

Hewlett-Packard Desktop Computer System

HP 9871A Printer Programming Techniques





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About This Manual



Introduction

This programming techniques manual has been written to supply you with enough information under one cover to use your Desktop Computer and the HP 9871A Printer for most applications.

It is assumed that you have some proficiency in the HP Extended BASIC, but enough information should be found to direct you as a new 9871A user to a successful printing session.

Some of the more advanced interfacing techniques and data formatting may not be found. If you cannot find information pertaining to these subjects, refer to the following system manuals:

HP System Computer Operating and Programming Manual
 HP System I/O Programming Manual

and the following companion manuals:

| | |
|--|-----------------|
| HP 9871A Printer Option 001 Operating and Service Manual | P/N 09871-90001 |
| HP 9871A Printer Installation Manual | P/N 09871-90035 |
| HP 98032A 16-Bit Interface Installation and Service Manual | P/N 98032-90000 |
| HP 98034A HP-IB Interface Installation and Service Manual | P/N 98034-90000 |

Syntax Guidelines

The following conventions apply to the program statements and functions found in this manual.

- `DOT MATRIX` : All items printed in dot matrix are required exactly as shown.
- [] : All items in square brackets are optional unless the brackets are printed in dot matrix.
- ... : Three dots indicate that successive parameters are allowed, when each is separated by a comma.
- { } : When more than one item appears in an item list with no separators, individual items are enclosed in braces.

Chapter 1

General Information

Introduction

The HP 9871A Printer is a character-serial impact printer capable of performing all normal printer functions plus plotting. It is connected to the Desktop Computer via one of two possible I/O interface cables.

The easier to use of the two interfacing techniques is the HP 98032A General Purpose I/O (GPIO) Interface Cable with Option x71. This interface allows a one to one communication between one computer I/O slot and the printer.

The HP 98034A HP-IB Interface Cable¹ is a much more versatile communication system which allows controlling many peripheral devices such as the 9871A Printer with one computer I/O slot.

The GPIO Interface with Option x71 is physically the same interface as the Option 071. For the convenience of handling the purchase of the interface for the 9871A Printer and your computer combination, the interface has been given a unique option number, x71. In discussing the interface in this manual, it will be referred to as Option 071 to help maintain the fact that it is the same as any other x71 option.

In order to take advantage of the many I/O techniques, other than those available with the statements `PRINT` and `PRINT USING`, requires the installation of the System I/O ROM. Refer to your HP System Desktop Computer Operating and Programming Manual for ROM installation if necessary.

All printer functions are controlled from the computer; the print intensity is the only manual printer adjustment. Statements sent from the computer are interpreted as instructions in the printer's processor.

The printer has a 158-character buffer which stores instructions and characters when they are sent faster than the printer can print them.

¹ Any reference to the 98034A HP-IB Interface Cable is referring to the **98034A revised** Interface Cable.

In addition to the normal typewriter and printer functions (bell, line feed, backspace, etc.), the 9871A has some unique functions:

- A variable “view” feature allows you to see the last line that was printed.
- A reverse linefeed.
- A “character replacement” function allowing any ASCII character or group of characters to be redefined by a desired string of characters.
- A built-in self test to check the printer’s operation.
- It can be returned to its power-up state by the reset instruction.

Installation

CAUTION

BE SURE THAT THE COMPUTER AND PRINTER ARE EACH SET UP ACCORDING TO THEIR INSTALLATION PROCEDURES AND THE POWER IS TURNED **OFF** BEFORE CONNECTING THE INTERFACE CARD. FAILURE TO DO SO COULD RESULT IN DAMAGE TO THE EQUIPMENT. REFER TO THE COMPUTER OPERATING AND PROGRAMMING MANUALS AND THE HP 9871A PRINTER OPERATING AND SERVICE MANUAL FOR INSTALLATION INSTRUCTIONS.

Switch the computer and printer off before connecting the interface card. The card can be plugged into any I/O slot on the back of the computer. Connect the other end of the interface cable to the printer. The following photo shows a typical system layout and interconnecting cable.

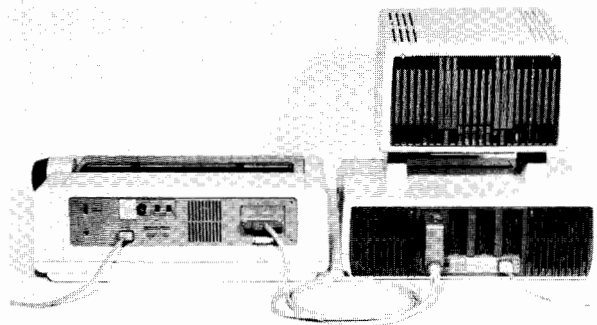


Figure 1-1. Typical System Layout

Chapter 2

Printer Control

Introduction

This chapter describes how to use the printer as a standard printing device and how to select the printer as a peripheral device.

There are many control features of the 9871A printer which allow virtually any type of form or format to be printed; this chapter shows how to control the printer using the control instructions.

Accessing the Printer

Printer Specifiers

There are three ways the printer may be accessed by the computer software.

- By defining the printer as the standard print device instead of the CRT display, the I/O ROM is not needed for this type of operation.
- Through the use of GPIO interface (98032A OPTION 071) select codes.
- Through the HP-IB interface (98034A) select code-address combination.

Either interfacing system, GPIO or HP-IB, may be used when defining the 9871A as the standard print device. Once the necessary control statement has been executed, only the PRINT statement need be used to exercise the printer.

Defining the Standard Printer

The PRINTER IS statement defines the standard print device for the system. The CRT, select code 16, is standard at power-up and after the command SCRATCH A is executed. The syntax for this function is:

```
PRINTER IS sc [, WIDTH (w) ]
```

4 Printer Control

Where the parameters are defined below.

sc: isc | isc,da | hpa

isc: Interface select code. This select code parameter can be any valid interface select code (1-12), but for standardization, the select code for the 9871A printer has been set to 2 at the factory.

da: The HP-IB device address which will be involved in the I/O operation. This may be a value of one or two digits.

hpa: Is a three or four digit HP-IB device bus address.

WIDTH (w):

The width parameter specifies the number (w) of characters per line. It may be a numeric expression or integer constant with usable values of 20 through 260; 80 is the default value, set when the computer is turned on.

The following two examples show the effect of line width control. The first example has no defined line width except the default value.

```
10  PRINTER IS 2
20  PRINT "80 CHARACTERS IS THE POWER-ON AND DEFAULT VALUE."
30  END
```

Resulting printout:

```
80 CHARACTERS IS THE POWER ON AND DEFAULT VALUE.
```

Example with width control:

```
10  PRINTER IS 2,WIDTH(29)
20  PRINT "80 CHARACTERS IS THE POWER-ON AND DEFAULT VALUE."
30  END
```

Resulting printout:

```
80 CHARACTERS IS THE POWER ON
AND DEFAULT VALUE.
```

Below is an example using the 9871A printer as the standard print device defined by the HP-IB address (hpa), 201.

```
10  PRINTER IS 2
20  PRINT "THIS EXAMPLE USES THE HP-IB SELECT CODE - ADDRESS COMBINATION TO";
30  PRINT "ACCESS THE PRINTER. THIS STRING IS 120 CHARACTERS LONG."
40  END
```

The 9871A printout is shown below. Notice that the long string has been limited to the 80 character line width.

```
THIS EXAMPLE USES THE HP-IB SELECT - CODE ADDRESS COMBINATION TO ACCESS THE PRIN
TER. THIS STRING IS 120 CHARACTERS LONG.
```



Control Instructions

The 9871A Control Instruction Set is composed of the standard ASCII control characters plus a number of codes that are uniquely used by the 9871A. These unique codes are prefixed by the ASCII escape character ESC (decimal 27).

Refer to the Appendix for a summary of the control instructions and their codes.

Control Statement

The control statement is a means of setting up the printer format so when the 9871A printer is used as the output device, the printed text will be in the desired form. The distinction between the two functions, "printing" and "controlling", can be made through the use of different output statements. Chapter 3 shows that it is also possible to use the control statement to output data.

The OUTPUT statement allows the option of sending data from the computer in several different formats. One of these data formats (B) is used to send data formatted in 8 bit groups (one byte of data). Generally all control statements are output to the printer in 8 bit bytes. This means you must use the OUTPUT statement for printer control.

Control Statement Syntax

Use the following syntax (with the select code/HP-IB address) to exercise the printer control instructions.

```
OUTPUT sc USING "#,B";[27,] instruction code
```

Spaces between the statement components are optional.

```
sc: isc | isc, da | hpa
```

isc: Interface select code. This select code parameter can be any valid interface select code (1-12), but for standardization, the select code for 9871A printer has been set to 2 at the factory.

da: The HP-IB device address which will be involved in the I/O operation. This may be a one or two digit value.

hpa: A three or four digit HP-IB device bus address.

```
"#, B";:
```

This is the data format specifier which is required for sending the single byte instruction to the printer. Refer to the section on the control specifier # for control of the CR-LF. The delimiter (;) must be used to separate the parameter list from the output list.

```
[27, ]:
```

As was mentioned earlier, the control instructions unique to the 9871A printer must be prefixed with the ASCII control code ESC (decimal 27). If standard ASCII control codes such as LF, i.e. linefeed, are used; the ESC code is omitted. The delimiter (,) is required between the ESC code and the instruction code.

instruction code:



Each printer instruction has a unique instruction number. These are specified in the statement by the decimal value which is sent to the printer in BCD form. These are listed in the Appendix.

Here is another control statement syntax using only the GPIO select code. This statement form is used to send spacing information to the printer. Notice that an additional optional parameter has been added.

```
OUTPUT sc ; 27, instruction [, INT (N/64), INT N]
```

The parameter, `INT (N/64), INT N`, where N is the variable, is a means of formatting two 8 bit bytes of data and sending it to the 9871A printer.

Clearing the Printer

The printer may be put into its default or power-up state by resetting the computer. This is done on the computer by pressing the  and  keys together, or by executing the following control statement:

```
OUTPUT 2 USING "B";27,69
```

Also, HP-IB addressing modes can be used with the printer reset instruction. Refer to the System I/O Programming Manual for details.

CAUTION

THERE IS A DEFINITE POSSIBILITY THAT DURING PROGRAM EXECUTION, THE RESET OPERATION, "CONTROL-STOP", MAY CAUSE THE ENTIRE MEMORY TO BE RESET, LIKE EXECUTING SCRATCH A. USE IT ONLY IF NOTHING ELSE, SUCH AS PRESSING THE "STOP" KEY, BRINGS THE MACHINE TO A READY STATE.

Executing SCRATCH A will put the computer into its power-up state. After executing SCRATCH A, the system's standard print device has to be redefined if the PRINT statement is used to output to the 9871A. Doing this may necessitate redefining some printing variables that have previously been defined, such as the line width.

NOTE

Since the reset instruction takes time to execute in the printer without sending a busy signal to the computer, a WAIT statement for an appropriate length of time (e.g., 1000 milliseconds) should be executed immediately after sending a reset.

The power-up state consists of the following printer conditions.

1. The carriage is moved to the extreme left and rotated into a mechanical stop. This synchronizes the internal logic with the mechanical position. The carriage is then moved to column 1.
2. All tabs are cleared.
3. Horizontal spacing is set to 10 characters per inch. Variable horizontal spacing is disabled.
4. Vertical spacing is set to 6 lines per inch.
5. The view-delay function is disabled.
6. Top of form is assumed at the current platen position.
7. Left margin is assumed at column 1.
8. Text length is assumed to be 11 inches.
9. Form length is assumed to be 11 inches.
10. The standard "shift-in" character set is assumed.
11. Text width is assumed to be 13.2 inches.
12. The origin for absolute plotting is set at the left margin and lower margin.
13. Character fill parameters are set to: decimal point spacing = 3, vertical offset = + 5.
14. All character replacements are cleared.
15. A ROM and RAM check is made (as in the Test Instruction in the next section).

General Control Functions

The general control functions and their decimal codes are listed below. With the exception of the Reverse Linefeed, they correspond to the standard ASCII control characters.

Bell (7) causes the printer to beep.

Backspace (8) moves the carriage back one character space.

Linefeed (10) rotates the platen to the next line. The carriage remains fixed.

Carriage Return (13) moves the carriage to the left-most printing position. The platen remains fixed.

Shift Out (14) replaces the character on spoke 1 with the one on spoke 8 and the character on spoke 2 with the one on spoke 89. On the standard disk, the circumflex (^) is replaced with the exponentiation (↑) character (spokes 1 and 8) and the accent character (') is replaced with an apostrophe ('). These remain set until the printer is reset or cancelled by a "shift in" function.

Shift In (15) cancels the shift out condition.

Reverse Linefeed (27,10) rotates the platen back one line. The carriage remains fixed.

The following example demonstrates the general control functions.

```

10  OUTPUT 2 USING "#,B";27,69          ! Start with RESET
20  WAIT 200
30
40  FOR C=0 TO 6                          ! Loop for column
50  OUTPUT 2 USING "B";48+C              ! Calculate and print number
60  NEXT C                                ! Next number
70
80  OUTPUT 2 USING "#,B";27,10,32        ! Reverse LF and SPACE
90  OUTPUT 2 USING "#,B";14,94           ! Shift chara set and print shifted ^
100 OUTPUT 2 USING "#,B";27,10,8        ! Reverse LF and BACKSPACE
110
120 FOR C=5 TO 0 STEP -1                  ! Count down loop for diagonal
130 OUTPUT 2 USING "#,B";48+C,94         ! Print number and shifted ^
140 OUTPUT 2 USING "#,B";8,27,10        ! BACKSPACE and REVERSE LF
150 NEXT C                                ! Next number
160
170 OUTPUT 2 USING "#,B";7,7,15         ! Ring bell twice and cancel shift
180 END

```

This program's results are shown below.

```

0      0+
1      1+
2      2+
3      3+
4 4+
55+
6+

```


Character Replacement (27,67, char, N, list). This instruction allows any ASCII code to be interpreted as any desired sequence of codes, so that the sequence is executed in place of the original character.

- The **chara** parameter is the decimal code of the character to be replaced.
- **N** is the number of characters in the replacement list.
- The character replacement list is generated in the printer's memory in the area normally occupied by the buffer. To accommodate the list, the buffer length is reduced by one character plus one additional character for every two characters in the replacement list. If the character replacement exceeds the printer memory available, the instruction is ignored and a "beep" sounds.
- To restore a character to its original definition, a "character replacement" command must be given specifying the character to be restored, and a list length of zero. This deletes the replacement list in the printer memory, and expands the buffer accordingly.
- The maximum buffer length is 158 characters.

View Delay (27,68, INT(N/64), INT N) When the printer is switched on or reset, the view delay function is disabled:

- After a view delay instruction has been given (N = positive number), the following conditions are set.

Whenever the printer's character buffer is empty, the platen advances to allow viewing of the last character printed. The platen automatically retracts before printing the next character.

The delay time (N) is the time before the platen advances, and the character disk rotates to home position.

The platen does not advance and the character disk does not home if another character is sent within the delay time.

- N is the delay value in milliseconds, the maximum N value is 2047 milliseconds or approximately 2 seconds. If N is a negative number, the platen does not advance, but the character disk still waits the specified delay before rotating home.
- The view delay default value is: $N = -200$.

Reset (27,69) sets the printer to its power-up state (the printer automatically assumes this state at turn-on).

For a more complete explanation of the **Reset** function, see the section on clearing the printer.

Test (27,122) resets the printer and executes a test program that is located in the printer. This command is a software equivalent to pressing the test button on the printer's rear panel. Refer to the System Test Booklet for the test printout.

The results of the Test Function are:

- Prints a 132 character test pattern followed by a carriage return and linefeed.
- Performs a check sum on internal ROM (Read Only Memory).
- Writes and then reads a test pattern in internal RAM (Random Access Memory).
- Resets the printer to its power up state.

Horizontal Tab Control

Set Horizontal Tab (27,49) sets a tab at the current position of the carriage for use with subsequent "horizontal tab" operations.

- To set a horizontal tab, move the carriage to the desired position by repeatedly sending the space instruction (decimal 32) to the printer till the desired character position is located. Then send the Horizontal Tab instruction (27,49) to the printer. Once the tab is set, the position is not affected by the Horizontal Character Spacing instruction.
- Tab settings are stored in the printer's buffer with each tab using one character space.

Clear Horizontal Tab (27,50) clears the horizontal tab at the current tab location.

- The carriage is moved to the tab location to be cleared by executing the required number of horizontal tabs. Then the Clear Horizontal Tab instruction (27,50) is sent to the printer which clears that tab from the printer's buffer.

Clear All Horizontal Tabs (27,51) clears all of the horizontal tabs regardless of the carriage position.

Horizontal Tab Right (9) moves the carriage to the next set horizontal tab position.

- If there are no tabs set to the right of the current position, the carriage moves to the right margin.

Horizontal Tab Left (27,52) moves the carriage left to the next set tab position.

- If there are no tabs set to the left of the current position, the carriage moves to the left margin.

NOTE

If a series of fast repeating carriage moves as from a SPACE instruction in a FOR-NEXT loop is sent to the printer, it is possible to “space” the carriage-position pointer through the printer buffer faster than the mechanical carriage can move. The correct carriage position will be in the buffer, but the mechanical carriage may still be in the home or column 1 position. If no printing is to occur at the “new” position then a HOR Tab Set will be correctly positioned. Of course, if printing does occur starting at the “new” position, the mechanical carriage is not positioned correctly. To allow the mechanical carriage to keep up with the spacing statements, put a WAIT statement of at least 200 milliseconds after the spacing statement. This will keep the carriage in step with the internal printer buffer.

This same problem can occur if a number of HOR or VERT Tabs have been set and the printer is to repeatedly tab and then immediately print. A WAIT statement after the tabs will allow the carriage to move to the new position before printing commences.

For another solution to this problem, refer to the EOL statement’s delay feature.



Here is an example exercising the Horizontal Tab Controls:

```

10  OUTPUT 2 USING "#,B";27,69          ! Reset printer
20  WAIT 200
30                                !
40  FOR N=1 TO 8                      ! Loop to set tabs
50                                !
60    FOR C=0 TO 8                    ! Loop to space
70      OUTPUT 2 USING "#,B";32      ! Output SPACE
80    NEXT C
90                                !
100  OUTPUT 2 USING "#,B";27,49       ! SET TAB
110  NEXT N
120                                !
130  OUTPUT 2 USING "#,B";13          ! Output CR
140  N=1                               ! Start column count at 1
150  OUTPUT 2 USING "#,D";N          ! Print column number
160                                !
170  FOR N=2 TO 8                    ! Loop to label remaining columns
180    OUTPUT 2 USING "#,B";9        ! TAB RIGHT
190    OUTPUT 2 USING "#,D";N        ! Print column number
200  NEXT N
210                                !
220  OUTPUT 2 USING "#,B";10,10,8     ! Do two LINEFEEDS and a BACKSPACE
230  N=N-1                             ! Reduce column number by 1
240  OUTPUT 2 USING "#,D";N          ! Print column number
250                                !
260  FOR N=7 TO 1 STEP -1            ! Loop to label remaining columns
270    OUTPUT 2 USING "#,B";8,27,52  ! BACKSPACE and TAB LEFT
280    OUTPUT 2 USING "#,D";N        ! Print column number
290  NEXT N
300                                !
310  END

```

Here are the results of the above program:

```

1      2      3      4      5      6      7      8
1      2      3      4      5      6      7      8

```

Vertical Tab Control

Set Vertical Tab (27,53) sets a tab at the current position of the platen for use in subsequent vertical tab operations.

- The tab is referenced from the top of form. Thus, linefeed commands should be used to move the platen from the established top of form to the desired tab position. Once the position has been located, sending the instruction 27,53 sets the tab.
- Each tab position is stored in the printer's buffer and uses one character space.

Clear Vertical Tab (27,54) clears the vertical tab at the current platen position.

- The platen is moved with as many Vertical Tab Down instructions as necessary to achieve the desired tab position. Then the Clear Vertical Tab instruction (27,54) is sent to the printer to clear the current tab position.

Clear All Vertical Tabs (27,55) clears all vertical tabs in the printer.

Vertical Tab Down (11) moves the platen down to the next set vertical tab position.

- If there are no tabs set below the current position, the platen moves to the bottom margin (see Form and Margin Control).

Vertical Tab Up (27,56) moves the platen up to the next set vertical tab position.

- If there are no tabs set above the current position, the platen moves to the top of form position.

An example of Vertical Tab control:

```

10  OUTPUT 2 USING "#,B";27,69          ! Reset printer
20  WAIT 200
30
40  FOR C=1 TO 5                        ! Set vert tabs loop
50    OUTPUT 2 USING "#,B";27,53        ! Set tab
60    OUTPUT 2 USING "#,A,B";"*,8      ! Print "*" and backspace
70    OUTPUT 2 USING "#,B";10,10,10    ! Linefeed three times
80  NEXT C
90
100 OUTPUT 2 USING "#,B";32,32         ! Space twice
110 C=5
120
130 FOR C=5 TO 1 STEP -1               ! Vert tab-up loop
140   OUTPUT 2 USING "#,B";27,56      ! Tab up
150   OUTPUT 2 USING "#,D,B";C,8      ! Print line number
160 NEXT C                             ! and backspace
170
180 END

```

The resulting printout:

* 1

* 2

* 3

* 4

* 5

Form and Margin Control

The following parameters may be set to define the size of a form and the size of the printing (or plotting) area, as shown in the illustration below.

- Top of form
- Form length
- Left margin
- Text length
- Text width

The following illustration shows the parameters as they are used.

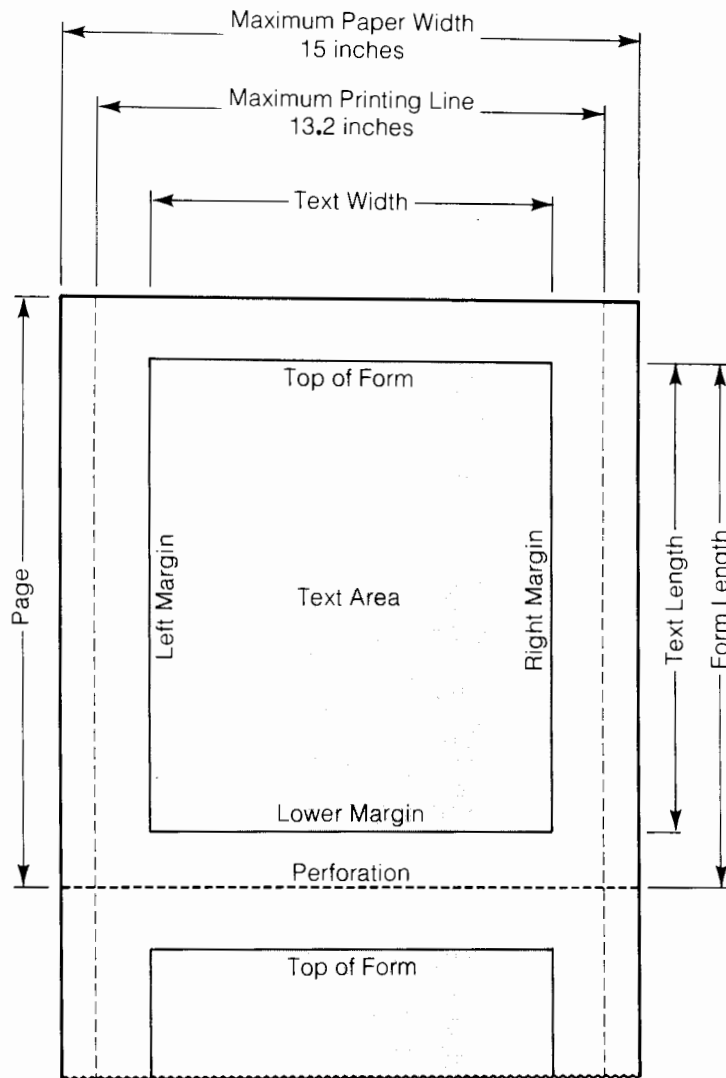


Figure 2-1. Form and Margin Parameters

Many of the control and plotting function codes have parameters that increment the printer in $1/96$ and $1/120$ inch increments. A summary of the most used increments and a conversion between the English and metric increments is in the Appendix under "HOR and VERT Increments".

Top of Form (27,84) establishes the current position of the platen as the top of form.

- To set the top of form, move the platen to the desired position and send the instruction 27,84 to the printer.
- This point is used as a reference for subsequent form length, text length, and formfeed instructions.

Form Length (27,70, INT (N/64), INT N) establishes the length of a page or form as shown in Figure 2-1.

- The parameter N specifies the number of $1/96$ inch increments from the top of form, and this distance is established as the form length.
- If no form length is set, the printer assumes the form length to be 11 inches or 1056 $1/96$ inch increments.
- Negative form length parameters set a form length of 273 inches.

Formfeed (12) moves the platen to the first line on the next form or page. The carriage remains fixed.

- To use the formfeed function, the top of form and form length should be set. If form length is not set, the formfeed instruction moves by default the paper to the bottom of an 11 inch form.

Set Left Margin (27,77) When the printer is first turned on, the left margin is set at the left-most printing position.

- To change the left margin, space to the desired position by sending repeated space instructions (decimal 32) and then send the left margin instruction (27,77) to the printer. Subsequent carriage returns will return the carriage to this position.

Text Width (27,87, INT (N/64), INT N) establishes the right and left margins by specifying the line width measured from the current carriage position.

- This command overrides a previously Set Left Margin command.
- The text width is specified in 1/120 inch increments (N) and the carriage position is set as the left margin.
- If any character or space exceeds the right margin, a carriage return and a linefeed are automatically executed and the character is printed in the first column of the next line.
- If no width is set, the text width is assumed to be 13.2 inches or 1584 1/120 inch increments.

Text Length (27,76,INT (N/64), INT N) sets the desired text length from the top of form position.

- The parameter N specifies the number of 1/96 inch increments to the lower margin. This new position is used by subsequent formfeed commands.
- Whenever a linefeed crosses this margin, a formfeed command is automatically executed. If no lower margin is set, the automatic formfeed does not occur.

Spacing Control

Horizontal Spacing (27,72, INT (N/64), INT N) defines the spacing between each printed character.

- This function overrides the normal 10 characters-per-inch spacing which is set when the printer is switched on or initialized. It also overrides any previous Horizontal Spacing command.
- The parameter N is an integer equal to the number of 1/120 inch increments desired following each printed character.
- Normal 10 characters-per-inch spacing is twelve 1/120 inch increments after each character.

Vertical Spacing (27,86, INT (N/64), INT N) defines the number of 1/96 inch increments to move when a linefeed command is given.

- This function overrides the normal 6 lines-per-inch spacing which is set when the printer is switched on or initialized. It also overrides any previous vertical spacing command.
- The parameter N is an integer equal to the number of 1/96 inch increments desired.
- Normal 6 lines-per-inch spacing is sixteen 1/96 inch increments per line.

Variable Spacing (27,88) this instruction sets the printer to a variable spacing mode.

- Each character sent to the printer must be followed by a spacing parameter while this mode is set.
- The spacing parameter specifies the number of 1/120 inch increments to be put between two characters. The number of increments can range from 0 through 31.
- If a space or backspace is output, the parameter specifies the width (in increments) of the space.
- A "reset" cancels this mode, and returns the spacing to the normal 10 characters-per-inch spacing (twelve 1/120 inch increments per character).

Here is a Form and Margin Control example surrounded by its printout.

```

10  OUTPUT 2 USING "#,B";27,69          ! Reset printer
20  WAIT 200
30
40  OUTPUT 2 USING "#,B";27,72,INT(4/64),INT(4) ! Set HOR spacing
50  OUTPUT 2 USING "#,B";27,86,INT(3/64),INT(3) ! Set VER spacing
60
70  FOR C=1 TO 180                       ! Draw top HOR line
80    OUTPUT 2 USING "#,B";46
90  NEXT C
100
110 OUTPUT 2 USING "#,B";8,10            !
120
130 FOR C=1 TO 111                       ! Draw right VERT line
140   OUTPUT 2 USING "#,B";46,8,10
150 NEXT C
160
170 FOR C=1 TO 180                       ! Draw bottom HOR line
180   OUTPUT 2 USING "#,B";46,8,8
190 NEXT C
200
210 FOR C=1 TO 112                       ! Draw left VERT line
220   OUTPUT 2 USING "#,B";46,27,10,8
230 NEXT C
240 END

```



Chapter 3

Programming

Introduction

This chapter shows you how to use the program statements to print text and numeric data.

A more detailed explanation of the PRINT statement, data formatting, and printing arrays may be found in your HP System Operating and Programming Manual.



Data Output

Alphanumeric data is usually output using the PRINT or OUTPUT statements. Either the free-field format (described below) or IMAGE statements (described later) may be referenced to govern the data form.

Use the OUTPUT USING or PRINT USING statements if individual characters or values are to be printed without character fields. The "USING" portion of the statement allows you to customize the printing format. For example, output a linefeed by using the statement:

```
OUTPUT USING "#, A"; CHR$(10)
```

A reason for using OUTPUT instead of the PRINT statement would be in the event that you wanted to retain the computer display device (select code 16) as the system printing device but also needed to print data on the 9871A printer. You can either use the default "printer is" value or execute PRINTER IS 16. Now the PRINT statement outputs to the display device and the OUTPUT statement may be used to print on the 9871A.

Free-field Format

The free-field printing format is automatically used whenever the computer is powered up or the SCRATCH A command is executed. Each print operation uses the free-field format unless an appropriate IMAGE statement is referenced, the OUTPUT USING format, or PRINT USING format statements are used, then the new format specifier list will override the free-field.

- The free-field format causes each numeric item separated by a comma to be printed, left-justified, in a 20-character field. See the discussion on the PRINT statement for the use of the comma and semicolon.
- After every fourth numeric item has been printed, a CR-LF is executed. The exception to this is if the print list ends with a comma or semicolon. The comma or semicolon at the end suppresses the CR-LF allowing a future print list to be appended to the end of the last line.
- The form in which numeric items appear is determined by one of three different formats: standard, fixed point, or floating point. The power-up/reset format is standard. The format may be changed by executing a “number format” statement.
- The standard format retains all significant digits with a maximum of twelve digits. Therefore, all numbers whose absolute values are greater than or equal to 1, but less than 10^{12} are output in fixed format showing all significant digits. Numbers between -1 and 1 are also output in fixed format if they can be represented precisely in twelve or fewer digits to the right of the decimal point. All other numbers are output in scientific notation.
- Leading and trailing zeroes are suppressed from the printout.
- String data is printed the same as numeric data except when the string is longer than a 20 character field. In this case, the string will be printed as an entity taking up one or more fields as needed. Any other items to be printed whether they be alpha or numeric will start printing in the next complete 20 character field.

Here is an example of free-field output using the standard format.

```

10  PRINTER IS 2
20  LET A=235
30  PRINT A,A/2,A/3,A/4,A/5,A/6
40  END

```

The resultant printout is:

```

235          117.5          78.3333333333          58.75
47          39.1666666667

```

Here is another example using the free-field format with numeric data mixed with alpha information.

```
10  PRINTER IS 2
20  LET A=235
30  PRINT "A=";A, "A/2=";A/2, "A/3=";A/3
40  END
```

The resultant printout is:

```
A= 235           A/2= 117.5           A/3= 78.3333333333
```

Even though a semicolon is used to separate the function label from the value of the function, which at first glance seems that it should not produce any spaces between items in the print list, a space does appear between them which is reserved for the sign symbol when used.

Data Statements

The following statements PRINT, OUTPUT, IMAGE, and EOL are used to format and send data to the 9871A Printer.

PRINT Statement

The PRINT statement may be used for output to the 9871A printer only if the standard computer printing device has been defined as the 9871A printer. This is accomplished by using the PRINTER IS statement as described in the section "Defining the Standard Printer."

The syntax for the PRINT statement is as follows:

```
PRINT [print list]
```

- The print list may contain any one or a combination of the following items.

| | |
|---------------------|---------------|
| variable names | TAB function |
| numeric expressions | SPA function |
| string expressions | LIN function |
| array identifiers | PAGE function |

- All items in the print list must be separated by commas or semicolons.
- A comma after a numeric item causes it to be left justified in the next 20-character field. A semicolon after a numeric item suppresses the use of the 20-character field causing items in the print list to be run together.

- A comma or semicolon after the last item in the list allows a future print list to be appended by suppressing the CR-LF.
- A CR-LF is automatically output when the printer line width is exceeded.

Another form of the PRINT command is:

```
PRINT USING line identifier [; print using list]
```

The "print using list" may contain the following items:

| | |
|---------------------|--------------------|
| variable names | string expressions |
| numeric expressions | array identifiers |

- The line identifier must refer to an IMAGE statement. It may be a line number or label.
- The output is totally controlled by the IMAGE statement.
- The items in the list are separated by commas or semicolons. However, they are separators only and have no effect on the printout, as with PRINT.

A third way of using the PRINT command is:

```
PRINT USING format string [; print using list]
```

The specifications for this form are the same as the above form with the following exceptions.

- The format string is a list of item format specifiers separated by delimiters(.). It specifies numeric and string fields, blanks, and carriage control. For an explanation of these specifiers, see the section on Format Specifiers.
- Each numeric or string item specifier must correspond to an appropriate item in the print using list. Each specifier determines how a single item in the print list is to be output.

OUTPUT Statement

NOTE

To use the OUTPUT statement, the I/O ROM option must be installed in the computer.

The OUTPUT statement provides a powerful method of sending data to a peripheral because of its many formatting specifications coupled with its ability to reference an image statement. Unlike the PRINT statement, the OUTPUT statement may utilize the printer without making it the standard print device.

The OUTPUT statement transfers data to the 9871A printer via the interface select code and the device address when an HP-IB interface is being used.

The syntax for the OUTPUT statement is as follows:

```
OUTPUT sc [USING format]; output list
```

Where the parameters are defined below.

sc: isc | isc,da | hpa

isc: Interface select code. This select code parameter can be any valid interface select code (1-12), but for standardization, the select code for the 9871A printer has been set to 2 at the factory.

da: The HP-IB device address which will be involved in the I/O operation. This may be a value of one or two digits.

hpa: A three or four HP-IB device bus address.

format: Line identifier or image specifier list.

line identifier: The line identifier may be a line number or a line number and label followed by a colon.

image specifier list: This list formats the data going to the 9871A printer. The specifier list must be enclosed in quotation marks. Using the specifier list "#, B" causes the computer to output only one byte of signed data per print-list item. The # symbol is used to suppress the automatic output CR-LF. See the section on Carriage Control.

output list: The output list may contain any one or a combination of the following:

| | |
|---------------------|--------------------|
| Variable names | String expressions |
| Numeric expressions | Array identifiers |

IMAGE Statement

The **IMAGE** statement is a formatting statement referenced by a **PRINT USING** or **OUTPUT USING** statement. Each item in the **PRINT** or **OUTPUT USING** output list must have a corresponding format specifier in the **IMAGE** statement.

The syntax is simply:

```
IMAGE format list
```

The format list is a list of item format specifiers separated by delimiters. It specifies numeric and string items, blanks, and carriage control. Each numeric or string specifier must correspond to an appropriate item in the **USING** list. See format specifiers.

EOL Statement

The **EOL** statement is used to add data to the end-of-line sequence after an output type statement. This statement is available with the installation of the optional I/O ROM.

Without **EOL** control, each line is terminated by sending a carriage return-linefeed. If the **EOL** statement has been executed prior to an output type statement, an additional sequence of code is sent from the computer after the CR-LF.

The **EOL** statement needs to be executed only once before it is referenced by a "L" specifier in an output format list. Once this has been done the only way to return to the normal end-of-line sequence, CR-LF, is to execute the **EOL** statement without a sequence list and delay parameter.

The **EOL** statement also has control over the time lapse between the end of printing the current line of data and when a subsequent line can be sent to the printer.

Syntax: **EOL** sc; [seq[, delay]]

Where the parameters are:

sc: isc | isc,da | hpa

The definitions for these parameters are the same used with the **PRINT** statement.

- seq: This parameter may be either a string variable or an expression that specifies the end-of-line sequence to be output for the "L" image specifier.
- delay: The delay parameter is a numeric expression specifying the number of milliseconds to delay between successive lines of output. When the parameter is omitted the delay is zero seconds.

The EOL statement can be used for delay only by using the following syntax.

```
EOL sc, delay
```

This will allow you to introduce the delay after each output type statement without changing the end-of-line sequence, CR-LF.

When the EOL statement is used, each PRINT USING, OUTPUT USING, or IMAGE specifier list that is to be influenced by the EOL statement must end its specifier list by "L". The "L" specifier is used to format the end-of-line sequence regardless of the length of the sequence. The normal end-of-line sequence, CR-LF, will be used if the "L" specifier is not used.

Using the delay control would be one way to solve the overrun problem mentioned after the section on the HORIZONTAL TAB. Use the above statement form without the sequence list to achieve the delay without modifying the output of the CR-LF.

Another use of the end-of-line control would be to use it to output multiple linefeeds after every printed line.

Format Specifiers

The item format specifiers determine how each item in the output list is to be printed. There are specifiers for alphabetic and numeric data with variations for printing text or data in many combinations.

Delimiters

Three delimiters are used to separate item specifiers:

- A comma is used only to separate two specifiers without any further control.
- A slash can also be used to separate two specifiers. It will also output a CR-LF.
- The commercial “at” sign separates two specifiers and also outputs the top-of-form which starts a new page.

The delimiter / can be replicated to produce multiple CR-LFs. In that case, the / must itself be delimited in the format string with commas. For example:

```
70 IMAGE 3A, 2/, 5A
```

For more information on this subject, see the section on replication.

Blank Spaces

Blank spaces may be included in the output by placing X in the format string. Multiple blanks may be specified by using [n]X; where n is the number of desired blanks. The X specifier can be used without being set off with delimiters.

String Specification

Text or literal output can be specified in three ways:

- Literal text is enclosed in quotes. This specifier may be included in the format string with or without delimiters. The text will be output from the IMAGE format string without being included in the PRINT or OUTPUT statement.
- [n]A may be used to specify the number of literal characters which are to be output in a string indicated in the PRINT or OUTPUT statement. Where n is the number of characters to be output.

- If the string item in the PRINT or OUTPUT USING list is longer than the number of characters in the "A" specifier, the string is truncated.
- If the string item is shorter than the number of characters specified, the rest of the item is filled with blanks.
- The K specifier is used to define an entire field for either numeric or string output.

Here are three examples of printed output with a literal string and multiple blanks.

```
10  PRINTER IS 2
20  IMAGE "***4X"LITERAL USING QUOTES "4X"***"
30  PRINT USING 20
40  END
```

The resultant printout is:

```
**  LITERAL USING QUOTES  **
```

And another example:

```
10  PRINTER IS 2
20  A$="LITERAL USING"
30  B$=" 'A' SPECIFIER"
40  IMAGE "***4X, 13A, 14A, 4X"***"
50  PRINT USING 40;A$;B$
60  END
```

And the printout is:

```
**  LITERAL USING 'A' SPECIFIER  **
```

The last example is:

```
10  PRINTER IS 2
20  A$="THIS IS TOO LONG"
30  PRINT USING "10A";A$
40  END
```

Which prints:

```
THIS IS TO
```

In analyzing the printout, remember that the PRINT USING format string assumes control of the printing operation from the free-field format and puts spacing under the user's control.

Note that in the first two lines the items are separated by three spaces as specified by the 3X, but the third line has four spaces and one in front of the first item. By reviewing the sign specifier, M, it will be found that it leaves a blank in place of the plus sign which has occurred for the first item in line 3. The first item is plus, so a blank is left. The second item is started three spaces over, and the format specification calls for three digits in the integer part of the number. Only two digits have been supplied so another blank was left. Also, here is a case of the minus sign "floating" over to the most left digit supplied.

The fourth line is similar to the third. A leading blank is inserted for the plus sign on item one and since it has four Z symbols for the three characters furnished, it winds up with a leading zero.

Digit Separator Symbols

For greater readability, digit separators are used to break large numbers into groups of digits (generally three digits per group). In the United States, the comma is customarily used; in Europe the period is commonly used.

- C Specifies a comma as a separator in the specified position.
- P Specifies a period as the separator in the specified position.

- The digit separator symbol is output only if it has been preceded by a digit in that item.
- The separator must appear between two digits.
- When leading zeroes are generated by the Z symbol, they are considered digits and may contain separators.

The following shows an example of the digit separators.

```

10  PRINTER IS 2
20  X=3421.56
30  Y=12345.67
40  Z=20.3
50  PRINT USING "DCDDD.DD,3X,DDDDD.DD";X,Y
60  PRINT USING "ZCZZZ.DD,3X,ZPZZZRDD";Z,Z
70  END

```

The printout is:

```

3,421.56    12,345.67
0,020.30    00.020,30

```

Exponent Symbol

The use of the exponent symbol `E` within a numeric-field format specifier will cause the printed data to be in the scientific notation. This will be in the form: {mantissa} {"E" sign} {exponent}. At least one digit symbol must precede the `E` symbol in the specifier.

Floating Specifiers

Specifiers: `S`, `M`, `X`, or text in quotes that precede all digit specifiers in a numeric specifier "float" past blanks to the leftmost digit of the number, or to the radix indicator.

Sign symbols and text that are imbedded between specifiers do not float.

A space, sign specifier, or text embedded in a numeric field stops the movement of a floating character.

Here is an example of floating characters:

```

10  PRINTER IS 2                                ! Define printer
20  IMAGE "$"DC3DC3D.DD                          ! INPUT image
30  INPUT "ENTER PRICE",X                       ! Input price
40  Tax=.05*X                                    ! Calculate tax
50  Total=X+Tax                                  ! Calculate total cost
60  PRINT USING "8A,DC3DC3D.DD";"COST      ",X   ! Print cost
70  PRINT USING "#,6A,4XSDDC3D.DD";"5% TAX";Tax ! Print tax
80                                          !
90  FOR C=1 TO 12                                ! Backspace loop
100  PRINT USING "#,A";CHR#(8)                  ! Backspace
110  NEXT C
120                                          !
130  PRINT USING "12A";" _____"            ! Draw line
140  PRINT "TOTAL      ";                       ! Print "Total"
150  PRINT USING 20;Total                       ! Print total cost
160  PRINT
170  PRINT
180  GOTO 30
190  END

```

The printouts below show several variations in the numbers of digits printed and how the plus sign and dollar sign float to the left of the most significant number.

| | |
|--------|----------------|
| COST | 1,234,567.89 |
| 5% TAX | +61,728.39 |
| TOTAL | \$1,296,296.28 |

| | |
|--------|--------|
| COST | 2.45 |
| 5% TAX | +1.12 |
| TOTAL | \$2.57 |

| | |
|--------|---------|
| COST | 23.45 |
| 5% TAX | +1.17 |
| TOTAL | \$24.62 |

| | |
|--------|----------|
| COST | 639.45 |
| 5% TAX | +31.97 |
| TOTAL | \$671.42 |

Compacted Specifier

A single symbol, **K**, is used to define an entire field for either numeric or string output. If the corresponding PRINT USING item is a string, the entire string is output. If it is numeric, it is output in STANDARD form. The **K** specifier outputs no leading or trailing blanks.

Replication

Many of the symbols used to make up image specifiers can be replicated (repeated) to specify multiple symbols, by placing an integer in the range 1 through 32767 in front of the symbol. The following IMAGE statements all specify the same image :

```
70  IMAGE DDD.DD
80  IMAGE D2D.2D
90  IMAGE 3D.DD
100 IMAGE 3D.2D
```

The following symbols **can't** be replicated:

| | | | |
|---|-----------------|---|-----------------|
| " | literal fields | E | exponent symbol |
| S | sign control | @ | delimiter |
| M | sign control | K | compactor |
| . | point radix | + | LF control |
| R | comma radix | - | CR control |
| C | comma separator | # | CR-LF control |
| P | point separator | | |

In addition to symbol replication, an entire specifier or group of specifiers can be replicated by enclosing it in parentheses and placing an integer in the range 1 through 32767 before the parentheses.

Up to four levels of nested parentheses can be used for replication.

Two of the above symbols, **K** and **@**, can be replicated by considering them as a one character group and enclosing it in parentheses then replicating the group. This would appear like the following:

```
IMAGE #, 3(K)
```

The following example also shows the group replication with nested parentheses.

```

10  OUTPUT 2 USING "#,B";27,69          ! Printer reset
20  WAIT 200
30  IMAGE 2(2(K)/)                     ! Format: 2 items and a LF twice
40  A#="HEW"                            ! Data list
50  B#="LETT-"
60  C#="PACK"
70  D#="ARD"
80  OUTPUT 2 USING 30;A#,B#,C#,D#      ! Print list
90  END

```

The printout is:

```

HEWLETT-
PACKARD

```

Carriage Control

The CR-LF normally output when the print using list is exhausted can be altered by using a carriage control symbol as the first item in a format string; a comma must separate it from the next item.

| | |
|---|---|
| # | Suppresses both the carriage return and linefeed. |
| + | Suppresses the linefeed. |
| - | Suppresses the carriage return. |

L Specifier

When the EOL (end-of-line) statement is used to modify the end-of-line data sequence, the L specifier must be the last one in the "USING" list or IMAGE specifier list.

If the L specifier is not used in a specific output type statement, even though the EOL statement has been executed, the output will be terminated with only the CR-LF sequence.

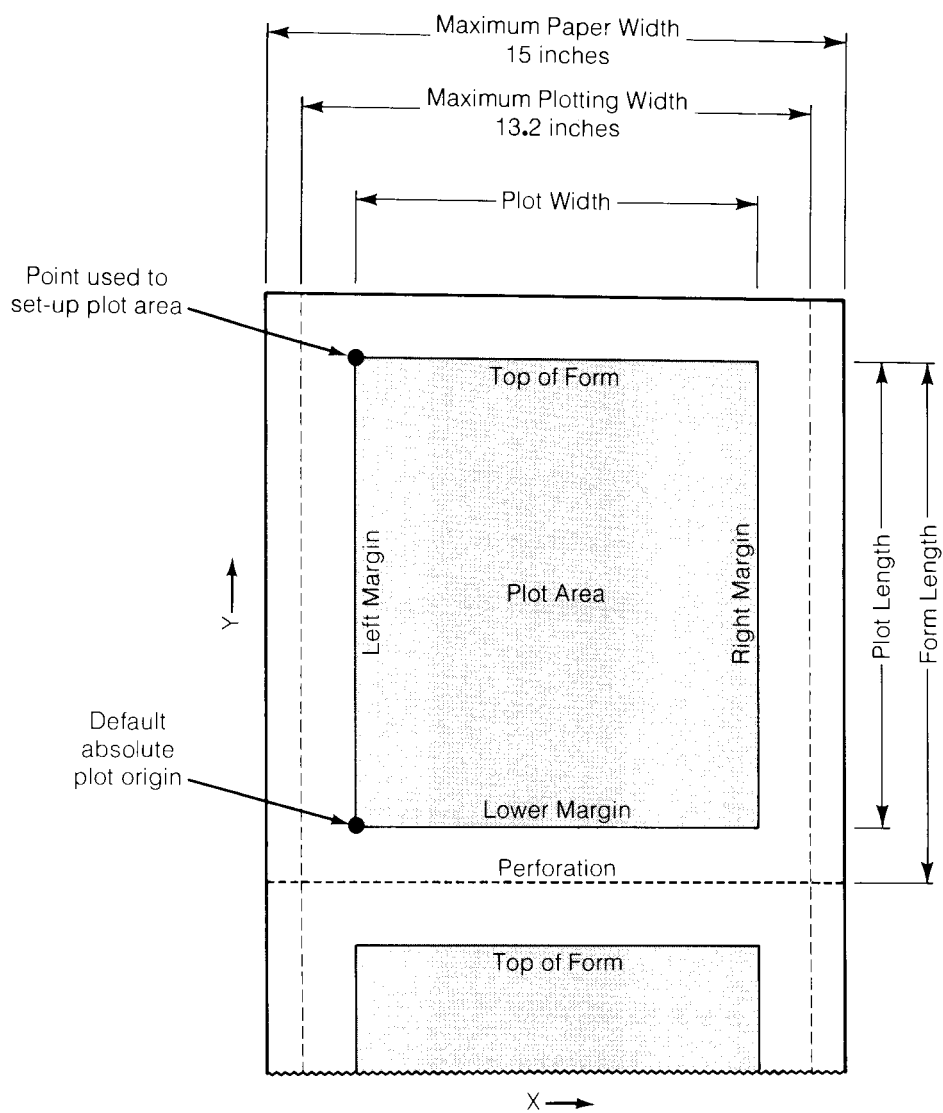


Figure 4-1. Plot Area Parameters

Chapter 4

Plotter Control

Introduction

The HP 9871A printer can be used as an incremental plotter using the instructions explained below. Data is plotted by using the various plotting control instructions. These instructions are explained at the beginning of this chapter and examples of their use are given at the end.

NOTE

Plotting should not be attempted with the option 98021A form feed installed. The form feed mechanism can feed the paper in one direction only.

Plotting Area

Paper Layout

The plotting area (shown on the opposite page) is defined by the top of form, text (plot) length, left margin, and text (plot) width functions described previously.

Setting Up Plot Area

Setting up an area for plotting is similar to setting up the text area. Move the platen to what will become the top of the plot area and the carrier to the left-most position for the minimum X position. Now execute the instructions Top of Form (27,84) and Text Width (27,87,INT(N/64),INT N).

To define the plot length, which is the same as text length, execute the Text Length (27,76,INT(N/64),INT N) instruction. See the section on form and margin control for an explanation of these instructions.

The following is an example showing the setup of an 11 x 8 1/2 inch plotting area.

```

10  OUTPUT 2 USING "#,B";27,69           ! Reset printer
20  WAIT 200
30  OUTPUT 2 USING "#,B";27,84           ! Set top of form
40  OUTPUT 2 USING "#,B";27,70,INT(1056/64),INT(1056) ! Define form length
50  OUTPUT 2 USING "#,B";27,87,INT(1320/64),INT(1320) ! Define HOR scale
60  OUTPUT 2 USING "#,B";27,76,INT(816/64),INT(816)  ! Define VERT scale

```

You may want to output multiple plots so line 40 of the program above sets the form length to the default value of 11 inches (the standard fan folded paper length).

Plotter Function Codes

The plotter function instructions are the same in structure as the control instructions. Refer to the section on control statement syntax on how to use these instructions. See the Appendix for a summary of the plotter functions and their codes.

Plot Origin (27,79,INT(X/64),INT X,INT(Y/64),INT Y) describes the origin of the X and Y axes for absolute or relative plotting.

- The normal origin is the intersection of the left margin for X and the lower margin for Y.
- Using the plot origin function, the X and Y axes can be offset. The intersection of the offset X and Y axes becomes the new origin.
- The X parameter defines where the Y axis is located by the number of 1/120-inch increments to the left (-) or right (+) of the left margin.
- The Y parameter defines where the X axis is located by the number of 1/96-inch increments up (+) or down (-) from the lower margin.

Plot Absolute (27,65,INT(X/64),INT X,INT(Y/64),INT Y) moves the specified number of 1/120-inch increments in X, and the number of 1/96-inch increments in Y. To place a mark at that point you have to use the PRINT or OUTPUT command to print a character.

Increments are referenced to a point defined by the Plot Origin Command.

The default origin point is the left margin for X and the lower margin for Y.

For X, the carriage is moved the specified distance to the right of the origin for positive parameters, and to the left of the origin for negative parameters.

For Y, the platen is moved above the origin for positive parameters, and below the origin for negative parameters.

Plot Relative (27,82,INT(X/64),INT X,INT(Y/64),INT Y) moves the specified number of 1/120-inch increments in X, and the number of 1/96-inch increments in Y.

- Increments are referenced to a point defined by the current position of the carriage and platen.
- For X, the carriage is moved to the right of the current position for positive parameters, and to the left of the current position for negative parameters.
- For Y, the platen is moved above the current position for positive parameters, and below the current position for negative parameters.

Character Fill (27,46,P1,INT(P2/64),INT P2,P3) establishes the character to be printed between plotted points. The function also specifies the spacing between those characters.

- The parameters P1, P2, and P3 are defined as follows:



P1 is the decimal equivalent of the ASCII code for the character to be used as the fill character.

P2 specifies the spacing to be used between fill characters. The spacing is specified in 1/120-inch increments for horizontal plotted lines; for lines with slopes of 1 or greater use 1/96-inch increments. Once a spacing parameter has been specified, the computer automatically converts to the proper incremental value as the slope of the plotted line changes.

P3 allows you to raise or lower the fill character vertically in 1/96-inch increments. This is useful for positioning characters to more closely follow the plotted line's path.

- The power-up default conditions are: (P1) the decimal point (decimal 46), (P2) spacing = 3, (P3) offset = + 5.

Absolute Plot with Character Fill (27,97,INT(X/64),INT X,INT(Y/64),INT Y) is identical to the absolute plot instruction except that fill characters, determined by a previous character fill setup instruction (or character fill default) are used.

- Fill characters are plotted along a straight line from the current X,Y position to the new position.
- If a character is printed at the point specified, a backspace instruction should be given to offset the carriage movement that results when the character is printed.

Relative Plot with Character Fill (27,114,INT(X/64),INT X,INT(Y/64),INT Y) is identical to the relative plot instruction except that fill characters determined by a previous character fill setup instruction (or character fill default) are used.

- Fill characters are plotted along a straight line from the current X,Y position to the new position.
- As with the absolute plot instruction, if a character is printed at the point specified, a backspace command should be given to offset the carrier movement that results when the character is printed.

The program below is an example of plotting a function, which for this exercise is $\text{SIN}(X)$ expressed as a voltage. Lines 10 through 80 set-up the printer to plot over the desired area. The rest of the program is divided into four FOR-NEXT loops which draw the various lines of the graphic output. The first loop does the actual function plot by calculating a value of the function then sending the XY coordinate values to the printer (line 140). Each loop increments the value "D", increasing the X value and calculating the corresponding Y value.

The next three loops draw the horizontal axis at $Y = 0$ and the borders at the left and bottom margins.

This example requires a piece of paper 14 inches wide by at least 11 inches long.

```

10  OUTPUT 2 USING "#,B";27,69           ! Reset printer
20  WAIT 200
30  OUTPUT 2 USING "#,B";27,53           ! Set VERT tab
40  OUTPUT 2 USING "#,B";27,84           ! Set top of form
50  OUTPUT 2 USING "#,B";27,70,INT(1056/64),INT(1056) ! Define form length
60  OUTPUT 2 USING "#,B";27,87,INT(1400/64),INT(1400) ! Define HOR scale
70  OUTPUT 2 USING "#,B";27,76,INT(850/64),INT(850)  ! Define VERT scale
80  OUTPUT 2 USING "#,B";27,79,INT(0),INT(0),INT(433/64),INT(433)
90                                     ! Set origin
100                                    !
110  DEG                                ! Plot function loop
120  FOR D=0 TO 360 STEP 10              ! Compute function
130  X=SIN(D)
140  OUTPUT 2 USING "#,B";27,65,INT(D*1320/360/64),INT(D*1320/360),INT(400*X/64
),INT(400*X)
150  OUTPUT 2 USING "#,A";"*"           ! Plot-point mark
160  NEXT D
170
180  FOR I=0 TO 110                      ! Draw HOR axis loop
190  OUTPUT 2 USING "#,A";"-"           ! Axis mark
200  OUTPUT 2 USING "#,B";8,8           ! Output 2 BACKSPACES
210  NEXT I
220  OUTPUT 2 USING "+,B";27,56         ! VERT Tab up
230
240  FOR J=0 TO 51                      ! Draw left margin loop
250  OUTPUT 2 USING "#,A";"!"           ! Output mark

```

```

260 OUTPUT 2 USING "#,B";10,8      ! Output LF-BS
270 NEXT J                          !
280                                !
290 OUTPUT 2 USING "#,B";27,10    ! BACK LINEFEED
300                                !
310 FOR K=0 TO 110                ! Draw baseline loop
320 OUTPUT 2 USING "#,A";"_"      ! Output baseline mark
330 NEXT K                          !
340                                !
350 OUTPUT 2 USING "#,B";12      ! Formfeed
360 END

```

The main problem in setting-up the scales is working out the min-max values for the function to be plotted and then scaling the plot statement (line number 140) to the page or plot area.

The example above was simple enough since the function $\text{SIN}(X)$ extends ± 1.0 volt about the X axis. The permissible plotting width in the example is 11.67 inches (1400 increments times $1/120$ inches per increment),

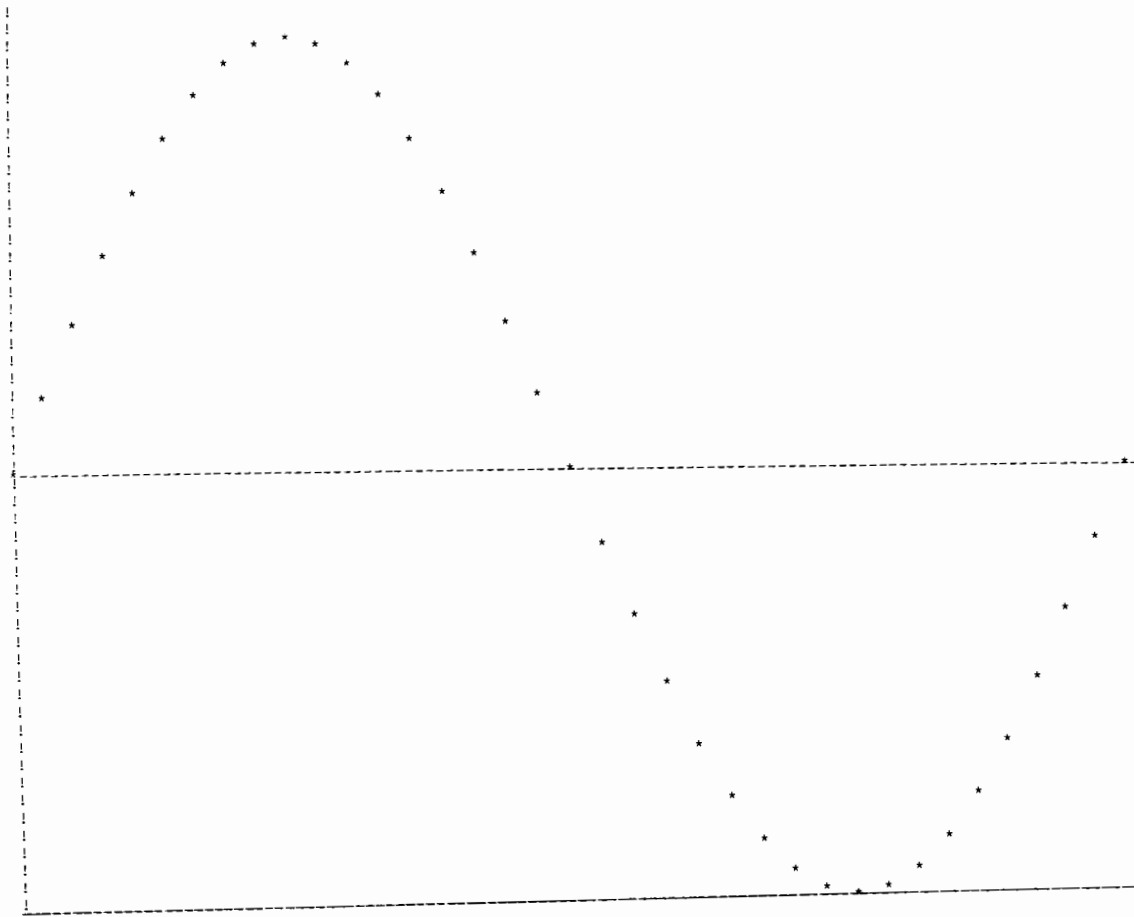
The permissible plotting length is 8.85 inches (850 increments times $1/96$ inches per increment). It was more convenient to make the number of increments an even number instead of the dimensional values, but the other way around would have worked.

Now the function's actual plotting width is determined. Find the number of increments per unit step of the argument of the function. Since the allowable plot width is 1400 increments, use a slightly smaller value which could be 1320 increments (11 inches). Now divide 1320 increments by the maximum number of steps, i.e. $1320 \text{ increments} / 360^\circ$. Then multiply this by the incrementing variable, "D." You now have $D * 1320 / 360$, which is the value of X in the Plot Absolute statement (line 140).

The same thing is done for the plot's height, i.e. length of paper. A smaller value than 850 increments could be 816 increments ($8\frac{1}{2}$ inches). As a matter definition, the unit height is the maximum Y axis height of the plot divided by the maximum function value.

Since the X axis for this function should be located halfway up the Y plot height, we use $\frac{1}{2}$ of the 816 or 408 increments for the location of the X axis from the lower margin. The maximum function value is 1.0 volt. So, divide the unit height of 408 by 1.0 volt which results in 408 increments per volt. Now multiply the number of increments per unit height by the value of the function for a given X value: The result is: $408 \text{ increments/volt} * X \text{ volts} = (408 * X)$ increments.

A reduced printout of the above plot program is shown below.



Chapter 5

Interface Service

Introduction

This chapter contains a brief description of the mechanical make-up of the interface cables.

If you have difficulty repairing the interface or if you would rather have HP repair it, contact the nearest Sales and Service office for assistance; office locations are listed at the back of this manual.

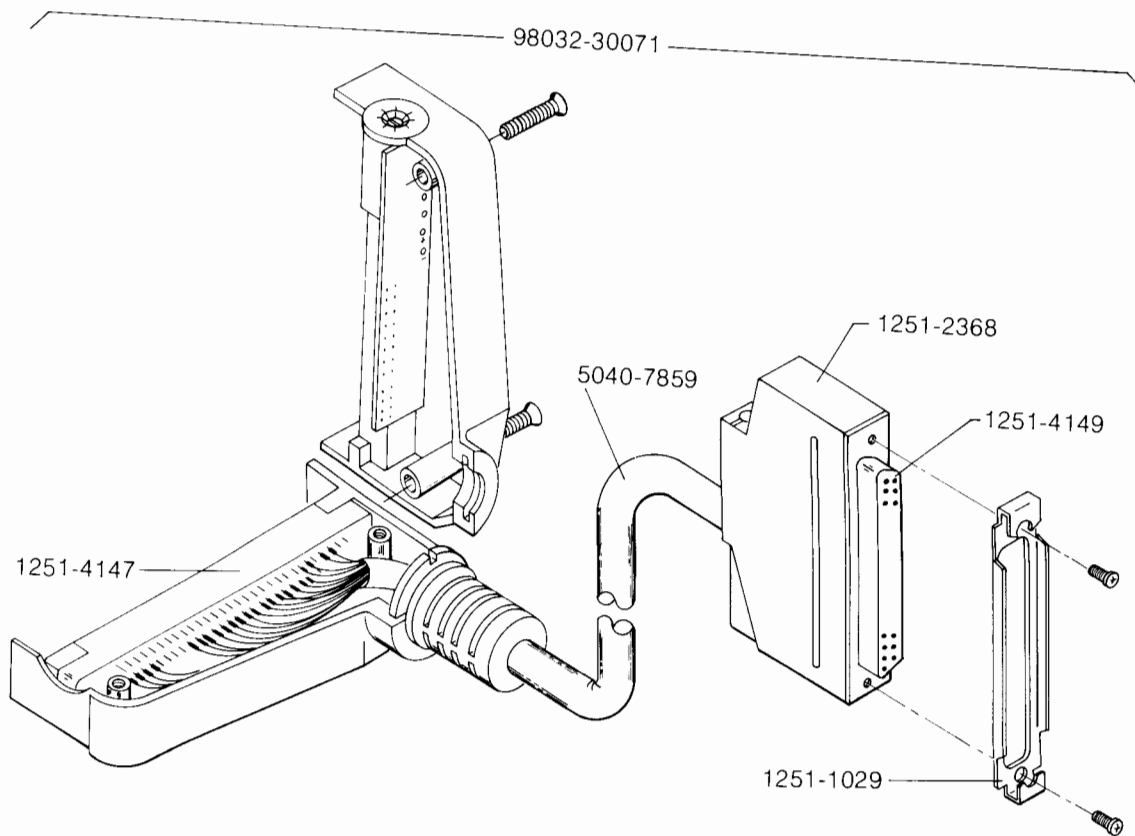
98032A Option 071

The HP 98032A I/O Interface is a general-purpose interface which can be used as a 16-bit data exchange between your desktop computer and the 9871A Printer. The interface transfers data in a "full-duplex" mode. That is, it can have data on the output lines and be inputting data at the same time.

The hardware and software characteristics of the interface are extremely flexible. The data exchange timing and logic can be "configured", by the use of jumpers, to meet a wide variety of peripheral requirements.

The following section gives you some of the physical characteristics and a description of the replaceable parts. For a more indepth description of the 98032A interface, refer to the HP 98032A 16-bit Interface Installation and Service Manual.

Cable Assembly



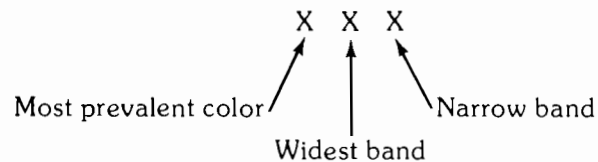
Replaceable Parts List

| HP Part No. | Qty. | Description |
|-------------|------|-----------------------------------|
| 98032-30071 | 1 | Cable Assembly, Opt. 071 |
| 1251-4147 | 1 | Connector, 2 x 25 (interface end) |
| 5040-7859 | 1 | Cable, Molded |
| 1251-4149 | 1 | Connector, 37 pin (printer end) |
| 1251-2368 | 1 | Hood |
| 1251-3399 | 17 | Pin |
| 1251-1029 | 1 | lock Assembly |
| 7120-4776 | 1 | Lable, Opt. 071 |
| 09845-90671 | 1 | Operating Note |

Cable Wiring Diagram

| Interface Connector | | Wire Color | Printer Connector | |
|---------------------|-----|----------------|-------------------|-----------------------|
| Line | Pin | | Pin | Line |
| $\overline{DO7}$ | A10 | (90) | 12 | CALC 7 |
| $\overline{DO6}$ | A11 | (903) | 13 | CALC 6 |
| $\overline{DO5}$ | A12 | (9) | 14 | CALC 5 |
| $\overline{DO4}$ | A13 | (97) | 32 | CALC 4 |
| $\overline{DO3}$ | A14 | (96) | 31 | CALC 3 |
| $\overline{DO2}$ | A15 | (95) | 30 | CALC 2 |
| $\overline{DO1}$ | A16 | (94) | 29 | CALC 1 |
| $\overline{DO0}$ | A17 | (93) | 28 | CALC 0 |
| GND | A18 | (6) | 26 | GND |
| \overline{PCTL} | A19 | (1) | 9 | \overline{CMD} |
| \overline{PRESET} | A21 | (3) | 10 | \overline{HLT} |
| GND | A24 | (98) | 33 | GND |
| CHASSIS | A25 | (Cable Shield) | | |
| GND | B18 | (Inner Shield) | 27 | GND |
| \overline{PFLG} | B19 | (2) | 11 | \overline{FLG} |
| \overline{PSTS} | B20 | (4) | 5 | $\overline{COVER ON}$ |
| $\overline{STI0}$ | B22 | (5) | 8 | $\overline{BUFR RDY}$ |
| STI1 | B23 | (7) | 7 | \overline{READY} |
| GND | B24 | (901) | 34 | GND |

Codes shown correspond to the standard resistor color code. Digits have this significance:

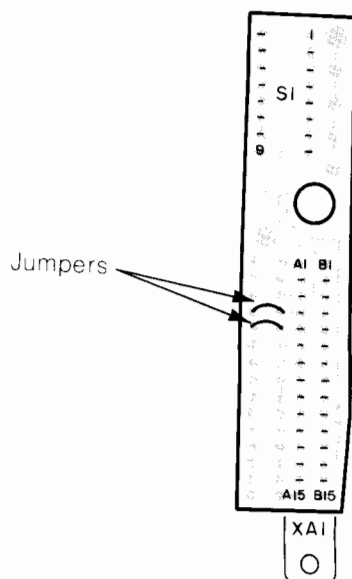


| | |
|------------|------------|
| 0 - Black | 5 - Green |
| 1 - Brown | 6 - Blue |
| 2 - Red | 7 - Violet |
| 3 - Orange | 8 - Gray |
| 4 - Yellow | 9 - White |

For example, pin B24 (GND) on the interface connector has color code 901. White (9) is the most prevalent color, black (0) is the widest color band, and brown (1) is the narrow color band.

Configuration Board Jumpers

The Option 071 Interface has two wire jumpers on the configuration board (inside the rear housing), at positions 4 and 5.



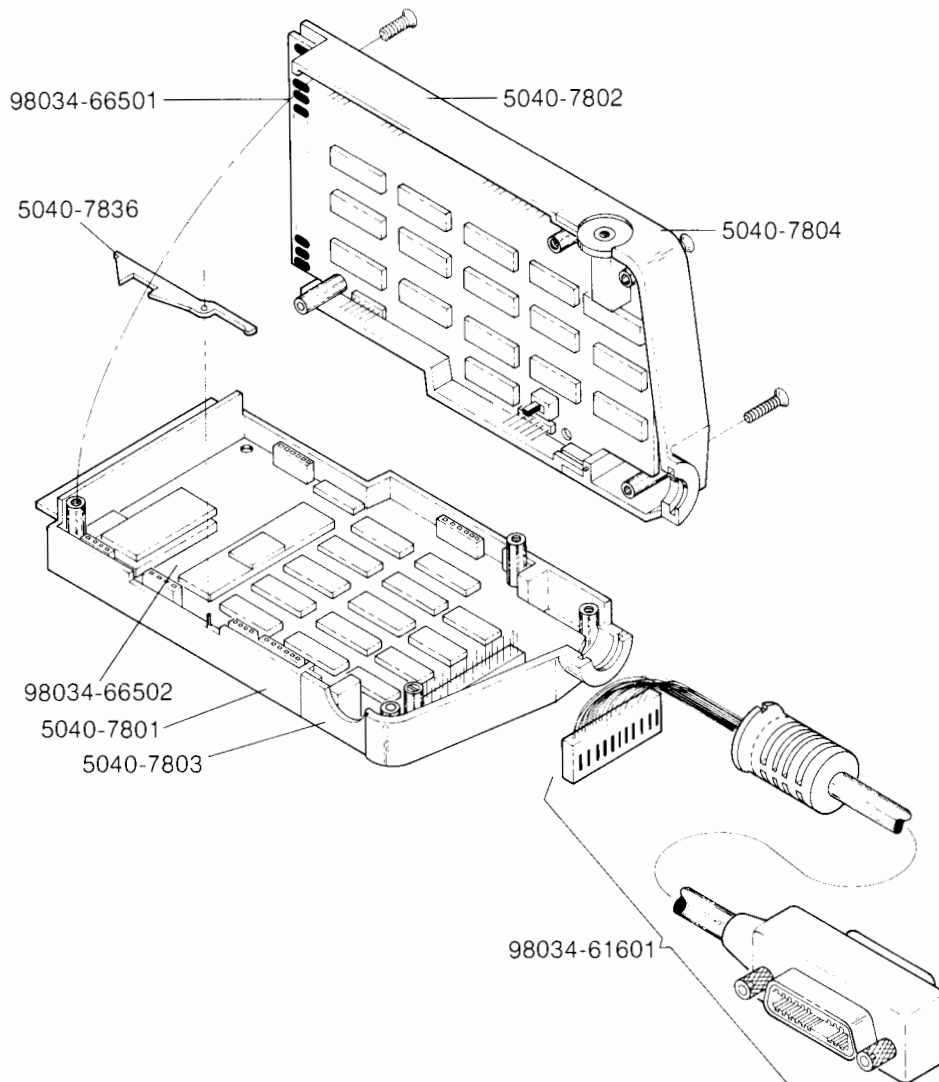
Option 071 Configuration Board Circuit Side

Refer to the 98032A Installation and Service Manual for other jumper information.

98034A HP-IB

Due to the microprocessor-based organization of this interface, it's recommended that the interface not be repaired to the discrete component level. Instead, contact your nearest HP Sales and Service office for assistance; office locations are listed at the back of this manual.

Interface Assembly



Replaceable Assemblies

The following table lists the assemblies which are available for direct replacement by the user.

Table 6. Replaceable Assemblies

| Assembly | HP Part Number |
|---|----------------|
| Calculator I/O Logic Board (A1) | 98034-66501 |
| HP-IB Control Logic Board (A2) | 98034-66502 |
| HP-IB Control Logic Board, without processor or ROM | 98034-69502 |
| Processor | 1820-1691 |
| ROM | 1816-0868 |
| Cable Assembly | 98034-61601 |

Appendix

HOR and VER Increments

Standard Printing Parameters

| | |
|----------------------|---------------------------------|
| Characters per inch: | 10 |
| Lines per inch: | 6 |
| Increments: | 1/96 inch = .27mm (Vertical) |
| | 1/120 inch = .21mm (Horizontal) |

Commonly used printing and plotting areas.

| HOR x VER Area | | Increments | |
|----------------|------------------------|---------------------------|---------------------------|
| | | HOR-Width 1/120" / Inc | VER-Length 1/96" / Inc |
| 4 x 5 inches | (10.16 x 12.70cm) | 480 | 480 |
| 5 x 7 inches | (12.70 x 17.78cm) | 600 | 672 |
| 8 x 10 inches | (20.32 x 25.40cm) | 960 | 960 |
| 8½ x 11 inches | (21.59 x 27.94cm) | 1020 | 1056 |
| 10 x 12 inches | (25.40 x 30.48cm) | 1200 | 1152 |
| 11 x 14 inches | (27.94 x 35.56cm) | 1320 | 1344 |
| 11 x 17 inches | (29.94 x 43.18cm) | 1320 | 1632 |
| 5 x 4 inches | (12.70 x 10.16cm) | 600 | 384 |
| 7 x 5 inches | (17.78 x 12.70cm) | 840 | 480 |
| 10 x 8 inches | (25.40 x 20.32cm) | 1200 | 768 |
| 11 x 8½ inches | (27.94 x 21.59cm) | 1320 | 816 |
| 12 x 10 inches | (30.48 x 25.40cm) | 1440 | 960 |
| 14 x 11 inches | (35.56 x 27.94cm) | 1680 | 1056 |
| | | .21mm / Inc | .27mm / Inc |
| 125 x 175mm | (4.92 x 6.89 inches) | 595 | 648 |
| 200 x 250mm | (7.87 x 9.84 inches) | 952 | 926 |
| 215 x 275mm | (8.46 x 10.83 inches) | 1024 | 1019 |
| 250 x 300mm | (9.84 x 11.81 inches) | 1190 | 1111 |
| 275 x 350mm | (10.83 x 13.78 inches) | 1310 | 1296 |
| 175 x 125mm | (6.89 x 4.92 inches) | 833 | 463 |
| 250 x 200mm | (9.84 x 7.87 inches) | 1190 | 741 |
| 275 x 215mm | (10.83 x 8.46 inches) | 1310 | 796 |
| 300 x 250mm | (11.81 x 9.84 inches) | 1429 | 926 |
| 350 x 275mm | (13.78 x 10.83 inches) | 1667 | 1019 |

Control Instructions and Codes

| Function | ASCII Character | Decimal Code | Decimal Parameter |
|--------------------------------|-----------------|--------------|-------------------|
| GENERAL | | | |
| • Bell | BELL | 7 | |
| • Backspace | BS | 8 | |
| • Linefeed | LF | 10 | |
| • Carrier Return | CR | 13 | |
| • Shift Out | SO | 14 | |
| • Shift In | SI | 15 | |
| • View Delay | ESC, D | 27, 68 | INT(N/64), INT N |
| • Reverse Line Feed | ESC, LF | 27, 10 | |
| • Character Replacement | ESC, C | 27, 67 | "CHAR", N, "LIST" |
| • Reset | ESC, E | 27, 69 | |
| • Self Test | ESC, R | 27, 122 | |
| HORIZONTAL TABULATION | | | |
| • Set Horizontal Tab | ESC, 1 | 27, 49 | |
| • Clear Horizontal Tab | ESC, 2 | 27, 50 | |
| • Clear All Horizontal Tabs | ESC, 3 | 27, 51 | |
| • Horizontal Tab Right | HT | 9 | |
| • Horizontal Tab Left | ESC, 4 | 27, 52 | |
| VERTICAL TABULATION | | | |
| • Set Vertical Tab | ESC, 5 | 27, 53 | |
| • Clear Vertical Tab | ESC, 6 | 27, 54 | |
| • Clear All Vertical Tabs | ESC, 7 | 27, 55 | |
| • Vertical Tab Up | ESC, 8 | 27, 56 | |
| • Vertical Tab Down | VT | 11 | |
| FORM AND MARGIN CONTROL | | | |
| • Set Top of Form | ESC, T | 27, 84 | |
| • Form Length | ESC, F | 27, 70 | INT(N/64), INT N |
| • Text Length | ESC, L | 27, 76 | INT(N/64), INT N |
| • Form Feed | FF | 12 | |
| • Set Left Margin | ESC, M | 27, 77 | |
| • Text Width | ESC, W | 27, 87 | INT(N/64), INT N |
| SPACING CONTROL | | | |
| • Horizontal Spacing | ESC, H | 27, 72 | INT(N/64), INT N |
| • Vertical Spacing | ESC, V | 27, 86 | INT(N/64), INT N |
| • Variable Spacing | ESC, S | 27, 83 | |

Plotter Functions and Codes

| Function | ASCII Character | Decimal Code | Decimal Parameter |
|---------------------------|-----------------|--------------|------------------------------------|
| PLOTTING CONTROL | | | |
| ● Absolute Plot | ESC, A | 27, 65 | INT(X/64), INT X, INT(Y/64), INT Y |
| ● Relative Plot | ESC, R | 27, 82 | INT(X/, INT X, INT(Y/64), INT Y |
| ● Character Fill Setup | ESC, . | 27, 46 | P1, INT(P2/64), INT P2, P3 |
| ● Absolute Plot With Fill | ESC, a | 27, 97 | INT(X/64), INT X, INT(Y/64), INT Y |
| ● Relative Plot With Fill | ESC, r | 27, 114 | INT(X/64), INT X, INT(Y/64), INT Y |
| ● Plot Origin | ESC, O | 27, 79 | INT(X/64), INT X, INT(Y/64), INT Y |



Specifiers

| | |
|---|---|
| , | separates two specifiers |
| / | separates two specifiers; also outputs carriage return-line feed |
| @ | separates specifiers; also indicates new page |
| X | outputs blank space |
| A | indicates single string character |
| D | specifies digit position—leading zeros replaced with blank spaces |
| Z | specifies digit position—leading zeros replaced with 0's |
| * | specifies digit position—leading zeros replaced with *'s |
| . | specifies decimal point as radix indicator ¹ |
| R | specifies comma as radix indicator (more common in Europe) ¹ |
| M | specifies a blank if a number is positive, – if negative |
| S | specifies + if a number is positive, – if negative |
| C | specifies comma as digit separator |
| P | specifies period as digit separator (more common in Europe) |
| E | causes output of E and two-digit exponent |
| K | defines field for numeric or string output |
| # | suppresses carriage return-line feed |
| + | suppresses line feed (on CRT display, suppresses output) |
| - | suppresses carriage return |
| L | specifies end-of-line replacement list |

¹ Only one radix specifier allowed in an `IMAGE` or an implicit image.

ASCII Character Set

| ASCII Char. | EQUIVALENT FORMS | | |
|-----------------|------------------|-----|-----|
| | Binary | Hex | Dec |
| NULL | 00000000 | 00 | 0 |
| SOH | 00000001 | 01 | 1 |
| STX | 00000010 | 02 | 2 |
| ETX | 00000011 | 03 | 3 |
| EOT | 00000100 | 04 | 4 |
| ENQ | 00000101 | 05 | 5 |
| ACK | 00000110 | 06 | 6 |
| BELL | 00000111 | 07 | 7 |
| BS | 00001000 | 08 | 8 |
| HT | 00001001 | 09 | 9 |
| LF | 00001010 | 0A | 10 |
| VT | 00001011 | 0B | 11 |
| FF | 00001100 | 0C | 12 |
| CR | 00001101 | 0D | 13 |
| SO | 00001110 | 0E | 14 |
| SI | 00001111 | 0F | 15 |
| DLE | 00010000 | 10 | 16 |
| DC ₁ | 00010001 | 11 | 17 |
| DC ₂ | 00010010 | 12 | 18 |
| DC ₃ | 00010011 | 13 | 19 |
| DC ₄ | 00010100 | 14 | 20 |
| NAK | 00010101 | 15 | 21 |
| SYNC | 00010110 | 16 | 22 |
| ETB | 00010111 | 17 | 23 |
| CAN | 00011000 | 18 | 24 |
| EM | 00011001 | 19 | 25 |
| SUB | 00011010 | 1A | 26 |
| ESC | 00011011 | 1B | 27 |
| FS | 00011100 | 1C | 28 |
| GS | 00011101 | 1D | 29 |
| RS | 00011110 | 1E | 30 |
| US | 00011111 | 1F | 31 |

| ASCII Char. | EQUIVALENT FORMS | | |
|-------------|------------------|-----|-----|
| | Binary | Hex | Dec |
| space | 00100000 | 20 | 32 |
| ! | 00100001 | 21 | 33 |
| " | 00100010 | 22 | 34 |
| # | 00100011 | 23 | 35 |
| \$ | 00100100 | 24 | 36 |
| % | 00100101 | 25 | 37 |
| & | 00100110 | 26 | 38 |
| ' | 00100111 | 27 | 39 |
| (| 00101000 | 28 | 40 |
|) | 00101001 | 29 | 41 |
| * | 00101010 | 2A | 42 |
| + | 00101011 | 2B | 43 |
| , | 00101100 | 2C | 44 |
| - | 00101101 | 2D | 45 |
| . | 00101110 | 2E | 46 |
| / | 00101111 | 2F | 47 |
| Ø | 00110000 | 30 | 48 |
| 1 | 00110001 | 31 | 49 |
| 2 | 00110010 | 32 | 50 |
| 3 | 00110011 | 33 | 51 |
| 4 | 00110100 | 34 | 52 |
| 5 | 00110101 | 35 | 53 |
| 6 | 00110110 | 36 | 54 |
| 7 | 00110111 | 37 | 55 |
| 8 | 00111000 | 38 | 56 |
| 9 | 00111001 | 39 | 57 |
| : | 00111010 | 3A | 58 |
| : | 00111011 | 3B | 59 |
| < | 00111100 | 3C | 60 |
| = | 00111101 | 3D | 61 |
| > | 00111110 | 3E | 62 |
| ? | 00111111 | 3F | 63 |

| ASCII Char. | EQUIVALENT FORMS | | |
|-------------|------------------|-----|-----|
| | Binary | Hex | Dec |
| @ | 01000000 | 40 | 64 |
| A | 01000001 | 41 | 65 |
| B | 01000010 | 42 | 66 |
| C | 01000011 | 43 | 67 |
| D | 01000100 | 44 | 68 |
| E | 01000101 | 45 | 69 |
| F | 01000110 | 46 | 70 |
| G | 01000111 | 47 | 71 |
| H | 01001000 | 48 | 72 |
| I | 01001001 | 49 | 73 |
| J | 01001010 | 4A | 74 |
| K | 01001011 | 4B | 75 |
| L | 01001100 | 4C | 76 |
| M | 01001101 | 4D | 77 |
| N | 01001110 | 4E | 78 |
| O | 01001111 | 4F | 79 |
| P | 01010000 | 50 | 80 |
| Q | 01010001 | 51 | 81 |
| R | 01010010 | 52 | 82 |
| S | 01010011 | 53 | 83 |
| T | 01010100 | 54 | 84 |
| U | 01010101 | 55 | 85 |
| V | 01010110 | 56 | 86 |
| W | 01010111 | 57 | 87 |
| X | 01011000 | 58 | 88 |
| Y | 01011001 | 59 | 89 |
| Z | 01011010 | 5A | 90 |
| [| 01011011 | 5B | 91 |
| \ | 01011100 | 5C | 92 |
|] | 01011101 | 5D | 93 |
| ^ | 01011110 | 5E | 94 |
| _ | 01011111 | 5F | 95 |

| ASCII Char. | EQUIVALENT FORMS | | |
|-------------|------------------|-----|-----|
| | Binary | Hex | Dec |
| ` | 01100000 | 60 | 96 |
| a | 01100001 | 61 | 97 |
| b | 01100010 | 62 | 98 |
| c | 01100011 | 63 | 99 |
| d | 01100100 | 64 | 100 |
| e | 01100101 | 65 | 101 |
| f | 01100110 | 66 | 102 |
| g | 01100111 | 67 | 103 |
| h | 01101000 | 68 | 104 |
| i | 01101001 | 69 | 105 |
| j | 01101010 | 6A | 106 |
| k | 01101011 | 6B | 107 |
| l | 01101100 | 6C | 108 |
| m | 01101101 | 6D | 109 |
| n | 01101110 | 6E | 110 |
| o | 01101111 | 6F | 111 |
| p | 01110000 | 70 | 112 |
| q | 01110001 | 71 | 113 |
| r | 01110010 | 72 | 114 |
| s | 01110011 | 73 | 115 |
| t | 01110100 | 74 | 116 |
| u | 01110101 | 75 | 117 |
| v | 01110110 | 76 | 118 |
| w | 01110111 | 77 | 119 |
| x | 01111000 | 78 | 120 |
| y | 01111001 | 79 | 121 |
| z | 01111010 | 7A | 122 |
| { | 01111011 | 7B | 123 |
| : | 01111100 | 7C | 124 |
| } | 01111101 | 7D | 125 |
| ~ | 01111110 | 7E | 126 |
| DEL | 01111111 | 7F | 127 |

9871A Character Disks

| Decimal Code | Spoke Number | Standard Characters | Decimal Code | Spoke Number | Standard Characters | Decimal Code | Spoke Number | Standard Characters |
|--------------|--------------|---------------------|--------------|--------------|---------------------|--|---------------------|---------------------------|
| 33 | 48 | ! | 76 | 55 | L | 119 | 88 | w |
| 34 | 61 | .. | 77 | 37 | M | 120 | 70 | x |
| 35 | 23 | # | 78 | 49 | N | 121 | 67 | y |
| 36 | 24 | \$ | 79 | 51 | O | 122 | 68 | z |
| 37 | 5 | % | 80 | 56 | P | 123 | 4 | π |
| 38 | 9 | & | 81 | 65 | Q | 124 | 64 | |
| 39 (SO) * | 2 | ' | 82 | 43 | R | 125 | 94 | → |
| 40 | 89 | . | 83 | 44 | S | 126 | 96 | ~ |
| 41 | 38 | (| 84 | 46 | T | Here are the unique characters found on the ASCII character disk. | | |
| 42 | 26 | * | 85 | 60 | U | | | |
| 43 | 25 | + | 86 | 62 | V | Decimal Code | Spoke Number | ASCII Character |
| 44 | 6 | . | 87 | 32 | W | 92 | 3 | \ |
| 45 | 27 | - | 88 | 28 | X | 123 | 4 | { |
| 46 | 33 | . | 89 | 35 | Y | 125 | 94 | } |
| 47 | 31 | / | 90 | 63 | Z | Here are the unique characters found on the European character disk. | | |
| 48 | 18 | 0 | 91 | 42 | [| | | |
| 49 | 17 | 1 | 92 | 3 | √ | Decimal Code | Spoke Number | European Character |
| 50 | 19 | 2 | 93 | 40 |] | 35 | 23 | € |
| 51 | 16 | 3 | 94 | 1 | ^ | 39 (SO) * | 89 | ƒ |
| 52 | 20 | 4 | 94 (SO) * | 8 | ↑ | 92 | 3 | ç |
| 53 | 15 | 5 | 95 | 11 | — | 94 (SO) * | 8 | • |
| 54 | 21 | 6 | 96 | 95 | \ | 123 | 4 | .. (U.C.) |
| 55 | 14 | 7 | 97 | 85 | a | 125 | 94 | .. (L.C.) |
| 56 | 22 | 8 | 98 | 93 | b | | | |
| 57 | 13 | 9 | 99 | 75 | c | | | |
| 58 | 52 | : | 100 | 86 | d | | | |
| 59 | 59 | : | 101 | 82 | e | | | |
| 60 | 10 | < | 102 | 74 | f | | | |
| 61 | 29 | = | 103 | 73 | g | | | |
| 62 | 12 | > | 104 | 81 | h | | | |
| 63 | 54 | ? | 105 | 79 | i | | | |
| 64 | 7 | @ | 106 | 91 | j | | | |
| 65 | 47 | A | 107 | 72 | k | | | |
| 66 | 58 | B | 108 | 87 | l | | | |
| 67 | 39 | C | 109 | 90 | m | | | |
| 68 | 53 | D | 110 | 78 | n | | | |
| 69 | 45 | E | 111 | 77 | o | | | |
| 70 | 57 | F | 112 | 92 | p | | | |
| 71 | 34 | G | 113 | 69 | q | | | |
| 72 | 41 | H | 114 | 83 | r | | | |
| 73 | 50 | I | 115 | 84 | s | | | |
| 74 | 66 | J | 116 | 80 | t | | | |
| 75 | 30 | K | 117 | 76 | u | | | |
| | | | 118 | 71 | v | | | |

The character spokes are numbered clockwise, 1 to 96, beginning with the circumflex (∧) character. Hold the character disk with the characters facing you and the locating tab up. The circumflex character (spoke 1) will be on top.

*SO is "shift out".

Status Codes

| Decimal Status Code | Condition Definition |
|------------------------|--|
| 1 | Ready |
| 2 | Handshake not complete Buffer Space |
| 3 | Buffer Space |
| 4 | Handshake not complete Not Ready |
| 5 | Not Ready |
| 6 | Handshake not complete Not Ready Buffer Space |
| 7 | Not Ready Buffer Space |
| 8 | Handshake not complete Cover off |
| 9 | Cover off |
| 10 | Handshake not complete Buffer Space Cover off |
| 11 | Buffer Space Cover off |
| 12 | Handshake not complete Not Ready Cover off |
| 13 | Not Ready Cover off |
| 14 | Handshake not complete Cover off, Not Ready Buffer Space |
| 15 | Not Ready Buffer Space Cover off |
| 0 | Handshake not complete |

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Telex: 001-2156
Cable: BLUEFROST
Blue Star Ltd
Sahas
414 2 Vir Savarkar Marg
Prabhadevi
Bombay 400 025
Tel: 45 78 67
Telex: 011-4093
Cable: FROSTBLUE
Blue Star Ltd
Band Box House
Prabhadevi
Bombay 400 025
Tel: 45 73 01
Telex: 011-3751
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