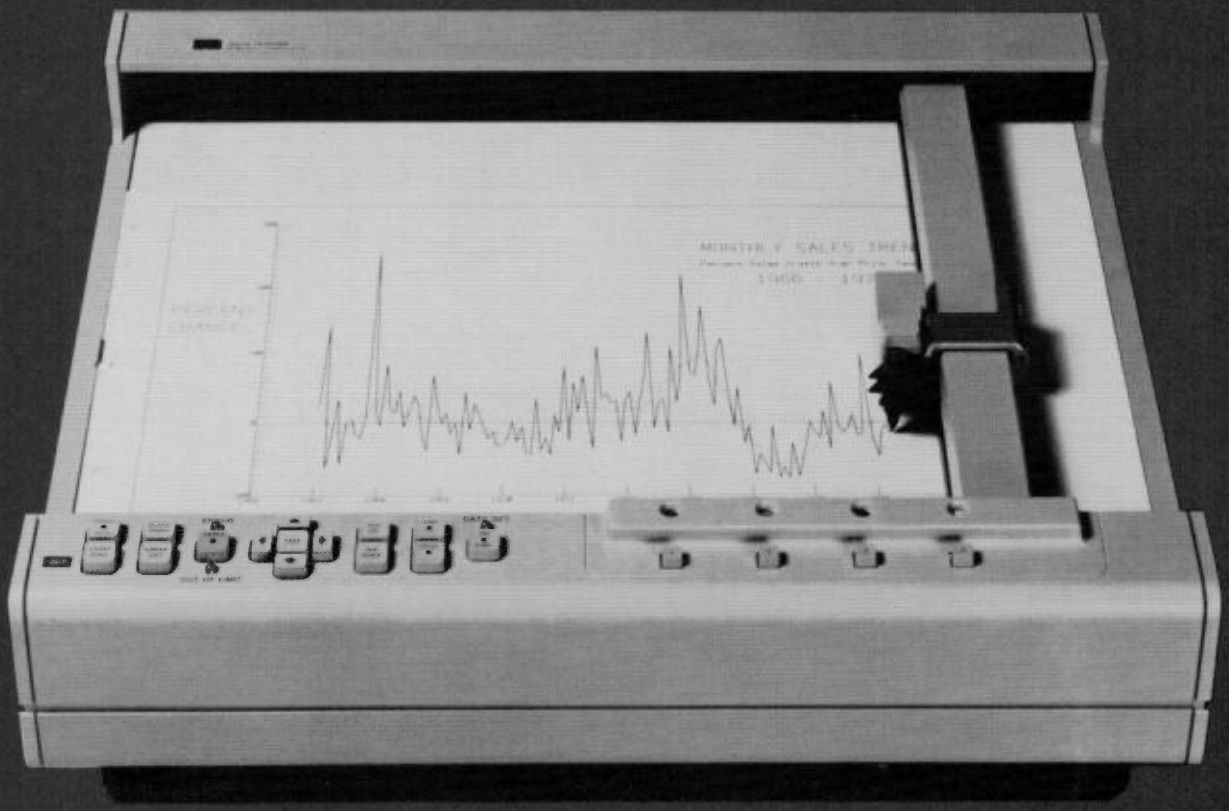
HP-PLOT/21 SOFTWARE CONVERSION GUIDE



APPLICATION NOTE 229-1

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INTRODUCTION

HP-PLOT/21 is a set of high-level, user-oriented FORTRAN IV subroutines designed to enable the HP 7221A user to effectively apply the plotter's capabilities to graphics solutions. The HP-PLOT/21 package is available for use with HP 3000 Series II computer systems and the commercial timeshare services of GE MARK III (Honeywell 6000) and TYMSHARE X (PDP-10) systems.

This application note provides sufficient information for the systems programmer to determine the feasibility of converting the package to operate on other systems. The following information is presented in this note:

Chapter 1. HP-PLOT/21 Modules and Subroutines.
This chapter provides a table of HP-PLOT/21 subroutines and their purpose.

Chapter 2. Conversion Considerations.
This chapter consists of a detailed analysis of areas that should be of interest to the systems programmer converting HP-PLOT/21 to other systems. These areas include character sets, system constructs and intrinsics, I/O, global variables, and handshake requirements. In addition, a matrix of differences among representative systems has been included which consolidates these areas of interest.

Chapter 3. Conversion Feasibility Program.
This chapter contains a FORTRAN IV program that may be used to determine the feasibility of conversion to the target system. The program contains a short series of tasks that reflect upon the areas discussed in Chapter 2.

Chapter 4. Sample Program and Plot.
This chapter contains a sample FORTRAN IV program and plot and serves to illustrate the basic tasks involved in plotting.

This application note uses the HP 3000 Series II system version of HP-PLOT/21 in all illustrations. Based on the target system characteristics, the systems programmer may wish to begin with one of the other available versions. In this case, some of the considerations described within this note may appear in somewhat different form in the actual source codes used. A thorough study of the HP-PLOT/21 Software User's Manual, part number 07221-90002, is recommended prior to attempting conversion.

Philosophy of HP-PLOT/21

HP-PLOT/21 has been designed to serve three major objectives:

1. Provide a general set of graphic functions which can support a wide variety of applications.

2. Allow simple access to the plotter's capabilities from a high level language without requiring extensive knowledge of the fundamental hardware syntax.

3. Provide full flexibility to scale, orient, and draw data and label axes, titles, numbers, and special symbols using any desired unit system.

The package was designed for maximum transportability between systems, is independent of a particular system's characteristics, and was written using the high-level language of FORTRAN IV.

CHAPTER 1
HP-PLOT/21 MODULES AND SUBROUTINES

The HP-PLOT/21 package consists of 86 FORTRAN IV subroutines designed to make the advanced capabilities of the HP7221A plotter accessible through simple program call statements. Fifty-five subroutines are directly accessible to the user and accomplish the four basic plotting functions: plotter setup, data plotting, axis drawing and labeling, and interactive functions such as digitizing. These subroutines are listed in table 1 along with their respective parameters. The remaining 31 subroutines are internal to the HP-PLOT/21 package, and handle such internal tasks as data unit conversion, data formatting, and handshake procedures. These subroutines are listed in table 2 along with their respective parameters and are presented for informative purposes only. They are used for activities internal to the HP-PLOT/21 package and the user should not attempt to call them directly.

Table 1. HP-PLOT/21 Modules and Subroutines

SYNTAX	PURPOSE
The Setup Group	
CALL ARCTOL(NUMB)	Specify maximum deviation for approximating arcs.
CALL CLIP(XMIN,XMAX,YMIN,YMAX)	Re-define the soft-clip limits.
CALL CLIPOF	Revoke soft clipping of User Unit data.
CALL CLIPON	Invoke soft clipping of User Unit data.
CALL FACTOR(FACT)	Alter the scale factor of the picture.
CALL LIMIT(XMIN,XMAX,YMIN,YMAX)	Adapt the plotter to paper size.
CALL LOCATE(XMIN,XMAX,YMIN,YMAX)	Define region-of-interest for mapping User Units.
CALL MAPUU(XMIN,XMAX,YMIN,YMAX)	Map and scale User-Units on region-of-interest.
CALL MARGIN(XLEFT,XRIGHT,YLOWER,YTOP)	Define region-of-interest via character margins.
CALL MSCALE(XOFSET,YOFSET)	Map User Unit system onto plotter space, in millimeters.
CALL PENSPD(ISPEED)	Specify maximum pen velocity.
CALL PLOTS(INTTYP,LOGIN,LOGOUT)	Initialize the plotting software and the plotter.
CALL RES(XRES,YRES)	Change resolution of the plotter.
CALL SCALE(ARAY,ALEN,NSCALE,NPOINT)	Scale an array of floating-point numbers for one axis of a graph.
CALL SETGU	Select the Graphic Unit system.
CALL SETIN	Select the Inches Unit system.
CALL SETUU	Select the User Unit system.
CALL SHOW(XMIN,XMAX,YMIN,YMAX)	Map and scale "square" User Units onto region-of-interest.
The Plotting Group	
CALL ARCREL(X,Y,RADIUS,ANGST,ANGEND)	Draw a circle or a portion thereof.
CALL DASLNA(LINTYP,PATLEN)	Specify dash-line pattern for plotted lines and arcs.
CALL DRAW(X,Y)	Perform absolute line-drawing.
CALL IPLOT(X,Y,IPEN)	Perform incremental plotting, with pen control.
CALL LINE(XARAY,YARAY,NSCALE,NPOINT,LPLOT,ISYMB)	Plot line or symbols from previously-scaled data arrays.
CALL MOVE(X,Y)	Perform absolute pen positioning.
CALL NEWPEN(NPEN)	Select another pen; or put away the current pen.
CALL PDIR(ANGLE)	Specify orientation angle of local relative co-ordinate system.
CALL PENDN	Logically lower the pen.
CALL PENUP	Logically raise the pen.
CALL PLOT(X,Y,IPEN)	Perform absolute data-plotting, with pen control.
CALL RANGOF(XMIN,XMAX,YMIN,YMAX,TPTS)	Report the range of User-Unit data passed to PLOT.
CALL RANGON	Record the range of User Unit data passed to PLOT.
CALL RPLOT(X,Y,IPEN)	Perform relative data-plotting, with pen control.

Table 1. HP-PLOT/21 Modules and Subroutines (Continued)

SYNTAX	PURPOSE
The Labeling Group	
CALL CDIR(ANGLE)	Establish direction of labeling.
CALL CFONT(NSFONT,NAFONT)	Designate standard and alternate character fonts.
CALL CPLOT(XCELL,YCELL)	Move in increments of character-cell blocks.
CALL CSIZE(CLINE,CRATIO,SLANT)	Specify height, width-ratio and slant of character cells.
CALL CSIZEA(HEIGHT,RATIO,SLANT)	Specify actual character height, width-ratio and slant.
CALL LABOFF	Terminate the label mode.
CALL LABON(NCHARS)	Invoke the label mode to draw specified number of characters.
CALL LBTERM(NTCHAR)	Designate automatic label-mode terminator character.
CALL LORG(LMODE)	Designate relative label origin position (SYMBOL and NUMBER).
CALL NUMBER(X,Y,HEIGHT,FNUMB,ANGLE,NDIGIT)	Draw floating-point number at specified location.
CALL SYMBOL(X,Y,HEIGHT,LARAY,ANGLE,ICHAR)	Draw characters or symbols at specified position.
The Axes Group	
CALL AXES(XTIC,YTIC,XORG,YORG,NXMAJ,NYMAJ,TICSIZ)	Draw pair of co-ordinate axes.
CALL AXIS(X,Y,LARAY,NCHAR,ALEN,ANGLE,AMIN,DX,OLEN)	Draw one axis for previously-scaled data array.
CALL FRAME	Draw rectangle around soft-clip region.
CALL FXD(NUMB)	Define floating-point format of axis labels.
CALL GRID(XTIC,YTIC,XORG,YORG,NXMAJ,NYMAJ)	Draw full grid on soft-clip region.
CALL LAXES(XTIC,YTIC,XORG,YORG,NXMAJ,NYMAJ,TICSIZ)	Draw pair of labeled co-ordinate axes.
CALL LGRID(XTIC,YTIC,XORG,YORG,NXMAJ,NYMAJ)	Draw full, labeled grid on soft-clip region.
The Interactive Group	
CALL DIGIT(XVALUE,YVALUE,NPENPO,NPENNO)	Report (digitize) pen position, status and pen number to user.
CALL OERROR(NCODE,NCMAND,NCOUNT)	Report current plotter error status to the user.
CALL PLOTOF	Terminate plot; condition terminal for communications.
CALL PLOTON	Condition plotter for subsequent communications.
CALL WHERE(X,Y,FACT)	Report current pen position and scale factor to user.

Table 2. HP-PLOT/21 Internal Modules and Subroutines

SYNTAX	PURPOSE
The Handshaking Group	
CALL DATOUT(NUMB) CALL HSHAKE	Check if host buffer should be outputted. Outputs the host computer buffer with handshake.
The Input/Output Group	
CALL OUTEMP(INT1) CALL OUTCK1(LOCTYP) CALL OUTRE1(LOCTYP, INT1) CALL OUTRE3(LOCTYP,INT1,INT2,INT3) CALL OUTRE4(LOCTYP,INT1,INT2,INT3,INT4)	When plotter buffer is empty, return its size. Transmit the output request at the proper time. Output request, for requests with one parameter. Output request, for requests with three parameters. Output request, for requests with four parameters.
The Transformation Group	
CALL UUTOPU(X,Y) CALL INTOPU(X,Y) CALL GUTOPU(X,Y) CALL MUTOPU(X,Y) CALL PUTOUU(X,Y) CALL PUTOIN(X,Y) CALL PUTOGU(X,Y) CALL PUTOMU(X,Y) CALL CHANGE(XCURRL,YCURRL) CALL PUTOUN(X,Y) CALL DELTA(XVALUE,YVALUE)	User units to plotter units conversion. Inches to plotter units conversion. Graphic units to plotter units conversion. Machine units to plotter units conversion. Plotter units to user units conversion. Plotter units to inches conversion. Plotter units to graphic units conversion. Plotter units to machine units conversion. Converts current units to plotter units. Converts plotter units to current units. Converts current units to plotter units relative to 0,0.
The Command Group	
CALL AMOVE CALL ADRAW CALL IMOVE CALL IDRAW CALL IPLOT1(X,Y,IPEN)	Physically raise pen for absolute moves. Physically lower pen for absolute moves. Physically raise pen for incremental moves. Physically lower pen for incremental moves. Perform incremental data plotting (used in CPLOT and PLOT with the parameter IPEN > 10)
The Parameter Conversion Group	
CALL AGP(X) CALL ANG(AN) CALL AXY(X,Y) CALL IXY(X,Y) CALL NMP(NUMB)	Absolute Graphic Parameter Angle Parameter Absolute XY Data Incremental XY Data Numeric Parameter
Other Subroutines	
CALL CLIPER(ARXY,NFLAG1) CALL AGLAX(XTIC,YTIC,XORG,YORG,NXMAJ, NYMAJ,TICSIZ,NTYPE) CALL INSERT(NUMBER)	General routine to clip a line segment. The general routine for LGRID,LAXES,AXES, and GRID. General routine used to insert any number between 0 and 128 into the host computer buffer.

NOTE: The internal modules and subroutines provided on this page have been provided for information only and the user should not attempt to call them directly.

CHAPTER 2
CONVERSION CONSIDERATIONS

There are certain areas that the systems programmer should research prior to attempting conversion of HP-PLOT/21 to other systems. These areas include:

Character Sets
An examination of the character sets available in the target system and the method of character representation.

Internal Representation
The number of characters stored in a single computer word in the target system.

Conversion of Decimal ASCII Representation to ASCII Characters
The changes required to convert the decimal ASCII characters for use by the software.

FORTRAN IV Constructs and Intrinsics
The use of the FORTRAN IV <DO> statement with a negative loop variable, data statements, logical expressions, and intrinsic and basic external functions of the HP-PLOT/21 software.

Input/Output
The use of free-format input and descriptors in the output routines.

Global Variables
The use of global variables for communication and output buffer purposes.

Handshake Requirements
Establishment of the nature of plotter outputs which provides compatibility with a wide variety of terminal protocols.

This chapter examines these areas in detail and provides a matrix of differences between representative systems which consolidates these areas of interest.

CHARACTER SETS

The HP7221A plotter uses the characters outlined in table 3. A careful examination should be made concerning the character sets available on the target system, as well as the method used to internally represent the characters. This method of internal representation may be BCD, EBCDIC, or one of many versions of ASCII.

The information regarding character representation will typically be found in the FORTRAN IV and/or operating system manuals of the target system. It is wise to verify what is stated in the target system manuals by programmatically generating all of the characters. Such an exercise is included in the conversion feasibility program.

INTERNAL REPRESENTATION

The number of characters stored in a single computer word will vary based upon the word size and the number of bits used to represent a single character. Typically, a system will utilize the same number of bits to represent each character internally. However, some systems may represent standard characters with a specific number of bits, while representing extended characters, such as lower case letters, with twice as many bits.

Table 3. HP7221A Plotter ASCII Character Usage

ASCII CHAR.	TERMINAL KEYBOARD	DECIMAL	OCTAL	BINARY 8 7	6 5 4	3 2 1	PLOTTER USAGE
NULL	CNTL @	0	000	0 0	0 0 0	0 0 0	Null (always ignored)
SOH	CNTL A	1	001	0 0	0 0 0	0 0 1	
STX	CNTL B	2	002	0 0	0 0 0	0 1 0	
ETX	CNTL C	3	003	0 0	0 0 0	0 1 1	Default Label Terminator
EOT	CNTL D	4	004	0 0	0 0 0	1 0 0	
ENQ	CNTL E	5	005	0 0	0 0 0	1 0 1	Causes Automatic ACK
ACK	CNTL F	6	006	0 0	0 0 0	1 1 0	Automatic Response to ENQ
BEL	CNTL G	7	007	0 0	0 0 0	1 1 1	
BS	CNTL H	8	010	0 0	0 0 1	0 0 0	Backspace
HT	CNTL I	9	011	0 0	0 0 1	0 0 1	Half-space Forward
LF	CNTL J	10	012	0 0	0 0 1	0 1 0	Line Feed (Typical Echo Bypass)
VT	CNTL K	11	013	0 0	0 0 1	0 1 1	Inverse Line Feed
FF	CNTL L	12	014	0 0	0 0 1	1 0 0	Set Label Origin
CR	CNTL M	13	015	0 0	0 0 1	1 0 1	Carriage Return (Default Output Terminator)
SO	CNTL N	14	016	0 0	0 0 1	1 1 0	Select Standard Character Set
SI	CNTL O	15	017	0 0	0 0 1	1 1 1	Select Alternate Character Set
DLE	CNTL P	16	020	0 0	0 1 0	0 0 0	
DC1	CNTL Q	17	021	0 0	0 1 0	0 0 1	Typical Output Trigger Character
DC2	CNTL R	18	022	0 0	0 1 0	0 1 0	
DC3	CNTL S	19	023	0 0	0 1 0	0 1 1	
DC4	CNTL T	20	024	0 0	0 1 0	1 0 0	
NAK	CNTL U	21	025	0 0	0 1 0	1 0 1	
SYN	CNTL V	22	026	0 0	0 1 0	1 1 0	
ETB	CNTL W	23	027	0 0	0 1 0	1 1 1	
CAN	CNTL X	24	030	0 0	0 1 1	0 0 0	
EM	CNTL Y	25	031	0 0	0 1 1	0 0 1	
SUB	CNTL Z	26	032	0 0	0 1 1	0 1 0	
ESC	CNTL [	27	033	0 0	0 1 1	0 1 1	First Character of Device Control Instructions
FS	CNTL \	28	034	0 0	0 1 1	1 0 0	
GS	CNTL]	29	035	0 0	0 1 1	1 0 1	
RS	CNTL ~	30	036	0 0	0 1 1	1 1 0	
US	CNTL –	31	037	0 0	0 1 1	1 1 1	
SP		32	040	0 0	1 0 0	0 0 0	
!		33	041	0 0	1 0 0	0 0 1	
"		34	042	0 0	1 0 0	0 1 0	
#		35	043	0 0	1 0 0	0 1 1	~ # AUTOMATIC MACRO Instruction
$		36	044	0 0	1 0 0	1 0 0	
%		37	045	0 0	1 0 0	1 0 1	
&		38	046	0 0	1 0 0	1 1 0	
'		39	047	0 0	1 0 0	1 1 1	~ ' LABEL ON Instruction
(		40	050	0 0	1 0 1	0 0 0	ESC • (PLOTTER ON Instruction
)		41	051	0 0	1 0 1	0 0 1	ESC •) PLOTTER OFF Instruction
*		42	052	0 0	1 0 1	0 1 0	~ * MACRO DEFINE Instruction
+		43	053	0 0	1 0 1	0 1 1	
,		44	054	0 0	1 0 1	1 0 0	
-		45	055	0 0	1 0 1	1 0 1	
.		46	056	0 0	1 0 1	1 1 0	Second Character of Device Control Instructions
/		47	057	0 0	1 0 1	1 1 1	~ / LABEL SLANT Instruction
0		48	060	0 0	1 1 0	0 0 0	Only allowed characters in the <ASC> parameter strings of the SET OUTPUT MODE and SET HANDSHAKE MODE 1 and 2 instructions
1		49	061	0 0	1 1 0	0 0 1	
2		50	062	0 0	1 1 0	0 1 0	
3		51	063	0 0	1 1 0	0 1 1	
4		52	064	0 0	1 1 0	1 0 0	
5		53	065	0 0	1 1 0	1 0 1	
6		54	066	0 0	1 1 0	1 1 0	
7		55	067	0 0	1 1 0	1 1 1	
8		56	070	0 0	1 1 1	0 0 0	
9		57	071	0 0	1 1 1	0 0 1	
:		58	072	0 0	1 1 1	0 1 0	<ASC> String Terminator
;		59	073	0 0	1 1 1	0 1 1	<ASC> String Delimiter
<		60	074	0 0	1 1 1	1 0 0	
=		61	075	0 0	1 1 1	1 0 1	
>		62	076	0 0	1 1 1	1 1 0	
?		63	077	0 0	1 1 1	1 1 1	

Table 3. HP7221A Plotter ASCII Character Usage (Continued)

ASCII CHAR.	TERMINAL KEYBOARD	DECIMAL	OCTAL	BINARY 8 7	6 5 4	3 2 1	PLOTTER USAGE
@		64	100	0 1	0 0 0	0 0 0	
A		65	101	0 1	0 0 0	0 0 1	ESC • A OUTPUT IDENTIFICATION Instruction
B		66	102	0 1	0 0 0	0 1 0	ESC • B OUTPUT BUFFER SPACE Instruction
C		67	103	0 1	0 0 0	0 1 1	ESC • C OUTPUT CURRENT POSITION Instruction
D		68	104	0 1	0 0 0	1 0 0	ESC • D OUTPUT DIGITIZED POINT Instruction
E		69	105	0 1	0 0 0	1 0 1	ESC • E OUTPUT ERROR Instruction
F		70	106	0 1	0 0 0	1 1 0	ESC • F OUTPUT STATUS Instruction
G		71	107	0 1	0 0 0	1 1 1	ESC • G OUTPUT GRAPHIC LIMITS Instruction
H		72	110	0 1	0 0 1	0 0 0	ESC • H SET HANDSHAKE MODE 1 Instruction
I		73	111	0 1	0 0 1	0 0 1	ESC • I SET HANDSHAKE MODE 2 Instruction
J		74	112	0 1	0 0 1	0 1 0	ESC • J ABORT DEVICE CONTROL Instructions
K		75	113	0 1	0 0 1	0 1 1	ESC • K ABORT GRAPHIC Instructions
L		76	114	0 1	0 0 1	1 0 0	ESC • L OUTPUT BUFFER SIZE Instruction
M		77	115	0 1	0 0 1	1 0 1	ESC • M SET OUTPUT MODE Instruction
N		78	116	0 1	0 0 1	1 1 0	
O		79	117	0 1	0 0 1	1 1 1	
P		80	120	0 1	0 1 0	0 0 0	~ P LABEL FONT Instruction
Q		81	121	0 1	0 1 0	0 0 1	~ Q FIXED DASH LINES Instruction
R		82	122	0 1	0 1 0	0 1 0	~ R VARIABLE DASH LINES Instruction
S		83	123	0 1	0 1 0	0 1 1	~ S SET GRID SIZE Instruction
T		84	124	0 1	0 1 0	1 0 0	~ T ARC TOLERANCE Instruction
U		85	125	0 1	0 1 0	1 0 1	
V		86	126	0 1	0 1 0	1 1 0	~ V VELOCITY SELECT Instruction
W		87	127	0 1	0 1 0	1 1 1	~ W SET GRAPH LIMITS Instruction
X		88	130	0 1	0 1 1	0 0 0	
Y		89	131	0 1	0 1 1	0 0 1	
Z		90	132	0 1	0 1 1	0 1 0	
[		91	133	0 1	0 1 1	0 1 1	
\		92	134	0 1	0 1 1	1 0 0	~ \ SET STRING TERMINATOR Instruction
]		93	135	0 1	0 1 1	1 0 1	
^		94	136	0 1	0 1 1	1 1 0	
_		95	137	0 1	0 1 1	1 1 1	~ _ INITIALIZE Instruction
`		96	140	0 1	1 0 0	0 0 0	
a		97	141	0 1	1 0 0	0 0 1	
b		98	142	0 1	1 0 0	0 1 0	
c		99	143	0 1	1 0 0	0 1 1	
d		100	144	0 1	1 0 0	1 0 0	
e		101	145	0 1	1 0 0	1 0 1	
f		102	146	0 1	1 0 0	1 1 0	
g		103	147	0 1	1 0 0	1 1 1	
h		104	150	0 1	1 0 1	0 0 0	
i		105	151	0 1	1 0 1	0 0 1	
j		106	152	0 1	1 0 1	0 1 0	
k		107	153	0 1	1 0 1	0 1 1	
l		108	154	0 1	1 0 1	1 0 0	
m		109	155	0 1	1 0 1	1 0 1	
n		110	156	0 1	1 0 1	1 1 0	
o		111	157	0 1	1 0 1	1 1 1	
p		112	160	0 1	1 1 0	0 0 0	p MOVE Instruction
q		113	161	0 1	1 1 0	0 0 1	q DRAW Instruction
r		114	162	0 1	1 1 0	0 1 0	r INCREMENTAL MOVE Instruction
s		115	163	0 1	1 1 0	0 1 1	s INCREMENTAL DRAW Instruction
t		116	164	0 1	1 1 0	1 0 0	t ARC CLOCKWISE Instruction
u		117	165	0 1	1 1 0	1 0 1	u ARC COUNTERCLOCKWISE Instruction
v		118	166	0 1	1 1 0	1 1 0	v PEN SELECT Instruction
w		119	167	0 1	1 1 0	1 1 1	w ROTATE Instruction
x		120	170	0 1	1 1 1	0 0 0	ROTATE AT LAST ANGE Instruction
y		121	171	0 1	1 1 1	0 0 1	No Operation
z		122	172	0 1	1 1 1	0 1 0	MACRO INSTRUCTION TERMINATE
{		123	173	0 1	1 1 1	0 1 1	MACRO INSTRUCTION INVOKE
|		124	174	0 1	1 1 1	1 0 0	No Operation
}		125	175	0 1	1 1 1	1 0 1	No Operation
~		126	176	0 1	1 1 1	1 1 0	First Character 2nd Order Graphic Instructions
DEL		127	177	0 1	1 1 1	1 1 1	Always Ignored

Subroutines AGLAX, NUMBER, and SYMBOL perform functions that are based upon the number of bits used in character representation and the number of characters that may be stored in a computer word. The subroutines use two global variables which are initialized in the subroutine PLOTS. These variables expedite activities involved in character manipulation and facilitate conversion to other systems. The two globals are:

MNCHAR – Set to the number of characters that may be stored in a single computer word.

MCBITS – Set to the number of bits used to represent a single character.

The use of these two globals is best illustrated by the following excerpt from the SYMBOL subroutine, in which characters passed in a packed array are extracted and placed in the HP-PLOT/21 output buffer:

Variable Definitions –

IARRY = The array passed to SYMBOL containing a packed string of characters to be plotted.

INUM = The number of characters contained in the array <IARRY>.

IWD = An array used as a temporary work area for the procedure.

IDATA = A temporary storage location which accepts single words as they are unpacked from array <IARRY>.

MOUTAR = A global array which functions as the host output buffer. This array accepts single characters that have been extracted from the array <IARRY> and makes them available to the plotter.

MCOUNT = A pointer indicating the next available cell in the output buffer <MOUTAR>.

Character Manipulation Routine

```
C
C       Initialize variables used as pointers during routine
C
        I = 1
        ICHARS = 0
C
C       Extract a word of packed characters from array
C
   10   IDATA = IARRY(I)
C
C       Begin loop to unpack the characters
C
        DO 20 K = MNCHAR,1,-1
        IWD(K) = IDATA-IDATA/(2**MCBITS)*(2**MCBITS)
        IDATA=IDATA/(2**MCBITS)
   20   CONTINUE
C
C       Begin loop to insert characters into output buffer
C
        DO 30 J = 1,MNCHAR
        ICHARS = ICHARS+1
        IF( ICHARS .GT. INUM ) GO TO 40
        MOUTAR(MCOUNT)=IWD(J)
        MCOUNT=MCOUNT+1
   30   CONTINUE
```

```
C
C       Increment pointer and go get next word
C
        I=I+1
        GO TO 10
C
C       End of routine
C
   40   STOP
```

The character manipulation routine is just one of several HP-PLOT/21 subroutines that have been designed to facilitate conversion to other systems.

CONVERSION OF DECIMAL ASCII REPRESENTATION TO ASCII CHARACTERS

Throughout the HP-PLOT/21 software, the decimal integer representations of ASCII characters are either passed as parameters to other subroutines or inserted directly into the output buffer array <MOUTAR>, dependent upon the most convenient and efficient method of transfer. When output buffer array <MOUTAR> is transmitted to the plotter, the decimal integers are converted to their representative ASCII character using a FORTRAN IV format statement described in the Input/Output section of this document. Since the target system's character representation may differ, these decimal representations may require change to yield the proper ASCII characters.

FORTRAN IV CONSTRUCTS AND INTRINSICS

Although the HP-PLOT/21 software was designed with transportability in mind, there exist a multitude of FORTRAN IV dialects.[1] For that reason, the following constructs and intrinsics may require change:

a. Use of the FORTRAN IV <DO> Statement With A Negative Loop Variable

Many systems do not allow this construct. In addition, some systems do not allow evaluation of an expression in a <DO> statement. Subroutines AGP and SYMBOL contain this construct. An excerpt from the AGP subroutine which converts an absolute graphic parameter to a binary format required by the plotter follows:

Variable Definitions –

X = The real value passed to the routine for conversion to special binary format.

MOUTAR = A global array used by HP-PLOT/21 as the output array. The contents of this buffer are sent to the plotter.

MCOUNT = A pointer indicating the next available cell in the output buffer <MOUTAR>.

MLOCCM = Internal flag used by HP-PLOT/21 to signal events to other routines.

Real to special binary routine –

```
C
C       Check MIN-MAX of real value
C
        IF(X .LT. 0.0) X=0.0
        IF(X .GT. 32767.0) X=32767.0
C
C       Convert to integer
C
        NUMB=IFIX(X+.5)
```

```
C
C       Check for space available in output buffer
C
        CALL DATOUT(3)
C
C       Begin conversion to special binary format
C
        NOPTS=1
        IF(NUMB .GT. 15) NOPTS=2
        IF(NUMB .GT. 1023) NOPTS=3
        DO 100 J=MCOUNT+NOPTS-1,MCOUNT,-1
        NEW=NUMB/2**6
        MOUTAR(J)=NUMB-NEW*2**6
        IF(J.EQ.MCOUNT)MOUTAR(MCOUNT)=MOUTAR(MCOUNT)+96
        IF(MOUTAR(J).LT.32)MOUTAR(J)=MOUTAR(J)+64
        NUMB=NEW
100     CONTINUE

        MCOUNT=MCOUNT+NOPTS
        MLOCCM=16
        RETURN
```

The problem involving the <DO> statement in the previous routine may be easily fixed by modifying the routine to appear as follows:

```
C
C       Check MIN-MAX of real value
C
        IF(X .LT. 0) X=0.0
        IF(X .GT. 32767.) X=32767.0
C
C       Convert to integer
C
        NUMB=IFIX(X+.5)
C
C       Check for space available in output buffer
C
        CALL DATOUT(3)
C
C       Begin conversion to special binary format
C
        NOPTS=1
        IF(NUMB .GT. 15) NOPTS=2
        IF(NUMB .GT. 1023) NOPTS=3
        ICOUNT=MCOUNT+NOPTS-1
        DO 100 J=1, NOPTS
        NEW=NUMB/2**6
        MOUTAR(ICOUNT)=NUMB-NEW*2**6
        IF(J.EQ.NOPTS)MOUTAR(ICOUNT)=MOUTAR(ICOUNT)+96
        IF(MOUTAR(ICOUNT) .LT. 32) MOUTAR(ICOUNT)=MOUTAR(ICOUNT)+64
        NUMB=NEW
        ICOUNT=ICOUNT-1
100     CONTINUE
        MCOUNT=MCOUNT+NOPTS
        MLOCCM=16
        RETURN
```

b. Data Statement

Most FORTRAN IV dialects permit the use of a string constant in a DATA statement. The HP-PLOT/21 software contains only one DATA statement which is located in the subroutine AXIS. The string constant is used when labeling an axis with exponent information.

The DATA statement appears as:

```
DIMENSION IXX(2)

DATA IXX/2H-1, 2H0␣/
```

where ␣ is a mandatory space.

Since a single string character requires only 7 bits of storage in the HP3000 computer, two characters may be stored in its 16-bit word.

The format of this DATA statement may differ on the target system based upon the method of internal representation discussed earlier.

c. Logical Expressions

The following logical operators are used throughout the software:

.AND.	AND
.OR.	INCLUSIVE OR
.NOT.	COMPLEMENT

These are all FORTRAN IV ANSI standard expressions and should present no conversion problem.

Some systems require that variables used in an arithmetic assignment statement with logical operators be type LOGICAL. The following example from the HP-PLOT/21 routine AXY demonstrates this HP3000 system requirement:

```
      INTEGER NINT
      LOGICAL NCOMP
      EQUIVALENCE (NCOMP,NINT)

      NCOMP=BOOL(NUMB) .AND.
     & BOOL ((2**(MIN0(6,15-I*6-NXOFF))-1)*2**(I*6+NXOFF))

      MOUTAR(NBYTE)=NINT/(2**(I*6+NXOFF))
```

This series of FORTRAN IV statements extracts selected bits based upon a dynamic mask. Variables used during a masking operation must be type LOGICAL. This is accomplished by using the equivalence of NCOMP (type logical) and NINT (type integer) together with the intrinsic function BOOL, which converts an integer expression to logical.

Many systems do not have such a requirement and the example above may either appear as:

```
NCOMP=AND(NUMB,(2**(MIN0(6,15-I*6-NXOFF))-1)*2**(I*6+NXOFF))
```

or as the original series of statements, but without the intrinsic BOOL. The use of this construct may be found in the routines AXY and NUMBER.

d. FORTRAN IV Intrinsic and Basic External Functions.

Table 5 lists the FORTRAN IV intrinsic functions and basic external functions used in the HP-PLOT/21 software:

Table 5. HP-PLOT/21 Intrinsic and Basic External Functions

INTRINSIC FUNCTION	DEFINITION	NUMBER OF ARGUMENTS	FUNCTION REFERENCE	TYPE OF ARGUMENT	TYPE OF FUNCTION
Absolute Value	|a|	1	ABS(*a*)	Real	Real
			IABS(*a*)	Integer	Integer
Truncation	sign of a times largest integer $\leq$ |a|	1	AINT(*a*)	Real	Real
Remaindering	a_1 (*mod* a_2)	2	MOD (a_1, a_2)	Integer	Integer
Choosing largest value	MAX (a_1, a_2, . . .)	at least 2	AMAX1 (a_1, a_2, . . . , a_n)	Real	Real
			MAX0 (a_1, a_2, . . . , a_n)	Integer	Integer
Choosing smallest value	Min (a_1, a_2, . . .)	at least 2	AMIN1 (a_1, a_2, . . . , a_n)	Real	Real
			MIN0 (a_1, a_2, . . . , a_n)	Integer	Integer
Fix	Conversion from real to integer	1	IFIX (*a*)	Real	Integer
Float	Conversion from integer to real	1	FLOAT (*a*)	Integer	Real
Convert integer expression to type logical	BOOL		BOOL (*a*)	Integer	Logical

BASIC EXTERNAL FUNCTION	DEFINITION	NUMBER OF ARGUMENTS	FUNCTION REFERENCE	TYPE OF ARGUMENT	TYPE OF FUNCTION
Natural Logarithm	Log_e (*a*)	1	ALOG (*a*)	Real	Real
Common Logarithm	Log_{10} (*a*)	1	ALOG10 (*a*)	Real	Real
Trigonometric Sine	Sin (*a*)	1	SIN (*a*)	Real	Real
Trigonometric Cosine	Cos (*a*)	1	COS (*a*)	Real	Real

INPUT/OUTPUT

a. Input

Several of the routines use free-format input with commas as delimiters. For example:

```
READ (MDEVIN,*) INT1,INT2,INT3
```

where: MDEVIN = The logical unit number of the input device
* = The free-format identifier

The variables INT1, INT2, and INT3 will receive a stream of data from the plotter which might appear as –

350, 350, 16000, 11400 carriage return

The commas separating the various numerical values and the carriage return terminating the response are automatically supplied by the plotter for all output requests.

Free-format input is used in the routines OUTEMP, OUTRE1, OUTRE3, and OUTRE4.

b. Output

The HP-PLOT/21 output routines use the ASCII string edit descriptor (nH) and the rightmost ASCII character field descriptor (Rw).

All output is performed with suppression of carriage return, linefeed. The method of suppression differs among systems and may involve the placement of a special control character either preceding or following a format specification. For example, in the case of the HP3000 system, the following technique is used:

10 FORMAT(%320C,200R1)

where:

The sequence %320C signals the system that output is to take place with suppression of carriage return, line feed.

The sequence 200R1 is the format specification for 200 ASCII characters, each located in the right-most part of an output buffer word.

Some systems limit the number of characters that can be transmitted to a terminal device regardless of whether there is carriage return, line feed suppression. If this condition exists, the user must alter the limitation value or change the size of the block in <MOUTAR>.

Output occurs in the routines HSHAKE, OUTCK1, OUTEMP, and PLOTS.

GLOBAL VARIABLES

The HP-PLOT/21 subroutines utilize several global variables for both communication and output buffer purposes via a labeled common block. Some systems may disallow labeled common in which case unlabeled common may be used. Occasionally, systems will have restrictions involving the number of continuation lines permitted for a single source statement. This may necessitate splitting the common into two common blocks. As long as the common block retains a contiguous one-to-one correspondence between the common block variables, this should present little difficulty.

HANDSHAKE REQUIREMENTS

The subroutine PLOTS sets up the handshake sequence with the plotter via an instruction to Set Output Mode. The Set Output Mode instruction establishes the nature of the plotter outputs, providing compatibility with a wide variety of terminal protocols. The Set Output Mode sequence transferred to the plotter is presented in table 6.

The internal plotter flow upon receipt of a Set Output Mode instruction is shown in figure 1. Due to plotter parser requirements, the plotter does not act upon the instruction in the exact sequence transferred to the plotter. A description of the primary operations performed in the flow chart is as follows.

Table 6. Set Output Mode Sequence

(ESC) (.) (M) [<ASC>$_1$] (;) [<ASC>$_2$] (;) [<ASC>$_3$] (;) [<ASC>$_4$] (;) [<ASC>$_5$] (:)

<ASC>$_1$ Turn-around delay (Ø to 9999 milliseconds)

Default: Ø milliseconds (no delay)

<ASC>$_2$ Output trigger character;ASCII decimal equivalent (Ø to 126)

Default: Ø (ASCII equivalent of NULL)

<ASC>$_3$ Echo-terminate character;ASCII decimal equivalent (Ø to 126)

Default: Ø (ASCII equivalent of NULL)

<ASC>$_4$ Output terminator; 1 or 2 characters; ASCII decimal equivalents (Ø to
<ASC>$_5$ 127)

Default: 13; Ø (ASCII equivalents of Carriage Return and NULL)

DEFAULT: (ESC) (.) (M) (:) is the same as

(ESC) (.) (M) (Ø) (;) (Ø) (;) (Ø) (;) (1) (3) (;) (Ø) (:)

Trigger Character

Beginning with the receipt of an output instruction and continuing until receipt of the trigger character, all input except Device Control instructions is ignored. If the trigger character is defaulted or specified as zero (NULL character), then a trigger is not required and input is not ignored.

Turn-Around Delay

Following receipt of the output instruction and trigger character (if any), the turn-around delay begins at the end of which time transmission begins.

Output Terminator

Following transmission of the requested information, the two terminator characters are transmitted. If the first character, or both characters are defined as zero (NULL character), then no terminator characters are transmitted. If the second character is defined as zero, then only the first character is transmitted. If the output terminator is defaulted, then only a carriage return is transmitted.

Echo Terminate Character

The echo terminate character is used to prevent plotter response to an output request from being echoed by the host computer and interpreted as plot data by the plotter. Beginning with the start of transmission and continuing until receipt of the echo-terminate character, all input except Device Control instructions is ignored. If the echo-terminate character is defaulted or specified as zero (NULL character), then an echo-terminate character is not required and any echoed input will not be ignored.

In the default situation, the plotter transmits requested information terminated by a carriage return, immediately following receipt of an output instruction.

Now that the basic concepts of the set output mode instruction have been examined, the following excerpt from the PLOTS subroutine will clarify the complete handshake sequence:

```
      WRITE(MDEVOT,100)
100 FORMAT(%320C,30H (ESC).( (ESC) .M10;17;10;13: (ESC).E (ESC).J (ESC).F (ESC).J)
```

An examination of this sequence for handshake with the HP3000 system shows that —

Turn-around delay	= 10 milliseconds
Output trigger character	= 17 (decimal DC1)
Echo terminate character	= 10 (decimal line feed)
Output terminator	= 13 (decimal carriage return)

(ESC) .E
(ESC) .J
(ESC) .F
(ESC) .J

} Used to clear plotter status information

Information regarding the handshake requirements for the target system may typically be found in either the device driver manuals or the I/O section of the system reference manual.

SYSTEM DIFFERENCES

Table 4 is a consolidation of system differences for consideration when determining conversion feasibility. The systems listed should be considered as a representative of a family of similar systems rather than as specific configurations. Many installations may offer extended capabilities to the user through operating system enhancement or programming language extensions, or both.

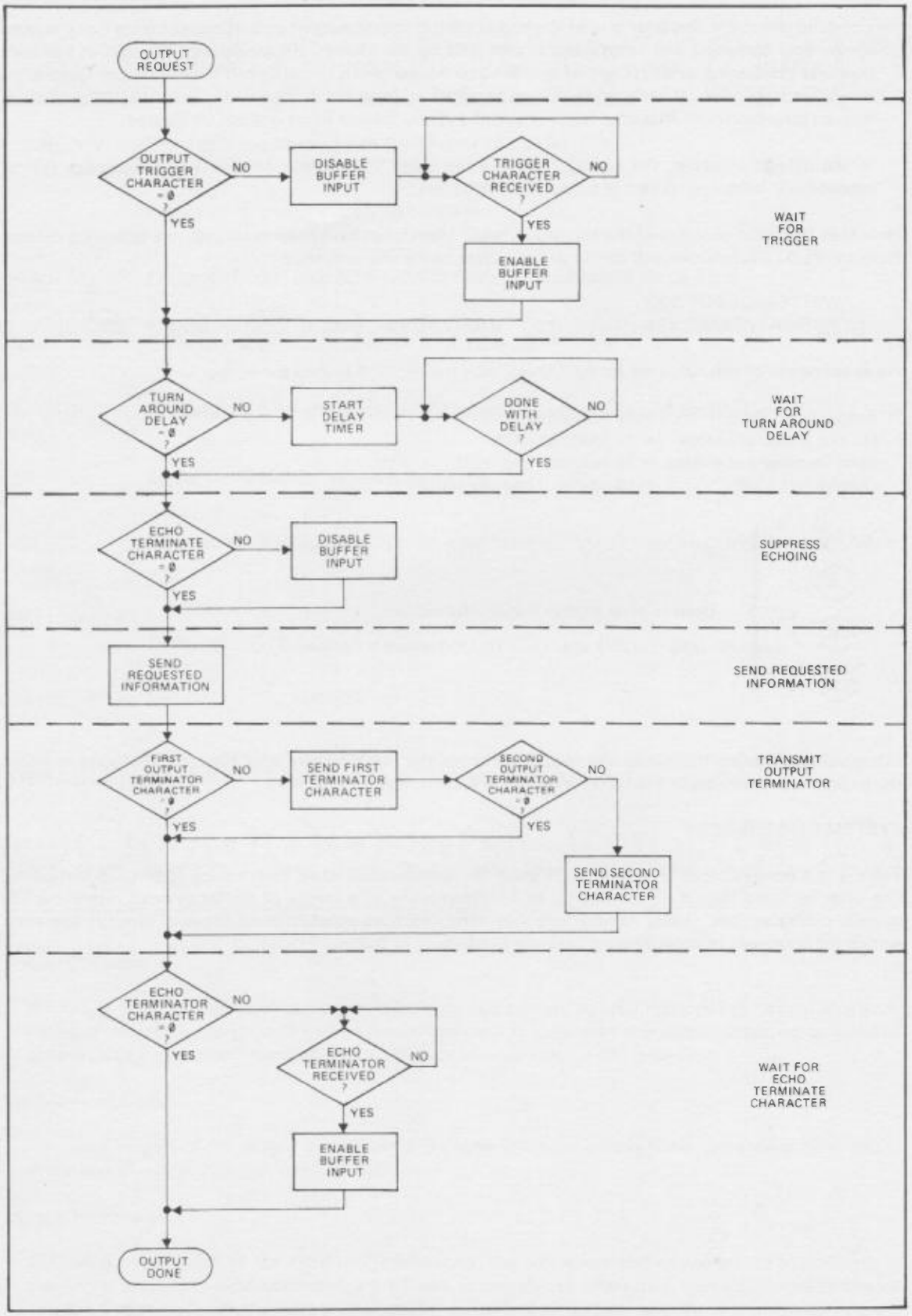


Figure 1. Plotter Output Mode Flowchart

Table 4. System Differences

	SUPPORTED SYSTEMS			REPRESENTATIVE SYSTEMS			
SYSTEM	HP 3000 SERIES II	GE MARK III (HONEYWELL 6000)	TYMSHARE X (PDP 10)	CDC CYBERNET® (CYBER 173)	IBM 370	DATA GENERAL ECLIPSE	DEC PDP 11
Word Size (bits)	16	36	36	60	32	16	16
Character Representation (bits)	7 ASCII	9 ASCII	7 ASCII	6 or 12 [1] ASCII	8 ASCII	8 ASCII	7 ASCII
Characters per word	2	4	5	5 or 10	4	2	2
Fortran IV constructs NOT allowed	Non-type logical in arithmetic assignment with logical operators	1. Negative <DO> loop 2. Expression evaluation in <DO> statement	Non-type logical in arithmetic assignment with logical operators	1. Negative <DO> loop 2. Expression evaluation in <DO> statement	1. Negative <DO> loop 2. Expression evaluation in <DO> statement	1. Negative <DO> loop 2. Expression evaluation in <DO> statement	1. Negative <DO> loop 2. Expression evaluation in <DO> statement
Method of suppression of carriage return, line feed in formatted output	%320C precedes format spec	1H& precedes format spec	& follows format spec	:A:: follows format spec and must be on a 12-bit boundary in a 60-bit word	1H+ precedes format spec	Z follows format spec	1H+ precedes format spec
Handshake differences	10 msec turn DC1 trigger LF echo CR terminator	DC1 trigger LF echo CR terminator	10 msec turn No DC1 LF echo CR terminator	100 msec turn No DC1 LF echo CR terminator	Data unavailable	Data unavailable	Data unavailable
Free-format Input	Read(I/O Unit,*) IOLIST	Read, IOLIST	Accept n, IOLIST	Read(I/O Unit,*) IOLIST	Read(I/O Unit) IOLIST	Read(I/O Unit) IOLIST	Read(I/O Unit, *) IOLIST

[1] Allows only 64 characters to be used with SYMBOL routine due to representation differences.

CHAPTER 3
CONVERSION FEASIBILITY PROGRAM

The following program will enable the programmer to ascertain the degree of difficulty involved in converting HP-PLOT/21 to operate on another system. The program has been designed to:

1. Uncover any compile-time errors.

2. Uncover any run-time problems.

3. Display the target system's character set.

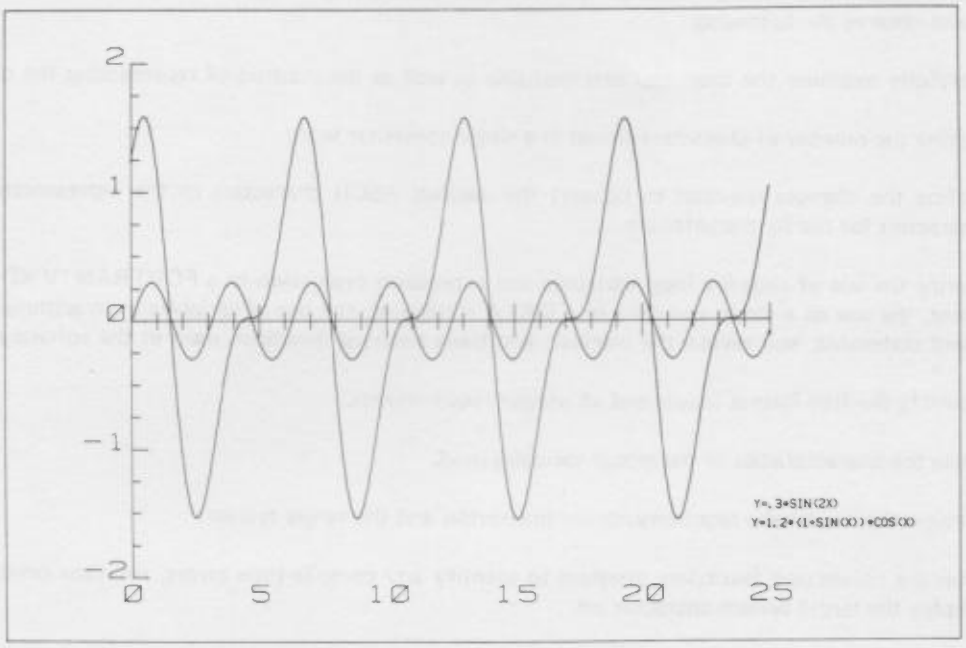
It may be necessary to set the variable IOUT equal to the logical device number of the target system's terminal.

```
      PROGRAM TEST
C
C     This is the conversion feasibility program.  The
C     program contains a series of tests that involve
C     the possible problem areas outlined in the conversion
C     considerations section of the application note.
C
C     ** Labeled common block **
C
C     This labeled common block is from the HP-PLOT/21
C     graphics software routines.
C
      COMMON/GSDATA/XCHARA,XMAPT1,XMAPT2,YMAPT1,YMAPT2,TEMP66,
     &XLASTL,YLASTL,XMAXGU,YMAXGU,XLASTA,YLASTA,XMINRG,YMINRG,
     &XRESPU,YRESPU,XFACTS,YFACTS,XMAXIN,YMAXIN,XMAXRG,YMAXRG,
     &XOFFPU,YOFFPU,XMINMU,YMINMU,XMAXMU,YMAXMU,XMAPL1,YMAPL1,
     &XMAPL2,YMAPL2,XMINUU,YMINUU,XMAXUU,YMAXUU,XRELPU,YRELPU,
     &XWIND1,YWIND1,XWIND2,YWIND2,XRATIO,YCHARH,XEXTR1,YEXTR2,
     &XCHARS,YLABAN,XRELAN,YACTAN,XDLLEN,YRANGE,XMAXPU,YMAXPU,
     &MERRO1,MERRO2,MERRO3,MONOFF,MPENPO,MPENNO,MLNTYP,
     &MCLEAR,MCLIPF,MLTERM,MDEVIN,MCSTDF,MCALTF,MLBPOS,MEMPTY,
     &MBUFSI,MCOUNT,MSTART,MARSIZ,MSETUN,MLOCCM,MINIT1,MSCLIP,
     &MFXDNO,MDEVOT,MBUFAP,MPLOST,MNCHAR,MCBITS,MOUTAR(200)
C
C
C     Now we will initialize arrays and other variables
C     utilized during our tests
C
      DIMENSION ICHARS(128),IARAY(3)
C
C     *** NOTE ***  - IOUT - should be set to the logical unit
C                     of the terminal for the target system.
C
      IOUT=6
      IOLD=0
      INDEX1=1
      INDEX2=3
      WRITE(IOUT,1)
    1 FORMAT (1X,41HHP-PLOT/21 CONVERSION FEASIBILITY PROGRAM/)
C
C     ** Test 1 ** Display target character set
C
```

```
      WRITE(IOUT,5)
    5 FORMAT(1X,37HTEST 1 – DISPLAY TARGET CHARACTER SET/)
      DO 10 I = 1,128
      ICHARS(I) = I – 1
   10 CONTINUE
      DO 30 J = 1,128
      WRITE(IOUT,20) ICHARS(J)
   20 FORMAT(1X,R1)
   30 CONTINUE
C
C     ** Test 2 **  <DO statement> with expression
                    evaluation and negative loop
                    ( output from this test should be : 123 )
C
      WRITE(IOUT,35)
   35 FORMAT(1X,23HTEST 2 – <DO STATEMENT>/)
      WRITE(IOUT,36)
   36 FORMAT(1X,22HOUTPUT SHOULD BE : 123/)
      DO 40 K = INDEX1+INDEX2-1,INDEX2-2,-1
      IARAY(K) = K
   40 CONTINUE
      WRITE(IOUT,50) (IARAY(L),L=1,3)
   50 FORMAT(1X,3I1)
C
C
C     ** Test 3 **  Arithmetic assignment statement with
                    logical operators
                    ( output from this test should be : 10 )
C
      WRITE(IOUT,55)
   55 FORMAT(1X,40HTEST 3 – ARITHMETIC ASSIGNMENT STATEMENT/)
      WRITE(IOUT,56)
   56 FORMAT(1X,21HOUTPUT SHOULD BE : 10/)
      INEW = OR(IOLD,10)
      WRITE(IOUT,60) INEW
   60 FORMAT(1X,I5)
      STOP
      END
```

CHAPTER 4
SAMPLE PROGRAM AND PLOT

A graphic application program consists of four basic tasks: graph setup, plotting the data, annotating the plot (axes and labels), and termination. The following HP-PLOT/21 program shows these tasks in detail.




```
C
C   Sample program #1
C
C   Plotter set-up
C
      CALL PLOTS(1,5,6)
      CALL RES(1.0,1.0)
      CALL FRAME
      CALL SETIN
      CALL LOCATE(2.0,12.0,1.0,9.0)
      CALL MAPUU(0.,25.0,-2.0,2.0)
C
C   Initialize numeric values
C
      XSTART=0.0
      XEND=25.0
      STEP=.01
      X=0.0
      CALL PENUP
C
C   Generate and plot data
C
      CALL NEWPEN(3)
  100 X=X+STEP
      IF(X.GT.XEND) GO TO 200
      Y=1.2*(1.0+SIN(X))*COS(X)
      CALL PLOT(X,Y,4)
      GO TO 100
  200 CALL PENUP
      CALL NEWPEN(2)
      X=0
  250 X=X+STEP
      IF(X.GT.XEND) GO TO 300
      Y=.3*SIN(2.0*X)
      CALL PLOT(X,Y,4)
      GO TO 250
C
C   Draw and label axes
C
  300 CALL PENUP
      CALL NEWPEN(4)
      CALL CSIZEA(.125,1.0,0.)
      CALL FXD(-1)
      CALL LAXES(1.0,.25,0.,0.,-5,4,2.5)
C
C   Annotate plot
C
      CALL SETIN
      CALL CSIZEA(.125,.6,0.)
      CALL NEWPEN(2)
      CALL MOVE(11.75,2.3)
      CALL LABON(12)
      DISPLAY"Y=.3*SIN(2X)"
      CALL LABOFF
      CALL NEWPEN(3)
      CALL MOVE(11.75,2.0)
      CALL LABON(23)
      DISPLAY"Y=1.2*(1+SIN(X))*COS(X)"
      CALL LABOFF
C
C   Turn off the plotter
C
      CALL PLOTOF
      STOP
      END
```

SUMMARY

The HP-PLOT/21 subroutine package is available for use with HP3000 Series II computer systems and the commercial timeshare services of GE MARK III (Honeywell 6000) and TYMSHARE X (PDP-10) systems. The package can be converted for use on other systems, however, prior to conversion the systems programmer should be thoroughly familiar with the HP-PLOT/21 Software User's Manual, part number 07221-90002, and observe the following:

- Carefully examine the character sets available as well as the method of representing the characters.
- Define the number of characters stored in a single computer word.
- Define the changes required to convert the decimal ASCII characters to the representative ASCII characters for use by the software.
- Verify the use of negative loop variables and expression evaluation in a FORTRAN IV <DO> statement, the use of a string constant in a DATA statement, the use of variables in an arithmetic assignment statement, and review the intrinsic and basic external functions used in the software package.
- Identify the free-format inputs and all output requirements.
- Note the characteristics of the global variables used.
- Review the handshake requirements for the plotter and the target system.
- Run the conversion feasibility program to identify any compile-time errors, run-time problems, and display the target system character set.

REFERENCE

1. G. David Ripley and J. W. White, "A Survey and Analysis of Minicomputer Dialects," Department of Computer Science Report, University of Arizona, April 11, 1977.

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P.O. Box 25016
Tel-Aviv
Tel: 38973
Telex: 33569
Cable: BASTEL Tel-Aviv

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
59-1 Yoyogi 1-Chome
Shibuya-ku, **Tokyo** 151
Tel: 03-370-2281/92
Telex: 232-2024YHP
Cable: YHPMARKET TOK 23-724

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg., 4th Floor
4-20, Nishinakajima 5-chome
Yodogawa-ku, Osaka-shi
Osaka 532
Tel: 06-304-6021

Yokogawa-Hewlett-Packard Ltd.
Nakamo Building
24 Kami Sasajima-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 Mitsu Building
105, Chome-1 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
Hachiuchi Building
4th Floor
3-4, Tsukuba
Kumagaya, Saitama 360
Tel: 0485-24-6563

KENYA
Technical Engineering Services(E.A.)Ltd.
P.O. Box 18311
Nairobi
Tel: 557726/556762
Cable: PROTON

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P.O. Box 19012
Nairobi Airport
Nairobi
Tel: 336055/56
Telex: 22201/22301
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KOREA
Samsung Electronics Co., Ltd.
20th Fl. Dongbang Bldg. 250, 2-KA
C.P.O. Box 2775
Taepyung-Ro, Chung-Ku
Seoul
Tel: (23) 6811
Telex: 22575
Cable: ELEKSTAR Seoul

MALAYSIA
Teknik Mutu Sdn. Bhd.
2 Lorong 13/6A
Section 13
Petaling Jaya **Selangor**
Tel: 54994/54998
Telex: MA 37505

Protel Engineering
P.O. Box 1917
Lot 259, Satok Road
Kuching, **Sarawak**
Tel: 2400
Cable: PROTEL ENG

MOZAMBIQUE
A.N. Goncalves, Lda.
162, 1 Apt. 14 Av. D. Luis
Caixa Postal 107
Lourenco Marques
Tel: 27091, 27114
Telex: 6-203 NEGON Mo
Cable: NEGON

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
P.O. Box 9443
Courtenay Place
Wellington
Tel: 877-199
Telex: NZ 3839
Cable: HEWPACK Wellington

Hewlett-Packard (N.Z.) Ltd.
Pakuranga Professional Centre
267 Pakuranga Highway
Box 51092
Pakuranga
Tel: 569-651
Cable: HEWPACK Auckland

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Medical Supplies N.Z. Ltd.
Scientific Division
79 Carlton Gore Rd., Newmarket
P.O. Box 1234
Auckland
Tel: 75-289
Cable: DENTAL Auckland

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P.O. Box 1994
147-161 Tory St.
Wellington
Tel: 850-799
Telex: 3858
Cable: DENTAL, Wellington

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Medical Supplies N.Z. Ltd.
P.O. Box 309
239 Stanmore Road
Christchurch
Tel: 892-019
Cable: DENTAL, Christchurch

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Medical Supplies N.Z. Ltd.
303 Great King Street
P.O. Box 233
Dunedin
Tel: 88-817
Cable: DENTAL, Dunedin

NIGERIA
The Electronics Instrumentations Ltd.
N6B/770 Oyo Road
Oluseun House
P.M.B. 5402
Ibadan
Tel: 61577
Telex: 31231 TEIL Nigeria
Cable: THETEIL Ibadan

The Electronics Instrumentations Ltd.
144 Agege Motor Road, Mushin
P.O. Box 6645
Lagos
Cable: THETEIL Lagos

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Mushko & Company, Ltd.
Oosman Chambers
Abdullah Haroon Road
Karachi-3
Tel: 511027, 512927
Telex: 2894
Cable: COOPERATOR Karachi

Mushko & Company, Ltd.
38B, Satellite Town
Rawalpindi
Tel: 41924
Cable: FEMUS Rawalpindi

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The Online Advanced Systems Corporation
8th Floor, Filcapital Bldg.
Ayala Avenue
Makati, Metro**Manila**
Tel: 85-35-81, 85-34-91
Telex: 3274 ONLINE

RHODESIA
Field Technical Sales
45 Kelvin Road North
P.O. Box 3458
Salisbury
Tel: 705231 (5 lines)
Telex: RH 4122

SINGAPORE
Hewlett-Packard Singapore (Pte.) Ltd.
1150 Depot Road
Alexandra P.O. Box 58
Singapore 4
Tel: 270-2355
Telex: HPSG RS 21486
Cable: HEWPACK, Singapore

SOUTH AFRICA
Hewlett-Packard South Africa (Pty.) Ltd.
Private Bag, Wendywood
Sandton, Transvaal 2144
Hewlett-Packard Centre
Daphne Street, Wendywood,
Sandton, Transvaal 2144
Tel: 802-10408
Telex: 8-4782
Cable: HEWPACK JOHANNESBURG

Service Department
Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 39325
Gramley, Sandton, 2018
451 Wynberg Extension 3,
Sandton, 2001
Tel: 636-8188/9
Telex: 8-2391

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 thu 9
Telex: 57-0006

Service Department
Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 37099
Overport, Durban 4067
Braby House
641 Ridge Road
Durban, 4001
Tel: 88-7478
Telex: 6-7954

TAIWAN
Hewlett-Packard Far East Ltd.,
Taiwan Branch
39 Chung Hsiao West Road
Sec. 1, 7th Floor
Taipei
Tel: 3819160-4
Cable: HEWPACK TAIPEI

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

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Medical Only
International Aeradio (E.A.), Ltd.
P.O. Box 861
Dar es Salaam
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Telex: 41030

THAILAND
UNIMESA Co., Ltd.
Elcom Research Building
2538 Sukumvit Ave.
Bangkok
Tel: 3932387, 3930338
Cable: UNIMESA Bangkok

UGANDA
Medical Only
International Aeradio(E.A.), Ltd.
P.O. Box 2577
Kampala
Tel: 54388
Cable: INTAERIO Kampala

ZAMBIA
R.J. Tilbury (Zambia) Ltd.
P.O. Box 2792
Lusaka
Tel: 75793
Cable: ARJAYTEE, Lusaka

OTHER AREAS NOT LISTED, CONTACT:
Hewlett-Packard Intercontinental
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

CANADA

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

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.
837 E. Cordova Street
Vancouver V6A 3R2
Tel: (604) 254-0531
TWX: 610-922-5059 VCR

MANITOBA
Hewlett-Packard (Canada) Ltd.
513 Century St.
St. James
Winnipeg R3H 0L8
Tel: (204) 786-7581
TWX: 610-671-3531

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd.
800 Windmill Road
Dartmouth B3B 1L1
Tel: (902) 469-7820
TWX: 610-271-4482 HFX

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

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Blvd.
Pointe Claire H9R 1G7
Tel: (514) 697-4232
TWX: 610-422-3022
TLX: 05-821521 HPCL

FOR CANADIAN AREAS NOT LISTED:
Contact Hewlett-Packard (Canada) Ltd. in Mississauga

CENTRAL AND SOUTH AMERICA

ARGENTINA
Hewlett-Packard Argentina S.A.
Av. Leandro N. Alem 822 - 12
1001 **Buenos Aires**
Tel: 31-6063 4,5,6 and 7
Telex: Public Booth N.9
Cable: HEWPACK ARG

BOLIVIA
Casa Kavlin S.A.
Calle Potosi 1130
P.O. Box 500
La Paz
Tel: 41530,53221
Telex: CWC BX 5298, ITT 3560082
Cable: KAVLIN

BRAZIL
Hewlett-Packard do Brasil I.e.C. Ltda.
Avenida Rio Negro, 980
Alphaville
06400 **Barueri** SP
Tel: 429-2148/9,429-2118/9

Hewlett-Packard do Brasil I.e.C. Ltda.
Rua Padre Chagas, 32
90000 **Porto Alegre**-RS
Tel: (0512) 22-2998, 22-5621
Cable: HEWPACK Porto Alegre

Hewlett-Packard do Brasil I.E.C. Ltda.
Rua Siqueira Campos, 53
Copacabana
20000 **Rio de Janeiro**
Tel: 257-80-94-DDD (021)
Telex: 391-212-1905 HEWP-BR
Cable: HEWPACK
Rio de Janeiro

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Alameda 580-Of. 807
Casilla 2118
Santiago, 1
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Telex: 3520001 CALMET
Cable: CALMET Santiago

COLOMBIA
Instrumentación
Henrik A. Langebaek & Kier S.A.
Carrera 7 No. 48-75
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 69-88-77
Cable: AARIS Bogota
Telex: 044-400

COSTA RICA
Cientifica Costarricense S.A.
Calle Central, Avenidas 1 y 3.
Apartado 10159
San Jose
Tel: 21-86-13
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Eloy Alfaro #1824,3 Piso
Quito
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EL SALVADOR
Instrumentacion y Procesamiento Electronico de el Salvador
Bulevar de los Heroes II-48
San Salvador
Tel: 252787

GUATEMALA
IPESA
Avenida La Reforma 3-48
Zona 9
Guatemala City
Tel: 63627, 64786
Telex: 4192 Teletro Gu

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Torres Adalid No. 21, 11 Piso
Col. del Valle
Mexico 12, D.F.
Tel: (905) 543-42-32
Telex: 017-74-507

Hewlett-Packard Mexicana, S.A. de C.V.
Ave. Constitución No. 2184
Monterrey, N.L.
Tel: 48-71-32, 48-71-84
Telex: 038-843

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 25114, 23412, 23454
Cable: ROTERAN Managua

Calculators Only
Científico Costarricewse S.A.
Ciudad Jardin D-1
Managua
Tel: 24108

PANAMA
Electrónico Balboa, S.A.
P.O. Box 4929
Calle Samuel Lewis
Ciudad de Panama
Tel: 64-2700
Telex: 3431103 Curunda Canal Zone
Cable: ELECTRON Panama

PARAGUAY
Z.J. Melamed S.R.L.
Division: Aparatos y Equipos Médicos
División: Aparatos y Equipos Científicos y de Investigación
P.O. Box 676
Chile-482, Edificio Victoria
Asunción
Tel: 91-271, 91-272
Cable: RAMEL

PERU
Compañía Electro Médica S.A.
Los Flamencos 145
San Isidro Casilla 1030
Lima 1
Tel: 41-4325
Cable: ELMED Lima

PUERTO RICO
Hewlett-Packard Inter-Americas
Puerto Rico Branch Office
Calle 272
No. 203 Urb. Country Club
Carolina 00924
Tel: (809) 762-7255
Telex: 345 0514

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard de Venezuela C.A.
P.O. Box 50933
Caracas 105
Los Ruices Norte
3a Transversal
Edificio Segre
Caracas 107
Tel: 35-00-11 (20 lines)
Telex: 25146 HEWPACK
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard Inter-Americas
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1260
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

EUROPE, NORTH AFRICA AND MIDDLE EAST

AUSTRIA
Hewlett-Packard Ges m b H
Handelskai 52
P O. box 7
A-1205 **Vienna**
Tel (0222) 3511521 to 27
cable HEWPAK Vienna
Telex 75923 hewpak a

BELGIUM
Hewlett-Packard Benelux
S A /N V
Avenue de Col-Vert, 1,
(Groenkraglaan)
B-1170 **Brussels**
Tel (02) 672 22 40
Cable PALOBEN Brussels
Telex 23 494 paloben bru

CYPRUS
Kypronics
19, Gregorios & Xenopoulos Rd
P O. Box 1152
CY-**Nicosia**
Tel 45628/29
Cable KYPRONICS PANDEHIS
Telex 3018

CZECHOSLOVAKIA
Vyvojova a Provozni Zakladna
Vyzkumnych Ustavu v Bechovicich
CSSR-25097 **Bechovice u Prahy**
Tel 89 93 41
Telex 121333

Institute of Medical Bionics
Vyskumny Ustav Lekarskej Bioniky
Jedlova 6
CS-88346 **Bratislava-Kramare**
Tel 44-551/45-541

DDR
Entwicklungslabor der TU Dresden
Forschungsinstitut Meinsberg
DDR-7305
Waldheim/Meinsberg
Tel 37 667
Telex 112145

Export Contact AG Zuerich
Guenther Forgber
Schlegelstrasse 15
1040 **Berlin**
Tel 42-74-12
Telex 111889

DENMARK
Hewlett-packard A/S
Datavej 52
DK-3460 **Birkerod**
Tel (02) 81 66 40
Cable HEWPACK AS
Telex 166 40 hpas

Hewlett-Packard A/S
Navervej 1
DK-8600 **Silkeborg**
Tel (06) 82 71 66
Telex 166 40 hpas
Cable HEWPACK AS

FINLAND
Hewlett-Packard OY
Nahkahousuntie 5
P O. Box 6
SF-00211 **Helsinki** 21
Tel (90) 6923031
Cable HEWPACKOY Helsinki
Telex 12-1563 HEWPA SF

FRANCE
Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
F-91401 **Orsay** Cédex
Tel (1) 907 78 25
Cable HEWPACK Orsay
Telex 600048

Hewlett-Packard France
Agency Régionale
Le Saquin
Chemin des Mouilles
B P. 162
F-69130 **Ecully**
Tel (78) 33 81 25
Cable HEWPACK Eculy
Telex 31 06 17

Hewlett-Packard France
Agence Régionale
Péricentre de la Cépière
Chemin de la Cépière, 20
F-31300 **Toulouse-Le Mirail**
Tel (61) 40 11 12
Cable HEWPACK 51957
Telex 510957

Hewlett-Packard France
Agence Régionale
Aéroport principal de
Marseille-Marignane
F-13721 **Marignane**
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Cable HEWPACK MARGN
Telex 410770

Hewlett-Packard France
Agence Régionale
63, Avenue de Rochester
B P. 1124
F-35014 **Rennes** Cédex
Tel (99) 36 33 21
Cable HEWPACK 74912
Telex 740912

Hewlett-Packard France
Agence Régionale
74, Allée de la Robertsau
F-67000 **Strasbourg**
Tel (88) 35 23 20/21
Telex 890141
Cable HEWPACK STRBG

Hewlett-Packard France
Agence Régionale
Centre Vauban
201, rue Colbert
Entrée A2
F-59000 **Lille**
Tel (20) 51 44 14
Telex 820744

Hewlett-Packard France
Centre d' Affaires Paris-Nord
Bâtiment Ampère
Rue de La Commune de Paris
B P. 300
F-93153 **Le Blanc Mesnil Cédex**
Tel (01) 931 88 50

GERMAN FEDERAL REPUBLIC
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
D-6000 **Frankfurt** 56
Tel (0611) 50 04-1
Cable HEWPACKSA Frankfurt
Tel (0611) 50 04-1
Cable HEWPACKSA Frankfurt
Telex 04 13249 hpftmd

Hewlett-Packard GmbH
Technisches Buero Böblingen
Herrenbergerstrasse 110
D-7030 **Boblingen** Wurttemberg
Tel (07031) 667-1
Cable HEPAK Boblingen
Telex 07265739 bbn

Hewlett-Packard GmbH
Technisches Buero Dusseldorf
Emanuel-Leutze-Str. 1 (Seestern)
D-4000 **Dusseldorf** 11
Tel (0211) 59711
Telex 085 86 533 hpdd d

Hewlett-Packard GmbH
Technisches Buero Hamburg
Wendenstrasse 23
D 2000 **Hamburg** 1
Tel (040) 24 13 93
Cable HEWPACKSA Hamburg
Telex 21 63 032 hphh d

Hewlett-Packard GmbH
Technisches Buero Hannover
Am Grossmarkt 6
D-3000 **Hannover-Kleefeld 91**
Tel (0511) 46 60 01
Telex 092 3259

Hewlett-Packard GmbH
Werk Groetzingen
Ohmstrasse 6
D-7500 **Karlsruke 41**
Tel (0721) 69 40 06
Telex 07-825707

Hewlett-Packard GmbH
Technisches Buero Nuremberg
Neumeyer Str. 90
D-8500 **Nuremberg**
Tel (0911) 56 30 83/85
Telex 0623 860

Hewlett-Packard GmbH
Technisches Buero Munchen
Unterhachinger Strasse 28
ISAR Center
D-8012 **Ottobrunn**
Tel (089) 601 30 61-7
Cable HEWPACKSA Munchen
Telex 0524985

Hewlett-Packard GmbH
Technisches Buero Berlin
Keith Strasse 2-4
D-1000 **Berlin** 30
Tel (030) 24 90 86
Telex 18 3405 hpbln d

GREECE
Kostas Karayannis
18, Ermou Street
GR-**Athens** 126
Tel 3237731
Cable RAKAR Athens
Telex 21 59 62 rkar gr

Analytical Only
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Marni 17
GR - **Athens** 103
Tel 522 1915
Cable INTEKNIKA Athens
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Tel 362 6972 363 3830
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Lenin Krt. 67
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No. 13, Fourteenth St
Miremad Avenue
P O. Box 41-2419
IR-**Tehran**
Tel 851082-7
Telex 213405 HEWP IR

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Baghdad
Tel 5517827
Telex 2455 Hepairaq ik
Cable HEWPACDAD
Baghdad Iraq

IRELAND
Hewlett-Packard Ltd
King Street Lane
GB-**Winnersh**, Wokingham
Berks. RG11 5AR
Tel (0734) 78 47 74
Telex 847178/848179

ITALY
Hewlett-Packard Italiana S.p.A
Via Amerigo Vespucci 2
Casella postale 3645
I-20100 **Milano**
Tel (2) 6251 (10 lines)
Cable HEWPACKIT Milano
Telex 32046

Hewlett-Packard Italiana S.p.A
Via Pietro Maroncelli 40
(ang. Via Visentin)
I-35100 **Padova**
Tel (49) 66 48 88
Telex 41612 Hewpacki

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Hewlett-Packard Italiana S.p.A
Via d Agnardi. 7
I-56100 **Pisa**
Tel (050) 2 32 04
Telex 32046 via Milano

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Via G. Armellini 10
I-00143 **Roma**
Tel (06) 54 69 61
Telex 61514
Cable HEWPACKIT Roma

Hewlett-Packard Italiana S.p.A
Corso Giovanni Lanza 94
I-10130 **Torino**
Tel (011) 682245/659308

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Via Principe Nicola 43 G/C
I-95126 **Catania**
Tel (095) 37 05 04

Hewlett-Packard Italiana S.p.A
Via Amerigo Vespucci. 9
I-80142 **Napoli**
Tel. (081) 33 77 11

Hewlett-Packard Italiana S.p.A
Via E. Masi 9/B
I-40137 **Bologna**
Tel (051) 30 78 87

KUWAIT
Al-Khaldiya Trading &
Contracting Co
P O. Box 830
Kuwait
Tel. 42 49 10
Cable VISCOUNT

LUXEMBURG
Hewlett-Packard Benelux
S A /N V.
Avenue du Col-Vert, 1
(Groenkraaglaan)
B-1170 **Brussels**
Tel. (02) 672 22 40
Cable PALOBEN Brussels
Telex 23 494

MOROCCO
Gerep
190, Blvd. Brahim Roudani
Casablanca
Tel. 25-16-76/25-90-99
Cable Gerep-Casa
Telex 23739

NETHERLANDS
Hewlett-Packard Benelux N.V.
Van Heuven Goedhartlaan 121
P.O. Box 667
NL-1134 **Amstelveen**
Tel (020) 47 20 21
Cable PALOBEN Amsterdam
Telex 13 216 hepa nl

NORWAY
Hewlett-Packard Norge A/S
Nesveien 13
Box 149
N-1344 **Haslum**
Tel (02) 53 83 60
Telex 16621 hpnas n

POLAND
Biuro Informacji Technicznej
Hewlett-Packard
Ul. Stawki 2, 6P
00-950 **Warszawa**
Tel. 395962/395187
Telex 81 24 53 hepa pl

UNIPAN
Zaklad Doswiadczalny
Budowy Aparatury Naukowej
Ul. Krajowej Rady Narodowej 51/55
00-800 **Warszawa**
Tel 36190
Telex 81 46 48

Zaklady Naprawcze Sprzetu
Medycznego
Plac Komuny Paryskiej 6
90-007 **Lodz**
Tel. 334-41, 337-83

PORTUGAL
Telectra-Empresa Técnica de
Equipamentos Eléctricos S.a.r.l.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
P-**Lisbon** 1
Tel (19) 68 60 72
Cable TELECTRA Lisbon
Telex 12598

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Intercambio Mundial de Comércio
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Av. A.A. de Aguiar 138
P.O. Box 2761
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Cable INTERCAMBIO Lisbon

RUMANIA
Hewlett-Packard Reprezentanta
Bd N. Balcescu 16
Bucharest
Tel 158023/138885
Telex 10440

I.I.R.U.C.
Intreprinderea Pentru
Intretinerea
Si Repararea Utilajelor de Calcul
B-dul prof. Dimitrie Pompei 6
Bucharest-Sectorul 2
Tel. 12 64 30
Telex 11716

SAUDI ARABIA
Modern Electronic Establishment
King Abdul Aziz str (Head office)
P.O. Box 1228
Jeddah
Tel. 31173-332201
Cable ELECTRA

P.O. Box 2728 (Service center)
Riyadh
Tel. 62596-86232
Cable RAOUFCO

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

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 9.
E-**Seville** 5
Tel. 64 44 54/58

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

Calculators Only
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