen moves to lower right corner.
- c. Chart hold is on if roll paper is not loaded.
- d. Certain parameters are set to their default values. For a description, see the DF instruction (Chapter 6).

### Loading Pens

After the plotter's initialization process is complete and the plotter arm has stopped moving, you can install the pens. There are two methods of doing this. The first is to place the pen directly into the stable under the front panel; the second is to place each pen in the pen holder and store it using the front panel buttons.

**Direct Pen Storage**

1

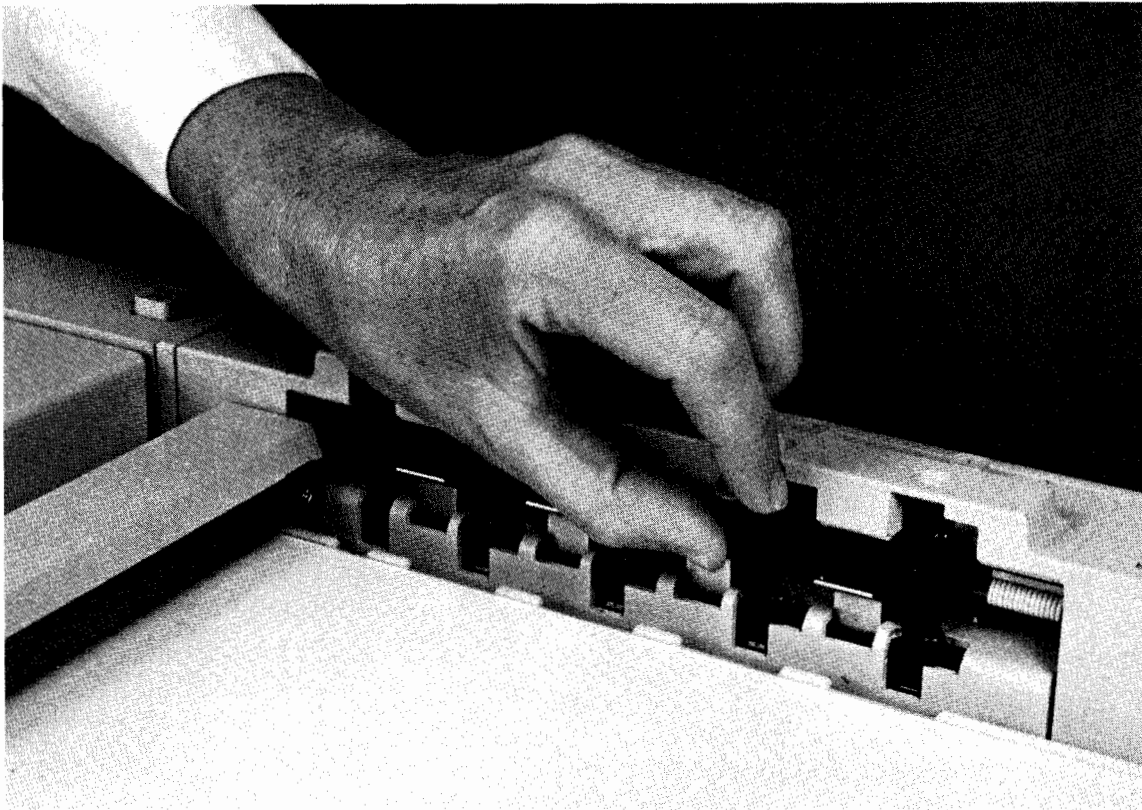
---

**WARNING**

To avoid the possibility of injured fingers, always turn the plotter off when directly storing pens.



---

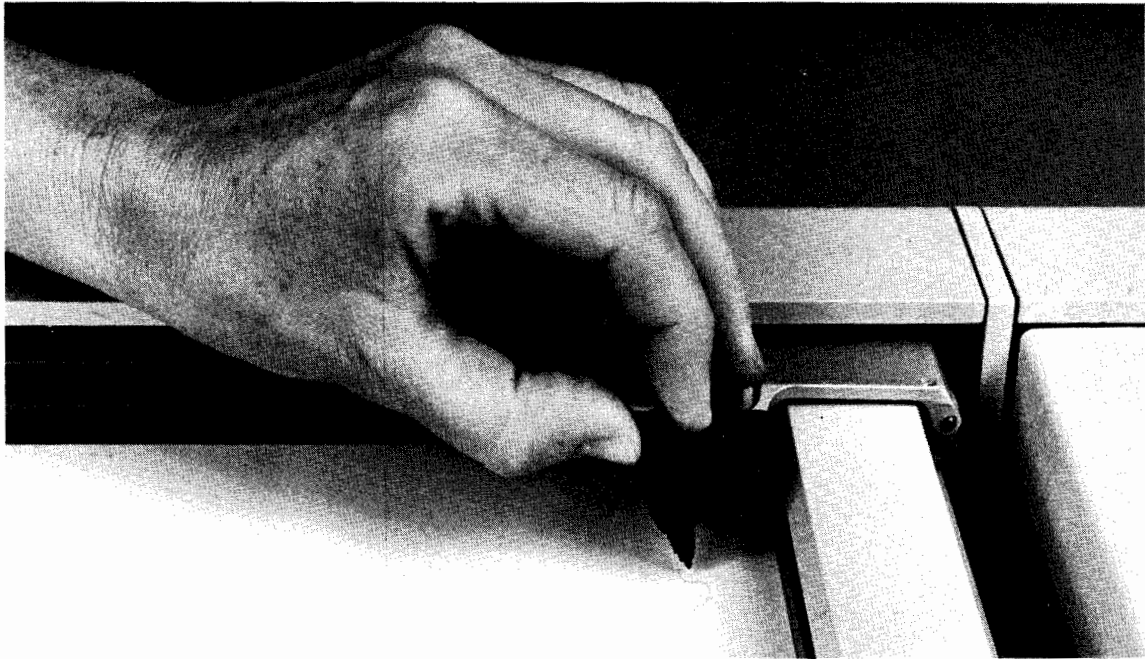
Turn the plotter off. Select the pen color to be placed in the first stall and remove the pen cap. Place the pen tip in the round boot at the base of the stall and press the pen down and in gently until the pen snaps into place. The colored circle on the top of the pen will be centered under the hole in the front panel. Repeat this procedure for the remaining pens and turn the plotter back on.






With the plotter turned off for safety reasons, pens may be removed from a stable by depressing the metal lever to the right of the pen, grasping the pen between thumb and index finger and pulling gently.

### Automatic Pen Storage

Select the color of pen that you want in pen storage location 1, remove the cap and place the pen in the pen holder as shown in the picture above. Note that the thick ring around the middle of the pen fits into the slot in the pen holder. Now press  and pen location button . The plotter arm will put the pen in the first storage location. Repeat this procedure with three more pens, substituting the appropriate pen location button for each one.



### Loading Sheet Paper

To load sheet paper, you first press . This releases the paper hold-down mechanism and moves the plotter arm to the upper right corner of the platen. Raise the paper stop by pushing down the upper portion of the stop with a pencil or other pointed object. Make sure the paper is positioned squarely against the ridge at the bottom of the platen and against the paper stop on the left side of the platen. Smooth the paper with the back of your hand so that skin oil is not deposited on the paper. Now press . This will activate the electrostatic hold-down mechanism and turn off the lamp in . Smooth the paper again with the back of your hand.

## Loading Roll Paper

---

### WARNING

To avoid the possibility of injured fingers, always turn off the plotter before changing roll paper.

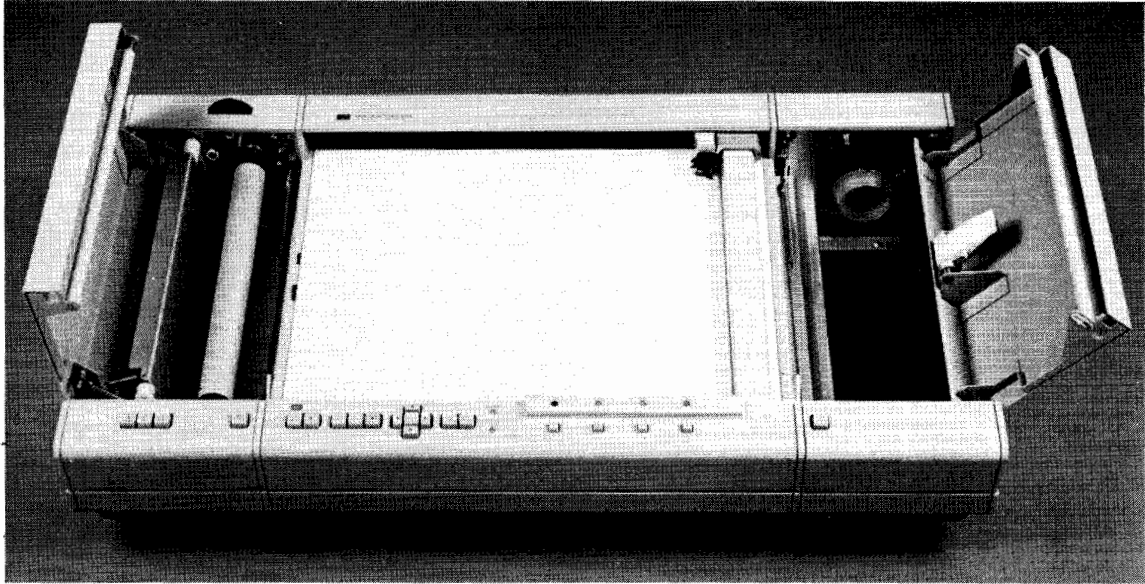
---

Store pens to avoid getting ink on the new paper. Turn off the plotter to avoid injury and to disable electrostatic hold-down. Depress the paper stop on the left side of the platen and open both left and right paper supply modules by pressing the door latch buttons. Grasping the roll of paper in your left hand continue loading as follows (see pictures):

1. Load roll between hubs in supply module with paper feeding across top of roll, aligning hub tabs with roll notches.
2. Feed paper across table and under arm.
3. Engage paper sprocket holes and sprockets at each end of take-up roller. Hold paper on roller while closing door.
4. Close supply module door. Make sure paper is not on top of front edge guide.
5. Advance paper with thumb wheel until tensioned. Turn plotter on and advance paper at least once with front panel buttons.

Successful loading of roll paper will turn the page advance option on. Electrostatic paper hold-down is disabled while roll paper is loaded.

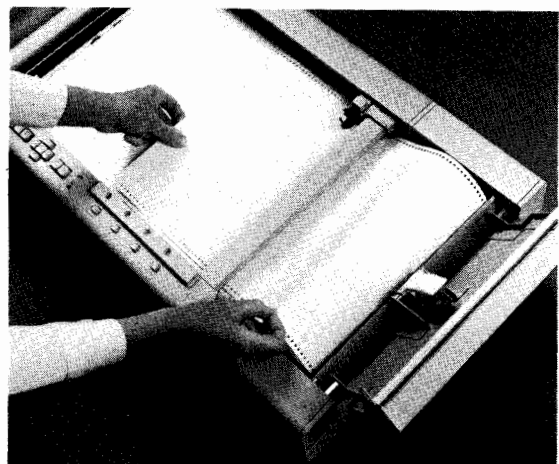
Set the English/metric switch on the back of the paper take-up module to the desired position. Paper advance distances for both settings are specified under the AF and AH commands (Chapter 8).



Paper Modules Open



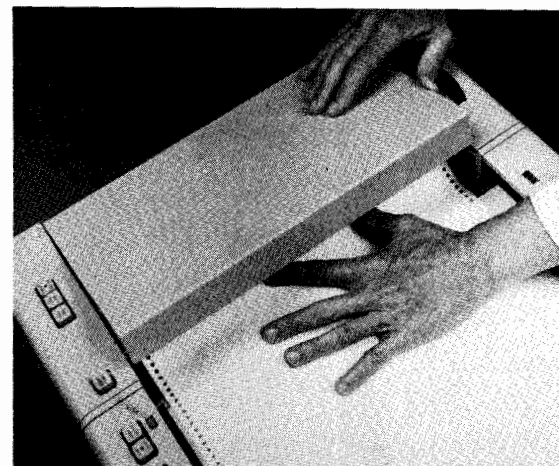
Installing Paper Roll



Threading Paper Across Platen



Engaging Paper on Sprockets



Closing Take-up Module Door

### Paper Loading

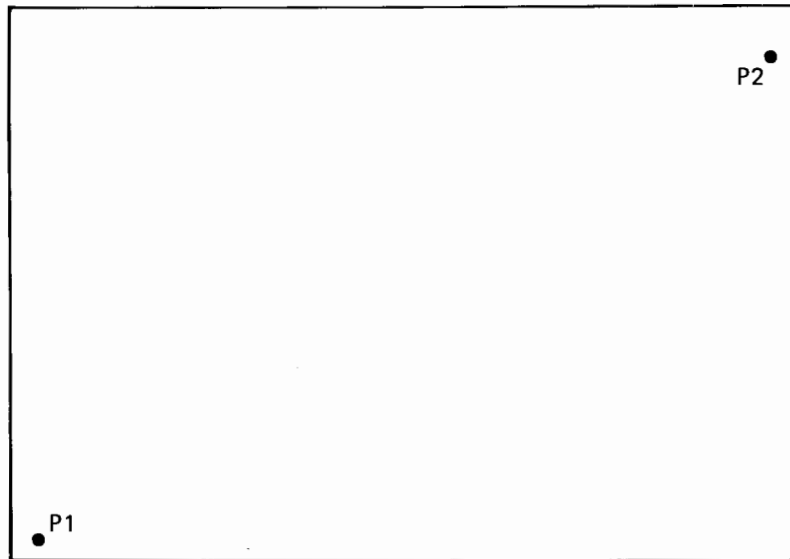


## Setting the Scaling Points

1

The scaling points, P1 and P2, do not restrict the plotter arm motion, but can be used to establish the scaling area.

When the plotter is initialized, it sets P1 at lower left and P2 at upper right as shown in the next figure.



Initialization Location of P1 and P2

The plotter unit values of P1 and P2 in the various modes at power-up are:




9872B or 9872S with automatic paper advance off P1 = 520, 380 and P2 = 15720, 10380.

9872S automatic paper advance on in metric mode P1 = 520, 1140 and P2 = 15720, 11140.

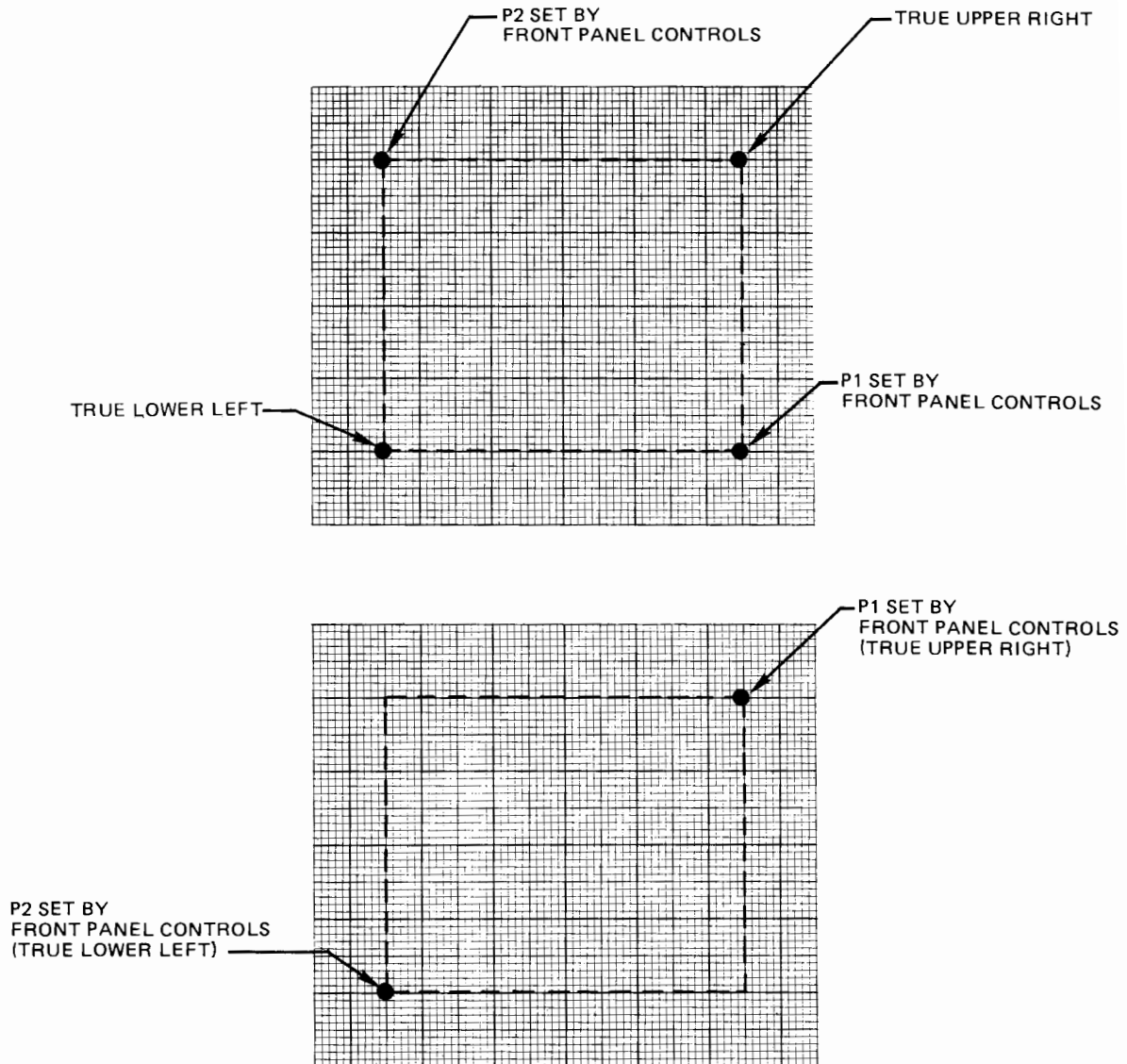
9872S automatic paper advance on in English mode P1 = 520, 1020 and P2 = 15760, 11180.

To relocate either or both of these points, use the following procedure:

Position the pen at the new location using the plotter arm controls on the front panel.

When the pen is at the desired location, press  and either  or  according to the point that is to be located there.

P1 and P2 as set by the plotter front panel controls do not need to have a true lower left/upper right relationship. Since these functions are used to define the scaling area, they may occupy opposite corners of any desired plotting area. Refer to the following examples for clarification:



## Bus Command Statements

Most operations of bus devices are controlled using the BUS COMMAND statement. BUS COMMAND is the primary statement for addressing a talker and listeners to send and receive data and for programming instruments.

In this manual we are concerned with controllers or computers and plotters as talkers and listeners. Each controller has a designated mnemonic which serves as the BUS COMMAND. For example, the HP 9830A calculator uses the mnemonic CMD. The basic form of the BUS COMMAND statement is

```
CMD "< Command String >" [ , "< Program Code String >" ]
```

where the portion within the brackets is optional. Actually, command strings and program code strings may follow CMD in the general form

```
CMD "< Command String >" , "< Program Code String >" ,  
" < Command String >" , "< Program Code String >" , . . .
```

The last program code string is optional. The command string is used to address a talker and listeners. The program code string is used to transmit remote programming instructions to a device. When using more intelligent controllers such as the HP 9825, HP 9835 or HP 9845, bus control becomes a function of the controller's operating system and need not be of concern to the user.

## Addressing the 9872 as a Talker or Listener

The controller addresses devices to talk or listen by using appropriate address codes. On low level controllers these appear in command strings containing bus command codes and address codes. In more intelligent controllers, addresses may be specified in the input or output statements or specified once and applied universally throughout the program.

It is important to understand the addressing protocol for your controller. Since operation of the 9872 depends on sending and receiving (except in listen only mode) ASCII data to and from the plotter, you may wish to review this aspect of your controller before proceeding.

When bus commands are necessary, the basic addressing sequence is

```
< Unlisten Command > < Talk Address > < Listen Addresses >
```

This sequence is made up of three major parts which serve the following purposes:

1. The unlisten command is the universal bus command with a character code of "?". It unaddresses all listeners. After the unlisten command is transmitted, no active listeners remain on the bus. The unlisten character "?" is independent of controller or device code setting.
2. The talk address designates the device that is to talk. A new talk address automatically unaddresses the previous talker. The plotter is preset at the factory to an address of 5. This address determines both the talk and listen characters. The corresponding talk character is "E". (See chart under Plotter Address Code, Chapter 1.) The ASCII representation of "E" is decimal 69 or binary 1000101. Note the five least significant bits have the decimal value 5.
3. The listen addresses designate one or more devices that are to listen. A listen address adds the designated device or devices as listeners. The plotter is preset at the factory to an address of 5. The corresponding listen character is "%". (See chart under Plotter Address Code, Chapter 1.) The ASCII representation of "%" is decimal 37 or binary 0100101. Again note that the five least significant bits have the decimal value 5.

If you change the plotter address (device code setting) from the preset value of 5, your talk and listen characters will change. (See chart under Plotter Address Code, Chapter 1.)

This basic addressing sequence simply states who is to talk to whom. The unlisten command ("?") plays a vital role in this sequence. It is important that a device receive only the data that are intended for it.

When a new talk address is transmitted in the addressing sequence, the previous talker is unaddressed. Therefore, only the new talker can send data on the bus and there is no need to routinely use an untalk command in the same manner as the unlisten command.

While more intelligent controllers may be operated in the same way, it is often simpler to declare the plotter the default listener or receiver of all data output with print statements. On the 9835A entering `PRINTER IS 7,5` establishes a plotter (factory set to 5) as listener over an HP-IB interface set at select code 7. Anything in a `PRINT` statement will be sent to the plotter.

You can alternately, using the I/O ROM (98332A), specify talker and listener in the actual I/O commands. For example output 705: "any ASCII string" will output the ASCII string to device 5 over an HP-IB interface set at select code 7 (seven).

## Sending and Receiving Data

### Controller-to-Plotter

Transmitting data from the controller to the plotter is typically accomplished using WRITE, PRINT @, or OUTPUT statements. It is important to thoroughly understand the output language of your controller. Some examples using various controllers follow:

#### 9830A

```

10 CMD " ?U%"
20 FORMAT      <format list>
30 OUTPUT (13,20) <variable list>

```

Unlisten command  
 Calculator talk address  
 Plotter listen address

Format statement number  
 Select code for bus I/O card

In this case the CMD statement addresses the calculator to talk and the plotter to listen. The output statement transmits the variable list in accordance with the FORMAT statement. The variable list is a sequence of plotter commands in ASCII enclosed in quotes. It is possible to have variables as parameters of plotter commands. The format list must correspond exactly with the variable list. (See Plotting With Variables, Chapter 2.)

Sometimes a format is specified as free-field with the \*, e.g. OUTPUT (13,\*) "PA 5000, 6000". No numbered format statement is required. If you use a 9830 you will always talk to the plotter using an OUTPUT statement.

## 9825

The 9825 uses a wrt statement. With the factory preset select code and listen address we transmit the same plot data by saying:

```
0: wrt 705,"PA5000,6000"
```

Using variables this becomes

```
2: fmt 1,2f6.0  
3: wrt 705.1,"PA",X,"",Y
```

where statement 2 is a format statement defining the variable list of statement 3. Sometimes it is necessary to send binary data, for example, the terminator (ETX) in a label command. Then we use a write binary statement (wtb):

```
wtb 705,"LBEXAMPLE",3
```

The 3 is interpreted as binary data and is the binary equivalent of the ASCII END OF TEXT character.

## 9835 and 9845

The 9835 and 9845 have two talk formats. The first, which requires using an I/O ROM, is an OUTPUT statement of the form:

```
OUTPUT 705;"PA5000,6000"
```

The second method does not require the I/O ROM. After defining the printer to be the 9872 plotter (with factory settings) by entering PRINTER IS 7,5 all PRINT statements will address the plotter. The plot statements become

```
30 PRINT USING "K"; "PA5000,6000"
```

and with variables

```
20 IMAGE 2A,4D,A,4D
30 PRINT USING 20;"PA",X,"",",Y
```

Note that the comma “,” must be specified in the FORMAT statement.

## 2647

If using a 2647 terminal attached to a 9872 plotter we assign file numbers. For example

```
ASSIGN "H# 5" to #1
PRINT #1;"PA 5000, 6000"
```

## Plotter-to-Controller

Transmitting data from the plotter to the controller is usually accomplished using READ, INPUT, or ENTER statements. It is important to thoroughly understand the input language of your controller. Some examples using various controllers follow:

### 9830A

```

10 CMD "?E5"
20 FORMAT      <format list>
30 OUTPUT (13,20) <variable list>

```

Unlisten command  
Plotter talk address  
Calculator listen address  
Format statement number  
Select code for bus I/O card

In this case, the CMD statement addresses the plotter to talk and the calculator to listen. The ENTER statement takes the incoming data and stores the data items in the variables specified in the variable list.

An example using free-field format is ENTER ( 13, \* ) S.

## 32 General Information

After outputting the desired information from the plotter to the controller, in order to get the controller to again talk and the plotter to listen, you must send the proper talk and listen addresses.

### 9835 and 9845

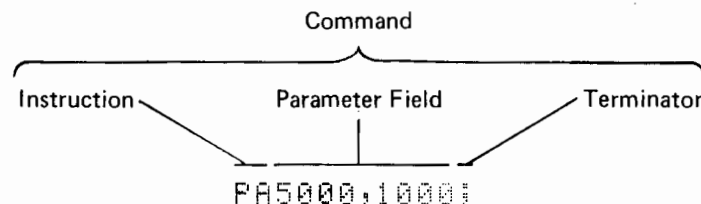
Using the 9835 or 9845 the above statement becomes 30 ENTER 7, 5; S, where the S defaults to free-field format. The I/O ROM is necessary to use this statement.

### 9825

On the 9825 a statement to send data from the plotter to the computer is red 705; A, B where format is again free-field. Note on the 9845, 9835 and 9825 there is no need to send talk and listen addresses in a separate command.

## The 9872 Instruction Set

The instruction set for the 9872 consists of 43 Hewlett-Packard Graphic Language (HP-GL) instructions which fall into 7 basic groups. The 9872S has an eighth group of three additional HP-GL instructions for paper advance. A command is defined as an instruction followed by its parameter field and a terminator as shown in the following example:



Each instruction is a two-letter mnemonic which can be either upper or lower case. The parameter field can be of three types:

1. Integer Format: Integers between -32768 and +32767 with scaling off and -16384 and +16383 with scaling on. No decimal is allowed. If no sign is specified, the parameter is assumed to be positive.
2. Decimal Format: Numbers between  $\pm 127.999$  with an optional decimal. Fractional inputs less than 0.004 are represented as zero. If no sign is specified, the parameter is assumed to be positive.

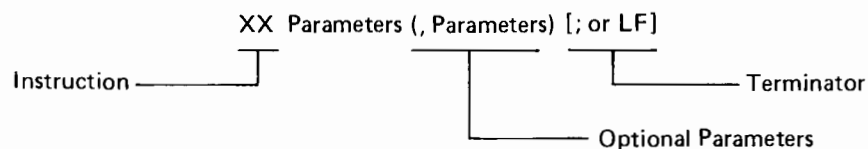


3. Label Fields: Any combination of text, expressions, or string variables. Refer to the label instruction LB (Chapter 3) for a complete description.

A terminator must be sent at the end of the parameter field for all instructions. For all instructions except LB, the terminator must be either a semi-colon or line feed. Some systems automatically send the terminator at the end of the parameter field. The syntax used throughout this manual will use [; or LF].

When using the label instruction LB, the terminator used must be a binary 3 (ETX).

Certain instructions (such as PA or PR) may have multiple parameters. These parameters must be separated by commas and must conform to a particular syntax. The syntax is listed under the respective instruction definition in the following chapters and will take the general form:



Consider the following program using the 9835 calculator as an example of some typical instructions, parameter fields, and terminators:

```
20 PRINT USING "K";"SP1;PA5000,5000;PD"
30 PRINT USING "K";"PR0,1000,1000,0,0,-1000,-1000,0;
  PU;SP0"
40 END
```

Line 20 causes the plotter to select pen #1 (SP1), move to the absolute platen position X=5000, Y= 5000 plotter units, and then puts the pen down (PD).

Line 30 moves the pen relative (PR) to the position commanded in line 20 in X,Y pairs first 0,1000 plotter units, then 1000,0 plotter units until it has drawn a square of 1000 plotter unit sides. The pen is then picked up (PU) and returned to the stable (SP0).

The "K" format specifies output without leading or trailing blanks. Note the use of the terminator (;) between commands. The terminator is not necessary at the end of the parameter field when no further commands follow because a line feed character is automatically sent by the 9835 calculator by the end quote ("). The instruction set for the 9872 plotter is summarized in the following table.

Instruction	Definition
VECTOR GROUP	
PA $x,y(x,y(,....))$	Plot absolute [i]
PR $x,y(x,y(,....))$	Plot relative [i]
PD	Pen down
PU	Pen up
CHARACTER GROUP	
CA n	Designate alternate set n [i]
CP spaces, lines	Character plot [d]
CS m	Designate standard set m [i]
DI run, rise	Absolute direction [d]
DR run, rise	Relative direction [d]
LB c....c	Label ASCII string [c]
SA	Select alternate character set
SI wide, high	Absolute character size [d]
SL $\tan \theta$	Absolute character slant (from vertical) [d]
SR wide, high	Relative character size [d]
SS	Select standard character set
UC (pen,) x,y (,pen) (,x,y) (,....)	User defined character [i]
LINE TYPE GROUP	
LT t,(l)	Designate line type t and length l [d]
SM c	Symbol mode [c]
SP n	Select pen [i]
VA	Adaptive velocity
VN	Normal velocity
VS v,(n)	Select velocity v for pen n [i]
DIGITIZE GROUP	
DC	Digitize clear
DP	Digitize point
OD	Output digitized point and pen status [i]
AXES	
TL tp,(tn)	Tick length [d]
XT	X axis tick
YT	Y axis tick
SET-UP GROUP	
IP p1x,p1y,p2x,p2y	Input p1 and p2 [i]
IW xlo,ylo,xhi,yhi	Input window [i]
OP	Output p1 and p2 [i]
SC	Scale [i]
CONFIGURATION AND STATUS	
AP	Automatic pen pickup [i]
DF	Set default values
IM e,(s,(p))	Input e,s, and p masks [i]
IN	Initialize
OA	Output actual position and pen status [i]
OC	Output commanded position and pen status [i]
OE	Output error [i]
OF	Output factors [i]
OI	Output identification [c]
OO	Output options [i]
OS	Output status [i]
PAPER ADVANCE GROUP	
AF or PG or PG1	Advance full page
AH	Advance half page
EC	Enable cutter [i]
<p>Formats: [i] = integer format between -32768 to +32767, scaling off, -16384 to +16383 scaling on.            No decimal.            [d] = decimal format between <math>\pm 127.999</math>. Decimal is optional.            [c] = ASCII character.</p>	

## Suggested Programming Practices

Certain programming practices will assure more effective use of the plotter. Among these are:

1. Initialize the plotter with the IN or DF command at the beginning of each program to assure no unwanted parameters are in effect from a prior plot. Use of IN will set P1 and P2 to default conditions and enable cutter on 9872S only. Use of DF will not alter P1 or P2 or assure that cutter is enabled.
2. With 9872S when operating from a remote terminal, use output option OO command to ascertain if paper advance option is on and if paper has been written on. Advance the paper at the completion of your plot to assure no other user draws over your plot.
3. Select a pen before the first plot command to assure plot is actually recorded on the paper.
4. Lift the pen before changing colors to avoid a dot of the new color at the termination of the last vector.
5. Store the pen (SP0) at the completion of a plot so pens do not dry out.
6. When using A3 or 8½ x 11 in. paper, reset P1 and P2 manually or programmatically to points inside the paper area. Default P2 will scale the plot beyond the limits of 8½ by 11 in. paper.
7. When setting up the 9872S for unattended operation you may wish to load your plotter with a new set of pens. Pens have sufficient ink to draw 140 "typical" full page plots (1 roll) where each plot consists of 10 linear feet of writing per pen (axes, labels and lines). If your plots differ from this norm you may wish to change pens more or less frequently.





## Chapter 2

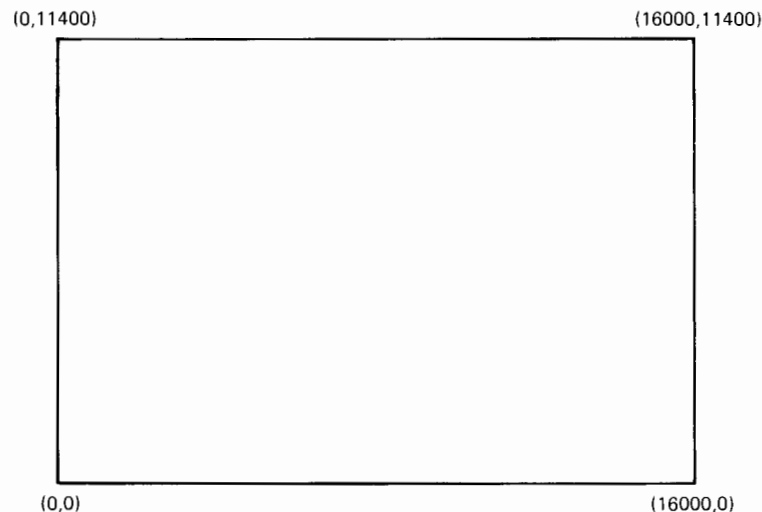
# Plotting

2

This chapter describes the instructions that enable you to perform all plotting movements. Plotting moves can be made to an absolute set of coordinates, or relative to the given pen position. The absolute coordinates or relative movements are in absolute plotter units if scaling is off or user units if scaling is on. In addition the pen can be raised or lowered before or after a move.

### The Plotter Unit

The plotting area defined on the platen is divided into plotter units where one plotter unit = 0.025 mm. The absolute plotting area and default window area is shown below:



Absolute Platen Area Scale (Mechanical Limits)

When the plotter is initialized by power-up, front panel, or use of the IN instruction, scaling points P1 and P2 are set. For the 9872B or the 9872S with the advance option OFF,  $P1_x = 520$ ,  $P1_y = 380$ ,  $P2_x = 15720$ , and  $P2_y = 10380$ . For the 9872S with advance ON, the values of P1 and P2 depend on the setting of the English/metric switch. In English mode  $P1_x = 520$ ,  $P1_y = 1020$ ,  $P2_x = 15760$  and  $P2_y = 11180$ , whereas in metric mode  $P1_x = 520$ ,  $P1_y = 1140$ ,  $P2_x = 15720$  and  $P2_y = 11140$ .

## The Plot Absolute Instruction PA

The plot absolute instruction PA provides the means to move the pen to the point specified by the X and Y coordinate parameters that complete the command.

Syntax:

```
PA X1 coordinate, Y1 coordinate (, X2 coordinate, Y2 coordinate, . . . , . . . ,
  Xn coordinate, Yn coordinate) [; or LF]
```

A PA command requires that both the X and Y coordinates be specified (coordinate pair). The X coordinate parameter specifies the absolute X location to which the pen will move in either plotter or user units. The Y coordinate parameter specifies the absolute Y location to which the pen will move in either plotter or user units. If scaling is on, the coordinates are in user units; if scaling is off, the coordinates are in absolute plotter units.

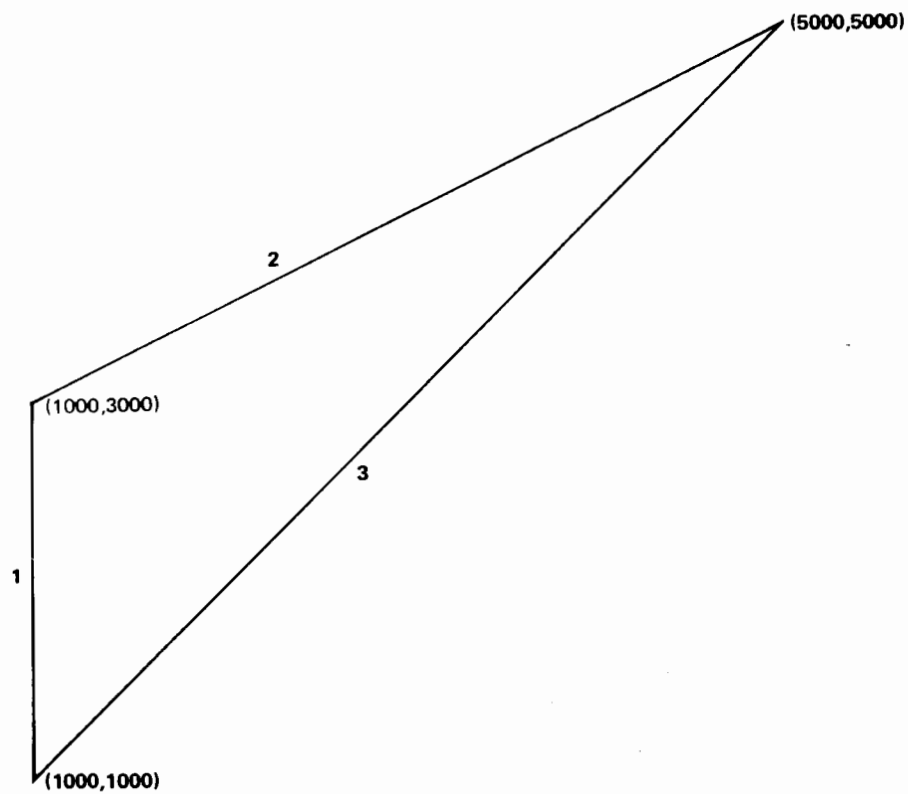
Any number of coordinate pairs, separated by commas, can be listed after the PA instruction.

Using the PU or PD instructions, a pen control command can be placed before or after the PA command, raising (PU) or lowering (PD) the pen. If no pen control command is specified, the pen will assume the pen state (pen up or pen down) of the previous statement.

Plotting is done only within the currently defined "window" area on the platen. Refer to the Input Window Instruction IW, Chapter 6, for further information.

The following program, using a 9835, causes the plotter to select pen 1 and draw a triangle. The lines have been numbered in the order they were drawn.

```
10 PRINT USING "
  K"; "PA1000,1000;
  PD"
20 PRINT USING "
  K"; "SP1;PA1000,3
  000,5000,5000,10
  00,1000"
30 END
```



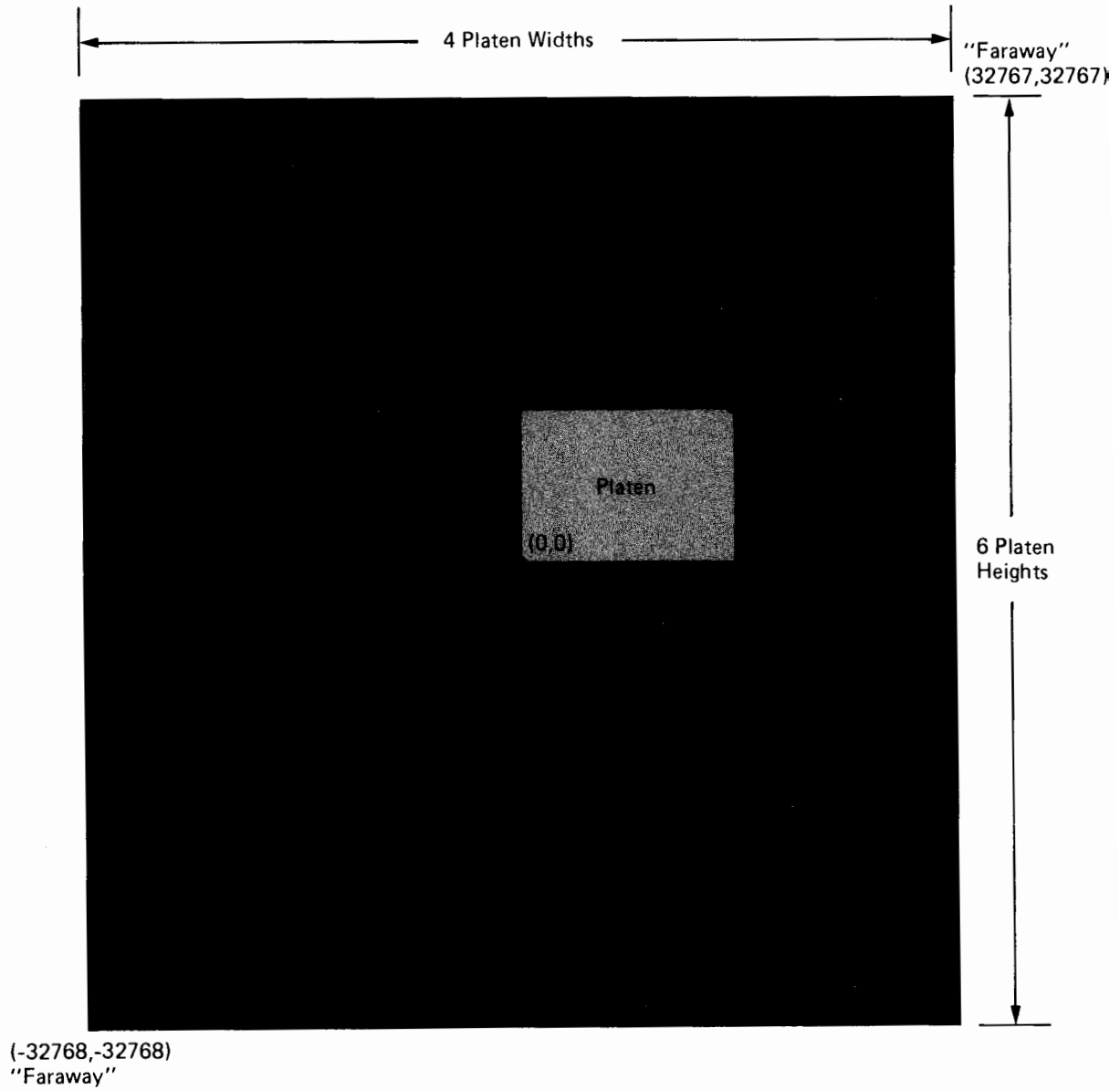
2

If the point specified by a PA command lies off the platen surface but within the “nearby” area a line is drawn to the platen limit and then the pen is raised. The pen remains raised until a point on the platen is specified. The OUT OF LIMIT light will turn on steady.

If the point specified by a PA command lies off the platen surface in the “faraway” area, the pen is raised and does not move from its last position. The OUT OF LIMIT lamp will blink. The pen remains raised until it moves from a point inside the platen area which was reached either using a valid PA command or using front panel controls.

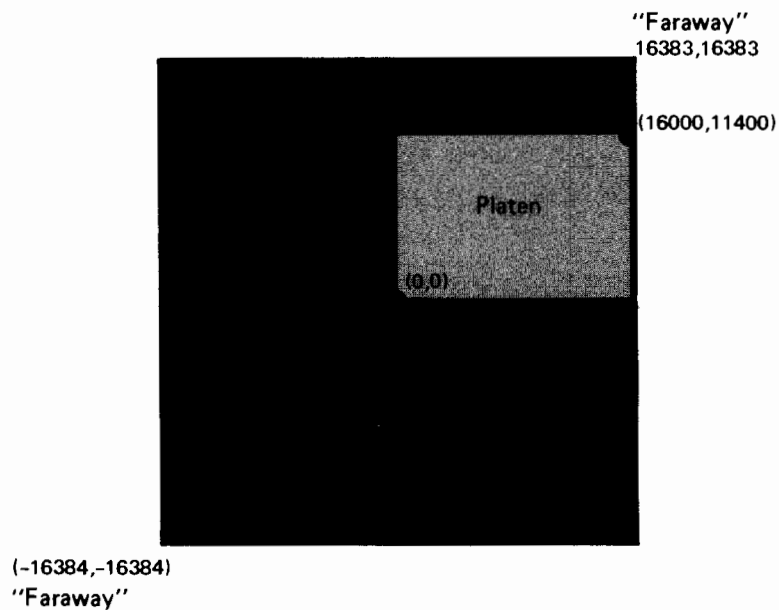
## 40 Plotting

“Nearby” and “faraway” areas when scaling is off are shown below. The numbers are plotter units. The platen area is lightly shaded. The “nearby” area is darker and the faraway area is the white area beyond the shading.





When scaling is on, nearby and faraway areas change considerably as can be seen in the following diagram. When scaling is on, a point is "faraway" if any parameter is more negative than -16384 or greater than +16383 or if its plotter unit equivalent is not between -16384 and +16383.



This diagram represents the maximum "nearby" area when scaling is on and, in the above diagram, you are limited by the plotter unit equivalents being beyond the acceptable range. Consider, however, the case where P2 is set to some point in the center of the platen area. Now if scaling is set at 0 to 16000 on both X and Y axis, you will be in the "faraway" area if you plot the point 17000,17000 yet that would lie within the platen area.

"Faraway" is that area in which the plotter is in its lost state. Another way of describing it is to say the coordinates are out-of-range. Coordinates with the platen area and "nearby area" are in-range. When scaling is off, in-range coordinates are defined as both X and Y parameters being integer plotting units having values between -32768 and +32767. When scaling is on, in-range coordinates must have both X and Y parameters between -16384 and +16383 and, when converted to plotter units, must also be between -16384 and +16383. When out-of-range parameters are given, the plotter will enter its lost state. The OUT OF LIMITS light will blink. However the error light will not turn on.

## The Plot Relative Instruction PR

The plot relative instruction PR provides the means to move the pen, relative to its current location, the number of plotter or user units specified by the X and Y parameters that complete the command. Parameters are in plotter units with scaling off and user units with scaling on.

Syntax:

```
PR X1 increment, Y1 increment, (X2 increment, Y2 increment, . . . , . . . ,
  Xn increment, Yn increment) [; or LF]
```

The X increment parameter specifies the number of plotter units or user units that the pen is to move horizontally.

The Y increment parameter specifies the number of plotter units or user units that the pen is to move vertically.

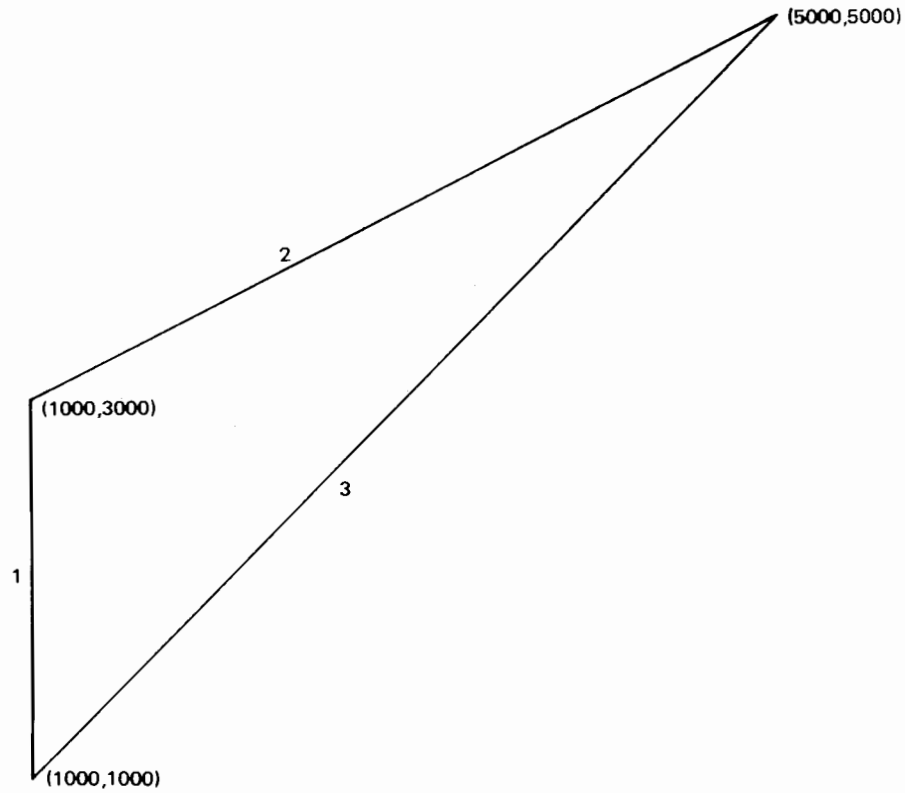
The sign of the increment parameters determine the relative direction that the pen moves; a positive value moves the pen in a positive direction and a negative value moves the pen in a negative direction.

Any number of coordinate pairs separated by commas can be listed after the PR instruction. The pen will move relative to the previous point in the order given.

A pen control command can be placed before or after the PR command, raising (PU) or lowering (PD) the pen. If no pen control command is specified, the pen will assume the pen state (pen up or pen down) of the previous statement.

The following program using the 9835 and PR instructions causes the plotter to draw a triangle identical to the one previously drawn using the PA instruction only.

```
10 PRINT USING "
  K";"SP1;PA1000,1
  000;PD"
20 PRINT USING
  "K";"PR0,2000,4
  000,2000,-4000,-
  4000"
30 PRINT USING
  "K";"PU;SP0"
40 END
```



2

In-range coordinates with scaling off are defined as:

1. both X and Y parameters being integer plotter units having values between  $-32768$  and  $+32767$ .
2. each succeeding X and Y increment, when added to the current X and Y coordinate, does not exceed  $\pm 32767$  plotter units when referenced from the point 0,0.

In-range coordinates with scaling on are defined as:

1. both X and Y parameters being integer user units having values between  $-16384$  and  $+16383$ .
2. each succeeding X and Y increment, when added to the current X and Y coordinate, is not less than  $-16384$  or greater than  $+16383$  user units, and when converted to plotter units does not exceed  $\pm 16383$  plotter units when referenced from 0,0.

If a PR command specifies a point off the platen in the "nearby" area as described under the PA instruction the pen draws a line to the limit of the platen and stops with the pen raised. The OUT OF LIMIT light turns on steady. The plotter recognizes subsequent PR commands while in this area. If a PR command specifies a point in the "faraway" area, the pen is raised and does not move. The OUT OF LIMIT light blinks and the plotter does not recognize subsequent PR commands until a PA command with valid parameters or pen movement with front panel controls moves the pen to the "nearby" area or within the platen area.

## The Pen Instructions PU and PD

The pen up instruction PU raises the pen without moving it to a new location. The pen down instruction PD lowers the pen without moving it to a new location.

Syntax:

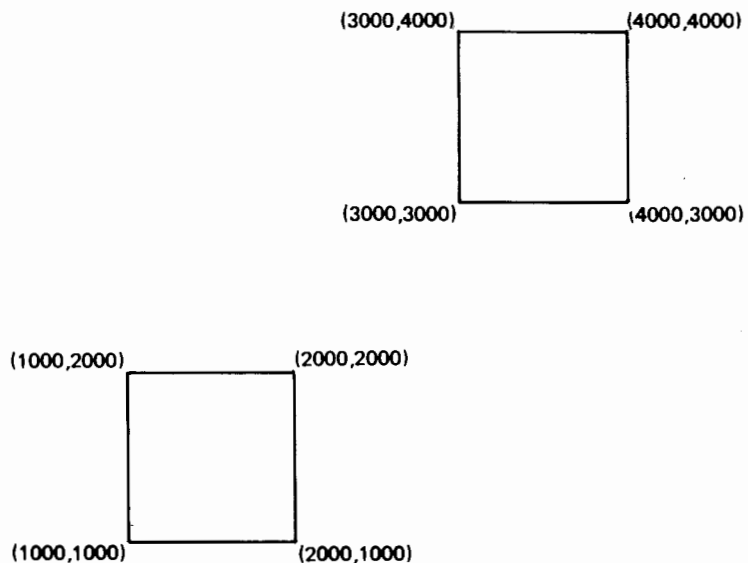
```
PU[; or LF]
or
PD[; or LF]
```

Neither instruction requires or permits any parameters. Both instructions require the terminator ; or LF to complete the command. Front panel pushbuttons on the plotter will override these commands.

Commands to raise or lower the pen before or after movement can be included with a PA or PR command.

The following example program using the 9835 causes the plotter to draw two squares.

```
10 PRINT USING "
K";"SP1;PA1000,1
000"
20 PRINT USING "
K";"PD;PR0,1000,
1000,0,0,-1000,-
1000,0;PU"
30 PRINT USING "
K";"PA3000,3000;
PD"
40 PRINT USING "
K";"PR0,1000,100
0,0,0,-1000,-100
0,0;PU;SP0"
50 END
```



## Plotting With Variables

In most plotting applications, it is necessary to plot using variables rather than fixed numbers. The values of the X and Y variables have the same restrictions of  $\pm 32767$  integer plotter units or  $\pm 16383$  user units as when plotting with literals. Note that the comma with quotation marks separating the variables must be sent as part of the field. The method of defining variable length varies from controller to controller, but an appropriate statement defining the length of each variable must appear in your program.

The following example using the 9830 illustrates the use of variables in plotting:

```

10 CMD "?UX"
15 FORMAT 2F6.0
80 FOR T=0*PI TO 2*PI STEP PI/20
90 X=500*COS T+4320
100 Y=500*SIN T+2880
110 OUTPUT (13,15)"PA",X,",",Y,"PD"
120 NEXT T

```

Line 15 defines the variable size as two integers of 6 digits each.

Line 110 causes the plotter to move to the absolute value defined by the X and Y variables. Note the comma sent as part of the string.

## 46 Plotting

Below are two versions of a 9835 program which draws a square. A different method of defining variable length has been used in each program.

```

10 FIXED 0
20 X=1000
30 PRINT USING "
K";"SP1;PU;PA",X
,"",X
40 PRINT USING "
K";"PD;PR0",X,"
",X,"0,0",-X,"
",-X,"0"
45 PRINT USING "
K";"PU;SP0"
50 END

```

Line 10 defines all variables as integers

"K" in line 30, 40 and 45 compacts output for plotter omitting leading and trailing blanks.

```

10 IMAGE 5A,5Z,A
,5Z
15 IMAGE 7A,5Z,A
,5Z,5A,M4Z,A,M4Z
,2A
20 X=1000
30 PRINT USING 1
0;"PU;PA",X,"",
X
40 PRINT USING 1
5;"PD;PR0",X,"
",X,"0,0",-X,"
",-X,"0"
50 END

```

Line 10 defines variables in statement 30.

Line 15 defines variables in statement 40.

In line 40 note the comma sent as part of the string after PRO.

# Chapter **3**

## Lettering

This chapter describes the instructions that enable you to letter alphanumeric characters and symbols with the plotter. You can also specify the size, width, and slant of the characters as well as the direction in which characters are lettered.

### The Label Instruction LB

The label instruction LB provides the means to letter text, expressions, or string variables on the plotter.

Syntax:

**LB** character string [ETX]

The label mode can be terminated only by sending the ASCII character (ETX) at the end of the character string. The means of doing this is controller dependent. On the 9835 a `Ⓞ` C is included inside the quotes at the end of the label command. Other control functions may be included in a like manner, for instance `Ⓞ` M will cause a carriage return and `Ⓞ` L a line feed. None of these characters is printable by the 9835 printer and, hence, do not appear in the listings. They are, however, visible on the CRT in edit mode.

On the 9830 such numbers must be sent in binary format and on the 9825 this is accomplished using a write binary command. For a complete description of the control functions, refer to the plotter ASCII code definitions listed in the appendix.

Literal text is specified in a label command by enclosing it in quotes. The following programs executed on the specified computer print the same label.

#### 9825


```
10: wtb 705,"LB
I AM A 9872 PLOT
TER",3
```

#### 9830A

```
10 CND "90%"
20 FORMAT B.
30 OUTPUT (13,20)"LB I AM A 9872A PLOTTER",3
40 END
```

```

9835
10 PRINT USING "
K"; "LBI AM A 987
2 PLOTTER"
99 END
    
```

 C (ETX) actually here nonprinting.


I AM A 9872 PLOTTER

In certain plotting applications, it is necessary to label using variables rather than literals. The variables are restricted in length only by the format or image statement associated with the label command.

The following example using the 9835 labels with variables:

```

10 X=50
20 PRINT USING "
2A,3(DDD),A"; "LB
",X,X+1,X+2,""
30 END
    
```

This statement defines the variables as three integers of three digits (including sign) each. The A indicates that the last character sent will be an ETX () causing the plotter to exit the label mode.

The plotter draws the integer, integer +1 and integer +2. The single space between integers is the sign space and since it is positive, it is not printed.

50 51 52

Any spaces required to fit into the context of the item being lettered must be sent enclosed in quotes. The following example letters the same variables as above, but with four spaces between each of the values plus the sign space.

```

10 X=50
20 PRINT USING
"2A,3(DDD,4A)";
"LB",X,"",X+
1,"",X+2,""
30 END
    
```

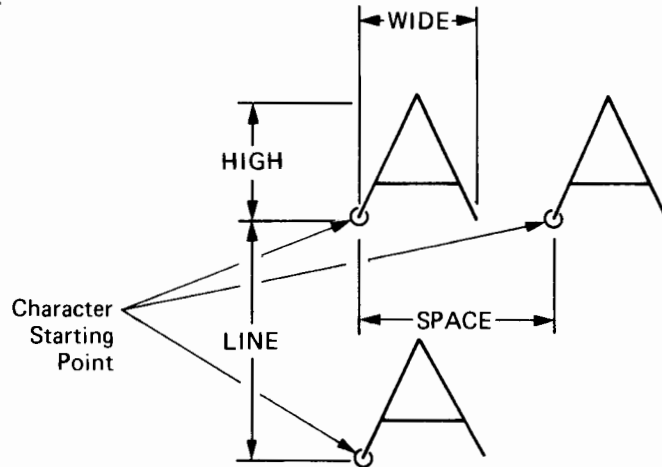
Note that four spaces enclosed in quotes are sent between each variable.  
The final 4A reads the ETX.

50 4 SPACES 51 4 SPACES 52

Before using a label command, the pen should be moved to the location where labeling is to begin by using one of the commands PA, PR, CP or by using the four direction controls on the plotter front panel.



This point will be the lower-left corner of the first character. After lettering a character, the pen stops at the lower-left corner of the next character space as shown below. For a further explanation of character spacing, refer to Spacing Between Characters and the Character Grid, Chapter 3.



3

Direction, size, and slant of the characters being lettered are as previously specified by the commands DI, DR, SI, SR, and SL, or by default values if not specified. The character set used is specified by the commands SA or SS, and CA or CS. If not specified, the default character set is set 0.

### The Absolute Direction Instruction DI

The absolute direction instruction DI provides the means to specify the direction in which characters are lettered.

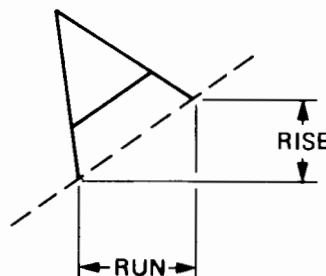
Syntax:

`DI run, rise [; or LF]`

Run and rise are in decimal format between ±127.999 and specify the direction according to the relationship:

$$\frac{\text{rise}}{\text{run}}$$

where



At least one parameter must be effectively non-zero ( | parameter |  $\geq$  .004).

A DI command with rise parameter of zero will produce horizontal labeling.

A DI command with run parameter of zero will label in a vertical direction.

A DI command with no parameters ( DI ; ) will default to the values DI 1,0 (horizontal).

A DI command with invalid parameters will turn on the error light and the direction will not change.

A change of scaling points P1 and P2 will not affect the direction of lettering.

A DI command remains in effect until another DI or DR command is executed or the plotter is initialized or set to default condition.

The following example, using the 9835, prints the numbers 9872 in a clockwise direction at each 45° point starting at the top. A nonprinting carriage return and ETX is included in each LB statement.

```

10 PRINT USING
   "K";"DI0,1;LB
   9872"
20 PRINT USING
   "K";"DI1,1;LB
   9872"
30 PRINT USING
   "K";"DI1,0;LB
   9872"
40 PRINT USING
   "K";"DI1,-1;LB
   9872"
50 PRINT USING
   "K";"DI0,-1;LB
   9872"
60 PRINT USING
   "K";"DI-1,-1;LB
   9872"
70 PRINT USING
   "K";"DI-1,0;LB
   9872"
80 PRINT USING
   "K";"DI-1,1;LB
   9872"
90 END

```

## The Relative Direction Instruction DR

The relative direction instruction DR provides the means to specify the direction in which characters are to be lettered relative to the scaling points P1 and P2.

Syntax:

DR run, rise [; or LF]

Run and rise are decimal numbers and specify the direction according to the relationship:

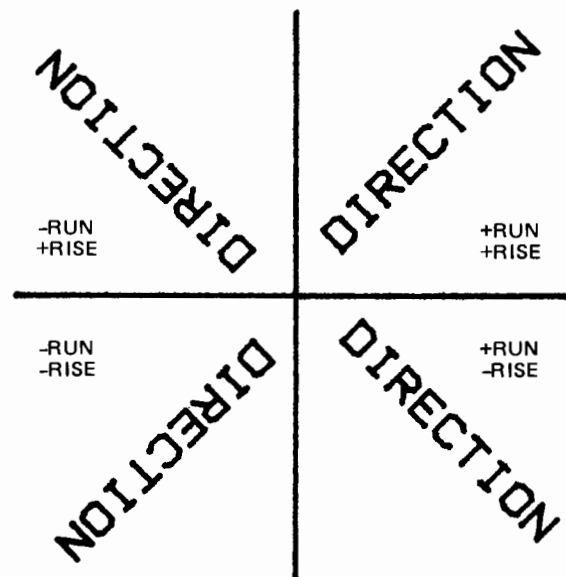
$$\frac{\text{rise}}{\text{run}}$$

where run is the desired percentage (0 to  $\pm 127.999$ ) of  $|P2_x - P1_x|$ , rise is the desired percentage (0 to  $\pm 127.999$ ) of  $|P2_y - P1_y|$ , and P1 and P2 are the scaling points.

3

If you call the current pen position the origin, the sign of the parameters determines in which quadrant the lettering will be.

In the example below rise and run assume all combinations of  $\pm 1$  with default P1 and P2.



The algorithm used is more accurate with parameters greater than 1. While DR 2, 3 and DR .02, .03 have the same ratio,  $\frac{\text{rise}}{\text{run}}$ , use of the former command is preferred.

A change in P1 or P2 will affect the direction of the lettering.

A DR command remains in effect until another DR or DI command is executed or the plotter is initialized or set to default conditions.

The following description may help you visualize the direction of labeling using the DR command with various parameters. Think of directional lines as being parallel to a line starting at the lower left scaling point (usually P1) and intersecting the opposite side or the top edge of the plotting area established by the current P1 and P2.

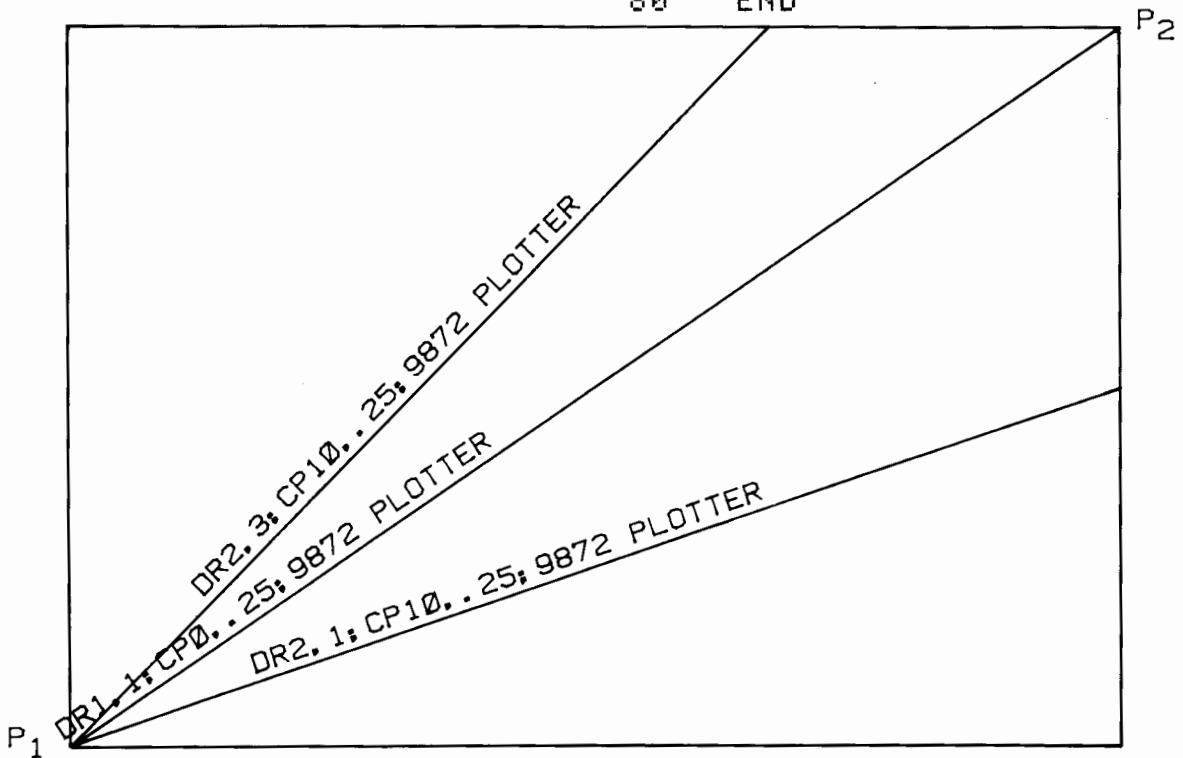
Form a fraction in lowest terms  $\leq 1$  using the run and rise parameters. If run = rise the fraction will equal 1 and the directional line will go from P1 to P2. If run > rise the directional line will intersect the side of the plotting area that fraction of the way up toward P2. If rise > run the directional line will intersect the top of the plotting area that fraction of the way across toward P2. Remember since lettering starts at the current pen position, labels will be parallel to these lines, not necessarily along them.

The accompanying program illustrates the DR command with a given P1 and P2.

```

5   PRINT USING
   "K";"PA1000,1000
   ;PD;PR9000,0,0,6
   000,-9000,0,-600
   0,0;PU"
10  PRINT USING
   "K";"IP1000,100
   0,10000,7000;PA1
   000,1000;PD;PA10
   000,7000;PU"
20  PRINT USING
   "K";"SI"!DR9872
30  PRINT USING
   "K";"PA1000,100
   0;DR1,1;CP0,.25;
   LBD1,1;CP0,.25;
   9872 PLOTTER"
40  PRINT USING
   "K";"PU;PA1000,
   1000;PD;PA7000,7
   000;PU"
50  PRINT USING
   "K";"DR2,3;PA10
   00,1000;CP10,.25
   ;LBD12,3;CP10,.2
   5;9872 PLOTTER"
60  PRINT USING
   "K";"PU;PA1000,
   1000;PD;PA10000,
   4000;PU;"
70  PRINT USING
   "K";"DR2,1;PA10
   00,1000;CP10,.25
   ;LBD12,1;CP10,.2
   5;9872 PLOTTER"
80  END

```



## The Absolute Character Size Instruction SI

The absolute character size instruction SI provides the means to specify the size of characters and symbols in centimeters.

Syntax:

```
SI width, height [: or LF]
```

The defined width and height must be in decimal format and specify the width and height of upper case letters and numerals. In order to produce legible characters, parameters should be greater than .1. Parameter values above 25 will allow a maximum of one character on the platen area without invoking the out-of-limit condition. Although the SI command specifies the width and height in centimeters, due to the chosen conversion factor (2.5 cm = 1 in.), the actual character size will be 98.1% of specified size.

An SI instruction with no parameters ( SI; ) will default to the values 0.285 cm wide by 0.375 cm high. An SI command with invalid parameters will turn on the error light and character size will not change.

An SI command remains in effect until another valid SI or SR command is executed or the plotter is initialized or set to default values.

The following example, using the 9835, writes the word height at a specified width of 0.75 cm and height of 1.5 cm in both upper and lower case characters.

```
10 PRINT USING "
K"; "SI.75,1.5;LB
HEIGHT height"
99 END
```

HEIGHT height

## The Relative Character Size Instruction SR

The relative character size instruction SR provides the means to specify the size of characters and symbols as a percentage of the distance between scaling points P1 and P2.

Syntax:

```
SR width, height [; or LF]
```

The width is the desired percentage (+0.004 to +127.999) of  $|P2_x - P1_x|$ , height is the desired percentage (+0.004 to +127.999) of  $|P2_y - P1_y|$ , and P1 and P2 are the scaling points. With default P1 and P2, the useful range of width and height parameters which produces legible characters and labels of suitable length is 0.4 to 5.

Note that character size will vary as P1 and P2 are changed. Character and line spacing are functions of character size. Refer to Spacing Between Characters, Chapter 3.

An SR command with no parameters (`SR;`) will default to the same values as `SR .75, 1.5`. Negative and zero parameters are invalid and will cause the error light to be turned on and use of the last valid SR parameters or the default values if no SR or SI has been previously specified.

An SR command remains in effect until another valid SR or SI command is executed or the plotter is initialized or set to default conditions.

The following program, using the 9835, shows the effect of changing P1 and P2 on the relative character size.

```

10 PRINT USING
"K";"IP1000,1000
;4000,5000;SR5,5
"
20 PRINT USING
"K";"PA1000,100
0;PD;PR500,0,-50
0,0,0,500,0,-500
;PU;CP1,.25;LBP1
"
30 PRINT USING
"K";"PA4000,500
0;PD;PR-500,0,50
0,0,0,-500,0,500
;PU;CP1,0;LBP2"
40 PRINT USING
"K";"IP1000,100
0,3000,2500;PA30
00,2500;PD;PR-50
0,0,500,0,0,-500
,0,500;PU;LBNEW
P2"
50 END

```

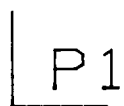
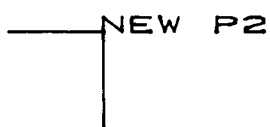
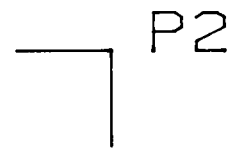
line 10 sets P1 and P2 which give larger lettering.  
SR remains unchanged throughout program.

line 20 draws corner and labels P1.

line 30 draws corner and labels P2.

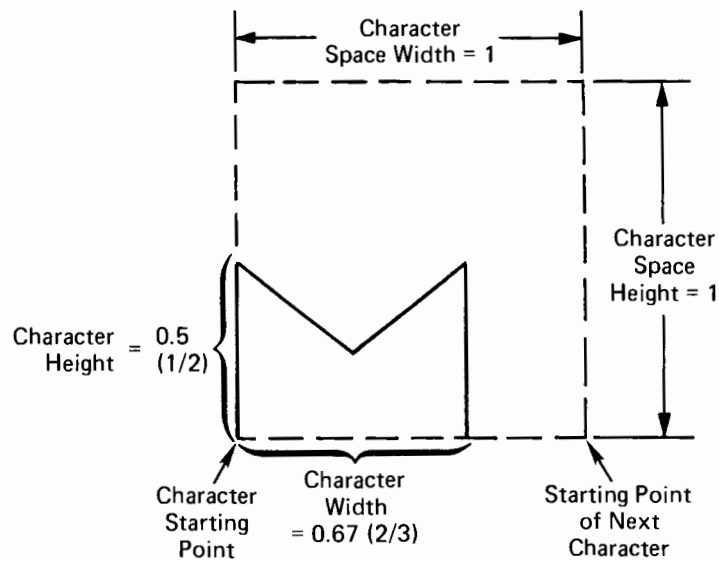
line 40 redefines P2, draws new corner and label showing effect of new P2 on relative character size.

3



## Spacing Between Characters and the Character Grid

Character spacing and line spacing are functions of character size. In the diagram below, you can see the relative position of a character, in this case M, within the character-space field. The character-space field is set indirectly by the SI or SR command, since the character-space height is twice the character's height and the character-space width is 1-1/2 times the character width. The space above and beside a character becomes the spacing between lines and characters.



When you specify the height of a character in an SI or SR command, however, you should specify the character height and not the height of the character-space field.



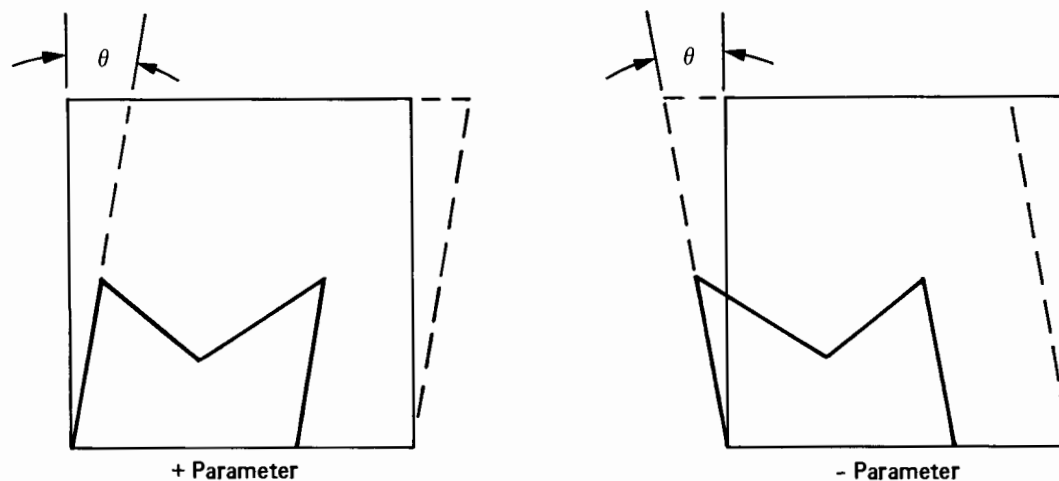
## The Character Slant Instruction SL

The character slant instruction SL provides the means to specify the slant with which characters are lettered.

Syntax:

`SL tan  $\theta$  [: or LB]`

The parameter is a decimal number between  $\pm 127.999$  and is equivalent to the tangent of the angle  $\theta$  from vertical as follows:



3

The useful parameter range is  $\pm 0.5$  to  $\pm 2$  when using default absolute character size and up to  $\pm 3.5$  for large letters.

A change in scaling points P1 and P2 will not affect the angle  $\theta$ .

An SL command with invalid parameters will turn on the error light and default to the last valid SL instruction or if none to SL0.

An SL command with no parameters (`SL ;`) will default to the same values as SL0 (no slant).

An SL command remains in effect until another valid SL command is executed or the plotter is reinitialized or set to default conditions.

The following example using the 9835 writes the word 9872 at a slant of +45°.

```
10 PRINT USING
K"; "SL1;LB9872"
20 END
```

*9872*

## The Character Plot Instruction CP

The character plot instruction CP provides the means to move the pen the specified number of character-space fields.

Syntax:

CP # of character-space widths, # of character-space heights [; or LF]

If no parameters are specified, a CP command ( CP; ) performs a carriage return and line feed operation by moving one character-space height down and returning to the margin defined by the last point that the pen was sent to by either a PA command, PR command, or the plotter front-panel controls.

When parameters are specified, the CP command moves the pen the specified number of character-space widths to the right (a positive value) or to the left (a negative value) and the number of character-space heights up (a positive value) or down (a negative value). The pen's position (raised or lowered) does not change when a CP command is executed. The parameters must be within the range of  $\pm 127.999$  excluding 0. However, since there are approximately 90 character widths and 40 character heights on the platen surface, assuming default sizing, the effective parameter range that will not invoke an out-of-limit condition is considerably less, depending on the pen position at the given time.

The CP; command is useful to produce lettering with alignment along a left-hand margin, while a CP command with small decimal parameters enables lettering along a line but not on top of it.

This is illustrated in the following program.

```

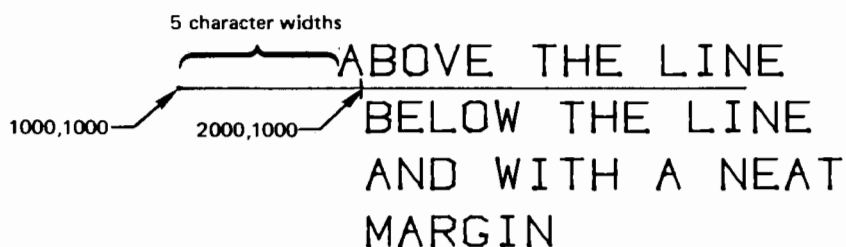
10 PRINT USING "
K";"PA1000,1000;
PD;PR3000,0;PU;P
R-3000,0"
20 PRINT USING "
K";"CP 5;.25;LBA
BOVE THE LINE"
30 PRINT USING "
K";"PA2000,1000;
CP0;-.75;LBBELOW
THE LINE"
40 PRINT USING "
K";"CP;LBRAND WIT
H A NEAT;CP;LBR
ARGIN"
50 END

```

line 20 moves label slightly above the line.

line 30 moves label below the line.

line 40 contains CP; which causes a carriage return, line feed to the margin defined by last plotted point. Labels are left justified to this margin.



In scaled mode, a CP command does not update X and Y pen position while a LB command will. Therefore, use PA to plot immediately after a CP command or insert a LB command, LB (ETX); will suffice, between a CP and PR command; otherwise plot will be in error.



## Chapter **4**

# Graph Enhancement

This chapter describes the instructions that enable you to enhance the plotted data with such things as axes with tick marks, pen selection for multicolor plotting, and special symbols.

### The Tick Instructions XT and YT

The tick instruction XT provides the means to draw a vertical X tick at the current pen location. The tick instruction YT provides the means to draw a horizontal Y tick at the current pen location.

Syntax:

```

    XT [; or LF]
or
    YT [; or LF]

```

Neither instruction requires any parameters. Both instructions require the terminator ; or LF to complete the command.

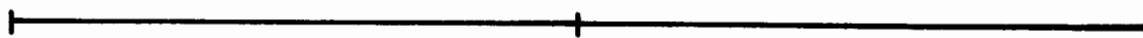
The tick length is specified by the tick length command using TL. If no tick length is specified, the default length is 0.5% of  $|P2_x - P1_x|$  or  $|P2_y - P1_y|$ .

The following example, using the 9835, draws a horizontal line, 6000 plotter units long, and places X ticks at the end points and at 4000 plotter units:

```

10 PRINT USING "
K"; "PA1000,1000;
PD;XT;PR3000,0;X
T;PR3000,0;XT;PU
"
20 END

```



## The Tick Length Instruction TL

The tick length instruction TL provides the means to specify the length of the tick marks drawn by the plotter. The tick lengths are specified as a percentage of the horizontal and vertical distances between the scaling points P1 and P2.

Syntax:

TL tp(, tn) [; or LF]

The parameter tp determines the length of the upward portion of a tick mark drawn along the X axis and the right-side portion of a tick mark drawn along the Y axis. Since we normally think of this as being in the positive half of a graph, we call it tp.

The parameter tn is optional. If a tn parameter is present it determines the downward portion of a tick mark along the X axis and the left-side portion of a tick mark along the Y axis. Since we normally think of this as being in the negative half of a graph, we call it tn.

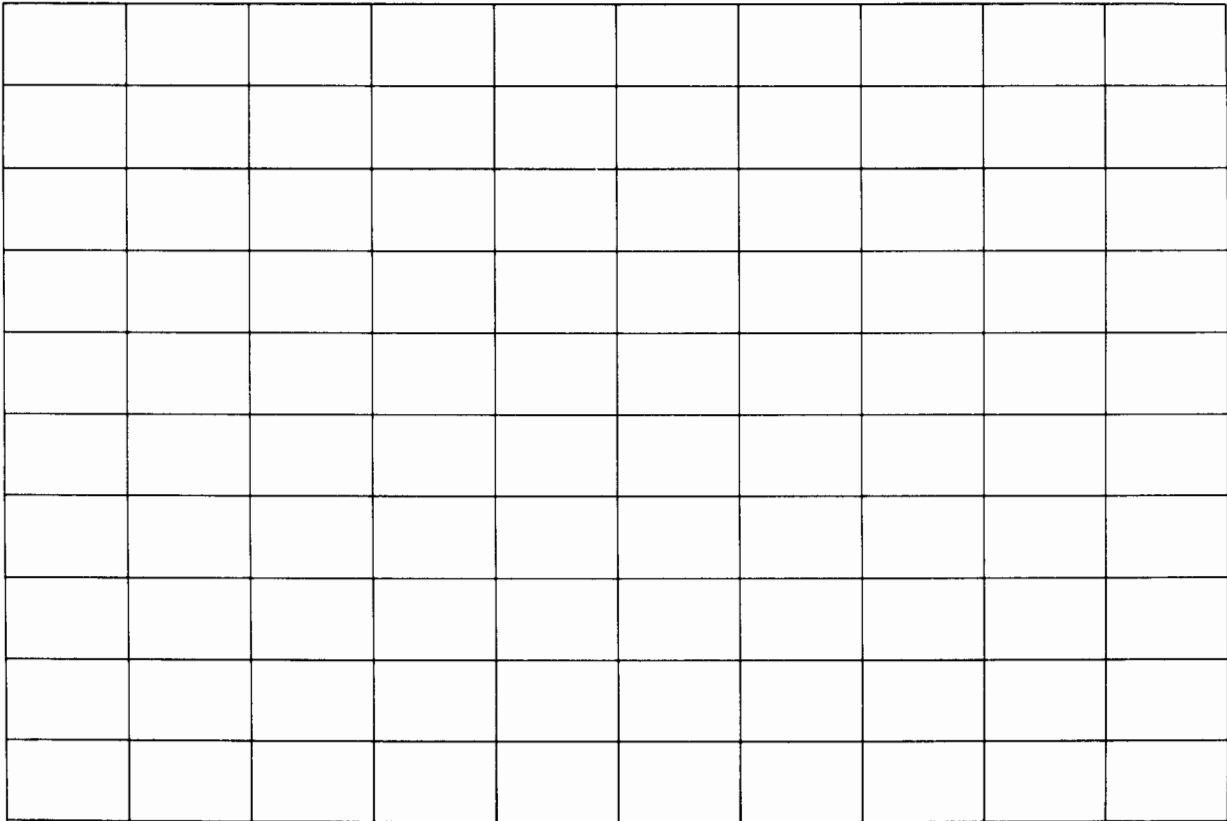
The plotter, when initialized or set to default conditions, sets the tick length values to 0.5% of  $|P1_y - P2_y|$  for an XT command and 0.5% of  $|P1_x - P2_x|$  for a YT command. A TL command with no parameters defaults to the same values.

The following example, using the 9830, draws a 10 x 10 grid on the plotter defined within the points P1=520, 380 and P2=15720, 10380. Note that only the up and right tick length parameter is specified since only the area above the X axis and to the right of the Y axis is being used.

```

10 CMD "?U%"
20 OUTPUT (13,*)"SP1;PA520,380;TL100;XT"
30 FOR I=1 TO 10
40 OUTPUT (13,*)"PR1520,0;XT"
50 NEXT I
60 OUTPUT (13,*)"PA520,380;YT"
70 FOR J=1 TO 10
80 OUTPUT (13,*)"PR0,1000;YT"
90 NEXT J
100 OUTPUT (13,*)"SP0"
110 END

```



4

Tick Length Example

## The Pen Select Instruction SP

The pen select instruction SP provides the means to select a pen through program control.

Syntax:

SP pen position number [; or LF]

The pen position number must be an integer in the range of 0 through 4. When the command SP is executed, the pen arm raises the pen it is currently holding (if any) and returns it to the position from which it was originally fetched. The new pen designated by the SP command is then fetched and the pen arm returns to its last position prior to the SP command.

A pen position number of 0 or no parameter directs the pen arm to return the pen it is currently holding to its stall then the pen arm returns to its last position prior to the SP command.

If the specified pen position is empty, or if all of the pen positions are full and there is a pen in the arm, then no operation occurs.

If the position from which the pen was originally fetched has since become occupied, the currently held pen is placed in the lowest numbered vacant stall.

Plotter front panel pen select controls can override the program command.

## The Symbol Mode Instruction SM

The symbol mode instruction SM is used with PA and PR commands and provides the means to draw a symbol at the end of each vector.

Syntax:

SM character [; or LF]

The character is limited to one of the centered characters of the character set chosen.



The PA or PR commands function as described in Chapter 2, except that the specified character is drawn at the end of each vector, centered on the plotted point. The character will be drawn at the end of the vector whether the pen is up or down.

The character is drawn according to the currently selected character set. Once selected, the character is independent of character set changes later in the program and can only be changed by a new SM command. If a character is not specified (SH) the symbol mode is cancelled. The size (SI and SR), slant (SL), and direction (DI and DR) commands affect the character drawn.

All ASCII characters from decimal 35 through 122 can be specified except for the following:

ASCII Character	Decimal Value	ASCII Character	Decimal Value
%	37	>	62
&	38	?	63
'	39	@	64
(	40	[	91
)	41	\	92
/	47	]	93
:	58	)	94
;	59		95
<	60	`	96
=	61		

The # (ASCII 35) can be specified only when currently in character set 0 or 1 at the time the SM command is executed.

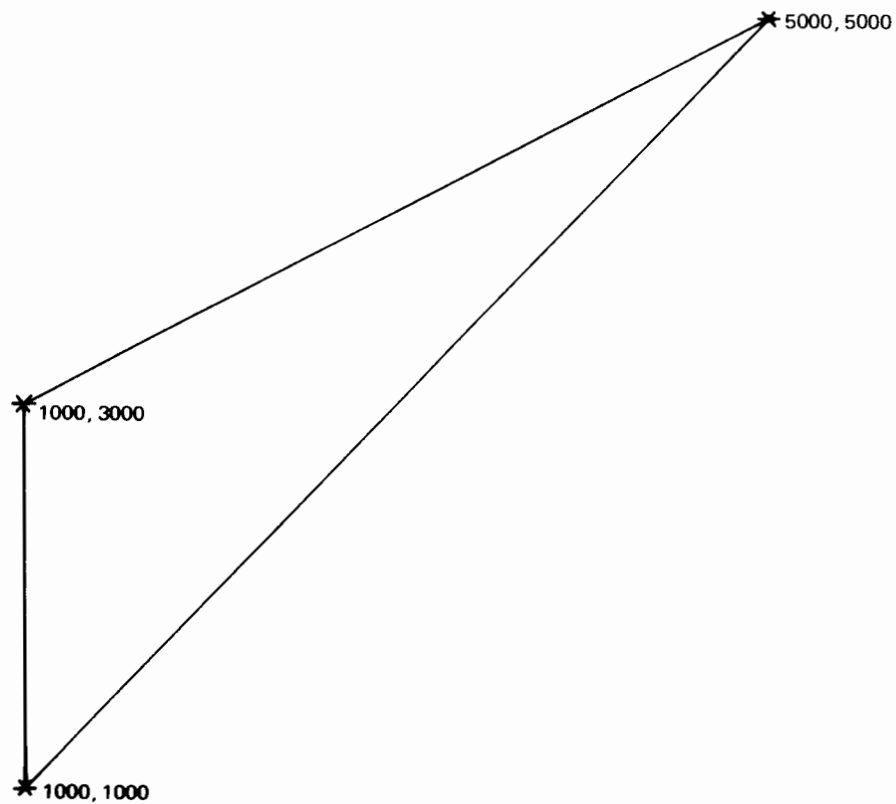
An SM command with invalid parameters will turn on error light and cancel symbol mode.

An SM command remains in effect until another SM command is executed or the plotter is reinitialized or set to default conditions.

## 66 Graph Enhancement

The following program, using the 9835, causes the plotter to draw a triangle with the symbol \* drawn at each vertex.

```
10 PRINT USING  
"K"; "PA1000,100  
0;PD;SM*;PA1000,  
3000"  
20 PRINT USING  
"K"; "PA5000,500  
0,1000,1000"  
30 END
```



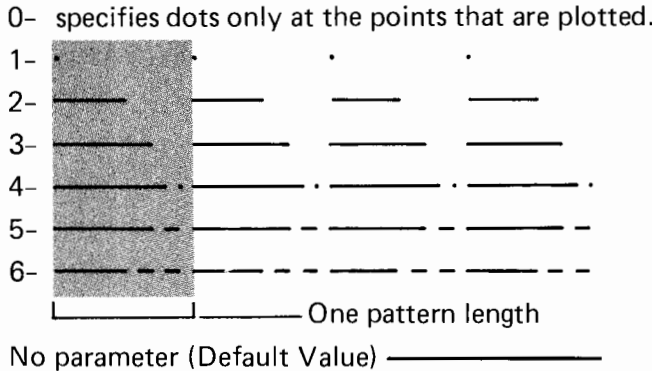
# The Line Type Instruction LT

The line type instruction LT provides the means to specify the type of line that will be used with PA and PR commands.

Syntax:

```
LT pattern number (, pattern length) [; or LF]
```

Shown below are the line patterns and their pattern numbers.



The shaded portion of each of the line patterns above is one complete segment of the pattern.

The pattern number parameter should be an integer 0 to 6. Decimal parameters in this range will be truncated to integers. Negative parameters will default to a solid line and positive parameters 7 or greater will use the last valid parameter or default value if not previously specified.

The optional pattern length parameter specifies the length of one complete segment of the pattern and is expressed as a percentage of the diagonal distance between the scaling points, P1 and P2. If a pattern length parameter is not specified, the last value received is used. If no pattern length has ever been specified, a length of 4% is used. Valid parameters are +0.004 to +127.999. Useful values for pattern length with default P1 and P2 are between 1 and 5 and depend somewhat on the pattern number.

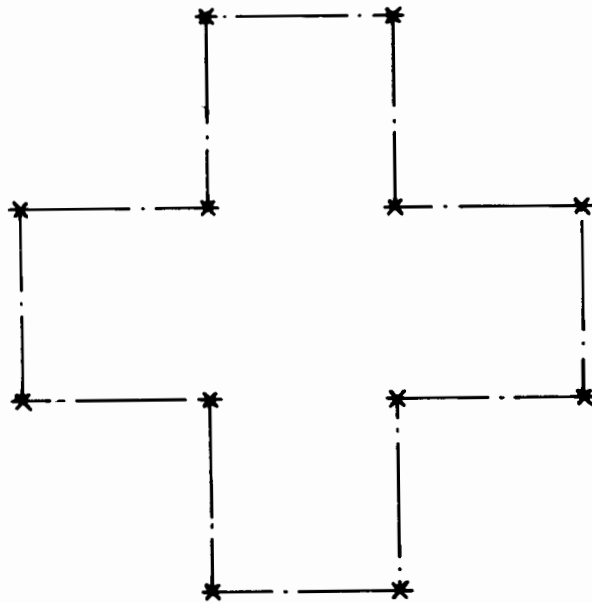
After this command, all subsequent vector commands with the pen down will cause the specified pattern to be drawn. Any portion of the pattern which is not used will be carried over into the next vector.

An LT command with no parameters (LT;) will default the line type to a solid line.

## 68 Graph Enhancement

The following example, using the 9830, plots a cross using line type 4, and draws the symbol \* at each corner point.

```
10 CMD "?U%"  
20 OUTPUT (13,*)"SP1;PA5000,5000;PD;LT4;SN*;PR1000,0,0,1000"  
30 OUTPUT (13,*)"PR1000,0,0,-1000,1000,0,0,-1000,-1000,0"  
40 OUTPUT (13,*)"PR0,-1000,-1000,0,0,1000,-1000,0,0,1000;SP0"  
50 END
```



# Chapter 5

## Digitizing

### The Digitize Point Instruction DP



The digitize point instruction DP provides the means to digitize points on the plotter.

Syntax:

DP [; or LF]



No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

When command DP is sent, the ENTER light turns on indicating that a point can be entered. When the  pushbutton is pressed, the X and Y coordinates of that point and pen up/down status are stored for retrieval by the OD command. Pressing the  pushbutton also turns off the ENTER light.

When using the digitizing sight, the pen should be down.


### The Digitize Clear Instruction DC

The digitize clear instruction DC provides the means to terminate the digitize mode.

Syntax:

DC [; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

This command enables you to terminate a digitize mode without entering coordinate values through the  pushbutton. The ENTER light is turned off (if it was on).

## The Output Digitized Point and Pen Status Instruction OD

The output digitized point and pen status instruction OD instructs the plotter to make the X and Y coordinates and pen status (up or down) associated with the last digitized point available for output to the computer.

Syntax:

OD [; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

The OD command is used only when a digitized point has been stored, as indicated by receipt of the output status byte with a true (1) condition on bit position 2 (see Output Status Instruction, Chapter 6).

To ensure data transfer from the plotter to the controller, the plotter must be instructed to talk and the controller to listen. The pen position and status will be output to the controller in ASCII as follows:

X        Y        P        CR        LF

where X is the X coordinate in absolute plotter units  
 Y is the Y coordinate in absolute plotter units  
 P is the pen status (0 = pen up, 1 = pen down).


The ranges of the X and the Y coordinates are the mechanical limits of the plotter; i.e.  $0 \leq X \leq 16000$  and  $0 \leq Y \leq 11400$ .


Upon receipt of the OD command by the plotter, bit position 2 of the output status byte is cleared, and the ENTER light is turned off (if it was on).

## Digitizing With the 9872

The plotter can be used as a digitizer as well as a plotter since digitizing is basically the inverse of plotting. Instead of sending the coordinates of a point to the plotter and the plotter then moving the pen to that point, you move the pen to a point on the plotter (typically by using the front panel controls), enter the point, then send the coordinates of that point to the controller. A special digitizing sight is provided with the plotter which allows you to visually position the pen over the point to be digitized. The sight is loaded and stored like a pen and is used in the pen down position.

In general, the DP command is used with the OS and OD commands. The output status command OS is explained in Chapter 6. A generalized program flow for the digitize mode is listed below.

1. Allocate in memory the number of points to be digitized for the variables X, Y, and P.
2. Develop a FOR-NEXT loop with the total number of points digitized.
3. Enter the digitize mode, output the pen status byte, and monitor bit position 2 of the pen status byte for a true (1) condition. The true condition indicates that the  pushbutton has been pressed.
4. Output the digitized point to the controller.
5. Continue the loop for all digitized points then print or display the values for each digitized point if desired.

The following example program using the 9835 enables you to digitize four points. At each point, you press the  pushbutton to send the coordinates of that point to the controller.

```

10  DIM X(4),Y(
4),P(4)
20  FOR D=1 TO
4
30  PRINT USING
"K";"DP"
40  DISP "ENTER
POINT";D;"PLEA
SE"
50  GOSUB 500
60  ENTER 7,5;X
(D),Y(D),P(D)
70  NEXT D
80  FOR L=1 TO
4
90  DISP X(L);Y
(L);P(L);
100 NEXT L
110 END
500 PRINT USING
"K";"OS"
510 ENTER 7,5;S
tatus
520 Status=INT(S
tatus/2)
530 Status=INT(S
tatus/2)
540 Status=Statu
s MOD 2
550 IF Status=0
THEN 500
560 PRINT USING
"K";"OD"
570 RETURN !****
DITIZE****

```

} Line 10 establishes the number of points to be measured and dimensions the string variable.

} Line 60 causes the plotter to output the data points to the controller.

The subroutine beginning at line 500 ensures that the pushbutton is pressed before continuing program execution.



## Chapter **6**

# Additional Plotter Control

In addition to the instructions described in the previous chapters, the plotter has additional capabilities grouped as follows:

### Pen Control Instructions

Automatic Pen Pickup AP  
Set Adaptive Pen Velocity VA  
Set Normal Pen Velocity VN  
Select Pen Velocity VS

### Character Control Instructions

Designate Standard Character Set CS  
Designate Alternate Character Set CA  
Select Standard Character Set SS  
Select Alternate Character Set SA  
User Defined Character UC

### Plotter Configuration and Status Instructions

Input Mask IM  
Input Window IW  
Default DF  
Initialize IN  
Output Actual Position and Pen Status OA  
Output Commanded Position and Pen Status OC  
Output Error OE  
Output Factors OF  
Output Identification OI  
Output Options OO  
Output Status OS

## External Plotter Commands

Device Clear  
Serial Polling  
Parallel Polling

## Pen Control Instructions

### The Automatic Pen Pickup Instruction AP

The automatic pen pickup instruction AP causes the plotter to automatically raise the pen whenever it has been down without motion for 65 seconds.

Syntax:

AP (integer) [; or LF]

An AP command with no parameters (AP;) enables automatic pen pickup. Pickup enabled is the default condition.

An AP command with a valid integer parameter disables automatic pen pickup. Using AP0 is recommended.

An AP command with invalid parameters has no effect on pickup.

### The Velocity Select Instruction VS

The velocity select instruction VS provides the means to specify the pen speed, in centimetres per second, for plotting and lettering operations.

Syntax:

VS pen velocity (, pen number) [; or LF]

The pen velocity parameter can be any integer between 1 and 36 and represents pen speed in cm/s. If the optional pen number (an integer, 1 to 4) is specified, the speed will apply only to that pen. If a pen number is not specified, the speed applies to all pens.

When the plotter is initialized, the pen velocity is defaulted to a value of 36 cm/s. A command VS with no parameters (`VS ;`) also defaults the pen velocity to 36 cm/s.

A VS command with invalid parameters turns on the error light and pen velocity does not change.

A VS command remains in effect until another valid VS command is executed or the plotter is reinitialized or set to default conditions.

## The Adaptive Pen Velocity Instruction VA

The adaptive pen velocity instruction VA provides the means to adapt the pen-down speed automatically to approximate the rate at which the computer sends coordinate data to the plotter.

Syntax:

`VA [ ; or LF]`

No parameters are used, however the terminator ; or LF must be included to complete the command. A VA command with parameters turns on the error light but does not alter the velocity mode. A VA command remains in effect until a VN is executed or the plotter is initialized or set to default values. This mode provides a smoother plot than the normal velocity mode when plotting coordinates that are generated by a relatively slow program routine (fewer than 15 coordinates/s). The maximum pen speed will not exceed the speed selected by the previous VS command.

If the time required to complete a plot is a consideration, care should be taken when including the VA command in a program, since the VA command slows the plotter down to the controller data rate. If the data creates long vectors, plotter movement will be very slow and should the data rate increase, it will take a few data points and a significant period of time before the plotter is again up to data speed.

## The Normal Velocity Instruction VN

The normal pen velocity instruction VN provides the means to cancel the adaptive pen velocity mode.

Syntax:

VN[; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command.

After receipt of a VN command, the pen returns to the velocity specified by the previous VS command or default velocity if no VS command has been executed.

A VN command with parameters will turn on the error light and adaptive velocity mode will not be cancelled.

## Character Control Instructions

### Character Sets

The plotter has the capability of lettering with any of five designatable character sets. Each of the five character sets has identical characters with the exception of certain symbols. The plotter, when initialized, automatically sets both the "standard" set and "alternate" set to the ANSI ASCII character set (Set 0), which follows:

#### CHARACTER SET 0

```
! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^
_ ` a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
```

Shown next are the symbols in the various character sets that are changed from set to set. The plotter will perform an automatic backspace before drawing any of the shaded symbols. Therefore, when an accented letter is required, the letter should be entered first, followed by the accent.



Decimal Value	Set 0 Std. ASCII	Set 1 9825 ASCII	Set 2 European ASCII	Set 3 Scandinavian ASCII	Set 4 Spanish/Latin American ASCII
35	#	#	£	£	¿
39	'	'	✓	✓	✓
91	[	[	[	Ø	[
92	\	f	ç	Æ	i
93	]	]	]	ø	]
94	^	↑	▲	æ	▲
95	—	—	—	—	—
96	`	`	`	`	`
123	{	π	•	•	~
124		†	•	•	~
125	}	→	•	•	~
126	~	~	•	•	~

## The Designate Standard Character Set Instruction CS

The designate standard character set instruction CS provides the means of selecting one of the five character sets (0 thru 4) as the standard character set.

6

Syntax:

CS 0 thru 4 [; or LF]

The character set selected is used for all labeling and lettering operations when the standard set is specified. Character set 0 is automatically set whenever the plotter is initialized.

A CS command with no parameters (CS) defaults to set 0.

A CS command with invalid parameters will turn on the error light and the character set designated as standard will not change.

## The Designate Alternate Character Set Instruction CA

The designate alternate character set instruction CA provides the means of selecting one of the five character sets (0 thru 4) as the alternate character set.

Syntax:

```
CA#0 thru 4 [; or LF]
```

The character set selected is used for all labeling and lettering operations when the alternate character set is specified.

Any of the five character sets (0 thru 4) can be specified. Character set 0 is automatically specified as the alternate character set whenever the plotter is initialized.

A CA command with no parameters (CA#) defaults to set 0.

A CA command with invalid parameter will turn on the error light and the character set designated as alternate will not change.

## The Select Standard Set Instruction SS

The select standard set instruction SS provides the means of selecting the standard set as the character set to be used for all labeling.

Syntax:

```
SS[; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the command. A SS command with parameters will turn on the error light but otherwise be ignored.

The standard character set is automatically selected when the plotter is first turned on or initialized. The standard set can be selected within a label command by sending the ASCII control character for shift-in (decimal 15).

## The Select Alternate Set Instruction SA

The select alternate set instruction SA provides the means of selecting the alternate set as the character set to be used for all labeling.

Syntax:

```
SA[; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the command. A SA command with parameters will turn on the error light but otherwise be ignored.

This command should be executed prior to executing a labeling statement whenever the alternate character set is to be used. The alternate set can be selected within a label command by sending the ASCII control character for shift-out (decimal 14).

The following program using CS, CA, and SS commands writes in 2 character sets where the character “—” is printed with and without backspace.

```
10 PRINT USING "
K";"CS0;CA4;SS;L
BS_E_T_0 S_E_T_
4_ "
20 END
```

Unprintable ASCII control character shift-out (decimal 14).

S\_E\_T\_0 SEI4

6

## The User Defined Character Instruction UC

The user defined character instruction UC provides the means to draw characters of your own design.

Syntax:

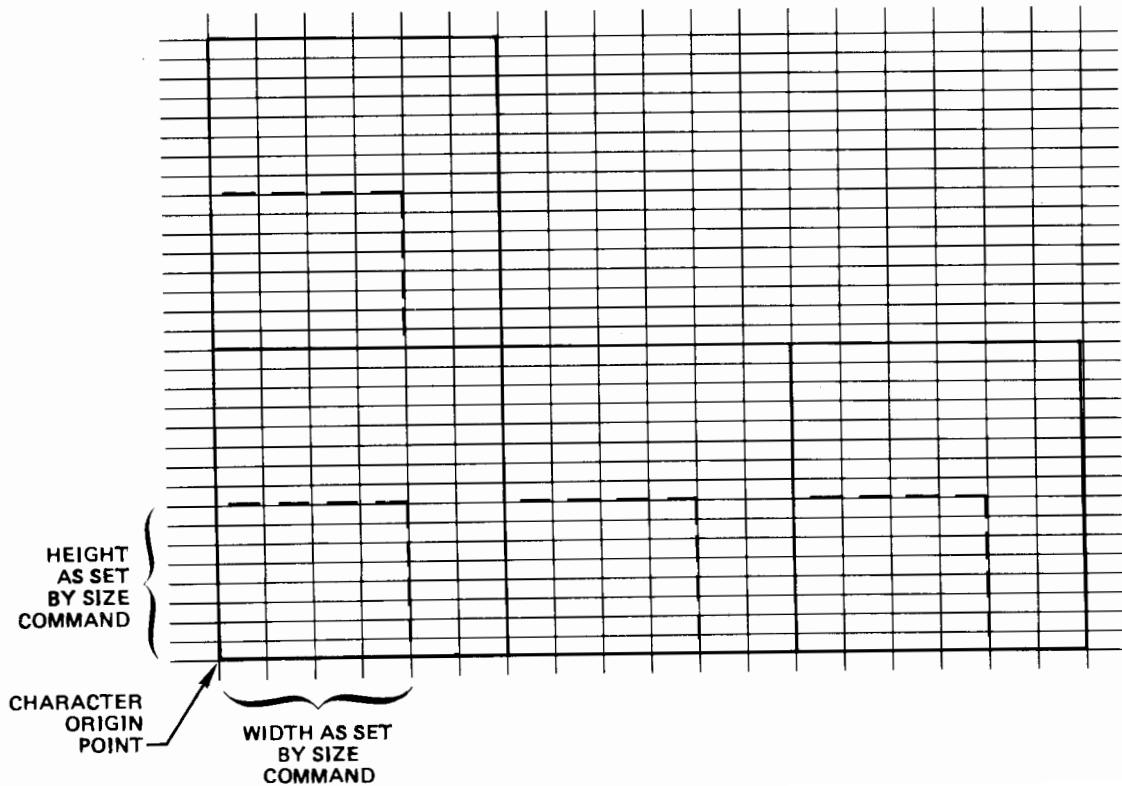
```
UC (pen control parameter,) X increment, Y increment,
   (pen control parameter,) (X increment, Y increment,)
   . . . , . . . . [; or LF]
```

Each segment of the character is drawn according to the three parameter values as follows:

1. Pen control parameter – sets pen status with an integer entry of +99 for pen down or -99 for pen up. Once a pen down (+99) has been sent, the pen will remain down for the following X and Y increment moves until a pen up (-99) is sent or the UC command is completed. The pen control parameter is internal to the UC command. It does not affect pen status as set by the PU or PD instructions.
2. X increment – specifies the number of character grid units that the pen will move horizontally. A positive value moves the pen to the right, and a negative value moves it to the left. The increment value must be an integer and can range from -98 thru +98 grid units.
3. Y increment – specifies the number of character grid units that the pen will move vertically. A positive value moves the pen up and a negative value moves it down. The increment value must be an integer and can range from -98 thru +98 grid units.

Use of integers outside the range -99 thru +99 will affect pen status in an unspecified manner.

The character grid units are scaled by the current size command. Each character block contains 6 horizontal grid units and 16 vertical grid units, as shown below.





Note that the character block width is 1-1/2 times the character width and twice the character height set by a size command.

Each character starts from the character block origin point. When the character is completed, the pen moves to the next character-block's origin (6 grid units from the initial starting point). This may not be a valid starting point if the new character is user-defined to be larger than a normal character. One of the plot commands may be needed to position the pen for the next character, if any, to be lettered.

Each UC command must have at least one pen down parameter (+99) in order to draw anything. A UC command without a pen down (+99) will result in a pen movement of one character block horizontally.

Plot commands (PA, PR, CP) which follow a UC command will be made using the pen status set by the previous PU or PD.

The UC command cannot be used to move the pen a specified number of character grid units. Use the CP command (Character Plot – CP, Chapter 3) for this.

The following routine using a 9835, plots to a point and draws the illustrated character:

```
10 PRINT USING "
K"; "IN;PA1000,70
00"
20 PRINT USING "
K"; "UC99,10,10,1
0,-10,-10,-10,-1
0,10,20,0,-99,-1
0,-10,99,0,20"
99 END
```

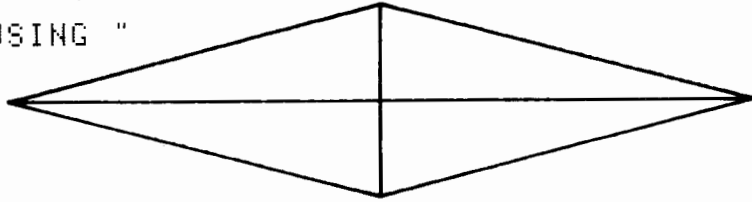


Looping through the above program 20 times, this graphic can be produced:

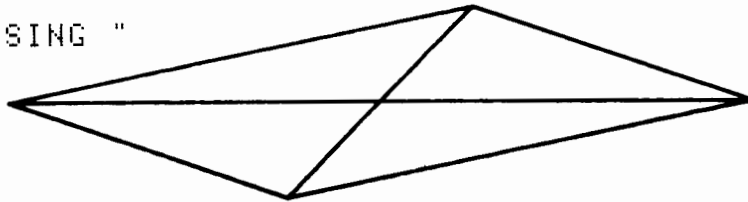


The first of the following illustrations is made by adding line 15 – the SI command (see Absolute Character Size – SI, Chapter 3) to the previous routine; the second illustration shows the effect of a second addition line 16 – the SL command (see Absolute Character Slant – SL, Chapter 3).

```
15 PRINT USING "  
K"; "SI2,1"
```



```
16 PRINT USING "  
K"; "SL1"
```



## Plotter Configuration and Status Instructions

### The Input Mask Instruction IM

The input mask instruction IM provides the means to specify the conditions under which an error message, require service message, and parallel poll response will occur.

Syntax:

```
IM E-mask value (S-mask value, P-mask value)[; or LF]
```

E-mask specifies the decimal equivalent of the bit values of the plotter error numbers that will set the error bit (bit 5) of the plotter status byte and turn on the error light on the plotter front panel.

E-Mask Bit Value	Error Number	Meaning
1	1	Instruction not recognized
2	2	Wrong number of parameters
4	3	Bad parameters received
8	4	Illegal character
16	5	Unknown character set
32	6	Position overflow
64	7	Not used
128	8	Out of roll paper

For example the default E-mask value 223 (1 +2 +4 +8 +16 +64 +128) will specify that all error numbers except 6 can set the error bit in the status byte and turn on the error light whenever they occur. Error 6, however, will not set the error bit or turn on the error light if it occurs since it is not included in the E-mask value. Note an E-mask value of 159 would result in identical plotter behavior since error 7 is not used on the 9872 plotter.

The S-mask value specifies the status-byte conditions that can send the require service message by setting interface line SRQ on the bus to a logical 1.

The S-mask is the decimal equivalent of the bit values of the selected status byte bits.

S-Mask Bit Values	Status Bit	Meaning
1	0	Pen down
2	1	P1 or P2 changed; cleared on "OP"
4	2	Digitized point available; cleared on "OD"
8	3	Initialized; cleared on "OS"
16	4	Ready for data
32	5	Error; cleared on "OS"
	6	Require service sent (SRQ)
	7	Not used

Only combinations of the first 6 bits (called bit 0 to bit 5) can be specified to send the require service message. Bit 6 is used to specify whether or not the plotter has sent the require service message and bit 7 is not used (always set to logical 0).

For example, an S-mask value of 16 specifies that the ready for data bit (bit 4) of the status byte will send the require service message. The other 5 bits (bits 0 thru 3 and bit 5) will not send the require service message.

The P-mask value specifies the status-byte conditions that will result in a logical 1 response to a parallel poll.

P-Mask Bit Value	Status Bit Number	Meaning
1	0	Pen down
2	1	P1 or P2 changed
4	2	Digitized point available
8	3	Initialized
16	4	Ready for data
32	5	Error
	6	Require service sent (SRQ)
	7	Not used

For example, a P-mask value of 48 specifies that only bits 4 and 5 (16 + 32) of the status byte can cause the plotter to respond to a parallel poll with a logical 1 on the appropriate data line.

The plotter, when cleared or initialized, automatically sets the E-mask to 223 (error numbers 1, 2, 3, 4, 5, 7, 8), the S-mask to 0 (none of the status-byte bits can send the require service message) and the P-mask to 0 (none of the status-byte bits can cause a parallel poll response of logical 1).

An IM command with no parameters (IM;) will automatically set the values to 223, 0, 0.

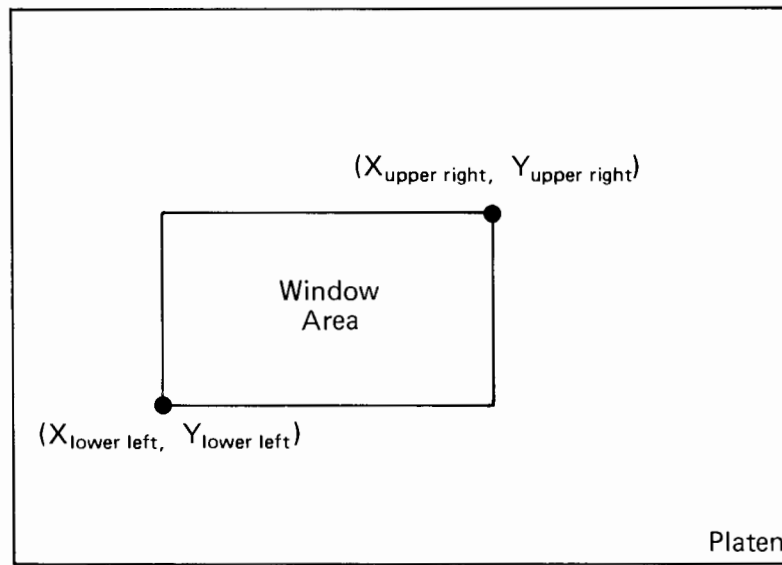
## The Input Window Instruction IW

The input window instruction IW provides the means to restrict the programmed pen motion to a specific rectangular area on the platen. This area is called the "window".

Syntax:

IW X lower left, Y lower left, X upper right, Y upper right [; or LF]

The four parameters specify, in absolute plotter units, the X and Y coordinates of the lower left and the upper right corners of the window area as shown below. The parameters should be positive and less than 16000 for X and 11400 for Y. Parameters between -32767 and 0 are set to 0 and parameters larger than platen area but less than 32767 are set to limits of platen. Parameters beyond  $\pm 32768$  will cause an error and the window will not change.



If command IW is not executed, or if executed without parameters (  $I\ W\ ;$  ) the window is automatically set at the mechanical limits of the plotter.

At this point the reader may wish to review the concept of "nearby" and "faraway" as described under the Plot Absolute (PA) Command, Chapter 2.

There are in general seven types of vectors that can be developed from a given "last point" to some "new point" as follows:

<u>Last Point</u>	to	<u>New Point</u>
1. Inside window area	to	inside window area
2. Inside window area	to	outside but "nearby"
3. Inside window area	to	outside but "faraway"
4. Outside window area but "nearby"	to	inside window area
5. Outside window area but "nearby"	to	outside but "nearby"
6. Outside window area but "faraway"	to	inside window area
7. Outside window area "faraway"	to	outside window area but "nearby"

In type 1, the pen will move as programmed from the last point to the new point with the pen up or down as commanded.

In type 2, the pen will move as programmed from the last point toward the new point. At the intersection of this move and the window limit, the pen will stop and lift, and the OUT OF LIMITS light will come on steady.

In type 3, the pen will be raised but not move and the plotter will assume out-of-range condition (enter lost state). The OUT OF LIMITS light will come on blinking.

In type 4, the OUT OF LIMITS light is on steady at the start of the vector. The pen will move (pen up) to the intersection of the current vector and the window limit. At this point, the OUT OF LIMITS light will go out, the pen will be under program control, either pen up or down as instructed, and will move to the new point.

In type 5, the pen is raised and the OUT OF LIMITS light is on steady at the start of the vector. If part of the vector is in the window area, the plotter will move with the pen up to the intersection of the current vector and the window limit nearest the last point. The light will go out and the pen will be moved under program control to the intersection of the vector and the other window limit. The pen will then stop and lift and the OUT OF LIMITS light will come on steady. If the vector from the last point to the new point does not intersect the window area, no move will be made. However X and Y coordinates of the current pen position are updated.

In type 6, the pen will move with pen up to the new point and the OUT OF LIMITS light will go out and the out-of-range mode (lost state) will be exited. Upon leaving the new point the pen will be under the control of the previous pen up or pen down instruction.

In type 7, the OUT OF LIMITS light will come on steady. If part of the vector is within the window area, the pen will move across the window with pen raised. If the vector from the last point to the new point does not intersect the window area, no move will be made.

In scaled mode a point will be within a window area, or outside but "nearby" or "faraway" if the plotter unit equivalents of the scaled parameters are within or outside that area.

The input window command can be used to specify a limited portion of the plot. The following example using the 9835 plots the function  $\sin X$  from  $-4\pi$  to  $4\pi$  and  $-1$  to  $1$ . The same program is then run, but with the window command line 5 inserted to demonstrate the "windowing" effect.

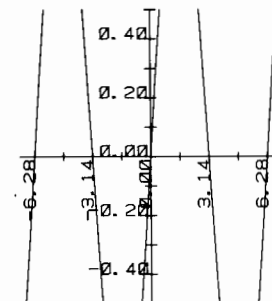
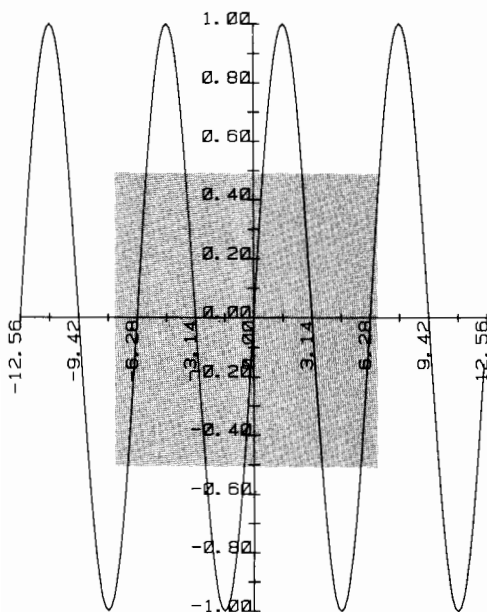
```

10 PRINT USING "K"; "SP1;PA520,5000;PD;XT"
20 FOR I=1 TO 16
30 PRINT USING "K"; "PR400,0;XT"
40 NEXT I
50 PRINT USING "K"; "PU;PA520,5000;DI0,1;CP-6.5,-.25"
60 FOR J=-12.56 TO 12.56 STEP 3.14
70 IMAGE 2A,MDD,DD,24A
80 PRINT USING 70;"LB",J,"";CP-6,0;PU;PR800,0"
90 NEXT J
100 PRINT USING "K"; "PA3720,1000;PD;YT"
110 FOR K=1 TO 20
120 PRINT USING "K"; "PR0,400;YT"
130 NEXT K
140 PRINT USING "K"; "PU;PA3720,1000;DI;CP-6.5,-.25"
150 FOR L=-1 TO 1 STEP .2
160 IMAGE 2A,MDD,DD,24A
170 PRINT USING 160;"LB",L,"";CP-6,0;PU;PR0,800"
180 NEXT L
190 FOR X=-4*PI TO 4*PI STEP PI/20
200 FIXED 0! A AND B ARE X,Y COORDINATES OF SIN FUNCTION
210 A=6400/25.14*X+3720
220 B=4000*SIN(X)+5000
230 IMAGE 2A,6D,A,6D,3A
240 PRINT USING 230;"PA",A,"",",",B,"";PD"
250 NEXT X
260 PRINT USING "K"; "PU;SP0;PA16000,11400"
270 END
    
```

```

5 PRINT USING "K"; "IW1920,3000,5520,7000"
    
```

Input window command sets the window for the sin X plot.



## The Default Instruction DF

The default instruction DF provides the means to set certain plotter functions to a predefined state.

Syntax:

DF [; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command.

A DF command sets the following plotter functions to the conditions shown:

Default Conditions	
Function	Conditions
Relative character direction	Horizontal (DR1,0)
Line type	Solid line
Line pattern length	4% of the distance from P1 to P2
Input window	Total platen area
Relative character size	0.75 x 1.5 cm
Automatic pen pickup	on
Pen velocity	36 cm/s
Adaptive pen velocity	off
Symbol mode	off
Tick length	.5% of $ P2_x - P1_x $ or $ P2_y - P1_y $
Standard character set	Set 0
Alternate character set	Set 0
Character slant	0°
Mask value	223,0,0
Digitize clear	on
Scaling	off

In addition, P1 and P2 are not changed and the current pen location is not changed. The state of the cutter and the status of the paper check bit are not changed on the 9872S.



## The Initialize Instruction IN

The initialize instruction IN provides the means of returning the plotter to the initial power-on state by program control.

Syntax:

```
IN[; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the command.

An IN command is the equivalent of switching the plotter off and then on again or initializing it from the front panel. The initialize command sets the plotter to the same conditions as the default command and sets these additional conditions.

The pen is moved to the lower right corner of the platen.

The scaling points P1 and P2 are set to the points P1 = (520, 380) and P2 = (15720, 10380) on the 9872B or the 9872S with chart advance off.

For the 9872S with chart advance on the settings are P1 = (520, 1020), P2 = (15760, 11180) in English mode and P1 = (520, 1140), P2 = (15720, 11140) in metric mode.

All errors are cleared and bit position 3 of the output status word is set true (1).

The cutter is enabled and the paper check bit is set to 1 on the 9872S.

## The Output Actual Position and Pen Status Instruction OA

The output actual position and pen status instruction OA instructs the plotter to make the X and Y coordinates and pen status (up or down) associated with the current position of the pen available for output.

Syntax:

```
OA[; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen only mode.

To ensure data transfer from the plotter to the controller, the plotter must be instructed to talk and the controller to listen. The pen position and status will be output to the computer in ASCII as follows:

```
X      Y      P      CR      LF
```

where X is the X coordinate in absolute plotter units  
 Y is the Y coordinate in absolute plotter units  
 P is the pen status (0 = pen up, 1 = pen down).

The range of the X and Y coordinates is the mechanical limits of the plotter ( $0 \leq X \leq 16000$ ,  $0 \leq Y \leq 11400$ ). When the pen has been moved by program control the range of the X, Y coordinate is the window limit.

## The Output Commanded Position and Pen Status Instruction OC

The output commanded position and pen status instruction OC instructs the plotter to make the X and Y coordinates and pen status (up or down) associated with the last valid pen position command or front panel move available for output.

Syntax:

```
OC [; or LF]
```



No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

The OC command outputs scaled units when scaling is on and the absolute plotter units when scaling is off.

To ensure data transfer from the plotter to the controller, the plotter must be instructed to talk and the controller to listen. The pen position and status will be output to the computer in ASCII as follows:

```
X      Y      P      CR      LF
```

where X is the X coordinate in absolute or scaled plotter units  
 Y is the Y coordinate in absolute or scaled plotter units  
 P is the pen status (0 = pen up, 1 = pen down).

The range of the X and Y coordinates is  $\pm 32767$ . The plotter will output a negative sign for negative numbers; positive signs are suppressed. When in scaled mode and in the lost state, the plotter will output 32767 for both X and Y.

6

## The Output Error Instruction OE

The output error instruction OE provides the means to make the decimal equivalent of the current error (if any) available for output to the computer.

Syntax:

```
OE [; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

When the plotter is instructed to talk and the computer instructed to listen after an OE command, the plotter will output a positive ASCII integer in the form:

error number                      CR                      LF

The error numbers are defined as follows:

Error Number	Meaning
0	No error
1	Instruction not recognized
2	Wrong number of parameters
3	Out of range parameters
4	Illegal characters
5	Unknown character set
6	Position overflow
7	Not used (always 0)
8	Out of roll paper

After outputting the error code to the controller, bit position 5 of the output status byte is cleared, and the error light (if lit) is turned off.

## The Output Status Instruction OS

The output status instruction OS provides the means to make the decimal equivalent of the output status byte available for output to the computer.

Syntax:

OS[; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command.

This instruction should not be used in listen-only mode.

Upon receipt of the OS command, the internal eight-bit status byte is converted to an ASCII decimal integer between 0 and 255. When the plotter is instructed to talk and the computer instructed to listen, the plotter will output a decimal integer in the form:

status            CR            LF

The status byte bits are defined as follows:

Bit Value	Bit Position	Meaning
1	0	Pen down
2	1	P1 or P2 changed
4	2	Digitized point available
8	3	Initialized
16	4	Ready for data
32	5	Error
64	6	Require service message set
128	7	Not used (always set to 0)

Upon power up, the status is digital 24, the sum of 8 (initialized) and 16 (ready for data). Upon completion of the OS command, bit position 3 is cleared.

## The Output Factors Instruction OF

The output factors instruction OF instructs the plotter to make two factors available for output.

Syntax:

OF [; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command.

The instruction should not be used in listen-only mode.

When, after an OF command, the plotter is instructed to talk and the computer is instructed to listen, the plotter will always output the two positive ASCII integer strings 40, 40 in the form:

40, 40                      CR                      LF

The numbers 40, 40 are the number of plotter units per millimetre in X and Y axis respectively.

## The Output Identification Instruction OI

The output identification instruction OI instructs the plotter to output an identifier.

Syntax:

OI[; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command.

This instruction should not be used in listen-only mode.

When the plotter is instructed to talk and the computer to listen the 9872B or 9872S will always return:

9872B                      CR                      LF

## The Output Options Instruction OO

The output options instruction OO instructs the plotter to make eight ASCII integers available for output to the computer.

Syntax:

OO[; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command. The instruction is not usable in listen-only mode.

When the plotter is instructed to talk and the computer instructed to listen, the plotter will output eight ASCII integers in the form:

C, 1, 0, 0, 0, 0, 0, 0 CR LF

where C is as described below, 1 means the plotter has pen select capability and the last six numbers are always zero on the 9872. C takes on a value 0-3 as follows:

C	Paper Check Bit	Advance Option
0	clear (0)	off (0)
1	clear (0)	on (1)
2	set (1)	off (0)
3	set (1)	on (1)

A 9872B will always output a value of C = 2.

The advance option is on if the out of paper sensor indicates paper. The paper check bit is set at power up or initialization, and anytime the pen is put down under either program or front panel control. It is also set anytime the out of paper switch indicates no paper before or after a paper advance or attempt to advance. The paper check bit is cleared to zero after any successful advance. This instruction can be used on the 9872S to ascertain whether the plotter is loaded with clean roll paper. The OO instruction should be sent before an IN instruction since the IN instruction will set the paper check bit to 1 and paper may be wasted.

## External Plotter Commands

### Plotter Reaction to Bus Clear Commands DCL, SDC ,and IFC

A computer can set all devices on the HP-IB system to a known state by sending device clear command DCL. A computer can also set selected devices to a known state by sending selected device clear command SDC along with the addresses of the devices. The basic difference is that devices will obey SDC only if they are addressed to listen, whereas DCL clears all devices on the bus.

The 9872 plotter will react identically to the three commands DCL, SDC and IFC sent over the HP-IB Bus.

The command will be received by the plotter when it looks for the next input. It will not be received while a plotter is internally occupied such as while drawing characters or dashed lines.

Once received, these commands will cause the plotter to complete plotting points in progress, stop with pen up, and reset itself to accept new input. However, if the computer continues sending data the plotter will not appear to have stopped.

These commands are not intended to either stop a plot program or reinitialize the plotter.

## Serial and Parallel Polling

### The Serial Poll

A serial poll enables the computer to learn the status or condition of devices on the bus. It is commonly used by the computer to determine who is requesting service.

The serial poll is so named because the computer polls devices one at a time rather than all at once. When polled, a device transmits a single byte of information to indicate the status of the device. Bit 6 of this byte is set to 1 if a device is requesting service. A computer must issue special commands to initiate and terminate a serial poll. During a serial poll, a device must be instructed to talk and the computer to listen. Therefore a serial poll can not be executed when a plotter is in listen only mode.



The 9872 plotter responds to a serial poll by sending the same status byte that would be sent if the OS instruction were executed. If the seventh bit (Bit position 6) of this status byte is 0 the plotter has not requested service.

Unless the user changes the S-mask value from default setting of 0 the plotter will never give a positive response to a serial poll (see Input Mask, Chapter 6). Bit position 6 will be set to 1 if the S-mask value is not zero when any of the conditions designated by the S-mask are true.

### The Parallel Poll

The plotter can also respond to a parallel poll by sending a logical 1 on one of the 8 data lines. The line used is determined by the plotter's address value as shown in the table below:

Plotter Address	Parallel Poll Bit Position	HP-IB Data Line Number
0	7	8
1	6	7
2	5	6
3	4	5
4	3	4
5	2	3
6	1	2
7	0	1

← 9872 PRESET ADDRESS

The address settings from 8 thru 30 will not respond to a parallel poll.

To execute a parallel poll, the computer sets the ATN and EOI lines to 1, reads the eight data lines, and determines from these lines which instrument on the bus is requesting service.

It is important to remember that the 9872 will not send a logical one unless the P-mask bit value has been changed from the default value of zero and some condition included in the new P-mask value is true. The plotter can respond positively to a parallel poll in listen only mode.



# Chapter 7

## Scaling

This chapter describes the instructions that enable you to scale the plot into user units.

### The Input P1 and P2 Instruction IP

The input P1 and P2 instruction IP provides the means to relocate the scaling points P1 and P2 through program control.

Syntax:

```
IP P1x, P1y, P2x, P2y [; or LF]
```

The new coordinates of P1 and P2 are specified in the order shown above, must be in absolute plotter units, and also within platen maximum range X = 0, 16000, Y = 0, 11400.

Upon receipt of a valid IP command, bit position 1 of the output status word is set true (1). A command IP with no parameters (IP) will default to the values P1=520, 380 and P2 = 15720, 10380 on the 9872B or 9872S with the advance option off. On 9872S with the advance option on, P1 = 520, 1020 and P2 = 15760, 11180 in English mode and P1 = 520, 1140 and P2 = 15720, 11140 in metric mode.

Upon initialization, character size is set relative (SR) to the locations of P1 and P2. Unless an SI command has been entered as part of the program, the character size will be directly affected by the IP command.

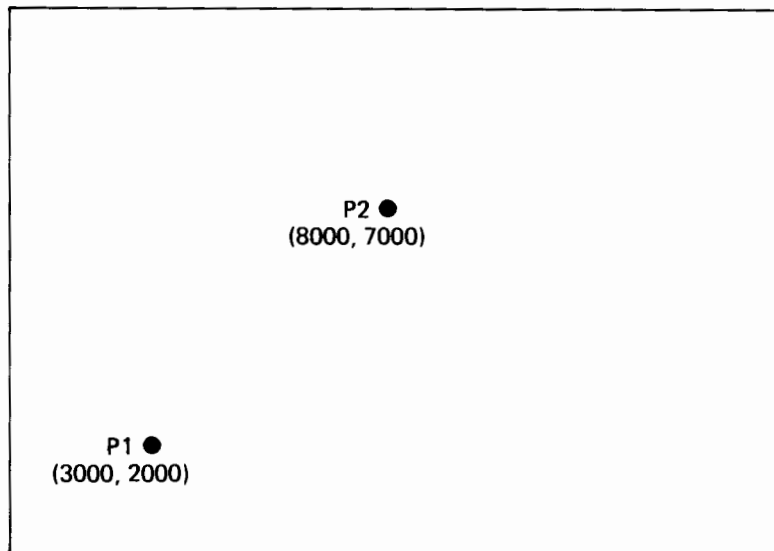
The following example using the 9835 relocates the scaling points P1 and P2 to the positions shown on the figure.

P1<sub>x</sub>   P1<sub>y</sub>   P2<sub>x</sub>   P2<sub>y</sub>

┆   ┆   ┆   ┆

┆   ┆   ┆   ┆

```
PRINT USING "K"; "IP3000,2000,8000,7000"
```



It may be desired to relocate the scaling points using front panel controls rather than a program instruction. An explanation of this method is included under Setting the Scaling Points, Chapter 1.

## The Output P1 and P2 Instruction OP

The output P1 and P2 instruction OP provides the means to make the current coordinates of the scaling points P1 and P2 (in absolute plotter units) available for output to the computer.

Syntax:

OP[ ; or LF]

No parameters are used, however the terminator ; or LF must be included to complete the command. This instruction should not be used in listen-only mode.

When the plotter is instructed to talk and the controller instructed to listen after an OP command, the plotter will output the coordinates in the following form:

P1<sub>x</sub>, P1<sub>y</sub>, P2<sub>x</sub>, P2<sub>y</sub>            CR            LF

Upon completion of output, bit position 1 of the output status word is cleared.

The following partial listing from a program using the 9835 demonstrates the use of the OP command:

```
40 PRINT USING "
K";"OP"
50 ENTER 7,5;A,B
,C,D
60 DISP A,B,C,D
```

Line 40 commands the plotter to output the new scaling points which may have been entered by front panel controls. It assumes the printer has been defined as the plotter.

Line 50 enters the new scaling points into the variables A, B, C, and D for further use in the program.

Line 60 displays the coordinates P1<sub>x</sub>, P1<sub>y</sub>, P2<sub>x</sub> and P2<sub>y</sub> on the screen.

## The Scale Instruction SC

The scale instruction enables you to assign convenient user unit values for the lower left, upper right coordinates of a plot without performing the mathematical conversion from plotter units to user units.

Syntax:

```
SC Xmin, Xmax, Ymin, Ymax [; or LF]
```

All four parameters are required and must be integers between -16384 and +16383.  $X_{max}$  must be greater than  $X_{min}$  and  $Y_{max}$  greater than  $Y_{min}$ . The parameters  $X_{min}$  and  $Y_{min}$  define the user-unit coordinates of P1; likewise,  $X_{max}$  and  $Y_{max}$  define the user-unit coordinates of P2.

The following program uses the SC command to scale the X axis into 30 units representing days and the Y axis into 100 units representing percent.

```

5   DIM P(30)
10  PRINT USING
    "K"; "SC -3,32,-
10,110"
20  FOR X=1 TO
30
30  P(X)=INT(RN
D*50+50)
40  NEXT X
50  PRINT USING
    "K"; "PA 0,0;PD"
60  FOR X=1 TO 30
70  PRINT USING
    "K"; "PR 1,0;XT"
80  NEXT X
90  PRINT USING
    "K"; "PU;PA 0,0;
PD"
100 FOR Y=1 TO
100 STEP 5
110 PRINT USING
    "K"; "PR 0,5;YT"
120 NEXT Y

```

Line 10  
P1 and P2 scaled -3,32 on X-axis and -10 to 110 on Y-axis which allows room to label graph.

Lines 20 – 40  
Data for this graph was generated randomly.

Lines 60 – 80  
Draw X-axis and ticks.

Lines 100 to 120  
Draw Y-axis and ticks.

```

125 PRINT USING
"K";"PU"
130 PRINT USING
"K";"PA-3,30;DI
0,1;LB% OF CAPAC
ITY"
140 PRINT USING
"K";"PA 13,-8;D
I1,0;LBDAY OF MO
NTH"
150 PRINT USING
"K";"PA 0,0"
160 FOR X=5 TO
30 STEP 5
165 IMAGE 2A,DD,
14A,DD,A
170 PRINT USING
165;"PA",X,"",-2
;CP-1,-1;LB",X,"
"
180 NEXT X

```

Lines 130 and 140 title axes.

Lines 160 to 180  
Label X-axis every 5 units.



```

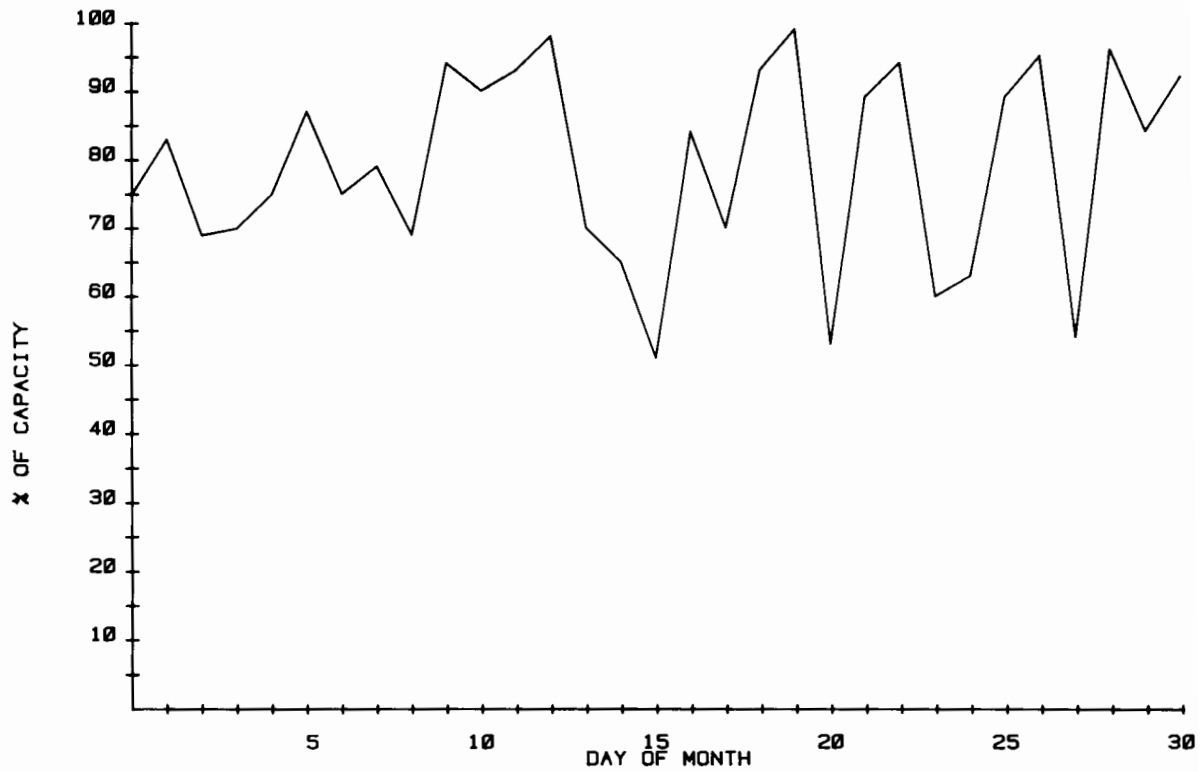
185 FOR Y=10 TO
100 STEP 10
186 IMAGE 4A,DDD
,11A,DDD,A
190 PRINT USING
186;"PA0,",Y,";
CP-5,0;LB",Y,""
200 NEXT Y
205 IMAGE 2A,DD,
A,DDD
207 PRINT USING
"K";"PA0,75;PD"
210 FOR X=1 TO
30
220 PRINT USING
205;"PA",X,"";
P(X)
230 NEXT X
240 PRINT USING
"K";"PU;SP0"
250 END!

```

Lines 185 to 200  
Label Y-axis every 10 units.

Lines 210 to 230 plot data.

The program results might represent industrial output as a percent of capacity for a 30-day month.



Under the SC instruction the PA and PR parameters are interpreted as integer user units and the minimum resolvable step is one unit. Any decimal units will be truncated. This truncation produces some unexpected, unsatisfactory results when trying to plot non-integer values. The following two examples illustrate the problem and its solution.



This is a program for drawing a circle in the center of the plotting area. In the first example the plotting area is scaled as a 25 x 18 unit area. The resolution of the plot cannot exceed 1 unit in 25. The result is an indiscernible plot.

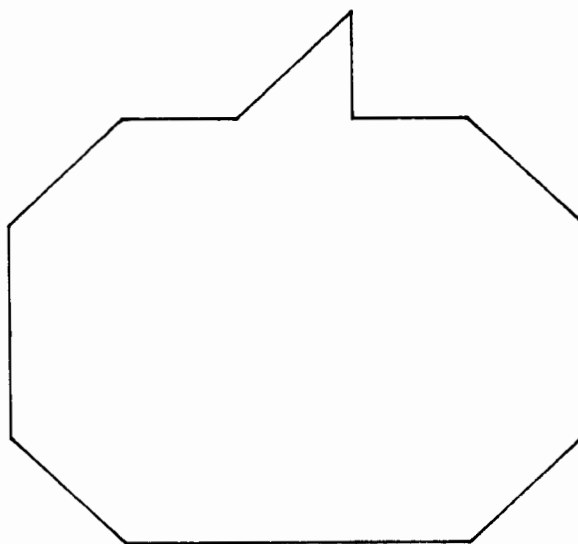
```

10 PRINT USING
  "K";"SC0,25,0,1
8"
15 IMAGE 2A,6D,A
,6D,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*COS(T
)+12.5
40 Y=2.5*SIN(T
)+9
50 PRINT USING
  15;"PA",X,"",Y
,;"PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END

```

Lines 30 and 40 add 12.5 to X and 9 to Y to center the plot in the scaled area.

X and Y are truncated to integers when plotted in line 50 using line 15 as the image statement.

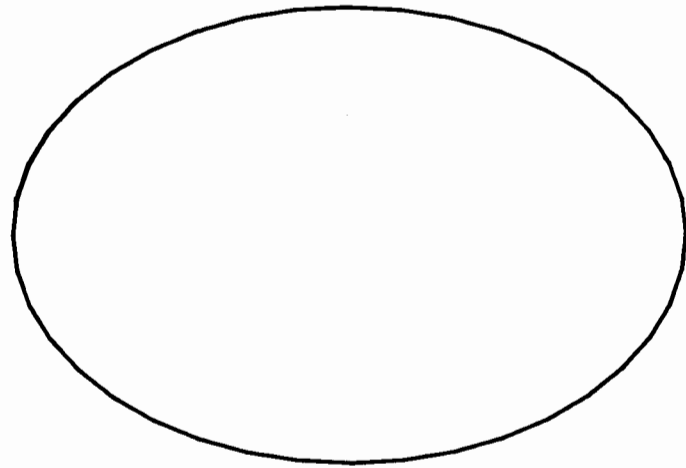


In the following example a constant of 1000 is used in both the scaling and the values of X and Y. Because the parameters in scaled mode must be between -16384 and +16383, we have changed the scale command to 16000 for  $X_{\max}$  and  $Y_{\max}$ . Note the offset to the center of the plot area has changed to correspond with the SC command (lines 30 and 40). The use of the multiplier 1000 solves the resolution problem.

```

10 PRINT USING
  "K";"SC0,16000,
0,16000"
15 IMAGE 2A,6D,A
,6D,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*1000*
COS(T)+8000
40 Y=2.5*1000*
SIN(T)+8000
50 PRINT USING
  15;"PA",X,",",Y
, ";PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END

```



Notice that the plot is not a circle. This is a result of the aspect ratio of the plotter ( $|P1_x - P2_x| \neq |P1_y - P2_y|$ ) and the parameters of the SC command. In the example above, which has been slightly reduced, P1 and P2 were the default values with the advance option off.

There are two ways to compensate for this distortion. The first is to define P1 and P2 so that the plotting area is square.

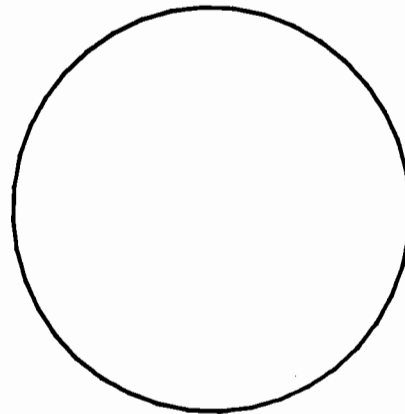
```

5 PRINT USING "K
";"IP1000,1000,1
0000,10000"
10 PRINT USING
  "K";"SC0,16000,
0,16000"
15 IMAGE 2A,6D,A
,6D,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*1000*
COS(T)+8000
40 Y=2.5*1000*
SIN(T)+8000
50 PRINT USING
  15;"PA",X,",",Y
, ";PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END

```

} Line 5 establishes a square plotting area.  
Each side being 9000 plotter units.

} Line 10 scales this area to sides of 16000  
user units.



We now plot a perfect circle.

The second method of solution is to use any scaling points but compensate for the aspect ratio either in the scaling instruction or the calculation of the X and Y variables.

#### Program 1

```

5 PRINT USING "K
";"IP"
10 PRINT USING
"K";"SC0,1520,0
,1000"
15 IMAGE 2A,60,A
,60,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*100*C
OS(T)+760
40 Y=2.5*100*S
IN(T)+500
50 PRINT USING
.15;"PA",X,";",Y
,;"PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END

```

Line 5 sets P1 and P2 to 520, 1140 and 15720, 11140 respectively, assuming the plotter is a 9872S in metric mode.

Line 10 sets 1 scaled unit = 10 plotter units (see line 5).

Lines 20 to 60 draw the circle — actually 40 line segments since step in line 20 is  $\pi/20$ .

The circle will be centered in the area defined by P1 and P2.

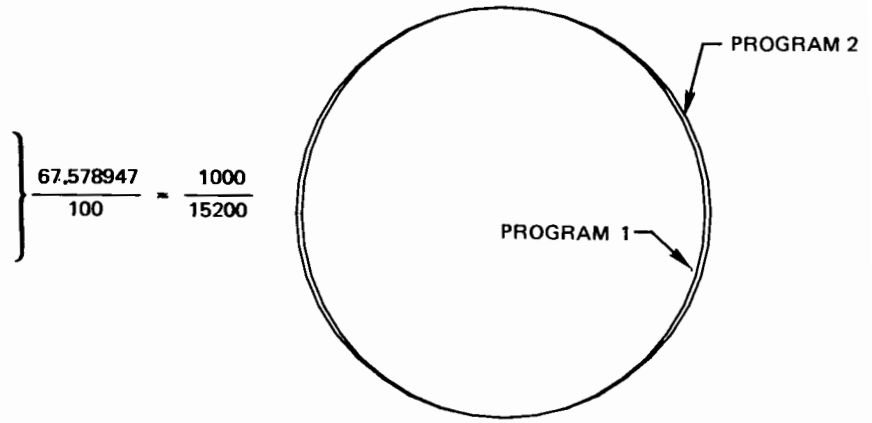
If the scale command sets an equal number of user units in the X and Y axis, the X or Y value must be adjusted to correspond with the aspect ratio when the plotting area is not square. Truncation produces a slightly different plot from the above circle in the X coordinates only.

**Program 2**

```

5 PRINT USING "K
";"IP"
10 PRINT USING
"K";"SC0,1000,0
,1000"
15 IMAGE 2A,6D,A
,6D,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*67.57
8947*COS(T)+500
40 Y=2.5*100*S
IN(T)+500
50 PRINT USING
15;"PA",X,"",Y
,";PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END
    
```

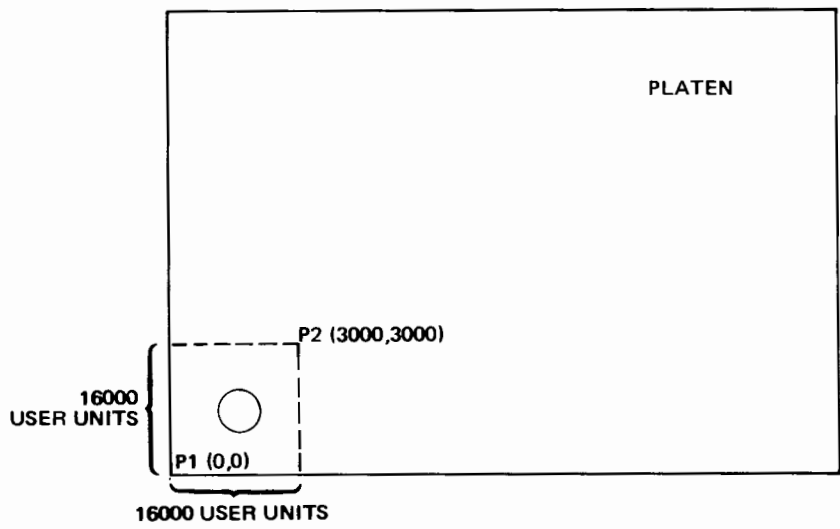
} Line 5 sets default P1 and P2, advance off so  $P1_x - P2_x = 15720 - 520 = 15200$  and  $|P1_y - P2_y| = 10380 - 380 = 10000$ .



Changing P1 and P2 with an IP command can move the plot to a different area of the platen and can change the plot size. If geometrically accurate plots are desired it is always necessary to adjust for a new P1 and P2 by changing the scale (SC) command or by scaling the X and Y values with a multiplier. The following listing plots a small circle in the lower-left-hand corner of the platen.

```

5 PRINT USING "K
";"IP0,0,3000,30
00"
10 PRINT USING
"K";"SC0,16000,
0,16000"
15 IMAGE 2A,6D,A
,6D,3A
20 FOR T=0 TO
2*PI STEP PI/20
30 X=2.5*1000*
COS(T)+8000
40 Y=2.5*1000*
SIN(T)+8000
50 PRINT USING
15;"PA",X,"",Y
,";PD"
60 NEXT T
70 PRINT USING "
K";"PU"
80 END
    
```



The following program is a rather complete plot using scaling. It will:

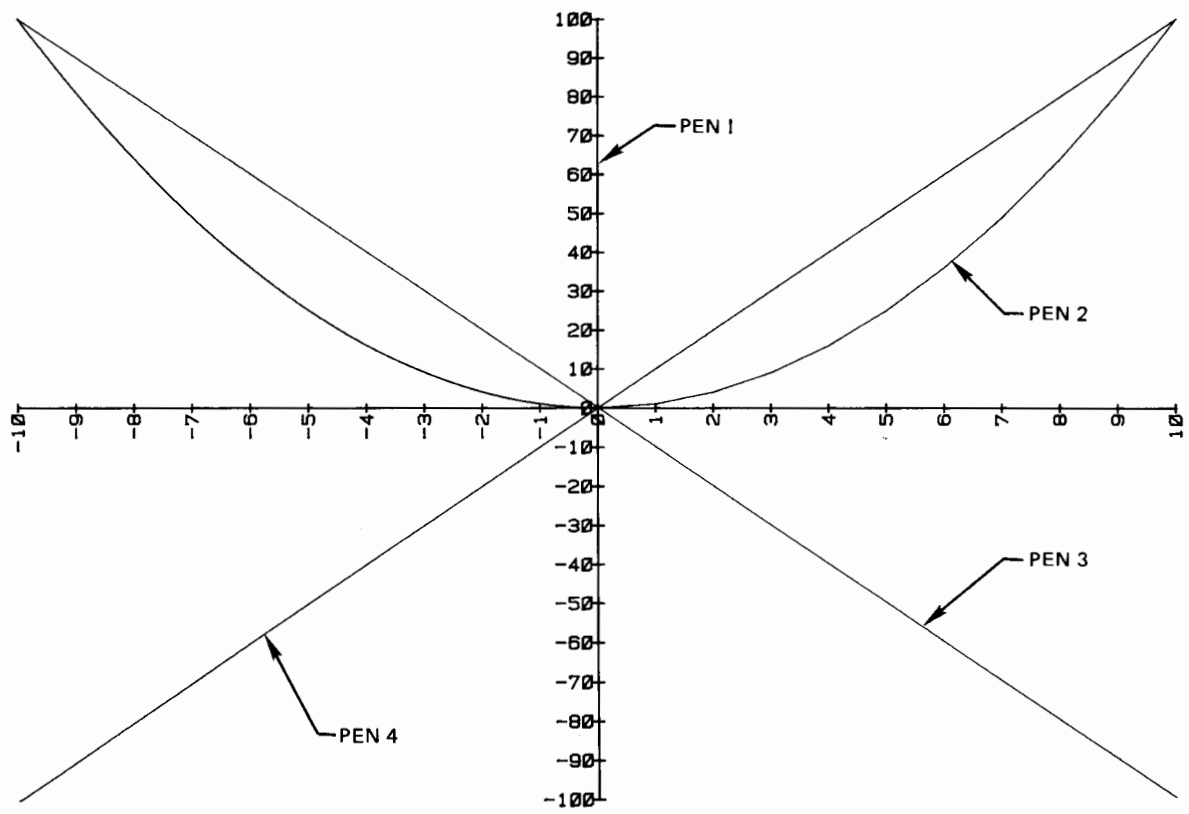
1. Draw, tick mark, and label the X axis centered on the page. Labeling and tick marks to be -10 to 10 in 1 unit increments.
2. Draw, tick mark, and label the Y axis centered on the page. Labeling and tick marks to be -100 to 100 in 10 unit increments.
3. Change the pen and draw the curve  $Y = X^2$  over the range  $0 \leq X \leq 10$  with 1 user unit resolution.
4. Change the pen and draw the line  $Y = -10X$  over the range  $-10 \leq X \leq 10$ .
5. Change the pen and draw the line  $Y = 10X$  over the range  $-10 \leq X \leq 10$ . Store the pen.
6. Change the pen and draw  $Y = X^2$  over the range  $-10 \leq X \leq 0$  with greater resolution than in 3 above. This is discernible on a full page plot.

```

1. { 10 PRINT USING "
    K";"SC-10,10,-10
    0,100"
    15 PRINT USING "
    K";"SP1"
    20 FOR X=-10 TO
    0 STEP 1
    30 IMAGE 2A,60,2
    9A,40,7A,60,5A
    40 PRINT USING
    30;"PA",X,"",0;X
    T;PU;DI0,1;CP-4.
    2,-.25;LB",X,";
    PU;PA",X,"",0;PD"
    50 NEXT X
    60 PRINT USING "
    K";"PU"
    70 FOR Y=-100
    TO 100 STEP 10
    80 IMAGE 4A,60,2
    7A,40,9A,60,3A
    90 PRINT USING
    80;"PA0",Y,"";Y
    T;PU;DI1,0;CP-4.
    2,-.25;LB",Y,";
    PU;PA0",Y,"";PD"
    100 NEXT Y
    105 PRINT USING
    "K";"SP2"
    110 PRINT USING
    "K";"PU"
    120 FOR X=0 TO
    10 STEP 1
    130 IMAGE 2A,30,
    A,40,3A
    140 PRINT USING
    130;"PA",X,"",
    X^2,";PD"
    150 NEXT X
    155 PRINT USING
    "K";"PU;SP3"
    160 FOR X=-10 TO
    10 STEP 1
    170 PRINT USING
    130;"PA",X,"",
    -10*X,";PD"
    180 NEXT X
    190 PRINT USING
    "K";"PU;SP4"
    200 FOR X=-10 TO
    10 STEP 1
    210 PRINT USING
    130;"PA",X,"",
    10*X,";PD"
    220 NEXT X
    225 PRINT USING
    "K";"SC-1000,100
    0,-1000,1000;SP2
    "
    230 FOR X=-1000
    TO 0 STEP 1
    235 IMAGE 2A,50,
    A,60,3A
    240 PRINT USING
    235;"PA",X,"",
    (X/10)^2/10,";PD"
    250 NEXT X
    260 PRINT USING
    "K";"SP0"
    999 END!PLOT

```

# 110 Scaling



There are two other implementations of scaling which may be of interest to the user. One involves use of an HP Graphics ROM or a software support package (controller dependent and available from your HP sales representative). Scaling with these plotting aids is accomplished with a scaling mnemonic, and aspect ratios and non-integers are handled automatically.

The second is use of algebraic formulas to convert from user to plotter units. Some users may wish to do this to compute desired window parameters without using output commands or to cope with non-integer data where it is difficult to figure a convenient multiplier. User units can be converted into plotter units by the computer using the following equations:

$$X \text{ scaled} = \left[ \frac{P2_x - P1_x}{U2_x - U1_x} \right] A_x + P1_x - U1_x \left[ \frac{P2_x - P1_x}{U2_x - U1_x} \right]$$

$$Y \text{ scaled} = \left[ \frac{P2_y - P1_y}{U2_y - U1_y} \right] A_y + P1_y - U1_y \left[ \frac{P2_y - P1_y}{U2_y - U1_y} \right]$$

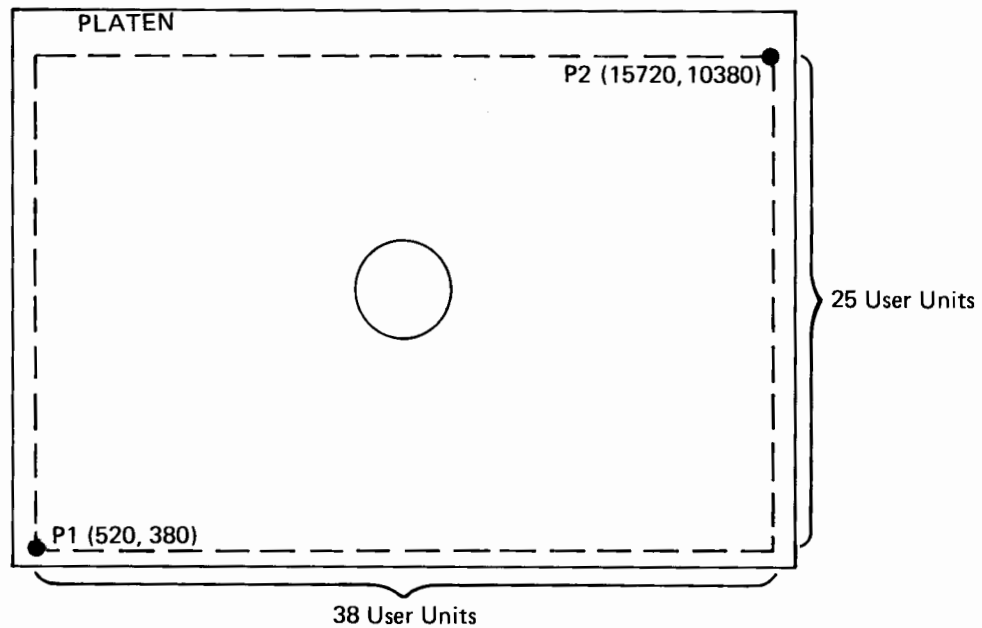
where:  $A_x$  is the X coordinate of the desired point in user units  
 $A_y$  is the Y coordinate of the desired point in user units  
 $P1_x$  is the X coordinate of P1 in plotter units  
 $P1_y$  is the Y coordinate of P1 in plotter units  
 $P2_x$  is the X coordinate of P2 in plotter units  
 $P2_y$  is the Y coordinate of P2 in plotter units  
 $U1_x$  is the X coordinate of P1 in user units  
 $U1_y$  is the Y coordinate of P1 in user units  
 $U2_x$  is the X coordinate of P2 in user units  
 $U2_y$  is the Y coordinate of P2 in user units

To demonstrate the use of the scaling equations, let's go through an example.

Example 1:

Problem

Scale the platen area ( $P1 = 520, 380$  and  $P2 = 15720, 10380$ ) into user units where  $P1 = 0, 0$  and  $P2 = 38, 25$  cm. At the center point ( $X = 19, Y = 12.5$  cm), draw a 2.5 cm radius circle as follows:



## Solution

- A. Recall that the equations of a circle are

$$X = R \cos t$$

$$Y = R \sin t$$

$$\text{where } 0 \leq t \leq 2\pi$$

- B. Since we are to plot relative to a point that is not at the origin, an offset  $X_O, Y_O$  must be added to the circle equations. The offset in user units is

$$X_O = 19$$

$$Y_O = 12.5$$

- C. The desired circle equations are then:

$$A_X = 2.5 \cos t + 19$$

$$A_Y = 2.5 \sin t + 12.5$$

- D. Determine the user scale:

$$X = 0 \text{ to } 38$$

$$Y = 0 \text{ to } 25$$

therefore

$$U1_X = 0$$

$$U1_Y = 0$$

$$U2_X = 38$$

$$U2_Y = 25$$



E. Determine the values for P1 and P2 which were set using the IP command.

$$P1 = 520, 380$$

$$P2 = 15720, 10380$$

therefore

$$P1_x = 520$$

$$P1_y = 380$$

$$P2_x = 15720$$

$$P2_y = 10380$$

F. Solving for X and Y:

$$\begin{aligned} X &= \left[ \frac{P2_x - P1_x}{U2_x - U1_x} \right] A_x + P1_x - U1_x \left[ \frac{P2_x - P1_x}{U2_x - U1_x} \right] \\ &= \left[ \frac{15720 - 520}{38 - 0} \right] [2.5 \cos t + 19] + 520 - 0 \left[ \frac{15720 - 520}{U2_x - U1_x} \right] \end{aligned}$$

$$= 400 (2.5 \cos t + 19) + 520 - 0$$

$$= 1000 \cos t + 8120$$

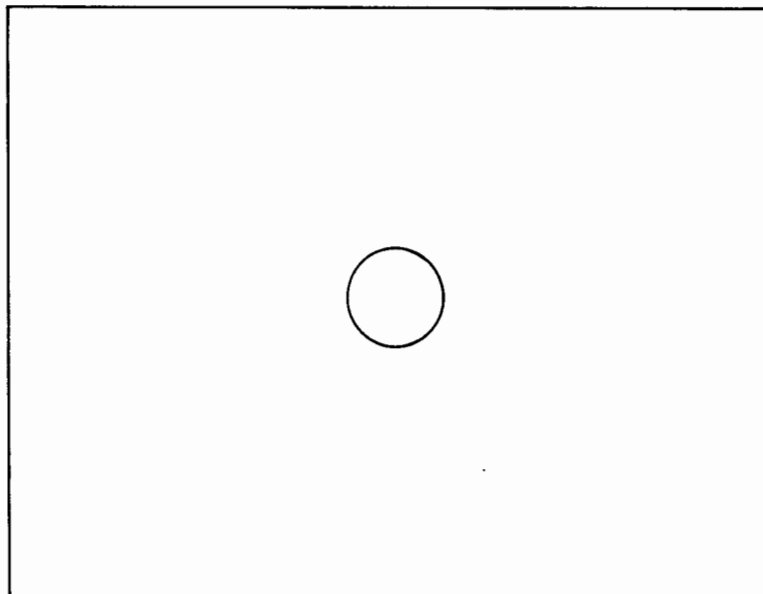
$$\begin{aligned} Y &= \left[ \frac{P2_y - P1_y}{U2_y - U1_y} \right] A_y + P1_y - U1_y \left[ \frac{P2_y - P1_y}{U2_y - U1_y} \right] \\ &= \left[ \frac{10380 - 380}{25 - 0} \right] [2.5 \sin t + 12.5] + 380 - 0 \left[ \frac{10380 - 380}{25 - 0} \right] \end{aligned}$$

$$= 400 (2.5 \sin t + 12.5) + 380 - 0$$

$$= 1000 \sin t + 5380$$

- G. Putting this all together, the following program using the 9835 will plot the required circle using sheet paper and default P1 and P2.

```
520 PRINT USING
"K";"IP;SP1"
530 FOR T=0*PI T
0 2*PI STEP PI/2
0
540 X=1000*COS(T
)+8120
550 Y=1000*SIN(T
)+5380
555 IMAGE 2A,6D,
A,6D,3A
560 PRINT USING
555;"PA";X,"";Y
,";PD"
570 NEXT T
580 PRINT USING
"K";"PU;SP0"
590 END
```



This program could be modified to use a subroutine to do the job of scaling. In this case, the equations in lines 540 and 550 would be programmed in user units and line 560 is replaced by a "GOSUB" statement. The subroutine at line 9000 scales and plots the circle. This listing is the same program as on the previous page except in 9830A format.

```

510 CMD "?U%"
520 OUTPUT (13,*)"SP1"
530 FOR T=0*PI TO 2*PI STEP PI/20
540 X=2.5*COST+19
550 Y=2.5*SINT+12.5
560 GOSUB 9000
570 NEXT T
580 OUTPUT (13,*)"PU:SP0"
590 END
9000 CMD "?U%","OP:"
9010 CMD "?E5"
9020 ENTER (13,9030)X1,Y1,X2,Y2
9025 CMD "?U%"
9030 FORMAT 4F6.0
9040 A=((X2-X1)/(38-0))*X+X1
9050 B=((Y2-Y1)/(25-0))*Y+Y1
9060 OUTPUT (13,9070)"PA",A," ";B,"PD"
9070 FORMAT 2F6.0
9080 RETURN

```



Lines 9000 through 9030 send the values of  $P1_x$ ,  $P1_y$ ,  $P2_x$ ,  $P2_y$  to the calculator and assign them to the variables  $X1$ ,  $Y1$ ,  $X2$ ,  $Y2$  respectively. Lines 9040 and 9050 are the scaling equations. This approach is usable for any  $P1$  and  $P2$  since they are entered at execution time.



Chapter **8**

# Automatic Paper Advance

The instructions in this chapter pertain only to the 9872S plotter which has automatic paper advance.

## The Advance Full Page Instruction AF

The advance full page instruction AF causes the paper to advance one full page.

Syntax:

```
AF [; or LF]
or
PG [; or LF]
or
PG1 [; or LF]
```

No parameters are used (PG1 is the only exception), however the terminator ; or LF must be included to complete the command.

When the advance option is off, executing this instruction causes an error condition to be set (error 8). The advance option is off if sheet paper is being used, roll paper is not properly loaded, or the plotter is a 9872B.

When the advance option is on, the paper advances one full page, measured from the left edge of the platen at the time of the advance command was initiated. This is 17 inches in English mode or 420 mm in metric mode.

If the cutter is on, the paper is cut along what was the left edge of the platen at the time the advance command was initiated. Lack of paper at the completion of an AF command will set the error condition (error 8). PG and PG1 are included to maintain compatibility with other Hewlett-Packard systems.

## The Advance Half Page Instruction AH

The advance half page AH instruction causes the paper to advance one half page.

Syntax:

```
AH[; or LF]
```

No parameters are used, however the terminator ; or LF must be included to complete the instruction.

When the advance option is off, executing this instruction causes an error condition to be set (error 8). When the advance option is on, the paper advances one half page measured from the left edge of the platen at the time the advance command was initiated. A half page is 8½ inches (216 mm) in English mode or 210 mm in metric mode.


If the cutter is on, the paper is cut along what was the left edge of the platen at the time the advance command was initiated. Lack of paper at the completion of an AH command will set the error condition (error 8).

## The Enable Cutter Instruction EC

The enable cutter instruction EC turns the cutter on and off.

Syntax:

```
EC(int) [; or LF]
```

An EC command with no parameter ( EC; ) turns the cutter on and the lamp in the front panel  switch is turned on.

An EC command with integer parameter turns the cutter off and the lamp in the switch goes off. Zero is the recommended parameter to disable the cutter.

If the cutter is already on, the EC command with no parameters has no effect.

# Appendix

## Binary Coding and Conversions

Binary is a base 2 number system using only 1's and 0's. By giving the 1's and 0's positional value, any decimal number can be represented. For example, this diagram shows how decimal 41 = binary 101001:

Decimal			Binary							
$4 \times 10^1$	+	$1 \times 10^0$	$1 \times 2^5$		$0 \times 2^4$		$1 \times 2^3$	$0 \times 2^2$	$0 \times 2^1$	$1 \times 2^0$
↓		↓	↓		↓		↓	↓	↓	↓
40	+	1	32	+	0	+	8	0	2	1
41 <sub>10</sub>			1 0 1 0 0 1 <sub>2</sub>							

### Binary-Decimal Conversions

To convert from binary to decimal, the positional values of the 1's are added up. From the above example this would be:

$$2^5 + 2^3 + 2^0 = 32 + 8 + 1 = 41$$

To convert from decimal to binary, the decimal number is repeatedly divided by 2. The remainder is the binary equivalent. For example:

		Remainder (read up)
2	$\overline{41}$	→ 1
2	$\overline{20}$	→ 0
2	$\overline{10}$	→ 0
2	$\overline{5}$	→ 1
2	$\overline{2}$	→ 0
2	$\overline{1}$	→ 1

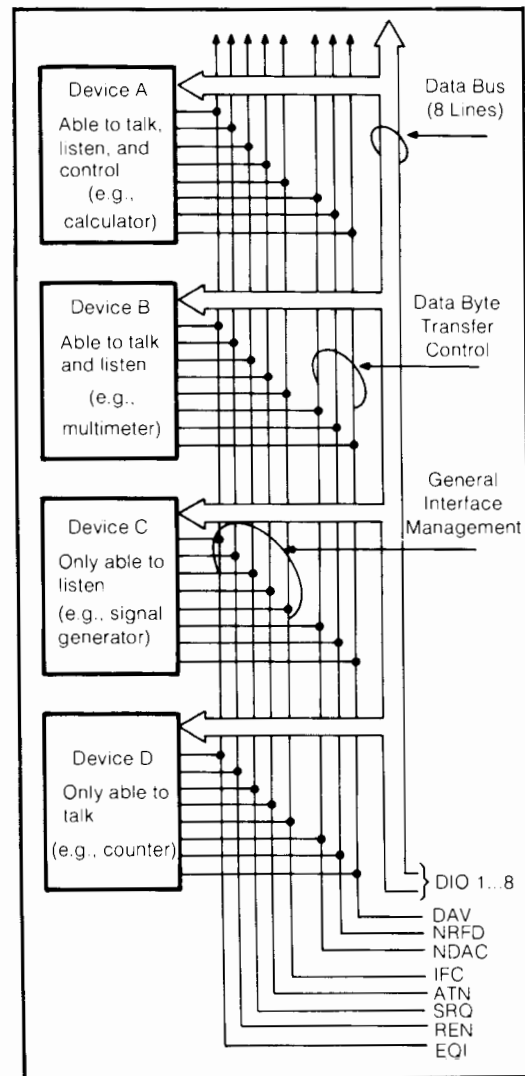
## The HP Interface Bus

This section provides a brief overview of the HP-IB hardware and control scheme. Sufficient information is provided to obtain an understanding of operation via HP-IB. For a more detailed explanation of HP-IB from a controller's standpoint, refer to the system controller operating manual.

### HP-IB Lines and Operations

The HP Interface Bus transfers data and commands between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the systems. The cables connect all instruments, controllers, and other components of the system in parallel to the signal lines.

The eight Data I/O lines (DIO1 thru DIO8) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines: Data Valid (DAV), Not Ready For Data (NRFD), and Not Data Accepted (NDAC). The other five lines are for management of bus activity. See the figure on the right.



HP-IB Signal Lines



Devices connected to the bus may be talkers, listeners, or controllers. The controller dictates the roll of each of the other devices by setting the ATN (attention) line true and sending talk or listen addresses on the data lines. Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a PC board. While the ATN line is true, all devices must listen to the data lines. When the ATN line is false, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

Several listeners can be active simultaneously but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers will be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three handshake lines (DAV, NRD and NDAC). No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

The ATN line is one of the five bus management lines. When ATN is true, addresses and universal commands are transmitted on only seven of the data lines using the ASCII code. When ATN is false, any code of 8 bits or less understood by both talker and listener(s) may be used.

The IFC (interface clear) line places the interface system in a known quiescent state via the Abort message.

The REN (remote enable) line is used with the Remote, Local, and Clear Lockout/Set Local messages to select either local or remote control of each device.

Any active device can set the SRQ (service request) line true via the Require Service message. This indicates to the controller that some device on the bus wants attention, say a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

The EOI (end or identify) line is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines true, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

In the interest of cost-effectiveness, it is not necessary for every device to be capable of responding to all the lines. Each can be designed to respond only to those lines that are pertinent to its function on the bus.

The operation of the interface is generally controlled by one device equipped to act as controller. The interface uses a group of commands to direct the other instruments on the bus in carrying out their functions of talking and listening.

The controller has two ways of sending interface messages. Multi-line messages, which cannot exist concurrently with other multi-line messages, are sent over the eight data lines and the three handshake lines. Uni-line messages are transferred over the five individual lines of the management bus.

The commands serve several different purposes:

- Addresses, or talk and listen commands, select the instruments that will transmit and accept data. They are all multi-line messages.
- Universal commands cause every instrument equipped to do so to perform a specific interface operation. They include multi-line messages and three uni-line commands: interface clear (IFC), remote enable (REN), and attention (ATN).
- Addressed commands are similar to universal commands, except that they affect only those devices that are addressed and are all multi-line commands. An instrument responds to an addressed command, however, only after an address has already told it to be talker or listener.
- Secondary commands are multi-line messages that are always used in series with an address, universal command, or addressed command (also referred to as primary commands) to form a longer version of each. Thus they extend the code space when necessary.

To address an instrument, the controller uses seven of the eight data-bus lines. This allows instruments using the ASCII 7-bit code to act as controllers. As shown in the table, five bits are available for addresses, so a total of 31 addresses are available in one byte. If all secondary commands are used to extend this into a two-byte addressing capability, 961 addresses become available (31 addresses in the second byte for each of the 31 in the first byte).

## Command and Address Codes

Code Form								Meaning	
X	0	0	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	Universal Commands	
X	0	1	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	Listen Addresses	
			except						
X	0	1	1	1	1	1	1	Unlisten Command	
X	1	0	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	Talk Addresses	
			except						
X	1	0	1	1	1	1	1	Untalk Command	
X	1	1	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	Secondary Commands	
			except						
X	1	1	1	1	1	1	1	Ignored	

Code used when attention (ATN) is true (low).

X = don't care



## Interface Functions

Interface functions provide the physical capability to communicate via HP-IB. These functions are defined in the IEEE Standard 488-1975. This standard, which is the designer's guide to the bus, defines each interface function in terms of state diagrams that express all possible interactions.

Bus capability is grouped under 10 interface functions, for example: Talker, Listener, Controller, Remote/Local. The following table lists the functions.

HP-IB Interface Functions	
Mnemonic	Interface Function Name
SH	Source Handshake
AH	Acceptor Handshake
T	Talker (or TE = Extended Talker)*
L	Listener (or LE = Extended Listener)*
SR	Service Request
RL	Remote Local
PP	Parallel Poll
DC	Device Clear
DT	Device Trigger
C	Any Controller
C <sub>N</sub>	A specific Controller (for example: C <sub>A</sub> , C <sub>B</sub> ...)
C <sub>S</sub>	The System Controller

\*Extended talkers and listeners use a two-byte address. Otherwise, they are the same as Talker and Listener.

Since interface functions are the physical agency through which bus messages are implemented, each device must implement one or more functions to enable it to send or receive a given bus message.

The following table lists the functions required to implement each bus message. Each device's operating manual lists the functions implemented by that device. Some devices, such as the 98034A Interface, list the functions implemented directly on the device.

Functions Used By Each Bus Message

Bus Message	Functions Required sender function → receiver function(s) (support functions)
Data	T→L* (SH, AH)
Trigger	C→DT* (L, SH, AH)
Clear	C→DC* (L, SH, AH)
Remote	C <sub>S</sub> →RL* (SH, AH)
Local	C→RL* (L, SH, AH)
Local Lockout	C→RL* (SH, AH)
Clear Lockout/Set Local	C <sub>S</sub> →RL*
Require Service	SR*→C
Status Byte	T→L* (SH, AH)
Status Bit	PP*→C
Pass Control	C <sub>A</sub> →C <sub>B</sub> (T, SH, AH)
Abort	C <sub>S</sub> →T,L*C

\*Since more than one device can receive (or send) this message simultaneously, each device must have the function indicated by an \*

## HP 9872 HP-IB Implementation

1. Functions implemented (IEEE STD 488-1975)
  - a. Source Handshake (SH1)
  - b. Acceptor Handshake (AH1)
  - c. Talker (T2) Serial Poll
  - d. Listener (L2)
  - e. Service Request (SR1)
  - f. No Remote Local (RL0)
  - g. Parallel Poll (PP2)
  - h. Device Clear (DC1)
  - i. No Device Trigger (DT0)
  
2. Device Clear or Selected Device Clear causes the plotter to:
  - a. Complete the present vector then stop with the pen up.
  - b. Reset parser to expect next instruction
  
3. PPRN for parallel poll is assigned by the rear panel address switch. Listen addresses zero through 7 assign DIO lines 8 – 1 respectively. All other listen addresses disable parallel poll.

## Plotter Default Conditions

Relative character direction	Horizontal (DR1,0)
Line type	Solid line
Line pattern length	4% of the distance from P1 to P2
Input window	Total platen area
Relative character size	.75% of $ P2_x - P1_x $ x 1.5% of $ P2_y - P1_y $
Automatic pen pickup	On
Pen velocity	36 cm/s
Adaptive pen velocity	Off
Symbol mode	Off
Tick length	.5% of $ P2_x - P1_x $ or $ P2_y - P1_y $
Standard character set	Set 0 (Set 1 for device clear)
Alternate character set	Set 0
Character slant	0°
Mask value	223,0,0
Digitize clear	On
Scaling	Off

P1 and P2 are changed only with the initialize command (IN). They are not affected by device clear and the default command (DF).

The pen is raised by device clear. On the 9872S the cutter is enabled only with the initialize command (IN). It is not affected by device clear and the default command (DF).

The current pen location is moved to the lower right corner with the initialize command (IN) but is unaffected by device clear and the default command (DF).

## Error Messages

- error 1      Instruction not recognized  
The plotter has received an illegal character sequence.
- error 2      Wrong number of parameters  
Too many or too few parameters have been sent with an instruction.
- error 3      Bad parameter  
The parameters sent to the plotter with an instruction are out of range for that instruction.
- error 4      Illegal character  
The character specified as a parameter is not in the allowable set for that instruction.
- error 5      Unknown character set  
A character set out of the range 0 thru 4 has been designated as either the standard or alternate character set.
- error 6      Position overflow  
An attempt to draw a character or perform a CP that is located outside of the plotter's numeric limit of -32768 to +32767.
- error 8      Out of paper  
Either the advance option is off when an AH or AF is attempted or the out-of-paper sensor indicates no paper after an advance.

# Syntax and Formulas

This section lists the formal syntax for each plotter instruction.

## Parameter Range Restrictions

The range of each parameter is listed with the syntax for each instruction.

## Vector Group

### Plot Absolute Instruction PA

PA  $X_1$  coordinate,  $Y_1$  coordinate (,  $X_2$  coordinate,  $Y_2$  coordinate, . . . , . . . ,  
 $X_n$  coordinate,  $Y_n$  coordinate) [; or LF]

X and Y coordinates must be integers and are limited to the range -32768 to +32767 with scaling off and -16384 to +16383 with scaling on.

### Plot Relative Instruction PR

PR  $X_1$  increment,  $Y_1$  increment (,  $X_2$  increment,  $Y_2$  increment, . . . , . . . ,  $X_n$   
increment,  $Y_n$  increment) [; or LF]

X and Y increments must be integers and are limited to values between -32768 and +32767 with scaling off and -16383 with scaling on. Result of adding increment to current X and Y pen position must be between -32768 and +32767 plotter units when referenced from platen point 0,0 with scaling off and -16384 and +16383 with scaling on.

### Pen Instructions PD and PU

PD [; or LF]

or

PU [; or LF]

Parameters are not used.



## Character Group

### Designate Alternate Character Set Instruction CA

CA 0 through 4 [; or LF]

If the parameter is omitted, default value is assumed.

### Character Plot Instruction CP

CP number of character space widths, number of character space heights [; or LF]

Both parameters must be within the range  $\pm 127.999$ . Decimal portion is optional.

### Designate Standard Character Set Instruction CS

CS 0 through 4 [; or LF]

If the parameter is omitted, default value is assumed.

### Absolute Direction Instruction DI

DI run, rise [; or LF]

Both parameters must be in the range of  $\pm 127.999$ . If the parameters are omitted, default values are assumed.

### Relative Direction Instruction DR

DR run as % of  $|P2_x - P1_x|$ , rise as % of  $|P2_y - P1_y|$

Both parameters must be in the range of  $\pm 127.999$ . If the parameters are omitted, default values are assumed. Parameters  $> 1$  or  $< -1$  preferred.

## Label Instruction LB

LB any combination of text, expressions, or string variables [E,T,X]

## Select Alternate Character Set Instruction SA

SA [; or LF]

Parameters are not used.

## Absolute Character Size Instruction SI

SI width, height [; or LF]

Both parameters must be in the range of  $\pm 127.999$ . If the parameters are omitted, default values are assumed.

## Character Slant Instruction SL

SL decimal number [; or LF]

Decimal number must be in the range of  $\pm 127.999$ . If the parameter is omitted, default value is assumed.

## Relative Character Size Instruction SR

SR width as % of  $|P2_X - P1_X|$ , height as % of  $|P2_Y - P1_Y|$

Both parameters must be in the range of  $\pm 127.999$ . If the parameters are omitted, default values are assumed.

## Select Standard Character Set Instruction SS

SS [; or LF]

Parameters are not used.

## User Defined Character Instruction UC

UC (pen control parameter,) X increment, Y increment,  
(pen control parameter,) (X increment, Y increment,)  
.... [; or LF]

Pen control parameter must be an integer

+99 = pen down

-99 = pen up

X and Y increments can range from -98 to +98 character grid units.



## Line Type Group

### Line Type Instruction LT

LT pattern number (, pattern length) [; or LF]

The range of pattern number is 0 through 6 and the range of pattern length is  $\pm 127.999$ .

If the parameters are omitted, default values are assumed.

### Symbol Mode Instruction SM

SM character [; or LF]

Character is limited to the centered characters of the character set chosen. If the parameter is omitted, default value is assumed.

## Pen Select Instruction SP

SP pen number [; or LF]

The range of the pen number is 0 through 4.

## Adaptive Pen Velocity Instruction VA

VA [; or LF]

Parameters are not used.

## Normal Velocity Instruction VN

VN [; or LF]

Parameters are not used.

## Velocity Select Instruction VS

VS 1 through 36 (, pen number) [; or LF]

The pen velocity parameter must be an integer in the range of 1 through 36. The pen number an integer in the range 1 through 4. If no parameters are specified, default values are assumed.

## Digitize Group

### Digitize Clear Instruction DC

DC [; or LF]

Parameters are not used. DC should not be used in listen-only mode.

## Digitize Point Instruction DP

DP [; or LF]

Parameters are not used. DP should not be used in listen-only mode.

## Output Digitized Point and Pen Status Instruction OD

OD [; or LF]

Parameters are not used. OD should not be used in listen-only mode.

## Axes Group

### Tick Length Instruction TL

TLtp (,tn) [; or LF]

Both parameters must be in the range of  $\pm 127.999$ . If both parameters are omitted, default values are assumed.

### Tick Instructions XT and YT

XT [; or LF]

or

YT [; or LF]

Parameters are not used.

## Setup Group

### Input P1 and P2 Instruction IP

IP P1<sub>x</sub>, P1<sub>y</sub>, P2<sub>x</sub>, P2<sub>y</sub> [; or LF]

Parameters must be in the range of -32768 to +32767. If the parameters are omitted, default values are assumed.

### The Input Window Instruction IW

IW X lower left, Y lower left, X upper right, Y upper right [; or LF]

X parameters must be in the range of 0 to +16000 and Y parameters must be in the range of 0 to +11400.

### Output P1 and P2 Instruction OP

OP [; or LF]

Parameters are not used.

### Scale Instruction SC

SC X<sub>min</sub>, X<sub>max</sub>, Y<sub>min</sub>, Y<sub>max</sub> [; or LF]

Defines user units for plotting area. All four parameters must be entered and be in the range -16384 to +16383.

## Configuration and Status Group

### Automatic Pen Pickup Instruction AP

AP[; or LF]

An integer parameter disables automatic pen pickup.

### Default Instruction DF

DF[; or LF]

Parameters are not used.

### The Input Mask Instruction IM

IME-mask value (, S-mask value (, P-mask value)) [; or LF]

The parameters must be in the range of 0 through 255. If the parameters are omitted, default values are assumed.

### The Initialize Instruction IN

IN[; or LF]

Parameters are not used.

### Output Actual Position and Pen Status Instruction OA

OA[; or LF]

Parameters are not used. OA should not be used in listen-only mode.

## Output Commanded Position and Pen Status Instruction OC

OC[; or LF]

Parameters are not used. OC should not be used in listen-only mode.

## Output Error Instruction OE

OE[; or LF]

Parameters are not used. OE should not be used in listen-only mode.

## Output Factors Instruction OF

OF[; or LF]

Parameters are not used. OF should not be used in listen-only mode.

## Output Identification Instruction OI

OI[; or LF]

Parameters are not used. OI should not be used in listen-only mode.

## Output Options Instruction OO

OO[; or LF]

Parameters are not used. OO should not be used in listen-only mode.

## Output Status Instruction OS

OS[; or LF]

Parameters are not used. OS should not be used in listen-only mode.



## Paper Advance Group

### Advance Full Page Instruction AF

AF [; or LF] or PG [; or LF] or PG1 [; or LF]

Parameters are not used. These instructions are not usable on the 9872B plotter.

### Advance Half Page Instruction AH

AH [; or LF]

Parameters are not used. AH is not usable on the 9872B plotter.

### Enable Cutter Instruction EC

EC (int) [; or LF]

EC with no parameter enables the cutter. Zero is the only recommended parameter to disable cutter.

EC is not usable on the 9872B plotter.

## ASCII Character Codes

Binary is often used as a code to represent not only numbers, but also alphanumeric characters such as "A" or "," or "?" or "x" or "2". One of the most common binary codes used is ASCII<sup>1</sup>. ASCII is an eight-bit code, containing seven data bits and one parity bit. The plotter uses ASCII for most I/O operations. The parity bit is ignored by the plotter. For example:

<u>Character</u>	<u>ASCII Binary Code</u>	<u>ASCII Decimal Code</u>
A	01000001	65
B	01000010	66
?	00111111	63

A complete list of ASCII characters and their octal and decimal representations is given next.

<sup>1</sup>American Standard Code for Information Interchange.

Plotter ASCII Code Definitions

Decimal Code	ASCII Character	9872 Function/Character Set				
		Set 0	Set 1	Set 2	Set 3	Set 4
0	NULL					Error 4 Generated
1	SOH					Error 4 Generated
2	STX					Error 4 Generated
3	ETX					End Label Instruction
4	ETO					Error 4 Generated
5	ENQ					Error 4 Generated
6	ACK					Error 4 Generated
7	BEL					No Operation (NOP)
8	BS					Backspace
9	HT					NOP
10	LF					Line Feed
11	VT					Inverse Line Feed
12	FF					NOP
13	CR					Carriage Return
14	SO					Select Alternate Character Set
15	SI					Select Standard Character Set
16	DLE					Error 4 Generated
17	DC1					NOP
18	DC2					NOP
19	DC3					NOP
20	DC4					NOP
21	NAK					Error 4 Generated
22	SYN					Error 4 Generated
23	ETB					Error 4 Generated
24	CAN					Error 4 Generated
25	EM					Error 4 Generated
26	SUB					Error 4 Generated
27	ESC					Error 4 Generated
28	FS					Error 4 Generated
29	GS					Error 4 Generated
30	RS					Error 4 Generated
31	US					Error 4 Generated
32	SP					Space
33	!	!	!	!	!	!
34	"	"	"	"	"	"
35	#	#	#	£	£	¢
36	\$	\$	\$	\$	\$	\$
37	%	%	%	%	%	%
38	&	&	&	&	&	&
39	,	,	,	,	,	,
40	(	(	(	(	(	(
41	)	)	)	)	)	)
42	*	*	*	*	*	*
43	+	+	+	+	+	+
44	,	,	,	,	,	,
45	-	-	-	-	-	-
46	.	.	.	.	.	.
47	/	/	/	/	/	/
48	Ø	Ø	Ø	Ø	Ø	Ø
49	1	1	1	1	1	1
50	2	2	2	2	2	2
51	3	3	3	3	3	3
52	4	4	4	4	4	4

NOTE: Characters offset to the left have the automatic backspace feature.

Plotter ASCII Code Definitions (Continued)

Decimal Code	ASCII Character	9872 Function/Character Set				
		Set 0	Set 1	Set 2	Set 3	Set 4
53	5	5	5	5	5	5
54	6	6	6	6	6	6
55	7	7	7	7	7	7
56	8	8	8	8	8	8
57	9	9	9	9	9	9
58	:	:	:	:	:	:
59	;	:	:	:	:	:
60	<	<	<	<	<	<
61	=	=	=	=	=	=
62	>	v	v	v	v	v
63	?	?	?	?	?	?
64	@	@	@	@	@	@
65	A	A	A	A	A	A
66	B	B	B	B	B	B
67	C	C	C	C	C	C
68	D	D	D	D	D	D
69	E	E	E	E	E	E
70	F	F	F	F	F	F
71	G	G	G	G	G	G
72	H	H	H	H	H	H
73	I	I	I	I	I	I
74	J	J	J	J	J	J
75	K	K	K	K	K	K
76	L	L	L	L	L	L
77	M	M	M	M	M	M
78	N	N	N	N	N	N
79	O	O	O	O	O	O
80	P	P	P	P	P	P
81	Q	Q	Q	Q	Q	Q
82	R	R	R	R	R	R
83	S	S	S	S	S	S
84	T	T	T	T	T	T
85	U	U	U	U	U	U
86	V	V	V	V	V	V
87	W	W	W	W	W	W
88	X	X	X	X	X	X
89	Y	Y	Y	Y	Y	Y
90	Z	Z	Z	Z	Z	Z
91	[	[	[	[	Ø	[
92	\	\	f	φ	Æ	
93	]	]	J	J	ø	]
94	)	,	↑	,	*	,
95						
96	'	'	'	'	'	'
97	a	α	α	α	α	α
98	b	β	β	β	β	β
99	c	γ	γ	γ	γ	γ
100	d	δ	δ	δ	δ	δ
101	e	ε	ε	ε	ε	ε
102	f	φ	φ	φ	φ	φ
103	g	ψ	ψ	ψ	ψ	ψ
104	h	η	η	η	η	η
105	i	ι	ι	ι	ι	ι
106	j	κ	κ	κ	κ	κ
107	k	λ	λ	λ	λ	λ

Plotter ASCII Code Definitions (Continued)

Decimal Code	ASCII Character	9872 Function/Character Set				
		Set 0	Set 1	Set 2	Set 3	Set 4
108	l	l	l	l	l	l
109	m	m	m	m	m	m
110	n	n	n	n	n	n
111	o	o	o	o	o	o
112	p	p	p	p	p	p
113	q	q	q	q	q	q
114	r	r	r	r	r	r
115	s	s	s	s	s	s
116	t	t	t	t	t	t
117	u	u	u	u	u	u
118	v	v	v	v	v	v
119	w	w	w	w	w	w
120	x	x	x	x	x	x
121	y	y	Y	Y	Y	Y
122	z	z	Z	Z	Z	Z
123	<	<	π	•	•	•
124	!	!	T	•	•	•
125	}	}	↑	•	•	•
126	~	~	~	•	•	•
127	DEL			Error 4 Generated		



# SALES OFFICES

Arranged alphabetically by country

## ANGOLA

Telectra  
Empresa Técnica de Equipamentos  
Eléctricos, S.A.R.L.  
R. Barbosa Rodrigues,  
41-1° DT. °  
Caixa Postal, 6487

## Luanda

Tel: 35515/6

## ARGENTINA

Hewlett-Packard Argentina S.A.  
Santa Fe 2035, Martinez  
6140 **Buenos Aires**  
Tel: 792-1239, 798-6086  
Telex: 122443 AR CIGY

Biotron S.A.C.I.y M.

Avda. Paseo Colon 221

9 piso

1399 **Buenos Aires**

Tel: 30-4846/1851/8384

34-9356/0460/4551

Telex: (33) 17595 BIO AR

## AUSTRALIA

### AUSTRALIA CAPITAL TERR.

Hewlett-Packard Australia Pty. Ltd.  
121 Wollongong Street  
**Fyshwick, 2609**  
Tel: 804244  
Telex: 62650

### NEW SOUTH WALES

Hewlett-Packard Australia Pty. Ltd.  
31 Bridge Street  
**Pymble, 2073**  
Tel: 4496566  
Telex: 21561

## QUEENSLAND

Hewlett-Packard Australia Pty. Ltd.  
5th Floor  
Teachers Union Building  
495-499 Boundary Street  
**Spring Hill, 4000**  
Tel: 2291544

## SOUTH AUSTRALIA

Hewlett-Packard Australia Pty. Ltd.  
153 Greenhill Road  
**Parkside, 5063**  
Tel: 2725911  
Telex: 82536

## VICTORIA

Hewlett-Packard Australia Pty. Ltd.  
31-41 Joseph Street  
**Blackburn, 3130**  
Tel: 89-6351  
Telex: 31024 MELB

## WESTERN AUSTRALIA

Hewlett-Packard Australia Pty. Ltd.  
141 Stirling Highway  
**Nedlands, 6009**  
Tel: 3865455  
Telex: 93859

## AUSTRIA

Hewlett-Packard Ges.m.b.H.  
Wehlstrasse 29  
P.O. Box 7  
A-1205 **Vienna**  
Tel: 35-16-21-0  
Telex: 13582/135066

## BAHRAIN

Medical Only  
Wael Pharmacy  
P.O. Box 648  
**Bahrain**  
Tel: 54886, 56123  
Telex: 8550 WAEL GJ

Al Hamidiya Trading and Contracting

P.O. Box 20074

## Manama

Tel: 259978, 259958

Telex: 8895 KALDIA GJ

## BANGLADESH

The General Electric Co. of  
Bangladesh Ltd.  
Magnet House 72  
Dikusha Commercial Area  
**Motijhall, Dacca 2**  
Tel: 252415, 252419  
Telex: 734

## BELGIUM

Hewlett-Packard Benelux S.A./N.V.  
Avenue du Col-Vert, 1,  
(Groenkraaglaan)  
B-1170 **Brussels**  
Tel: (02) 660 50 50  
Telex: 23-494 paloben bru

## BRAZIL

Hewlett-Packard do Brasil  
I.e.C. Ltda.  
Alameda Rio Negro, 750  
Alphaville  
06400 **Barueri SP**  
Tel: 429-3222

Hewlett-Packard do Brasil  
I.e.C. Ltda.

Rua Padre Chagas, 32  
90000-**Pôrto Alegre-RS**  
Tel: 22-2998, 22-5621  
Hewlett-Packard do Brasil  
I.e.C. Ltda.

Av. Epitácio Pessoa, 4664  
22471-**Rio de Janeiro-RJ**  
Tel: 286-0237  
Telex: 021-21905 HPBR-BR

## CANADA

**ALBERTA**  
Hewlett-Packard (Canada) Ltd.  
11620A - 168th Street  
**Edmonton T5M 3T9**  
Tel: (403) 452-3670  
TWX: 610-831-2431

Hewlett-Packard (Canada) Ltd.  
210, 7220 Fisher St. S.E.  
**Calgary T2H 2H8**  
Tel: (403) 253-2713  
TWX: 610-821-6141

## BRITISH COLUMBIA

Hewlett-Packard (Canada) Ltd.  
10691 Shellbridge Way  
**Richmond V6X 2W7**  
Tel: (604) 270-2277  
TWX: 610-925-5059

## MANITOBA

Hewlett-Packard (Canada) Ltd.  
380-550 Century St.  
**St. James,**  
Winnipeg R3H 0Y1  
Tel: (204) 786-6701  
TWX: 610-671-3531

## NOVA SCOTIA

Hewlett-Packard (Canada) Ltd.  
P.O. Box 931  
800 Windmill Road  
**Dartmouth B3B 1L1**  
Tel: (902) 469-7820  
TWX: 610-271-4482

## ONTARIO

Hewlett-Packard (Canada) Ltd.  
1020 Morrison Dr.  
**Ottawa K2H 8K7**  
Tel: (613) 820-6483  
TWX: 610-563-1636

Hewlett-Packard (Canada) Ltd.  
6877 Goreway Drive  
**Mississauga L4V 1M8**  
Tel: (416) 678-9430  
TWX: 610-492-4246

Hewlett-Packard (Canada) Ltd.  
552 Newbold Street  
**London N6E 2S5**  
Tel: (519) 686-9181  
TWX: 610-352-1201

## QUEBEC

Hewlett-Packard (Canada) Ltd.  
275 Hymus Blvd.  
**Pointe Claire H9R 1G7**  
Tel: (514) 697-4232  
TWX: 610-422-3022

## FOR CANADIAN AREAS NOT LISTED:

Contact Hewlett-Packard (Canada) Ltd. in Mississauga.

## CHILE

Jorge Calcagni y Cia. Ltda.  
Arturo Burchle 065  
Casilla 16475  
Correo 9, **Santiago**  
Tel: 220222  
Telex: JCALCAGNI

## COLOMBIA

Instrumentación  
Henrik A. Langebaek & Kier S.A.  
Carrera 7 No. 48-75  
Apartado Aéreo 6287  
**Bogotá, 1 D.E.**  
Tel: 269-8877  
Telex: 44400

Instrumentación  
H.A. Langebaek & Kier S.A.  
Carrera 63 No. 49-A-31  
Apartado 54098  
**Medellin**  
Tel: 304475

## COSTA RICA

Científica Costarricense S.A.  
Avenida 2, Calle 5  
San Pedro de Montes de Oca  
Apartado 10159  
**San José**  
Tel: 24-38-20, 24-08-19  
Telex: 2367 GALGUR CR

## CYPRUS

Kypronic  
19 Gregorios Xenopoulos Street  
P.O. Box 1152  
**Nicosia**  
Tel: 45628/29  
Telex: 3018

## CZECHOSLOVAKIA

Hewlett-Packard  
Obchodni zastupitelstvi v CSSR  
Pisemny styk  
Post. schranka 27  
CS 118 01 **Praha 011**  
CSSR

Vyvojova a Provozni Zakladna  
Vyzkumnych Ustavu v Bechovicich  
CSSR-25097 **Bechovice u Prahy**  
Tel: 89 93 41  
Telex: 12133

Institute of Medical Bionics  
Vyskumny Ustav Lekarskej Bioniky  
Jedlova 6  
CS-88346 **Bratislava-Kramare**  
Tel: 44-551  
Telex: 93229

## DENMARK

Hewlett-Packard A/S  
Datavej 52  
DK-3460 **Birkerød**  
Tel: (02) 81 66 40  
Telex: 37409 hpas dk  
Hewlett-Packard A/S  
Navervej 1  
DK-8600 **Silkeborg**  
Tel: (06) 82 71 66  
Telex: 37409 hpas dk

## ECUADOR

CYDE Cia. Ltda.  
P.O. Box 6423 CCI  
Av. Eloy Alfaro 1749  
**Quito**  
Tel: 450-975, 243-052  
Telex: 2548 CYEDE ED

## Medical Only

Hospitalar S.A.

Casilla 3590

Robles 625

## Quito

Tel: 545-250

## EGYPT

I.E.A.  
International Engineering Associates  
24 Hussein Hegazi Street  
Kasr-el-Aini  
**Cairo**  
Tel: 23 829  
Telex: 93830

## SAMITRO

Sami Amin Trading Office  
18 Abdel Aziz Gawish  
**Abdine-Cairo**  
Tel: 24932

## EL SALVADOR

IPESA  
Bulevar de los Heroes 11-48  
Edificio Sarah 1148  
**San Salvador**  
Tel: 252787

## ETHIOPIA

Abdella Abdulmalik  
P.O. Box 2635  
**Addis Ababa**  
Tel: 11 93 40

## FINLAND

Hewlett-Packard Oy  
Revontulentie, 7  
SF-02100 **Espoo 10**  
Tel: (90) 455 0211  
Telex: 121563 hewpa sf

## FRANCE

Hewlett-Packard France  
Zone d'activités de Courtaboeuf  
Avenue des Tropiques  
Boite Postale 6  
91401 **Orsay-Cédex**  
Tel: (1) 907 78 25  
TWX: 600048F

Hewlett-Packard France

Chemin des Mouilles

B.P. 162

69130 **Ecully**

Tel: (78) 33 81 25

TWX: 310617F

Hewlett-Packard France

20, Chemin de La Cèpière

31081 **Toulouse**

**Le Mirail-Cédex**

Tel: (61) 40 11 12

Hewlett-Packard France

Le Ligoures

Place Romée de Villeneuve

13100 **Aix-en-Provence**

Tel: (42) 59 41 02

TWX: 410770F

Hewlett-Packard France

2, Allée de la Bourgonette

35100 **Rennes**

Tel: (99) 51 42 44

TWX: 740912F

Hewlett-Packard France

18, rue du Canal de la Marne

67300 **Schiltigheim**

Tel: (88) 83 08 10

TWX: 890141F

Hewlett-Packard France

Immeuble péricentre

rue van Gogh

59650 **Villeneuve D'Ascq**

Tel: (20) 91 41 25

TWX: 160124F

Hewlett-Packard France

Bâtiment Ampère

Rue de la Commune de Paris

B.P. 300

93153 **Le Blanc Mesnil-**

**Cédex**

Tel: (01) 931 88 50

Telex: 211032F

Hewlett-Packard France

Av. du Pdt. Kennedy

33700 **Merignac**

Tel: (56) 97 01 81

Hewlett-Packard France

Immeuble Lorraine

Boulevard de France

91035 **Evry-Cédex**

Tel: 077 96 60

Telex: 692315F

Hewlett-Packard France

23 Rue Lothaire

57000 **Metz**

Tel: (87) 65 53 50

## GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH  
Vertriebszentrale Frankfurt  
Bernier Strasse 117  
Postfach 560 140  
D-6000 **Frankfurt 56**  
Tel: (06011) 50041  
Telex: 04 13249 hpffm d

Hewlett-Packard GmbH

Technisches Büro Böblingen

Herrenberger Strasse 110

D-7030 **Böblingen,**

Württemberg

Tel: (07031) 667-1

Telex: 07265739 bbn

Hewlett-Packard GmbH

Technisches Büro Düsseldorf

Emanuel-Leutze-Str. 1 (Seestern)

D-4000 **Düsseldorf**

Tel: (0211) 5971-1

Telex: 085/86 533 hpdd d

Hewlett-Packard GmbH

Technisches Büro Hamburg

Kapstadtring 5

D-2000 **Hamburg 60**

Tel: (040) 63804-1

Telex: 21 63 032 hpgh d

Hewlett-Packard GmbH

Technisches Büro Hannover

Am Grossmarkt 6

D-3000 **Hannover 91**

Tel: (0511) 46 60 01

Telex: 092 3259

Hewlett-Packard GmbH

Technisches Büro Nürnberg

Neumeyerstrasse 90

D-8500 **Nürnberg**

Tel: (0911) 52 20 83

Telex: 0623 860

Hewlett-Packard GmbH

Technisches Büro München

Eschenstrasse 2-4

D-8021 **Taufkirchen**

Tel: (089) 6117-1

Telex: 0524985

Hewlett-Packard GmbH

Technisches Büro Berlin

Kaithstrasse 2-4

D-1000 **Berlin 30**

Tel: (030) 24 90 86

Telex: 018 3405 hpbln d

## GREECE

Kostas Karayannis  
8 Omirou Street  
**Athens 133**  
Tel: 32 30 303/32/37 731

Telex: 21 59 62 RKAR GR

## GUAM

Guam Medical Supply, Inc.  
Suite C, Airport Plaza  
P.O. Box 8947

**Tamuning 96911**

Tel: 646-4513

## GUATEMALA

IPESA  
Avenida Reforma 3-48  
Zona 9

**Guatemala City**

Tel: 316627, 314786, 66471-5,

ext. 9

Telex: 4192 Teletro Gu

**SALES OFFICES** 

Arranged alphabetically by country (cont.)

**HONG KONG**

Hewlett-Packard Hong Kong Ltd.  
11th Floor, Four Seas Bldg.  
212 Nathan Rd.

**Kowloon**

Tel: 3-697446 (5 lines)  
Telex: 36678 HX

Medical/Analytical Only

Schmidt & Co. (Hong Kong) Ltd.  
Wing On Centre, 28th Floor  
Connaught Road, C.

**Hong Kong**

Tel: 5-455644  
Telex: 74766 SCHMX HX

**INDIA**

Blue Star Ltd.

Sahas

414/2 Vir Savarkar Marg  
Prabhadevi

**Bombay** 400 025

Tel: 45 78 87

Telex: 011-4093

Blue Star Ltd.

Band Box House

Prabhadevi

**Bombay** 400 025

Tel: 45 73 01

Telex: 011-3751

Blue Star Ltd.

Bhavdeep

Stadium Road

**Ahmedabad** 380 014

Tel: 43922

Telex: 012-234

Blue Star Ltd.

7 Hare Street

**Calcutta** 700 001

Tel: 23-0131

Telex: 021-7655

Blue Star Ltd.

Bhandari House

91 Nehru Place

**New Delhi** 110 024

Tel: 682547

Telex: 031-2463

Blue Star Ltd.

T.C. 7/603 'Poonima'

Maruthankuzhi

**Trivandrum** 695 013

Tel: 65799

Telex: 0884-259

Blue Star Ltd.

11 Magarath Road

**Bangalore** 560 025

Tel: 55668

Telex: 0845-430

Blue Star Ltd.

Meeakshi Mandiram

XXXXV/1379-2 Mahatma

Gandhi Rd.

**Cochin** 682 016

Tel: 32069

Telex: 085-514

Blue Star Ltd.

1-1-117/1 Sarojini Devi Road

**Secunderabad** 500 033

Tel: 70126

Telex: 0155-459

Blue Star Ltd.

133 Kodambakkam High Road

**Madras** 600 034

Tel: 82057

Telex: 041-379

**ICELAND**

Medical Only

Elding Trading Company Inc.

Hafnarvöli - Tryggvögötu

P.O. Box 895

**IS-Reykjavik**

Tel: 1 58 20/1 63 03

**INDONESIA**

BERCA Indonesia P.T.

P.O. Box 496/Jkt.

Jin. Abdul Muis 62

**Jakarta**

Tel: 349255, 349886

Telex: 46748 BERSIL IA

BERCA Indonesia P.T.

P.O. Box 174/Sby.

23 Jln. Jimerto

**Surabaya**

Tel: 42027

**IRELAND**

Hewlett-Packard Ltd.

Kestrel House

Clanwilliam Place

Lower Mount Street

**Dublin 2, Eire**

Hewlett-Packard Ltd.

2C Avonberg Ind. Est.

Long Mile Road

**Dublin 12**

Tel: 514322/514224

Telex: 30439

Medical Only

Cardiac Services (Ireland) Ltd.

Kilmore Road

Artane

**Dublin 5, Eire**

Tel: (01) 315820

**ISRAEL**

Electronics Engineering Div.

of Motorola Israel Ltd.

16, Kremenetski Street

P.O. Box 25016

**Tel-Aviv**

Tel: 38973

Telex: 33569, 34164

**ITALY**

Hewlett-Packard Italiana S.p.A.

Via G. Di Vittorio, 9

20063 **Cernusco Sul**

**Naviglio (MI)**

Tel: (2) 903691

Telex: 334632 HEWPACIT

Hewlett-Packard Italiana S.p.A.

Via Turazza, 14

35100 **Padova**

Tel: (49) 664888

Telex: 430315 HEWPACI

Hewlett-Packard Italiana S.p.A.

Via G. Armellini 10

I-00143 **Roma**

Tel: (06) 54 69 61

Telex: 610514

Hewlett-Packard Italiana S.p.A.

Corso Giovanni Lanza 94

I-10133 **Torino**

Tel: (011) 659308

Telex: 221079

Hewlett-Packard Italiana S.p.A.

Via Principe Nicola 43 G/C

I-95126 **Catania**

Tel: (095) 37 05 04

Telex: 970291

Hewlett-Packard Italiana S.p.A.

Via Nuova san Rocco A

Capadimonte, 62A

80131 **Napoli**

Tel: (081) 710698

Hewlett-Packard Italiana S.p.A.

Via Martin Luther King, 38/111

I-40132 **Bologna**

Tel: (051) 402394

Telex: 511630

**JAPAN**

Yokogawa-Hewlett-Packard Ltd.

29-21, Takaoid-Higashi 3-chome

Suginami-ku, **Tokyo** 168

Tel: 03-331-6111

Telex: 232-2024 YHP-Tokyo

Yokogawa-Hewlett-Packard Ltd.

Chuo Bldg., 4th Floor

4-20, Nishinakajima 5-chome

Yodogawa-ku, **Osaka-shi**

**Osaka**, 532

Tel: 06-304-6021

Telex: 523-3624

Yokogawa-Hewlett-Packard Ltd.

Sunitomo Seimei Nagaya Bldg.

11-2 Shimomasajima-cho,

Nakamura-ku, **Nagoya**, 450

Tel: 052-571-5171

Yokogawa-Hewlett-Packard Ltd.

Tanigawa Building

2-24-1 Tsuruya-cho

Kanagawa-ku

**Yokohama**, 221

Tel: 045-312-1252

Telex: 382-3204 YHP YOK

Yokogawa-Hewlett-Packard Ltd.

Mito Mitsui Building

105, 1-chome, San-no-maru

**Mito**, Ibaragi 310

Tel: 0292-25-7470

Yokogawa-Hewlett-Packard Ltd.

Inoue Building

1348-3, Asahi-cho, 1-chome

**Atsugi**, Kanagawa 243

Tel: 0462-24-0452

Yokogawa-Hewlett-Packard Ltd.

Kumagaya Asahi

Hachijuni Building

4th Floor

3-4, Tsukuba

**Kumagaya**, Saitama 360

Tel: 0485-24-6563

**JORDAN**

Mouasher Cousins Co.

P.O. Box 1387

**Amman**

Tel: 24907/39907

Telex: SABCO JO 1456

**KENYA**

ADCOM Ltd., Inc.

P.O. Box 30070

**Nairobi**

Tel: 331955

Telex: 22639

Medical Only

International Aeradio (E.A.) Ltd.

P.O. Box 19012

Nairobi Airport

**Nairobi**

Tel: 336055/56

Telex: 22201/22301

Medical Only

International Aeradio (E.A.) Ltd.

P.O. Box 95221

**Mombasa**

**KOREA**

Samsung Electronics Co., Ltd.

4759 Shingil-6-Dong

Yeong Deung POU

**Seoul**

Tel: 833-4122, 4121

Telex: SAMSAN 27364

**KUWAIT**

Al-Khaldiya Trading & Contracting

P.O. Box 830-Safat

**Kuwait**

Tel: 42 4910/41 1726

Telex: 2481 Areeg kt

**LUXEMBURG**

Hewlett-Packard Beneluz S.A./N.V.

Avenue du Col-Vert, 1

(Groenraagaan)

B-1170 **Brussels**

P.O. Box 660 5050

Telex: 23 494

**MALAYSIA**

Hewlett-Packard Sales

(Malaysia) Sdn. Bhd.

Suite 2.21/2.22

Bangunan Angkasa Raya

Jalan Ampang

**Kuala Lumpur**

Tel: 483680, 485653

Protel Engineering

P.O. Box 1917

Lot 259, Satok Road

Kuching, **Sarawak**

Tel: 53544

**MEXICO**

Hewlett-Packard Mexicana,

S.A. de C.V.

Av. Periférico Sur No. 6501

Tepepan, Xochimilco

**Mexico** 23, D.F.

Tel: 905-676-4600

Telex: 017-74-507

Hewlett-Packard Mexicana,

S.A. de C.V.

Rio Volga #800

Col. Del Valle

**Monterrey, N.L.**

Tel: 78-32-10

**MOROCCO**

Dolbeau

81 rue Karatchi

**Casablanca**

Tel: 3041 82

Telex: 23051/22822

Gerep

2, rue d'Agadir

Boite Postal 156

**Casablanca**

Tel: 272093/5

Telex: 23 739

**MOZAMBIQUE**

A.N. Goncalves, Ltd.

162, 1° Apt. 14 Av. D. Luis

Caixa Postal 107

**Maputo**

Tel: 27091, 27114

Telex: 6-203 NEGON Mo

**NETHERLANDS**

Hewlett-Packard Benelux N.V.

Van Heuven Goedhartlaan 121

P.O. Box 667

1181KK **Amstelveen**

Tel: (20) 47 20 21

Telex: 13 216

**NEW ZEALAND**

Hewlett-Packard (N.Z.) Ltd.

4-12 Cruickshank Street

Kilbirnie, Wellington 3



# SALES OFFICES

Arranged alphabetically by country (cont.)

## PUERTO RICO

Hewlett-Packard Inter- Americas  
Puerto Rico Branch Office  
Calle 272,  
#203 Urb. Country Club  
**Carolina** 00630  
Tel: (809) 762-7255  
Telex: 345 0514

## QATAR

Nasser Trading & Contracting  
P.O. Box 1563

## Doha

Tel: 22170  
Telex: 4439 NASSER

## ROMANIA

Hewlett-Packard Reprezentanta  
Bd.n. Balcescu 16  
**Bucuresti**  
Tel: 15 80 23/13 88 85  
Telex: 10440

## SAUDI ARABIA

Modern Electronic  
Establishment (Head Office)  
P.O. Box 1228, Baghdadiyah Street  
**Jeddah**  
Tel: 27 798  
Telex: 40035  
Cable: ELECTA JEDDAH

Modern Electronic Establishment  
(Branch)  
P.O. Box 2728

## Riyadh

Tel: 62596/66232  
Telex: 202049

Modern Electronic Establishment  
(Branch)  
P.O. Box 193

## Al-Khobar

Tel: 44678-44813  
Telex: 670136  
Cable: ELECTA AL-KHOBAR

## SINGAPORE

Hewlett-Packard Singapore  
(Pte.) Ltd.  
6th Floor, Inchcape House  
450-452 Alexandra Road  
P.O. Box 58  
Alexandra Post Office  
**Singapore** 9115  
Tel: 631788  
Telex: HPSG RS 21486

## SOUTH AFRICA

Hewlett-Packard South Africa  
(Pty.), Ltd.  
Private Bag Wendywood,  
Sandton, Transvaal, 2144  
Hewlett-Packard Centre  
Daphne Street, Wendywood,  
**Sandton**, 2144  
Tel: 802-5111/25  
Telex: 8-4782

Hewlett-Packard South Africa  
(Pty.), Ltd.  
P.O. Box 120  
Howard Place,  
Cape Province, 7450  
Pine Park Centre, Forest Drive,  
**Pinelands**,  
Cape Province, 7405  
Tel: 53-7955 thru 9  
Telex: 57-0006

## SPAIN

Hewlett-Packard Española, S.A.  
Calle Jerez 3  
**E-Madrid** 16  
Tel: (1) 458 26 00 (10 lines)  
Telex: 23515 hpe

Hewlett-Packard Española S.A.  
Colonia Mirasierra  
Edificio Juban  
c/o Costa Brava, 13  
**Madrid** 34

Hewlett-Packard Española, S.A.  
Milanesado 21-23  
**E-Barcelona** 17  
Tel: (3) 203 6200 (5 lines)  
Telex: 52603 hpbe e

Hewlett-Packard Española, S.A.  
Av Ramón y Cajal, 1  
Edificio Sevilla, planta 9º  
**E-Sevilla** 5  
Tel: 64 44 54/58

Hewlett-Packard Española S.A.  
Edificio Albia II 7º B  
**E-Bilbao** 1  
Tel: 23 83 06/23 82 06

Hewlett-Packard Española S.A.  
C/Ramon Gordillo 1 (Entlo.)  
**E-Valencia** 10  
Tel: 96-36 1.13.54/36 1.13.58

## SRI LANKA

Metropolitan Agencies Ltd.  
209/9 Union Place  
**Colombo** 2  
Tel: 35947  
Telex: 1377METROLD CE

## SUDAN

Radison Trade  
P.O. Box 921  
**Khartoum**  
Tel: 44048  
Telex: 375

## SURINAM

Surtel Radio Holland N.V.  
Grote Hofstr. 3-5  
P.O. Box 155  
**Paramaribo**  
Tel: 72118, 77880

## SWEDEN

Hewlett-Packard Sverige AB  
Enighetsvägen 3, Fack  
S-161 **Bromma** 20  
Tel: (08) 730 05 50  
Telex: 10721  
Cable: MEASUREMENTS  
Stockholm

Hewlett-Packard Sverige AB  
Frötallsgatan 30  
S-421 32 **Västra  
Frölunda**  
Tel: (031) 49 09 50  
Telex: 10721 via Bromma office

## SWITZERLAND

Hewlett-Packard (Schweiz) AG  
Zürcherstrasse 20  
P.O. Box 307  
CH-8952 **Schlieren-  
Zürich**  
Tel: (01) 7305240  
Telex: 53933 hpag ch  
Cable: HPAG CH

Hewlett-Packard (Schweiz) AG  
Château Bloc 19  
CH-1219 **Le Lignon-  
Geneva**  
Tel: (022) 96 03 22  
Telex: 27333 hpag ch  
Cable: HEWPACAG Geneva

Hewlett-Packard (Schweiz) AG  
Château Bloc 19  
CH-1219 **Le Lignon-  
Geneva**  
Tel: (022) 96 03 22  
Telex: 27333 hpag ch  
Cable: HEWPACAG Geneva

## SYRIA

General Electronic Inc.  
Nuri Basha-Ahnaf Ebn Kays Street  
P.O. Box 5781

## Damascus

Tel: 33 24 87  
Telex: 11215 ITIKAL  
Cable: ELECTROBOR DAMASCUS

## Damascus

Medical only  
Sawah & Co.  
Place Azme  
B.P. 2308  
**Damascus**  
Tel: 16 367-19 697-14 268  
Telex: 11304 SATACO SY  
Cable: SAWAH, DAMASCUS

Suleiman Hilal El Mlawi  
P.O. Box 2528  
Mamoun Bitar Street, 56-58

## Damascus

Tel: 11 46 63  
Telex: 11270  
Cable: HILAL DAMASCUS

## TAIWAN

Hewlett-Packard Far East Ltd.  
Taiwan Branch  
Bank Tower, 5th Floor  
205 Tun Hau North Road  
**Taipei**  
Tel: (02) 751-0404 (15 lines)

Hewlett-Packard Far East Ltd.  
Taiwan Branch  
68-2, Chung Cheng 3rd. Road  
**Kaohsiung**  
Tel: (07) 242318-Kaohsiung

Analytical Only  
San Kwang Instruments Co., Ltd.  
20 Yung Sui Road  
**Taipei**  
Tel: 3615446-9 (4 lines)  
Telex: 22894 SANKWANG

**TANZANIA**  
Medical Only  
International Aeradio (E.A.), Ltd.  
P.O. Box 861  
**Dar es Salaam**  
Tel: 21251 Ext. 265  
Telex: 41030

**THAILAND**  
UNIMESA Co. Ltd.  
Elcom Research Building  
2538 Sukumvit Ave.  
**Bangchak, Bangkok**  
Tel: 39-32-387, 39-30-338

## TRINIDAD & TOBAGO

CARTEL  
Caribbean Telecoms Ltd.  
P.O. Box 732  
69 Frederick Street  
**Port-of-Spain**  
Tel: 62-53068

## TUNISIA

Tunisie Electronique  
31 Avenue de la Liberte  
**Tunis**  
Tel: 280 144

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Corema  
1 ter. Av. de Carthage  
**Tunis**  
Tel: 255800

Hewlett-Packard Ltd.

Trafalgar House

Navigation Road

**Altrincham**

Cheshire WA14 1NU

GB-England

Tel: (061) 928 6422

Telex: 668068

Hewlett-Packard Ltd.

Lygon Court

Hereward Rise

Dudley Road

**Halesowen**,

West Midlands, B62 8SD

GB-England

Tel: (021) 501 1221

Telex: 339105

Hewlett-Packard Ltd.

Wedge House

799, London Road

**Thornton Heath**

Surrey, CR4 6XL

GB-England

Tel: (01) 684-0103/8

Telex: 946625

Hewlett-Packard Ltd.

14 Wesley St

**Castleford**

Yorks WF10 1AE

Tel: (0977) 550016

TWX: 5557335

Hewlett-Packard Ltd.

Tradax House

St. Mary's Walk

**Maidenhead**

Berkshire, SL6 1ST

GB-England

Hewlett-Packard Ltd.

Morley Road

**Staplehill**

Bristol, BS16 4QT

GB-England

Medical Only

Cardiac Services Co.

95A Finaghy Rd. South

**Belfast** BT10 0BY

GB-Northern Ireland

Tel: (0232) 625566

Telex: 747626

Hewlett-Packard Ltd.

**South Queensferry**

West Lothian, EH30 9TG

GB-Scotland

Tel: (031) 331 1188

Telex: 72682

**UNITED STATES**

**ALABAMA**

700 Century Park South, Suite

128

**Birmingham** 35226

Tel: (205) 822-6802

P.O. Box 4207

8290 Whitesburg Dr.

**Huntsville** 35802

Tel: (205) 881-4591

## ARIZONA

2336 E. Magnolia St.

**Phoenix** 85034

Tel: (602) 273-8000

2424 East Aragon Rd.

**Tucson** 85706

Tel: (602) 273-8000

**ARKANSAS**

Medical Service Only

P.O. Box 5646

Brady Station

**Little Rock** 72215

Tel: (501) 376-1844

**CALIFORNIA**

1579 E. Shaw Ave.

**Fresno** 93771

Tel: (209) 224-0582

1430 East Orangethorpe Ave.

**Fullerton** 92631

Tel: (714) 870-1000

5400 West Rosecrans Blvd.

P.O. Box 92105

World Way Postal Center

**Los Angeles** 90009

Tel: (213) 970-7500

TWX: 910-325-66



SALES OFFICES 

Arranged alphabetically by country (cont.)

**CONNECTICUT**

47 Barnes Industrial Road  
Barnes Park South  
**Wallingford** 06492  
Tel: (203) 265-7801

**FLORIDA**

P.O. Box 24210  
2727 N.W. 62nd Street  
**Ft. Lauderdale** 33309  
Tel: (305) 973-2600

4080 Woodcock Drive #132  
Brownell Building

**Jacksonville** 32207

Tel: (904) 398-0663

P.O. Box 13910

6177 Lake Ellenor Dr.

**Orlando** 32809

Tel: (305) 859-2900

P.O. Box 12826

Suite 5, Bldg. 1

Office Park North

**Pensacola** 32575

Tel: (904) 476-8422

110 South Hoover Blvd.

Suite 120

**Tampa** 33609

Tel: (813) 872-0900

**GEORGIA**

P.O. Box 105005

450 Interstate North Parkway

**Atlanta** 30348

Tel: (404) 955-1500

TWX: 810-766-4890

Medical Service Only

**\*Augusta** 30903

Tel: (404) 736-0592

P.O. Box 2103

1172 N. Davis Drive

**Warner Robins** 31098

Tel: (912) 922-0449

**HAWAII**

2875 So. King Street

**Honolulu** 96826

Tel: (808) 955-4455

**ILLINOIS**

211 Prospect Rd.

**Bloomington** 61701

Tel: (309) 663-0383

5201 Tollview Dr.

**Rolling Meadows**

60008

Tel: (312) 255-9800

TWX: 910-687-2260

**INDIANA**

7301 North Shadeland Ave.

**Indianapolis** 46250

Tel: (317) 842-1000

TWX: 810-260-1797

**IOWA**

2415 Heinz Road

**Iowa City** 52240

Tel: (319) 351-1020

**KENTUCKY**

10170 Linn Station Road

Suite 525

**Louisville** 40223

Tel: (502) 426-0100

**LOUISIANA**

P.O. Box 1449

3229-39 Williams Boulevard

**Kenner** 70062

Tel: (504) 443-6201

**MARYLAND**

7121 Standard Drive

Parkway Industrial Center

**Hanover** 21076

Tel: (301) 796-7700

TWX: 710-862-1943

2 Choce Cherry Road

**Rockville** 20850

Tel: (301) 948-6370

TWX: 710-828-9684

**MASSACHUSETTS**

32 Hartwell Ave.

**Lexington** 02173

Tel: (617) 861-8960

TWX: 710-326-6904

**MICHIGAN**

23855 Research Drive

**Farmington Hills** 48024

Tel: (313) 476-6400

724 West Centre Ave.

**Kalamazoo** 49002

Tel: (616) 323-8362

**MINNESOTA**

2400 N. Prior Ave.

**St. Paul** 55113

Tel: (612) 636-0700

**MISSISSIPPI**

322 N. Mart Plaza

**Jackson** 39206

Tel: (601) 982-9363

**MISSOURI**

11131 Colorado Ave.

**Kansas City** 64137

Tel: (816) 763-8000

TWX: 910-771-2087

1024 Executive Parkway

**St. Louis** 63141

Tel: (314) 878-0200

**NEBRASKA**

Medical Only

7101 Mercy Road

Suite 101

**Omaha** 68106

Tel: (402) 392-0948

**NEVADA**

**\*Las Vegas**

Tel: (702) 736-6610

**NEW JERSEY**

Crystal Brook Professional Building

Route 35

**Eatontown** 07724

Tel: (201) 542-1384

W. 120 Century Rd.

**Paramus** 07652

Tel: (201) 265-5000

TWX: 710-990-4951

**NEW MEXICO**

P.O. Box 11634

Station E

11300 Lomas Blvd., N.E.

**Albuquerque** 87123

Tel: (505) 292-1330

TWX: 910-989-1185

156 Wyatt Drive

**Las Cruces** 88001

Tel: (505) 526-2484

TWX: 910-983-0550

**NEW YORK**

6 Automation Lane

Computer Park

**Albany** 12205

Tel: (518) 458-1550

TWX: 710-444-4961

650 Perinton Hill Office Park

**Fairport** 14450

Tel: (716) 223-9950

TWX: 510-253-0092

No. 1 Pennsylvania Plaza

55th Floor

34th Street & 8th Avenue

**New York** 10001

Tel: (212) 971-0800

5858 East Molloy Road

**Syracuse** 13211

Tel: (315) 455-2486

1 Crossways Park West

**Woodbury** 11797

Tel: (516) 921-0300

TWX: 510-221-2183

Tel: (513) 671-7400

**NORTH CAROLINA**

5605 Roanne Way

**Greensboro** 27409

Tel: (919) 852-1800

**OHIO**

Medical/Computer Only

9920 Carver Road

**Cincinnati** 45242

Tel: (513) 891-9870

16500 Sprague Road

**Cleveland** 44130

Tel: (216) 243-7300

TWX: 810-423-9430

962 Crupper Ave.

**Columbus** 43229

Tel: (614) 436-1041

330 Progress Rd.

**Dayton** 45449

Tel: (513) 859-8202

**OKLAHOMA**

P.O. Box 32008

6301 N. Meridian Avenue

**Oklahoma City** 73112

Tel: (405) 721-0200

9920 E. 42nd Street

Suite 121

**Tulsa** 74145

Tel: (918) 665-3300

**OREGON**

17890 S.W. Lower Boones Ferry

Road

**Tualatin** 97062

Tel: (503) 620-3350

**PENNSYLVANIA**

1021 8th Avenue

King of Prussia Industrial Park

**King of Prussia** 19406

Tel: (215) 265-7000

TWX: 510-660-2670

111 Zeta Drive

**Pittsburgh** 15238

Tel: (412) 782-0400

**SOUTH CAROLINA**

P.O. Box 6442

6941-0 N. Trenholm Road

**Columbia** 29206

Tel: (803) 782-6493

**TENNESSEE**

8906 Kingston Pike

**Knoxville** 37919

Tel: (615) 691-2371

3070 Directors Row

Directors Square

**Memphis** 38131

Tel: (901) 346-8370

**\*Nashville**

Medical Service Only

Tel: (615) 244-5448

**TEXAS**

4171 North Mesa

Suite C110

**El Paso** 79902

Tel: (915) 533-3555

P.O. Box 42816

10535 Harwin St.

**Houston** 77036

Tel: (713) 776-6400

**\*Lubbock**

Medical Service Only

Tel: (806) 799-4472

P.O. Box 1270

201 E. Arapaho Rd.

**Richardson** 75081

Tel: (214) 231-6101

205 Billy Mitchell Road

**San Antonio** 78226

Tel: (512) 434-8241

**UTAH**

2160 South 3270 West Street

**Salt Lake City** 84119

Tel: (801) 972-4711

**VIRGINIA**

P.O. Box 9669

2914 Hungary Spring Road

**Richmond** 23228

Tel: (804) 285-3431

Computer Systems/Medical Only

Airport Executive Center

Suite 302

5700 Thurston Avenue

**Virginia Beach** 23455

Tel: (804) 460-2471

**WASHINGTON**

Bellefield Office Pk.

1203 - 114th Ave. S.E.

**Bellevue** 98004

Tel: (206) 454-3971

TWX: 910-443-2446

P.O. Box 4010

**Spokane** 99202

Tel: (509) 535-0864

**\*WEST VIRGINIA**

Medical/Analytical Only

4604 Mac Corkle Ave., S.E.

# Subject Index

## a

Absolute Character Size (SI) . . . . . 53  
 Absolute Direction of Characters (DI) . . . . . 49  
 Absolute Plotting (PA) . . . . . 38  
 Accessories, Plotter . . . . . 4, 5  
 Adaptive Pen Velocity (VA) . . . . . 75  
 Address Code, Plotter . . . . . 18  
 Addressing the 9872 Plotter . . . . . 27  
 Advance Full Page (AF) . . . . . 117  
 Advance Half Page (AH) . . . . . 118  
 Alternate Character Set . . . . . 76, 78  
 ASCII Character Codes . . . . . 138  
 Automatic Paper Advance . . . . . 117  
 Automatic Pen Pick Up (AP) . . . . . 74

## b

Binary Conversions . . . . . 119  
 Bus Command Statements . . . . . 26

## c

(CA) Designate Alternate Character Set . . . . . 78  
 Changing Pens . . . . . 20  
 Changing Paper . . . . . 22  
 Character Plot (CP) . . . . . 58  
 Character Sets . . . . . 76  
 Character Size . . . . . 53, 54, 56  
 Character Slant (SL) . . . . . 57  
 Chart Hold . . . . . 13  
 Confidence Test . . . . . 17  
 Controls, Front and Rear Panel . . . . . 13  
 Clearing the Plotter . . . . . 95  
 (CS) Designate Standard Character Set . . . . . 77  
 Cutter Enable (EC) . . . . . 118

## d

Default Instruction (DF) . . . . . 88  
 Default Values, Plotter . . . . . 88, 126  
 Device Clear . . . . . 96, 121, 123  
 (DI) Absolute Direction of Characters . . . . . 49  
 Digitize Clear (DC) . . . . . 69  
 Digitize Point (DP) . . . . . 69  
 Digitizing . . . . . 69, 71  
 (DR) Relative Direction of Characters . . . . . 50

## e

Electrical Requirements . . . . . 6  
 E-Mask . . . . . 82  
 Enable Cutter Instruction (EC) . . . . . 118  
 Enable Cutter Pushbutton . . . . . 15  
 Error Messages . . . . . 92, 127  
 External Plotter Commands . . . . . 96

## f

Front Panel Controls . . . . . 13

## g

Graphic Limits . . . . . 37, 84

## h

HP Interface Bus HP-IB . . . . . 1, 120

## i

Initialize Instruction (IN) . . . . . 89  
 Input Mask (IM) . . . . . 82  
 Input P1 and P2 (IP) . . . . . 99  
 Input Window (IW) . . . . . 84  
 Instruction Set . . . . . 32, 128

## l

Labeling (LB) . . . . . 47  
 Line Type (LT) . . . . . 67  
 Listen-Only Mode . . . . . 20  
 Locating P1 and P2 (IP and OP) . . . . . 99, 101  
 Lowering the Pen (PD) . . . . . 44

## m

Maintenance . . . . . 9  
 Masks . . . . . 82, 83

## n

Normal Velocity (VN) . . . . . 76

## o

Out of Limit Light . . . . . 15, 86, 39, 44  
 Output Actual Position and Pen Status (OA) . . . . . 90

Output Commanded Position and Pen Status (OC) .....	90
Output Digitized Point (OD) .....	70
Output Error (OE) .....	91
Output Factors (OF) .....	93
Output Identification (OI) .....	94
Output Options (OO) .....	94
Output P1 and P2 (OP) .....	101
Output Status (OS) .....	92

## p

P-Mask .....	84, 97
(PG or PGI) Advance Full Page .....	117
P1 and P2, Inputting .....	99
Paper Advance .....	117
Paper Check Bit .....	95
Paper Loading .....	22
Parallel Poll .....	84, 97
Pen Down (PD) .....	44
Pen Loading .....	20
Pen Pickup, Automatic (AP) .....	74
Pen Select (SP) .....	64
Pen Position and Status .....	90
Pen Up (PU) .....	44
Plot Absolute (PA) .....	38
Plot Relative (PR) .....	42
Plotting With Variables .....	45
Programming Practices .....	35

## r

Raising the Pen (PU) .....	44
Relocating P1 and P2 .....	99, 13
Relative Character Size (SR) .....	54
Relative Direction of Characters (DR) .....	50
Relative Plotting .....	42
Rotating Characters .....	50, 51

## s

S-Mask .....	83, 84, 96
Scale Instruction (SC) .....	102

Scaling .....	99, 102, 111
Select Alternate Character Set (SA) .....	79
Select Standard Character Set (SS) .....	78
Selected Device Clear .....	96
Serial Polling .....	96
Setting the Scaling Points .....	25
Setup Information .....	20
(SI) Absolute Character Size .....	53
(SL) Slant, Character .....	57
Spacing, Character .....	56, 80
Spacing, Character Using (CP) .....	58
(SP) Pen Select .....	64
(SR) Relative Character Size .....	54
Standard Character Set .....	76, 77
Status Byte (S-Mask) .....	83, 97
Symbol Mode Plotting (SM) .....	64
Syntax Conventions .....	1
Syntax and Formulas .....	128

## t

Tick Instructions (XT) (YT) .....	61
Tick Length (TL) .....	62

## u

Units, Plotter .....	37
Units, User .....	38, 41, 42, 102
User Defined Characters (UC) .....	79

## v

(VA) Adaptive Pen Velocity .....	75
Variable in Labels .....	48
Variables, Plotting With .....	45
Variables, Sending to Plotter .....	29
Velocity Select (VS) .....	76
(VN) Normal Velocity of Pen .....	75

## x

(XT) X Tick .....	61
-------------------	----

## y

(YT) Y Tick .....	61
-------------------	----





PART NO. 09872-90008  
MICROFICHE NO. 09872-90058

PRINTED IN U.S.A.