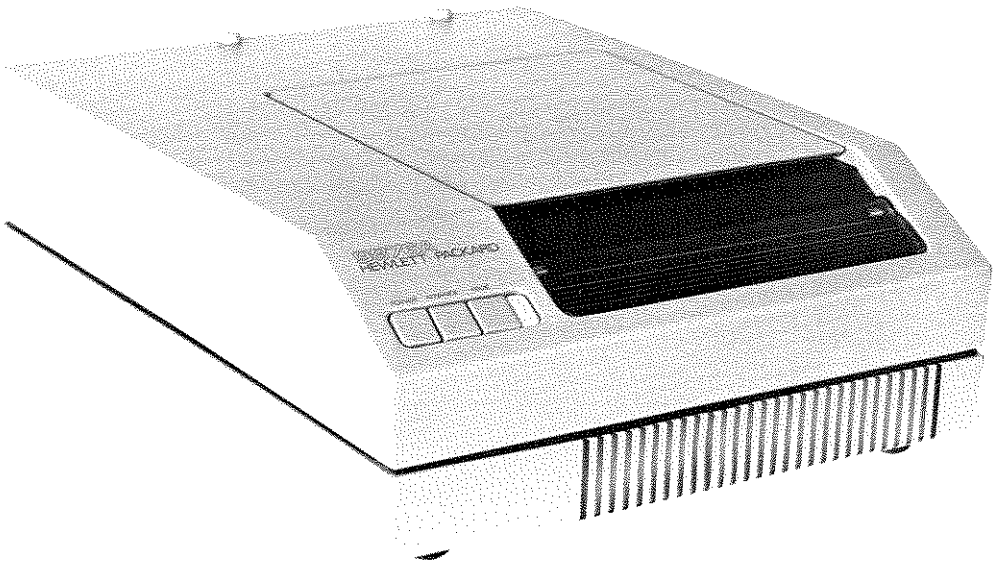
9876A Thermal Graphics Printer



April 1, 1982

Hewlett-Packard Greeley Division
3404 East Harmony Road, Fort Collins, Colorado 80525
(For World-wide Sales and Service Offices see back of manual.)

HEWLETT PACKARD

Warranty Statement

Hewlett-Packard products are warranted against defects in materials and workmanship. For Hewlett-Packard Desktop Computer Division products sold in the U.S.A. and Canada, this warranty applies for ninety (90) days from date of delivery.* Hewlett-Packard will, at its option, repair or replace equipment which proves to be defective during the warranty period.

Within HP service travel areas, warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses. In all other cases, products must be returned to a service facility designated by HP.

Buyer shall prepay shipping charges for products returned to HP for warranty service and HP shall pay for return of the products to Buyer. However, Buyer shall pay all shipping charges, duties and taxes for products returned to HP from another country.

Repairs necessitated by misused of the equipment, or by hardware, software, or interfacing not provided by Hewlett-Packard are not covered by this warranty.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES.

*For other countries, contact your local Sales and Service Office to determine warranty terms.

Federal Communications Commission Radio Frequency Interference Statement USA Only

The Federal Communications Commission (in Subpart J of Part 15, Docket 20780) has specified that the following notice be brought to the attention of the users of this product.

Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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CHAPTER 1

General Information

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General Information

Introduction

The HP 9876A is a thermal graphics printer that can provide printed and graphic copy of problems solved by HP Desktop Computers or any compatible controller. The 9876A adds these capabilities to your system:

- Fast printing – up to 480 lines/minute.
- 9 character sets resident in the printer.
- New character redefination of an existing character (7 new characters).
- Expanded size (150% taller) characters can be selected.
- Automatic underline and overbar highlighting.
- Top margin, text length and vertical line spacing can be selected.
- Graphics Mode with a 560 horizontal dot resolution.
- Self test for operational verification.

Environmental and Physical Specifications

Environmental

Operating Temp 0° C to 55° C
Non-Operating Temp −40° C to 75° C
Relative Humidity 10 to 95% at 25° to 40° C (77° to 104° F)
without condensation

Physical Dimensions

Height 147 millimetres (5.8 inches)
Width 351 millimetres (13.8 inches)
Length 446 millimetres (17.5 inches)
Weight 13.6 kilograms (30 pounds)

Equipment Supplied

The following items are supplied with each printer.

Item	Qty.	HP Part No.
Peripheral Manual	1	09876-90000
Power Cord	1	8120-1378[1]
Spare Fuses		
1.5 Amp Slow Blow	1	2110-0304
3 Amp Slow Blow	1	2110-0381
Thermal Paper		
Standard English		
(8½ by 11 inch)		
Black Packet	1	9270-0640[2]
Blue Packet	1	9270-0641[2]
Option 003 Metric		
(210 by 297 millimetre)		
Black Packet	1	9270-0642[2]
Blue Packet	1	9270-0643[2]
Metric Paper		
Spacer	1	5041-1503

1 Part number for the standard power cord is shown. Refer to "Power Cords" in Chapter 2 for options.

2 These part numbers are for a box of paper that contains 4 packets.

Initial Inspection

The printer and its accessories were carefully inspected before they were shipped to you. Please verify that the correct accessories are present; then inspect the printer for physical damage. If any damage is found, contact the nearest HP Sales and Service Office; office locations are listed at the back of this manual. Refer to Chapter 2 for installation and confidence test information.

Maintenance Agreements

When you buy Hewlett-Packard equipment, service is an important factor. If you are to get maximum use from your equipment, it must be in good working order. An HP Maintenance Agreement is the best way to keep your equipment in optimum running condition.

Consider these important advantages:

- Priority Service – Your Maintenance Agreement insures that you receive priority treatment, within an agreed upon response time.
- On-Site Service – There is no need to package your equipment and return it to HP. Fast and efficient modular replacement at your location saves you both time and money.
- Fixed Cost – The cost is the same regardless of the number of calls, so it is a figure that you can budget.
- A Complete Package – A single charge covers labor, parts, and transportation.
- Regular Maintenance – Periodic visits are included, per factory recommendations, to keep your equipment in optimum operating condition.
- Individualized Agreements – Each Maintenance Agreement is tailored to support your equipment configuration and your requirements.

After considering these advantages, we are sure you will find that a Maintenance Agreement is an important and cost-effective investment.

For more information, please contact your local HP Sales and Service Office.

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CHAPTER 2

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Introduction

This chapter describes the installation procedures that you can follow to install the 9876A Graphics Printer in your system. The paper loading and the confidence test procedures are also described in this chapter.

Printer Controls

The following figure shows the location of the various controls on the printer.

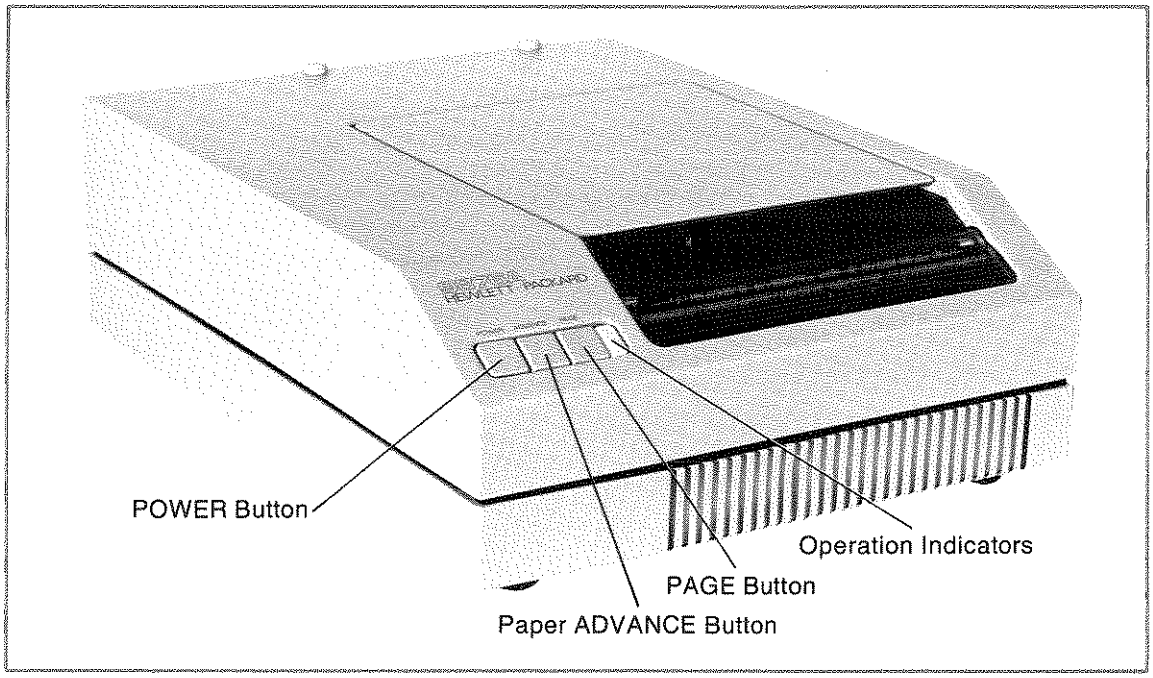


Figure 2-1: Printer Front Panel Controls

The POWER Button

Pressing the POWER button switches the printer either on or off. When the printer is switched on, all three operation indicators light up during normal operation. The printer is reset whenever the power is first switched on (refer to "Resetting the Printer" in Chapter 3 for a complete description of the printer's power-on or default conditions).

The PAGE Button

Pressing the PAGE button advances the paper to the top margin of the next perforated page. If paper without sense holes is used (the small hole in the upper left part of each form), the paper is advanced approximately 12.5 inches (31.75 cm).

The Paper ADVANCE Button

Pressing the ADVANCE button advances the paper until you release the button. Holding this button down and pressing the PAGE button will initiate the printer's confidence test routine. The confidence test is explained on page 2-7 of this chapter.

The Operation Indicators

The three operation indicators located to the right of the control buttons are under an opaque cover. These lights are used to indicate various operational conditions of the printer.

- All three continuously illuminated indicates normal operation.
- All three blinking indicates an out of paper condition.
- All three dark indicates the printer is switched off or power is not being supplied to the printer.
- Illumination of various combinations of the lights indicates either self test or internal control line failures. These test failures are describe under "Confidence Test" in this chapter and under "Print Head Primary Protection" in the Theory of Operation in Chapter 5.

Power Requirements

The printer operates from power line voltages of 100, 120, 220 or 240 volts AC. The range of operation is within ±10% of each nominal voltage. Two switches on the printer's back panel permit selection of any one of the four nominal voltages (see Figure 2-2). The line frequency must be within 48 to 66 Hz. The printer requires a maximum of 155 voltamps.

CAUTION

The printer may be damaged if the line voltage switch settings are incorrect. Check the switch settings before applying power.

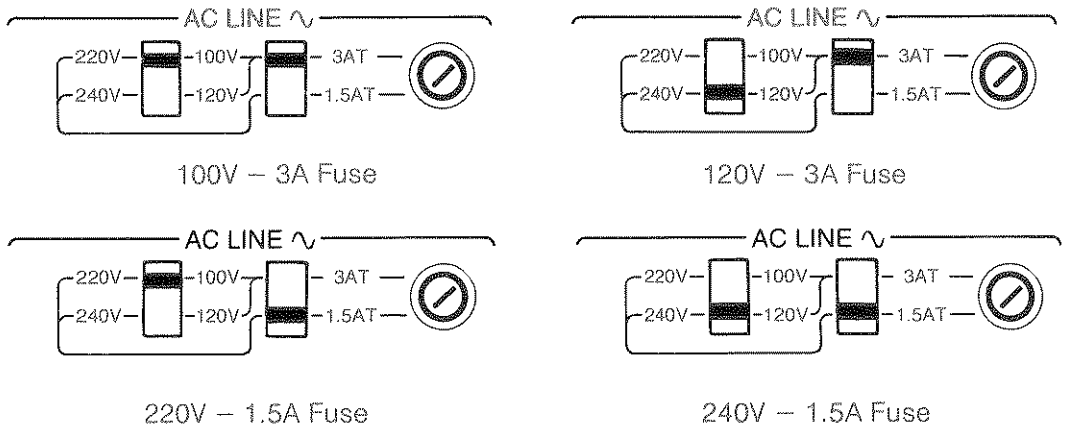


Figure 2-2: Line Voltage Switches

Grounding Requirements

The National Electrical Manufacturers' Association (NEMA) recommends that the printer be grounded to protect operating personnel from electrical shock. The printer is equipped with a three-conductor power cable which, when connected to an appropriate receptacle, grounds the cabinet of the unit.

Power Cords

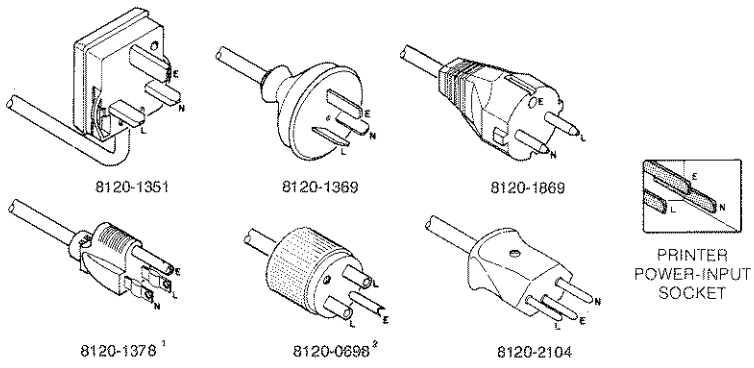
Power cords supplied by HP will have polarities matched to the power-input socket on the equipment, shown below:

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

WARNING

IF IT IS NECESSARY TO REPLACE THE POWER CORD, THE REPLACEMENT CORD MUST HAVE THE SAME POLARITY AS THE ORIGINAL, OTHERWISE A SAFETY HAZARD FROM ELECTRICAL SHOCK TO PERSONNEL, WHICH COULD RESULT IN INJURY OR DEATH, MIGHT EXIST. IN ADDITION, THE EQUIPMENT COULD BE SEVERELY DAMAGED IF EVEN A RELATIVELY MINOR INTERNAL FAILURE OCCURRED.

Power cords with different plugs are available for the equipment; the part number of each cord is shown in Figure 2-3. Each plug has a ground connector. The cord packaged with the equipment depends upon where the equipment is to be delivered. If your equipment has the wrong power cord for your area, please contact your local HP Sales and Service Office.



[1] UL and CSA approved for use in the United States of America and Canada with equipment set for either 100 or 120 Vac operation.

[2] UL and CSA approved for use in the United States of America and Canada with equipment set for either 220 or 240 Vac operation.

Figure 2-3: Power Cords

Fuses

The printer must be fitted with a 3 amp slow blow fuse for 100-120 V operation or a 1.5 amp slow blow fuse for 220-240 V operation. Fuse part numbers are listed in the Equipment Supplied Table in Chapter 1.

WARNING

BEFORE CHANGING THE FUSE, BE SURE THAT THE PRINTER IS DISCONNECTED FROM ANY POWER SOURCE.

To remove a fuse, press in on the cap of the fuse holder and twist the cap in the direction indicated by the arrow on the cap. Pull the cap free and remove the fuse.

To install a fuse, place either end of the fuse into the pocket in the cap and reinstall the cap by pressing in on the cap and twisting it in the opposite direction from the arrow.

Always be sure that the correct fuse is used. The wrong fuse could result in damage to the printer if a malfunction or unusual line voltage occurs.

Switching the Printer On

The following steps can be followed when you are switching your printer on for the first time.

1. Verify that the line voltage switch is set for the voltage level in your area.
2. Verify that the proper fuse is installed for the line voltage setting (3 amp Slow Blow for 100V-110V or 1.5 amp Slow Blow for 220V-240V).
3. Connect the power cord to the printer and an ac power source.
4. Switch the printer on by pressing the POWER button on the printer's front panel.
5. Check that the three indicator lights on the front panel are all on. If these lights are flashing, the printer is out of paper. If any of the indicator lights are not on, an error condition within the printer exists. Refer to "Confidence Test" on page 2-7 for further information concerning the error conditions represented by the indicator lights.

Loading Printer Paper

1. Remove the last part of the previous stack of paper (if any) from the printer by pressing the ADVANCE button until the paper is passed through the rollers.
2. Open the access cover on the top of the printer by lifting the front edge of the cover.
3. If you are using 210 by 297 millimetre paper (P/N 9270-0642 or 9270-0643), the metric paper spacer (P/N 5041-1503) must be in place on the right side of the paper trays. The spacer is installed by inserting its two tabs into the matching holes in the side of the paper tray as shown below. Note that the two slots along the edge of the spacer face up when it is properly installed.

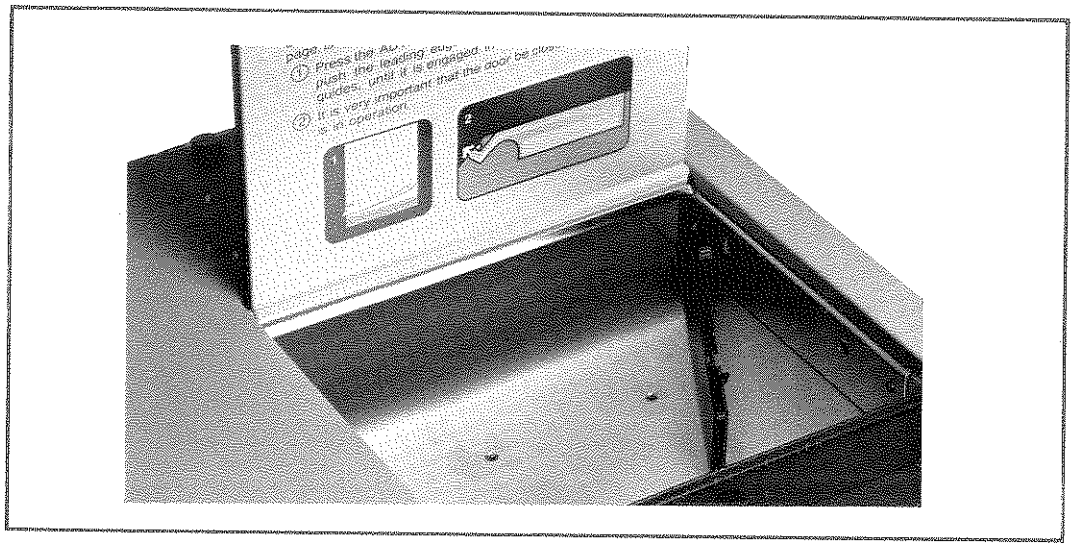


Figure 2-4 : The Metric Paper Spacer's Location in the Paper Tray

NOTE

Using metric paper without the paper spacer in place can allow the paper to move far enough to the right to cause the paper to miss the paper sensor. This causes the printer to behave as if it is out of paper. The indicators will flash, the paper will advance continuously for 15 seconds whenever the ADVANCE button is pressed and the Confidence Test routine will not be executed.

If you are using 8½ by 11 inch paper (P/N 9270-0640 or 9270-0641), the metric paper spacer should be removed from the printer's paper tray. To remove the spacer, insert a flat blade screw driver into either of the slots along the top edge of the spacer and gently pry the spacer out from the edge of the paper tray until the tabs are free of the holes.

4. Load the new stack of paper (with the cardboard sheet on the bottom) into the printer's paper tray with the loose edge of the paper towards the front of printer and the first perforated fold toward the rear. The small hole in the paper should be on the left side (when facing the printer). See Figure 2-5 "Loading Paper".

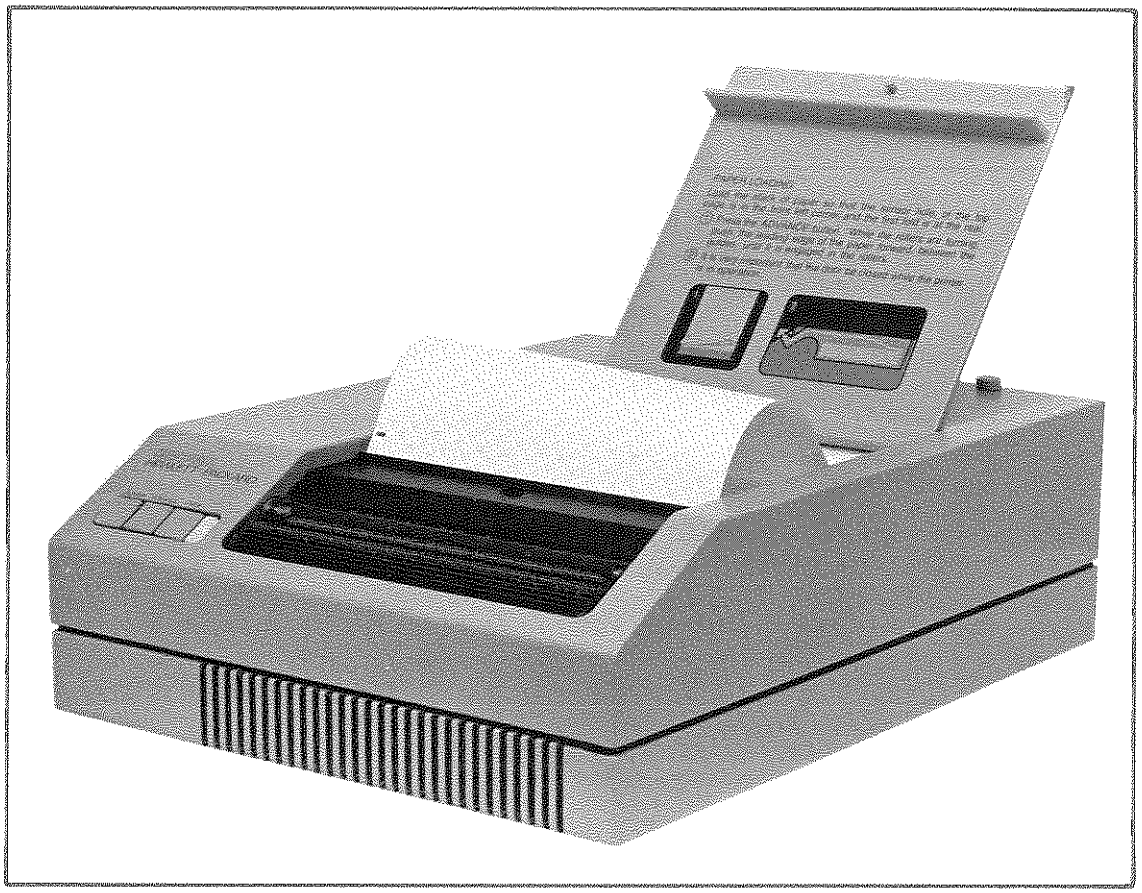


Figure 2-5: Loading Paper

NOTE

The loose edge of the paper should not be ragged or have any creases or wrinkles in it.

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5. After pressing the ADVANCE button, push the loose edge of the top page into the rollers as shown below. The paper rollers will continue to move for 15 seconds after pressing the ADVANCE button or until the paper is loaded and the first sense hole in the paper is detected. This typically results in the paper stopping at the top margin of the second sheet of paper.

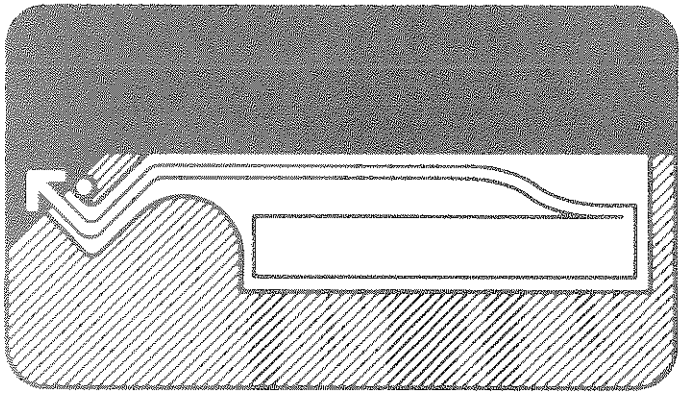


Figure 2-6: Feeding the Paper into the Rollers

6. Close the access cover. The access cover must be closed while the printer is in operation to allow proper feeding of the paper.

Printer Confidence Test

The 9876A Printer has a built in confidence test routine that checks its operational condition. The test is initiated by holding the ADVANCE button down and then pressing the PAGE button. The confidence test is also initiated when the printer receives the Confidence Test escape sequence, Ecz.

The test takes approximately 5 seconds and produces the following printout. The printer is reset to its power-on condition when the test is completed.

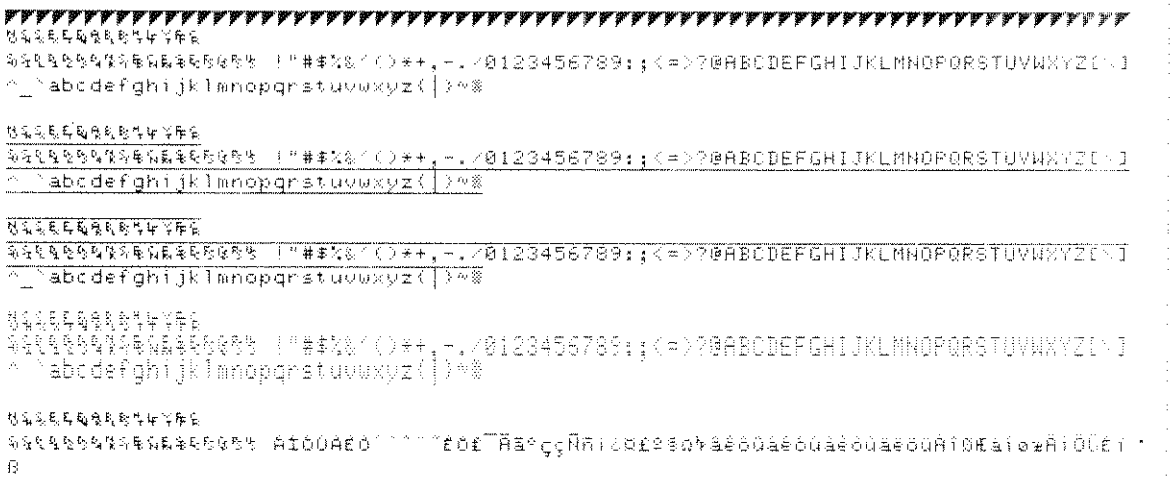


Figure 2-7: Confidence Test Printout

NOTE

The last lines of the printout are the characters from the currently selected secondary character set. The printout above shows the European Extension set characters printed on the last two lines.

Immediately following the confidence test (before any more data is accepted), the self test, described below, is automatically performed.

Self Test

The printer contains a self test routine to check the five print head control lines and the data lines whenever the printer is first switched on and in between printing operations. This test, however, does not print out anything.

If the test fails, the top indicator on the front panel will remain illuminated and the lower two will be dark. If this occurs, press the PAGE button and the first area of failure is displayed by one of the following combinations of the operation indicators.

Indicators	Area of Failure	Indicators	Area of Failure
Top ○ Middle ● Bottom ○	The printer is overheated[1].	Top ● Middle ○ Bottom ●	CLEAR line failure.
Top ● Middle ● Bottom ○	BURN line failure.	Top ○ Middle ● Bottom ●	LOAD line failure.
Top ○ Middle ○ Bottom ●	SHIFT line failure.	Top ● Middle ● Bottom ●	BSD (Bit Serial Data) line failure.

1 An overheated condition will immediately light its pattern of indicators without requiring you to press the PAGE button.

If the printer fails the confidence test, switch the power off and then on again and repeat the test procedure. If the printer still fails the test, contact the nearest HP Sales and Service Office for assistance. Refer to the Appendix of this manual for a list of office locations.

Printer Overheat Protection

If either the printer's power supply or its print head become overheated during printer operation, the power supply will shut down and the printer will stop accepting data. When the printer cools sufficiently to safely resume operation, the power supply is reactivated, all three of the indicators are illuminated and the printer begins accepting data again. None of the data that was in the printer's buffer will be lost if the printer overheats. Operation will resume at the point that it was interrupted when the printer cools down.

Printer Interface Options

The 9876A Printer can be ordered with various interface options. Since the I/O cable installation procedure for your printer is dependent upon the type of interface that you have ordered, the installation notes have been included in this manual. These notes contain the procedure for any special switch settings or cable connections that your specific interface option requires.

HP-IB Interface Installation Note

This installation note describes the cable connections, the address code and other switch settings and the paper guide installation for the 9876A printer with an HP-IB interface.

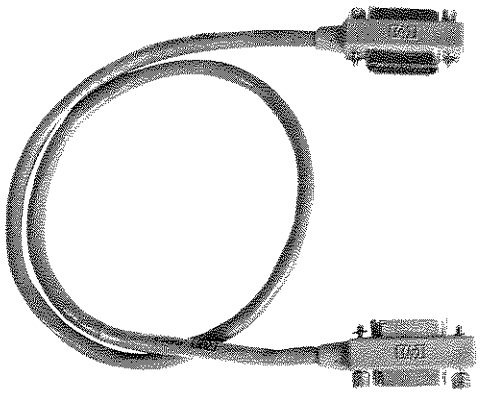
Insert this note in your printer's binder at the end of Chapter 2.

The following picture (Figure 2-8) shows the HP-IB connector on the printer's back panel and an HP-IB cable connected to it.

Connecting the Standard 9876A Printer

The standard printer is connected to a controller via the HP-IB. The HP-IB is Hewlett-Packard's implementation of the IEEE Standard 488-1975. The printer connects to an HP-IB Interface via standard HP-IB cables (listed below).

Length	Accessory Number
1 metre	10631A
2 metres	10631B
4 metres	10631C



Standard HP-IB Cables

The following interfaces are used to connect the HP 9876A Thermal Printer to HP Desktop Computers and Controllers.

Hewlett-Packard HP-IB Interfaces

Interface	Controller
HP 98135A	9815A
HP 98034A	9825A
HP 59405A Opt. 30	9830
HP 98034A	9831A
HP 98034A, Revised	System 45, System 35

The following picture (Figure 2-8) shows the HP-IB connector on the printer's back panel and an HP-IB cable connected to it.

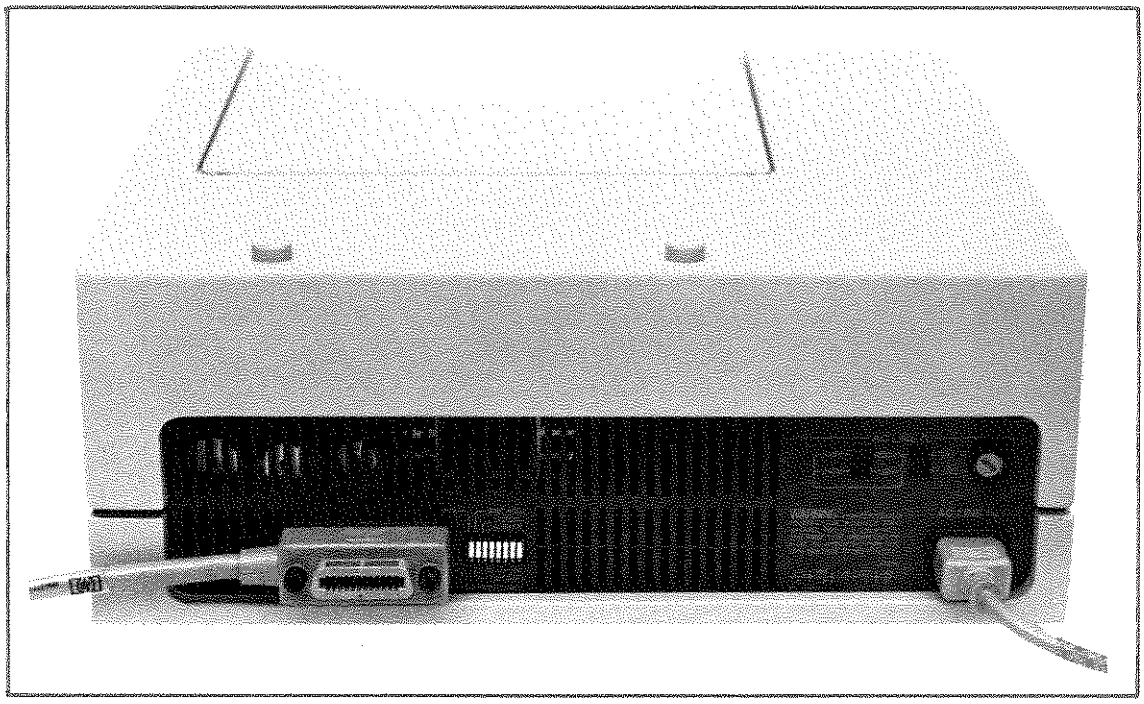


Figure 2-8: HP-IB Cable Connection

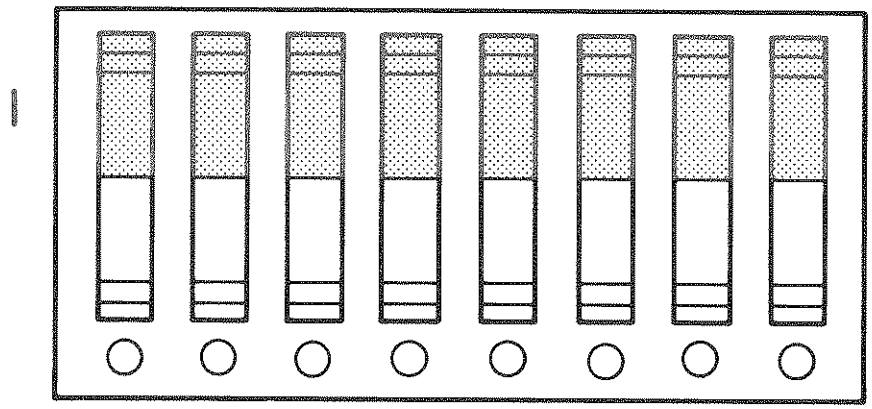
Rear Panel Switch Settings

The 8 switches located on the rear panel of the printer are used to select the following on the HP-IB printer:

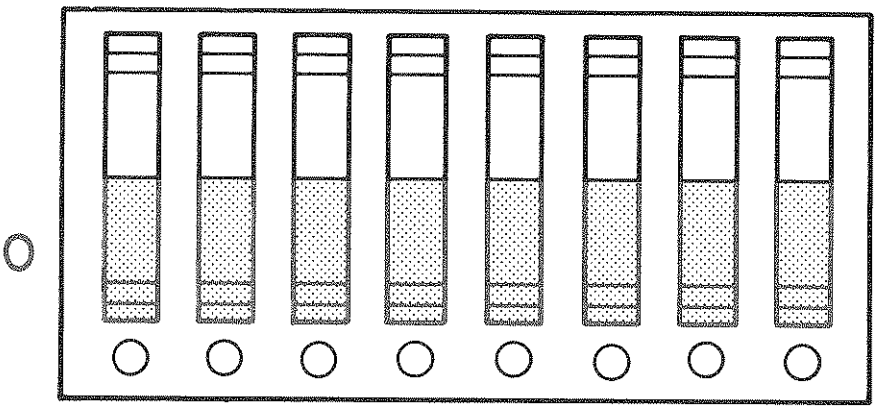
- The printer's address code
- The printer's Listen Always Mode
- Select 8 bit or 7 bit ASCII code
- Enable or disable SRQ (Service Request)

Whenever the switch settings are changed, the printer must be initialized by switching it off and on again or by sending it a RESET instruction .

Pressing the top of the switch sets the 1 or on position as shown below.



Pressing the bottom of the switch sets the 0 or off position as shown below.



Printer Address Code

Since each HP-IB system can have as many as 15 devices connected to it, each device must be set to a unique address code. The printer can be set to any one of 31 HP-IB address codes ranging from 0 through 30. The following table shows the 31 pair of address characters, the address switch settings and the decimal value of the 5 least-significant bits of the ASCII[1] Code for each pair of address characters.

Address Characters and Codes

1 = Depress TOP of Switch

0 = Depress BOTTOM of Switch

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

1 American Standard Code for Information Interchange

HP controllers using the 98034A or the 98135A HP-IB interfaces use the 5-bit decimal value of each pair of address characters as an address code. Using the address code instead of the address characters, the controller automatically addresses the printer as a talker or a listener according to the I/O operation being performed. Refer to the HP-IB operating section of the controller's I/O programming manual for further information concerning HP-IB addressing.

The Address Code Switches (A1→A5)

To select a specific address code on the printer, the address switches on the back panel (shown in color in Figure 2-9) are set to correspond to the positions listed in the preceeding table for the desired address code.

The printer is shipped from the factory with the address switches (shown in color below) set to an address code of 01.

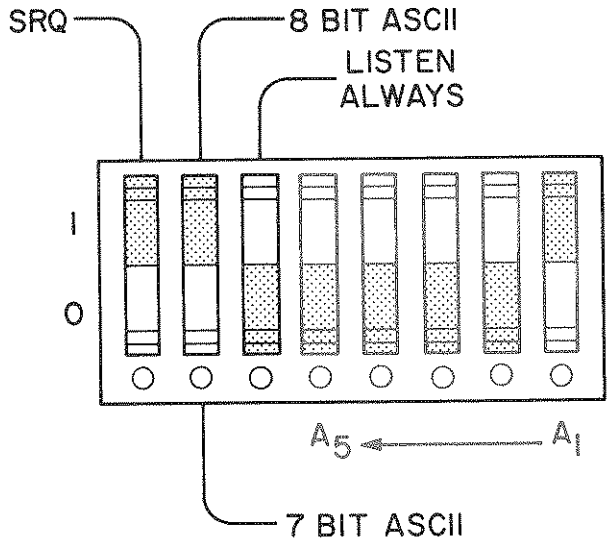


Figure 2-9: Address Code Switches – Set to 01

To set a switch to correspond to a 0 in the address code table, press the bottom of the switch.

To set a switch to correspond to a 1 in the address code table, press the top of the switch.

The Listen Always Switch

The listen always switch is set to the 0 position at the factory (shown in color below). With this switch set to the 0 or off position, the printer must be addressed by the controller before it will respond to messages sent on the bus.

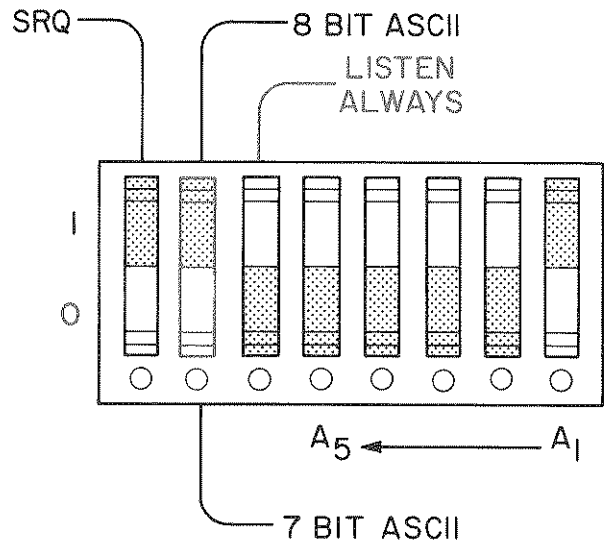


Figure 2-10: Listen Always Switch – Set "OFF"

If you want the printer to print all data sent on the bus, set this switch to the 1 or on position by pressing the upper portion of the switch. This sets the printer to a "listen always" condition. In this condition, the printer will print all data sent on the bus without being addressed by the controller.

NOTE

The printer will not respond to a Serial Poll operation when it is set to the Listen Always mode.

The 7 or 8-bit ASCII Switch

The printer can be set to accept either 7 or 8-bit ASCII coded data by depressing switch 7 towards the coding being selected. 7 bit ASCII is selected by pressing the upper portion of the switch and 8-bit ASCII is selected by pressing the lower portion of the switch. The printer is shipped with 8-bit ASCII selected.

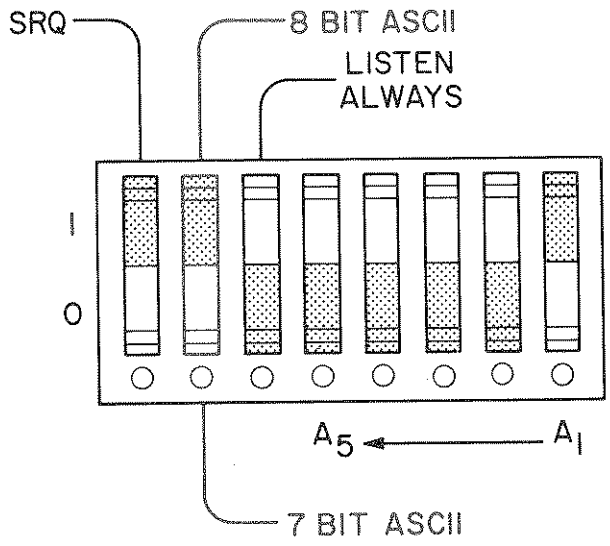


Figure 2-11: 7 Bit/8 Bit ASCII Switch – Set to 8-Bit

Selecting 8 bit ASCII allows either the primary character or secondary set to be selected by the 8th bit of each character code. Whenever the 8th bit is a logical 0 (false or clear) the primary character is selected for that character.

The secondary character set is selected whenever the 8th bit is a logical 1 (true or set). The Shift Out (S_O) and Shift In (S_I) characters are ignored by the printer when the 8-bit ASCII mode is selected.

Selecting 7-bit ASCII allows the primary character set to be selected by the Shift In character (S_I). The Secondary character set is selected by the Shift Out character (S_O). The 8th bit of each ASCII character code (except graphic data characters) is always ignored when the 7 bit ASCII mode is selected.

Service Request (SRQ) Enable Switch

The printer is shipped with the SRQ switch (shown in color below) set to the 1 or on position that enables the printer to send the Require Service Message. The Require Service Message and polling are explained in Chapter 4 "HP-IB Operation". Setting this switch to the 0 or off position prevents the printer from sending the Require Service Message.

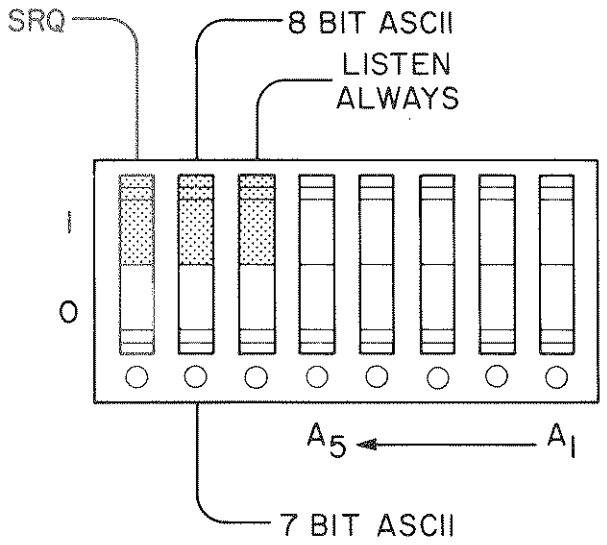


Figure 2-12: SRQ Enable Switch – Set "ON"

The Paper Stacking Guide

The paper stacking guide has been provided with your printer to facilitate proper paper stacking when the printer is operated unattended or if more than 30 sheets are to be stacked at one time.

Installing The Paper Stacking Guide

The paper stacking guide is installed by inserting the short prongs on the bottom of the guide into the matching holes located along the front edge of the paper access cover. The stacking guide should be installed as shown in Figure 2-13.

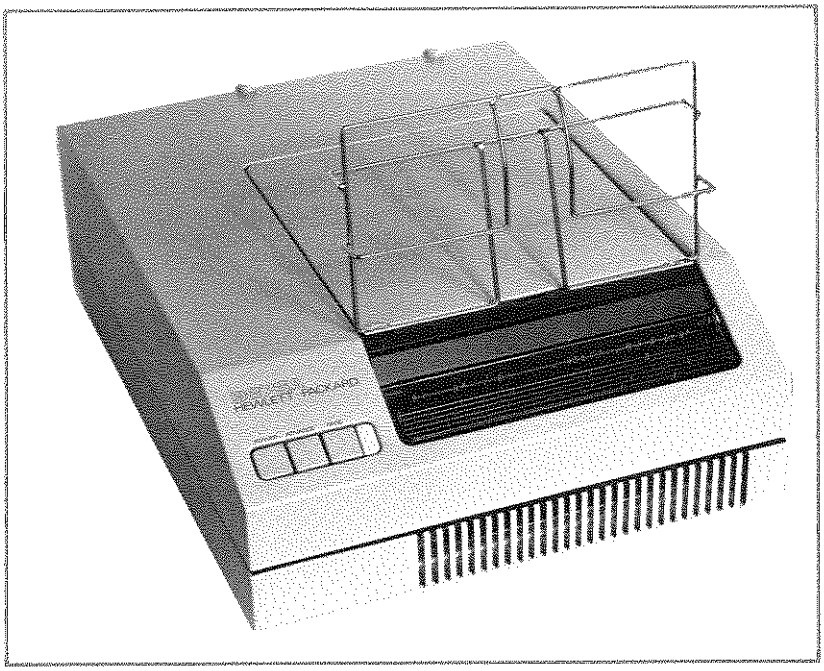


Figure 2-13: The Paper Stacking Guide

The paper should pass up through the paper guide and then begin to stack on the top of the printer. Care should be taken to insure that the paper begins stacking in a manner that follows the folds established by the paper's original packaging.

Thus, either the leading edge or the first fold must rest against the paper stops at the rear of the printer depending upon the original fold sequence.

NOTE

Some difficulty in stacking can occur if the printer is idle for more than 5 minutes and continuous stacking is desired. This difficulty can be minimized by performing a form feed operation whenever printing stops for a period of time.

Option 001 Installation Note

This installtion note describes how to configure the printer and connect the interface cable to a 9876A printer with an 8-bit parallel interface.

Configuring the Printer

Various characteristics of the printer are configured by either connecting printer interface connector pins to ground or by leaving the pins disconnected. The following tables list all of the pins on the printer's connector (Table 2-1) and the pin connections that should be made to select the various printer configurations (Table 2-2).

Following Tables 2-1 and 2-2 are more detailed descriptions of the various functions that are selectable from the printer's interface connector.

Detailed 8-bit parallel interfacing information is in the 8-bit parallel section of Chapter 4.

Table 2-1: Printer Connector Pins

Line Name	Pin	Pin	Line Name
7-bit/8-bit ASCII	20	1	GND
FR, SW, UK, KA	21	2	GND
SP, EE, UK, KA	22	3	GND
FR, EE, GER, KA	23	4	GND
Auto Carriage Return	24	5	GND
LATCH	25	6	GND
GND	26	7	GND TRUE Data Logic
GND	27	8	GND
GND	28	9	Data In 0
GND	29	10	Data In 5
+5 Volts	30	11	Data In 4
OTP (Out of Paper)	31	12	Data In 6
ACK (Acknowledge)	32	13	Data In 2
GND	33	14	Not Cycle Initiate ($\overline{CI}$)
BUSY	34	15	Cycle Initiate (CI)
PREADY	35	16	$\overline{RESET}$
$\overline{BUSY}$	36	17	Data In 7
Not Out of Paper ($\overline{OTP}$)	37	18	Data In 3
		19	Data In 1

Table 2-2: Printer Configurations

Printer Characteristic	Pin Connections		
7-bit ASCII Mode	20 to 1		
8-bit ASCII Mode*	20 to N/C		
Default Secondary Character Set			
Danish/Norwegian	21 to N/C	22 to N/C	23 to N/C
European Extended*	21 to N/C	22 to 3	23 to 4
French	21 to 2	22 to N/C	23 to 4
German	21 to N/C	22 to N/C	23 to 4
Katakana	21 to 2	22 to 3	23 to 4
Spanish	21 to N/C	22 to 3	23 to 4
Swedish/Finnish	21 to 2	22 to N/C	23 to N/C
United Kingdom	21 to 2	22 to 3	23 to N/C
Auto Carriage Return	24 to N/C		
Normal Carriage Return Operation*	24 to 5		

* These configurations are selected at the factory if you are using an HP 98032A Opt. 076 Interface.

The remaining pins on the printer's connector are used to configure and control the transfer of data to the printer. These pins and their use are described in Chapter 4, "Interfacing".

7-Bit/8-Bit ASCII

The printer can be configured to accept either 7 or 8-bit ASCII coded data either by connecting pin 20 to pin 1 (7-bit) or not connecting pin 20 to any other pin (8-bit).

The type of ASCII determines the method used to select between the primary and secondary character sets.

7-bit ASCII uses the Shift In and Shift Out characters to select character sets. Shift In selects the primary set and Shift Out selects the secondary character set. The 8th bit of each character code is ignored in the 7-bit ASCII mode.

8-bit ASCII uses the 8th bit of each character code to select the character set. If the bit is a logical 0 (false or clear), the primary set is selected for that character. If the bit is a logical 1 (true or set), the secondary set is selected for that character. The Shift In and Shift Out characters are ignored in the 8-bit ASCII mode.

The 8-bit ASCII mode is selected at the factory if you are using an HP 98032A Opt. 076 Interface.

Default Character Set Designation

Pins 21, 22 and 23 of the printer's connector are used to select the default secondary character set. Any one of the available character sets may be selected as the default set by connecting or disconnecting combinations of pins 21, 22 and 23 with pins 2, 3 and 4.

The European Extended Set is selected at the factory if you are using an HP 98032A Opt. 076 Interface. The European Extended Set provides access to all of the characters contained in the available European character sets and was designed to be used with HP System 35 and 45 Desktop Computers with European language keyboard options. HP Desktop Computers with Katakana keyboards, however, must have the Katakana character set selected as the default secondary set.

Auto Carriage Return

The printer can be configured to perform a carriage return automatically whenever a linefeed character is received. This is necessary for controllers that send only a linefeed character at the end of each line of data. Thus, in this configuration (pin 24 connected to pin 6), the printer will perform an automatic carriage return whenever a linefeed is performed.

The printer is configured for normal carriage return operation (pin 24 not connected to pin 6) at the factory if the HP 98032A Opt. 076 Interface is being used.

Connecting An Interface

The photo Figure 2-14 shows the location of the printer's interface connector. To attach the typical connector, position the slide lock on the face of the connector to the left (as viewed from the cable end of the connector). Press the cable connector onto the printer's connector and move the slide lock to the left. The connector should now be locked in place on the printer.

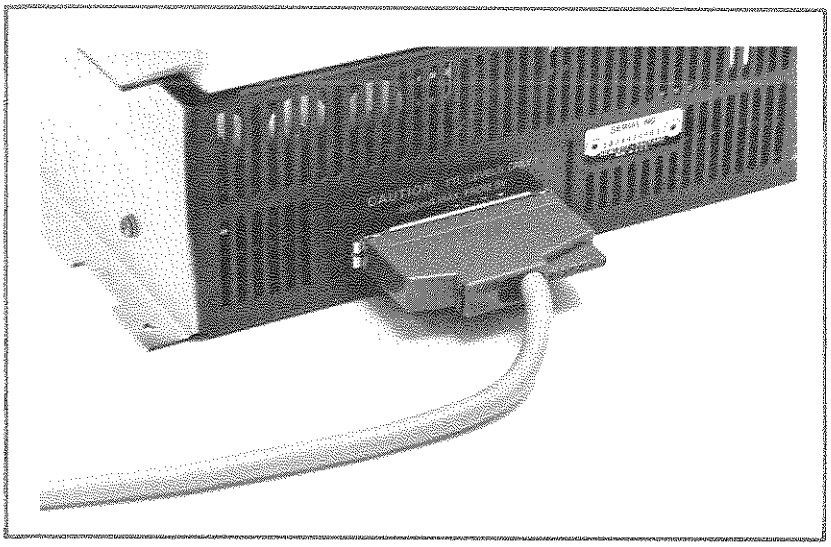
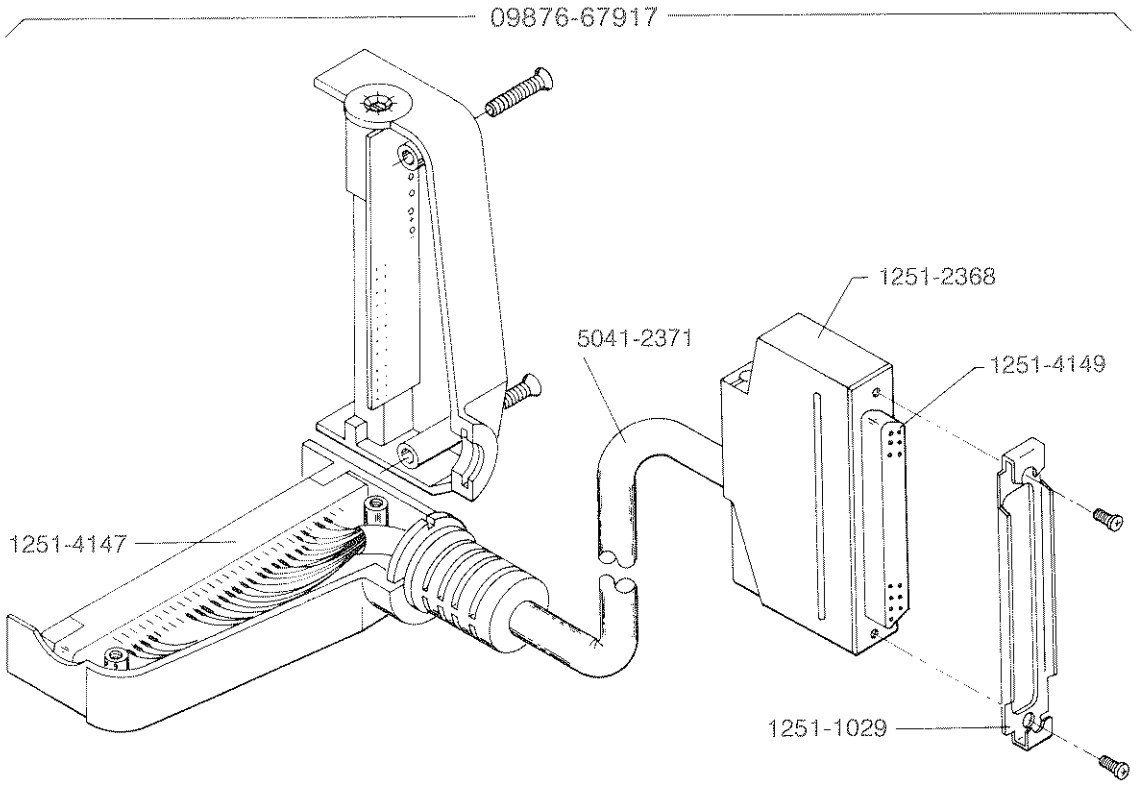


Figure 2-14: Connecting the Interface to the Printer

HP 98032A Opt. 076

The Option 076 to the 98032A 16-Bit Interface provides you with an interface that is pre-wired for use with HP 9825, HP System 35 and HP System 45 Desktop Computers.

Figure 2-15 shows the hardware components that comprise the Option 076 cable and lists the HP replaceable part numbers for the components.



Replaceable Parts List

HP Part No.	Qty.	Description
09876-67917	1	Cable Assembly
1251-4147	1	Connector, 2 x 25 (Interface End)
5041-2371	1	Cable, Molded
1251-4149	1	Connector, 37 Pin (Printer End)
1251-2368	1	Hood
1251-3399	25	Pin
1251-1029	1	Lock Assembly

Figure 2-15: 98032A Option 076 Hardware

Select Code

The Option 076 Interface is set to select code 6 at the factory. To change the select code setting, use a small screwdriver to rotate the switch that is accessible through the interface rear housing (see Figure 2-16). Do not set the switch to a select code used with other internal or external peripherals. For information on select codes reserved for internal peripherals, refer to the Operating and Programming Manual for your computer.

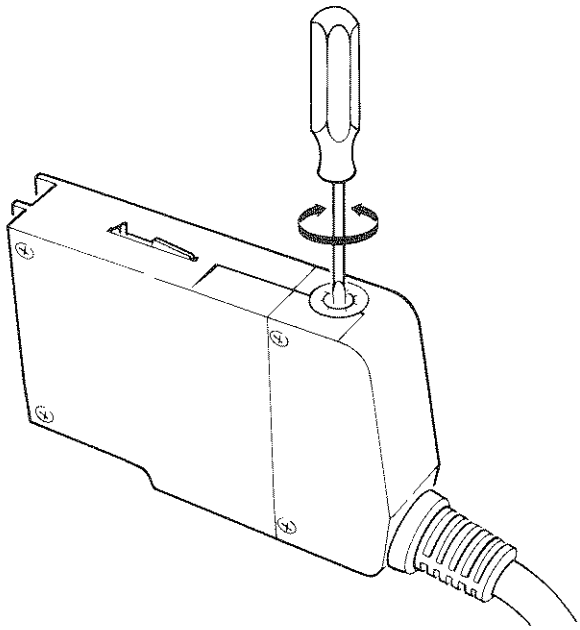


Figure 2-16: Select Code Switch

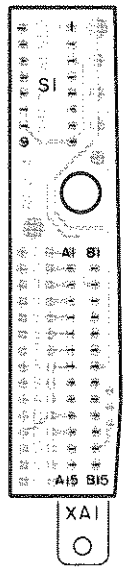
98032A Opt. 076 Cable Wiring Diagram

Interface Connector			Printer Connector	
Line	Pin	Wire Color	Pin	Line
No Connection	A1	White - Brown	3	GND
No Connection	A2		1	GND
No Connection	A3		2	GND
No Connection	A4		3	GND
No Connection	A5		4	GND
No Connection	A6		5	GND
No Connection	A7		6	GND
No Connection	A8		7	GND True Data
No Connection	A9			
$\overline{DO7}$	A10	Violet	17	Data In 7
$\overline{DO6}$	A11	Yellow	12	Data In 6
$\overline{DO5}$	A12	Brown	10	Data In 5
$\overline{DO4}$	A13	Orange	11	Data In 4
$\overline{DO3}$	A14	White - Black	18	Data In 3
$\overline{DO2}$	A15	Blue	13	Data In 2
$\overline{DO1}$	A16	White	19	Data In 1
$\overline{DO0}$	A17	Black	9	Data In 0
GND (N/C)	A18			
$\overline{PCTL}$	A19	White - Yellow	14	$\overline{CI}$
No Connection	A20		15	CI
No Connection	A21		16	$\overline{RESET}$
No Connection	A22			
No Connection	A23			
GND	A24	Red	8	GND
Chassis	A25	Drain	27	GND
GND	B1	White - Orange	29	GND
No Connection	B2		20	7-bit/8-bit ASCII
No Connection	B3		21	(PA3) FR,SW,UK,KA
No Connection	B4		22	(PA4) SP,EE,UK,KA
No Connection	B5		23	(PA5) FR,EE,GER,KA
No Connection	B6		24	Auto Carriage Return
No Connection	B7		25	LATCH
No Connection	B8		26	GND
No Connection	B9		30	+5 Volts
No Connection	B10		31	OTP (Out of Paper)
No Connection	B11		32	$\overline{ACK}$ (Acknowledge)
No Connection	B12			
No Connection	B13			
No Connection	B14			
No Connection	B15			
No Connection	B16			
No Connection	B17			
No Connection	B18		36	$\overline{BUSY}$
$\overline{PFLG}$	B19	White - Red	34	BUSY
$\overline{PSTS}$	B20	Grey	37	$\overline{OTP}$ (Not Out of Paper)
No Connection	B21			
STI0	B22	Green	35	PREADY
No Connection	B23			
GND	B24	White - Green	28	GND
No Connection	B25			

Configuration Board Jumpers

The Option 076 Interface requires no wire jumpers on the configuration board (inside the rear housing).

No Jumpers



Option 076 Configuration Board

(Circuit Side)

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

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Printer Operations

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Chapter 3
Printer Operations

Introduction

This chapter describes the printer's response to ASCII coded data that is sent to it. The HP-IB printer must be properly addressed as a listener by the active controller in the HP-IB system before it will receive data on the bus unless the printer is set to the Listen Always mode. Address switch settings and the Listen Always mode setting are described in the installation note that was supplied with the printer.

The specific statements and address code parameters that the controller uses to send data to the printer are explained in the controller's I/O manual.

The printer interprets the ASCII coded characters that it receives as one of the following:

- Data to be printed
- Printer control characters or codes
- Graphics Mode Data (8 bit bytes)

A table listing the ASCII coded characters and their equivalent binary, decimal, octal and hexadecimal representations is in the Appendix.

Printing Data

The printer accepts data characters to be printed into an 80 character buffer. The characters in the buffer are printed when any of the following occurs:

- The buffer contains 80 characters and the printer receives another printable character.
- The printer receives a linefeed character.
- The printer receives a carriage return character followed by any other character.
- The printer receives a formfeed character.
- The printer receives a backspace character.
- The printer is Reset.
- The printer's confidence test is initiated.

1 American Standard Code for Information Interchange.

For example, the strings of characters shown below are accepted by the printer and result in the print out shown after the character strings.

```
HP 9876A Thermal Graphics Printer HP 9876A Thermal Graphics Printer HP 9876A Thermal Graphics Printer CR LF
```

```
HP 9876A Thermal Graphics Printer HP 9876A Thermal Graphics Printer HP 9876A The
rmal Graphics Printer
```

Notice that the characters "rmal" of the third word "Thermal" is printed on the second line since it was the 81st character in the string. The last part of the string is printed when the carriage return and linefeed characters are received.

The 9876A Printer can also be programmed to provide control of forms, line spacing, character height, character sets, underline and overline highlights. Graphics capability is also provided.

The 9876A Character Matrix

Characters are printed by the 9876A in a 7 dot wide by 12 dot high matrix. This matrix is shown below.

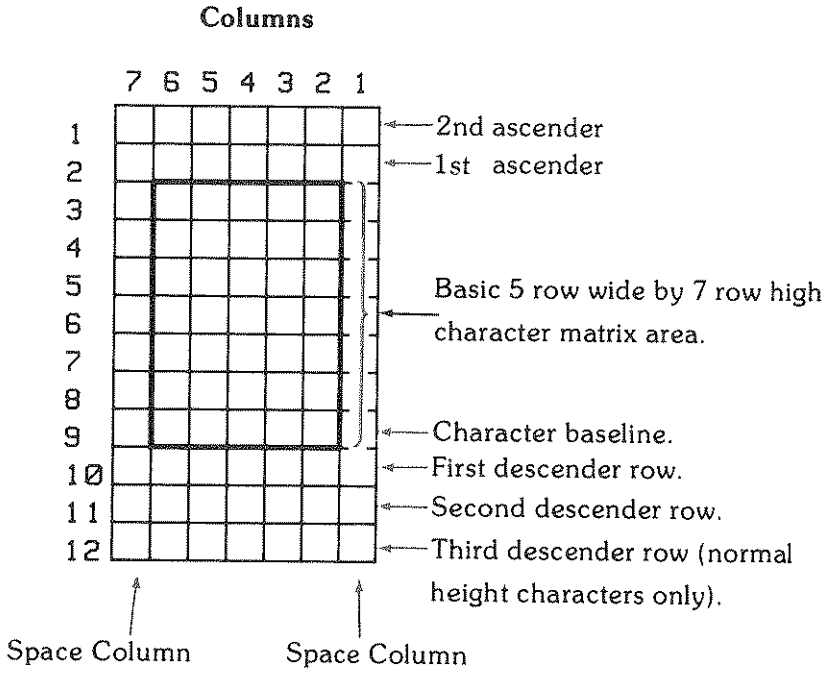


Figure 3-1: 9876A Character Matrix

Most of the characters are printed in the basic 5 by 7 matrix area. The ascender rows are used for the characters that extend above the basic matrix area such as characters with circumflexes the vertical bar character, etc. and auto-overlining. The descender rows are used for the characters that extend below the basic matrix area such as lower case y, g, p etc. and auto-underlining.

The dot patterns used to print the various characters available with the 9876A are listed in the Appendix.

Summary of the Instruction Codes

The printer has various functions that can be programmed to provide control of the forms, the character height, line spacing, character set selection, auto-underline and auto-overline high-lighting and a graphic data mode. These functions are selected when specific ASCII character codes are sent to the printer from the controller.

The following table lists the printer instructions codes and the function that each code selects on the printer. A detailed description of each of the instruction codes is given in the remainder of this chapter after the table.

General Form Control Codes

Instruction	Character Code	Description	Default Condition	Page
Carriage Return	C_R	Prints the contents of the buffer and sets the chracter position to the beginning of the line. Does not advance the paper.		3-5
Linefeed	L_F	Prints the contents of the buffer and advances the paper one line. Maintains the current character position.		3-5
Formfeed	F_F	Advances the paper to the top margin of the next form after printing the contents of the buffer and resets the character position to the left margin.		3-5
Backspace	B_S	Sets the character position one space towards the left margin. Will Overstrike, not replace the character in the left position.		3-6
Horizontal Tab	H_T	Sets the character position to the next preset TAB position to the right of the present position. CR-LF is executed if a TAB is not set to the right of the present position.		3-6

Shift Out	S_O	Selects the currently designated secondary character set for printing operations if the printer is set for 7-bit code. SO is ignored if the printer is set for 8-bit code.		3-6
Shift In	S_I	Selects the primary chracter set for printing operations if the printer is set for 7-bit code. SI is ignored if the printer is set for 8-bit code.	The Primary set is selected	3-6
Escape	E_C	Prepares the printer to receive a character sequence instruction to modify its operational characteristics.		3-6

Escape Sequence Control Codes

Instruction	Character Code	Description	Default Condition	Page
Reset	$E_C E$	Resets the printer to its power on default conditions after printing the contents of the buffer.		3-7
Confidence Test	$E_C z$	Prints the contents of the buffer and then executes the confidence test routine. The printer is reset after the test is complete.		3-7
Display Control Codes Mode Start Stop	 $E_C Y$ $E_C Z$	Prints all control codes that are sent to the printer. Ignores all codes except CR which it prints and then executes (along with an automatic LF.)	Display Mode is off	3-8
Vertical Line Spacing	E_C & l (Lower Case L) Number of dot rows between character base lines. 0 thru 60 S	Specifies the number of dot rows between character baselines. Affects only the spacing between lines of characters, not the size of the characters.	12 dot rows per line	3-9
Character Height Expanded Normal	 E_C & k 1 S E_C & k 0 S	 Selects characters that are 50% taller than normal characters. Selects the normal height characters.	 Normal height characters	3-11
Top Margin	E_C & l (Lower case L) Top margin length 0.4 to 250 milimetres T	Sets the distance, in millimetres, from the form perforations to the top of the first line of text.	13mm top margin	3-13
Text Length In Millimetres In Lines	 E_C & l (Lower case L) Text length in millimetres 1 thru 300 G E_C & l (Lower case L) Number of Lines 1 thru 127 F	 Specifies the distance between the top and bottom margins in millimetres. Specifies the number of lines of text between the top and bottom margins.	 256mm text length 66 lines	3-14

Character Position	E C & a Character Position 0 thru 79 C	Sets the printer to the specified character position.	The printer begins at the left margin	3-16
Tab Control Set a Tab	E C 1	Sets the current character position as a horizontal tab location.		3-16
Clear a Tab	E C 2	Clears a horizontal tab at the present character position.		
Clear all Tabs	E C 3	Clears all horizontal tab locations currently set on printer.	All tabs are cleared	
Secondary Character Set Designation	E C) character set designator	Designates the printer's secondary character set using the following character set designators: Danish / Norwegian Set 0D European Extended Set 0E French Set 0F German Set 0G Katakana Extended Set 1K Spanish Set 1S Swedish / Finnish Set 0S United Kingdom 1E US ASCII 0U	European Extended Set selected	3-18
Print Highlighting Auto-Underline Auto-Overline Both Underline and Overline Neither Underline or Overline	E C & d D E C & d P E C & d T E C & d @	Selects the various combinations of the auto-underline or auto-overline character highlights	Neither Auto-underline or auto-overline are selected	3-22
New Character Generation	E C & n Decimal value of character replaced c Sequence that defines the Pattern	Defines a new character and assigns it to replace the character that is specified by its decimal value.	All characters are cleared	3-23
Clearing a Redefined Character	E C & n Decimal value of character C	Clears the specified character (that is refered to by its decimal value) of any previous redefinition it may have had.		3-27
Graphics Mode	E C * b Number of bytes to be interpreted as graphic data 1 thru 70. W	Prepares the printer to receive the specified number of bytes as binary equivalent graphic data.	Graphics Mode is not set.	3-28

General Form Control Codes

Carriage Return (C R) prints the line of characters currently stored in the printer's buffer and resets the print position to the left margin. This does not advance the paper after the line is printed.

Linefeed (L F) prints the line of characters currently stored in the printer's buffer. This advances the paper to the next line but the printer remains set at the current character position.

Formfeed (F F) advances the paper to the top margin line of the next form after printing any characters contained in the buffer.

Example:

These strings of data characters are received by the printer.

```
oOOOOoOC R
I I |+=| -C R L F
HP 9876A L F Printer C R L F
```

This is the resulting printout:

```
oOOOOoO
I I |+=| -
HP 9876A
        Printer
```

The first line, oOOOOoO, is printed and the printer is reset to the first print position at the left margin due to the cariage return (C R). The paper, however, is rolled back down into the printer after the characters are printed since a linefeed was not included in the string.

The second line I I |+=| -, is printed over the first line resulting in the characters shown in the printout. The print position is reset to the left margin due to the carriage return (C R) and the paper is advanced to the next line due to the linefeed (L F).

The third string is printed with "HP 9876A" on one line, then the paper is advanced to the next line but the character print position is not changed since a cariage return was not included after the first portion of the string. The last portion of the string, "Printer", is printed on the next line and then the character print position is reset to the left margin and the paper advanced to the next line due to the cariage return (C R) and linefeed (L F) characters at the end of the string.

Backspace (B S) prints the contents of the printer's buffer (without performing a carriage return or linefeed operation) and then repositions the printer by one character position towards the left margin. This allows you to overstrike characters. Backspace is also useful to underline individual characters instead of using the auto-underline code. If the printer is at the left margin when a backspace is received, the B S will be ignored.

Horizontal Tab (H T) sets the printer to the next preset tab position that is to the right of the current character position. If there is not a preset tab position, a carriage return (C R) and linefeed (L F) are performed. The escape sequence instructions that are used to set and clear tab positions are described on page 3-16.

Shift Out (S O) selects the character set that is currently designated as the secondary character set for printing operations (if the printer is set to receive 7 bit code). Refer to the installation note that was shipped with the printer for the switch setting that selects 7 or 8 bit ASCII code. This control character is ignored by the printer if the printer is set to receive 8 bit code.

Shift In (S I) selects the US ASCII primary character set if the printer is set to receive 7 bit code. Refer to the installation note that was shipped with the printer for the switch setting that selects 7 or 8 bit ASCII code. This control character is ignored by the printer if the printer is set to receive 8 bit code.

The escape sequence instruction that is used to designate the character set that will be the secondary set is explained on page 3-18.

Escape Sequence Instructions

The control codes described in this section are all preceded by the escape character (E C). The escape character instructs the printer to accept the character sequence following it as an instruction code. Without this character, the instruction code characters are interpreted as data and are printed.

The following printer functions are specified by escape character sequences:

- Resetting the Printer
- Initiating the Confidence Test
- Printing Control Codes
- Vertical Line Spacing
- Top Margin Control
- Text Length
- Character Position Control
- Tab Control
- Character Set Selection
- Character Height
- Print Highlighting
- Character Generation and Replacement
- Graphic Data Mode

Resetting the Printer

E C E

This escape sequence prints the current contents of the buffer and then resets the printer to the following power-on default conditions.

- Vertical Line Spacing is 12 dot rows between character base lines which produces 6.5 lines/inch (2.5 lines/cm).
- The character height is set to normal height characters.
- The top margin is 13 millimetres (3 character lines) below the form perforation to the top of the first line of text.
- The text length is set to 256 millimetres from the top margin.
- All horizontal tabs are cleared.
- The Primary character set is selected for printing operations.
- The Secondary Character Set is designated as the European Extended Set.
- Both the auto-underline and the auto-overline highlightings are set "off".
- All new characters that have been generated are cleared.
- The control code display mode is not set.
- The Graphic Data mode is disabled.

This escape sequence will not reset the printer if it is in the Display Control Codes mode.

The Confidence Test Instruction

E C z

The printer's confidence test routine is initiated whenever the E C z escape sequence is received. This is the same test that is described in Chapter 2.

When this sequence is received, the current contents of the data buffer are printed and then the Confidence Test is performed. When the test is complete, the printer is reset to its power-on conditions.

Display Control Codes Mode

$E_C Y$

When the printer receives the Display Control Codes escape sequence, it is set to a mode in which it prints all control codes except carriage return (C_R) as data instead of executing them as instructions. Carriage return is printed "CR" and then a carriage return and linefeed are executed.

This mode is very useful when developing or editing programs that send instruction codes to the printer.

The printer cancels the Display Control Codes Mode when it receives the following escape sequence:

$E_C Z$

Since the printer does not execute any control characters or escape sequences during the Display Control Codes Mode, it is set to the same conditions when the mode is canceled as it was when the mode was set.

For example, the following strings of characters result in the following printout.

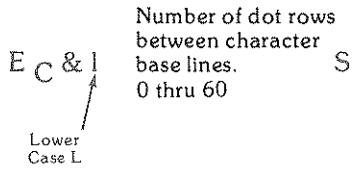
E_C & d D E_C & k 1 S 9876A Printer C_R L_F

E_C Y H_T F_F E_C1 E_C2 E_C3 E_C & d H 9876A Printer C_R L_F

E_C Z C_R L_F 9876A Printer C_R L_F

```
9876A Printer
␉␌␛1␛2␛3␛&dH9876A Printer␍
␛Z␍
9876A Printer
```

Vertical Line Spacing



The vertical line spacing escape sequence specifies the number of vertical dot rows that extend from one character's base line to the base line of the character directly below. You can specify from 0 thru 60 dot rows. Specifying fewer than 7 dot rows when normal character height is set (or fewer than 10 dot rows when expanded character height is set) will result in one line printing over a portion of the previous line. Thus, you should subtract either 7 (normal character height) or 10 (expanded character height) from the number of dot rows specified for vertical line spacing to actually determine the number of dot rows that will appear between printed lines. Two additional rows are needed to print characters that extend above the basic character matrix such as character with a circumflex or the vertical bar character as well as auto-overlining. Two more dot rows are needed to print characters that extend below the base line (such as lower case characters y,g,j, etc.) as well as one more row for underlining. The following figure shows the spacing between both normal and expanded characters. The spacing between the first and second lines is 12 dot rows/line (default) while the spacing between the second and third lines is set to 16 dot rows/line by the escape sequence, E C & l 16 S.

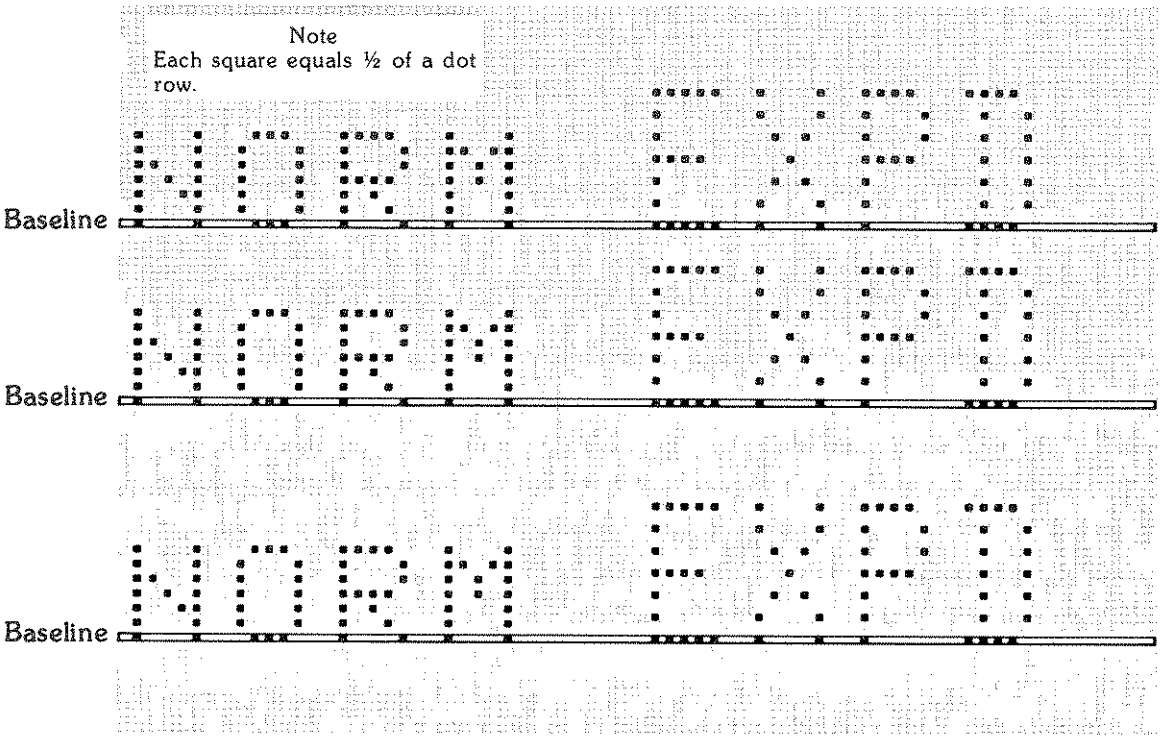


Figure 3-2: Line Spacing for Normal and Expanded Characters

The printer sets the vertical line spacing to 12 dot rows per line when it is first switched on or reset. When a new line spacing is set, it remains set until it is either changed or the printer is reset.

The number of dot rows specified can range from 0 thru 60. If 0 rows per line is specified, the printer prints each line on top of the last and does not advance the paper. The center of each dot row measures 0.33mm (1/77 inches) from the center of the next dot row.

For example, if these strings of characters are received by the printer:

1. 9876A Printer $C_R L_F$ 9876A Printer $C_R L_F$
2. E_C & l5S 9876A Printer $C_R L_F$ 9876A Printer $C_R L_F$
3. E_C & l24S 9876A Printer $C_R L_F$ 9876A Printer $C_R L_F$
4. E_C & l12 S 9876A Printer $C_R L_F$ 9876A Printer $C_R L_F$

This is the resulting printout:

```
9876A Printer
9876A Printer
9876A Printer
9876A Printer

9876A Printer

9876A Printer
9876A Printer
```

The first string is printed with the default line spacing of 12 dot rows/line. The second string is printed with 5 dot rows/line. This causes the lines to over print each other since a minimum of 7 dot rows/line is needed to completely print normal size characters.

The third string specifies 24 dot rows/line and then prints the characters. This is the equivalent of skipping every other line with default (12 rows/line) line spacing. Notice that the first printing with this spacing still overlaps the previous line that had 5 dot rows/line spacing. This happens because vertical spacing rows begin at the top of the character matrix and are added downward. Thus the spacing between two lines is determined by the top line's vertical spacing.

The fourth string specifies the default line spacing of 12 dot rows/line and then prints the two lines of characters.

Changing the Character Height

E_C&k1S

The above escape sequence selects the Expanded character height. Expanded characters are 50% times taller than normal characters. The width of both expanded and normal characters is the same.

The escape sequence shown below selects the normal character height. This height is set when the printer is first switched on or reset.

E_C&k0S

The following figure shows the expanded and normal character heights. Notice that expanded height characters have the same dot pattern as normal characters except that the vertical space between dot rows is expanded by 50%. The horizontal dot spacing, however, is unchanged. Also, note that expanded characters have only two rows of descenders where normal characters have three descender rows. This causes the auto-underline to print over the bottom dot of characters that extend to the second descender row such as y or vertical bar.

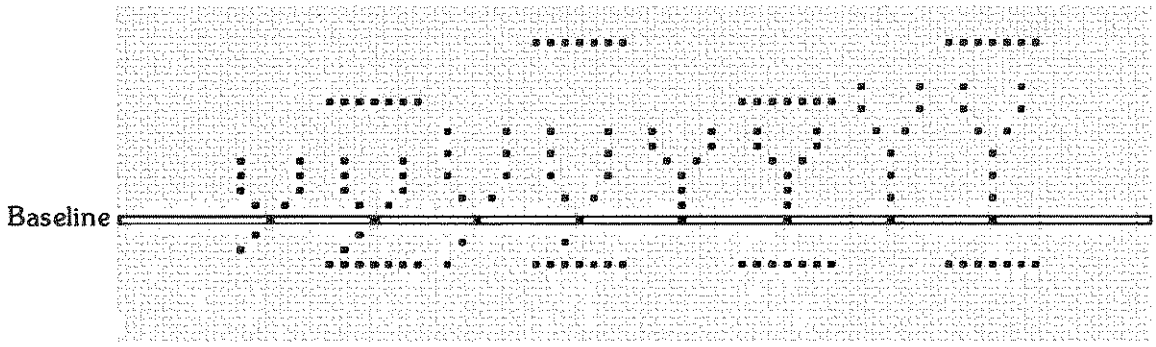


Figure 3-3: Normal and Expanded Height Characters

The next figure shows what happens when several lines of expanded characters are printed with default line spacing. Characters that do not extend into either the ascender or descender area do not overlap each other. Characters that extend into the ascender and descender area, however, will overlap each other with the 12 rows/line default line spacing.

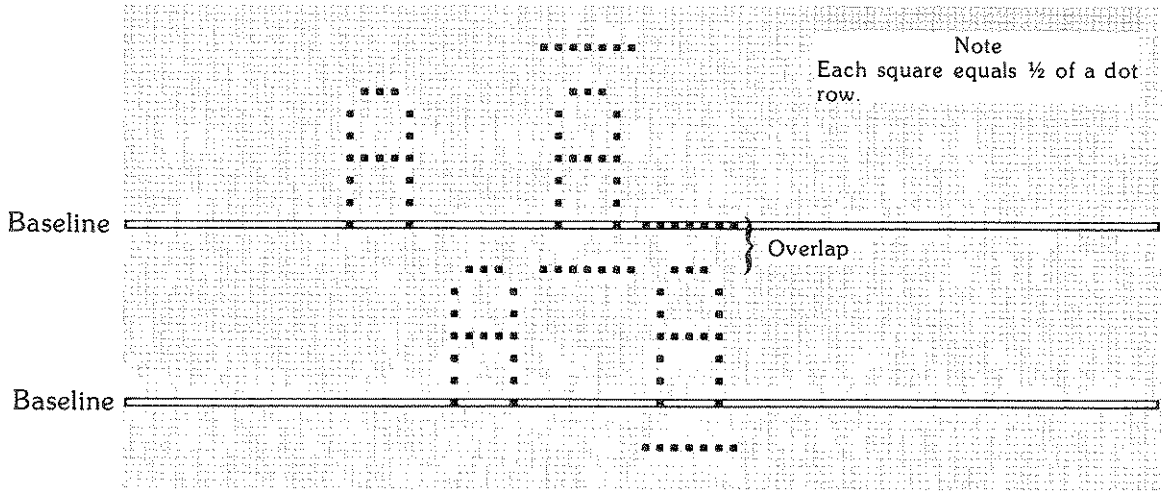


Figure 3-4: Expanded Height Character Overlap

This overlapping can be eliminated by changing the vertical line spacing to 16 dot rows/line for printing applications that use both ascender and descender areas with expanded height characters.

The following figure shows the previous figure's expanded characters printed after changing the vertical line spacing to 16 dot rows/line with the escape sequence, E $_C$& l 16 S.

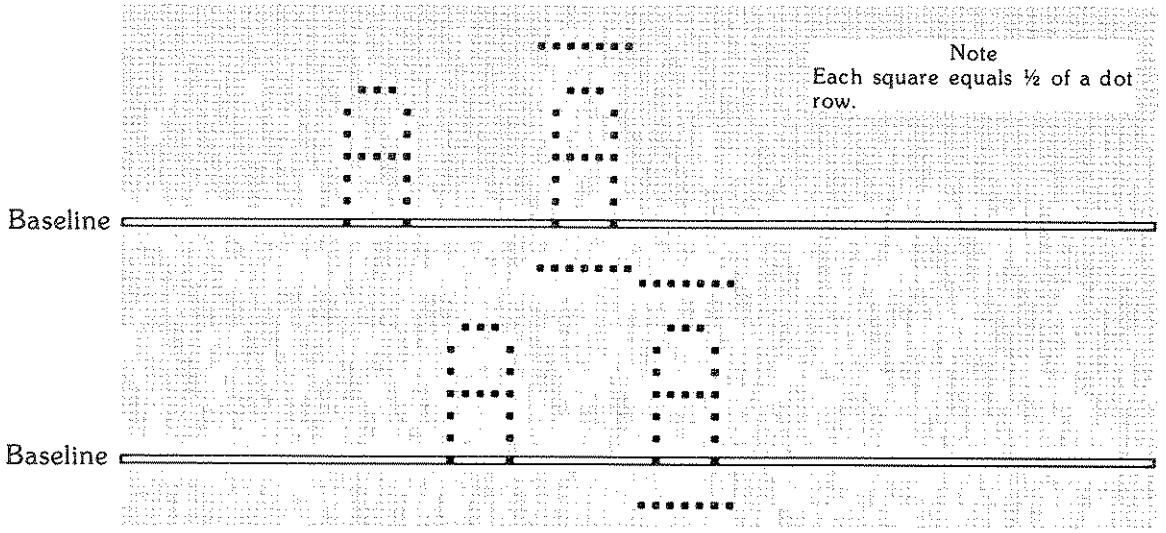
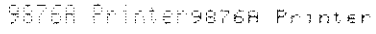


Figure 3-5: Expanded Printing with Extra Vertical Line Spacing

Once the expanded character height has been selected, it remains selected until either the normal height is specified or the printer is reset. You can set the expanded and normal heights at any point and any number of times in a line of characters.

For example, this string of characters sets the expanded character height, prints the words "9876A Printer", resets the Normal character height and prints "9876A Printer" again.

E C & k 1 S 9876A Printer E C & k 0 S 9876A Printer C R L F



Top Margin Control

E C & l Top margin length 0,4 to 250 millimetres T
(Lower case L)

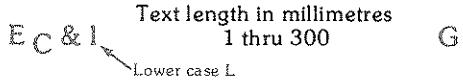
This escape sequence specifies the top margin distance, in millimeters, from the form perforations to the top of the first line of text. The printer advances the paper to this top margin line whenever it receives a formfeed (F F) character or receives characters to print that would exceed the currently set text length.

The printer sets a default top margin length of 13mm whenever it is first switched on or reset.

The top margin length can range form 4 thru 250 millimetres. The accuracy of the top margin length is ±2mm for lengths ranging from 4 thru 100mm. For lengths ranging from 101 thru 250mm the accuracy is ±4mm.

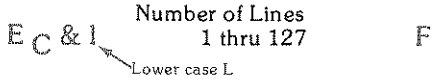
Specifying a top margin length of 0 causes the printer to ignore the form perforations. This setting must be used for any graphics applications that print continuously over several pages.

Text Length Control



The escape sequence above specifies the length in millimetres of the printable text area below the top margin line.

The text length can also be specified as the number of lines to be printed from the top margin. This is done using the escape code sequence show below.



The values used to set the text length can range from 1 thru 300 millimetres or 1 thru 127 lines. If you specify a text length that is larger than the physical text area available on the page (page length – top margin), the printer will print on the available text area and then advance to the top margin line of the next form.

NOTE

The maximum number of lines of text length that can be physically printed is affected by the currently specified vertical line spacing. The greater the line spacing, the fewer the number of lines that can be printed on a page.

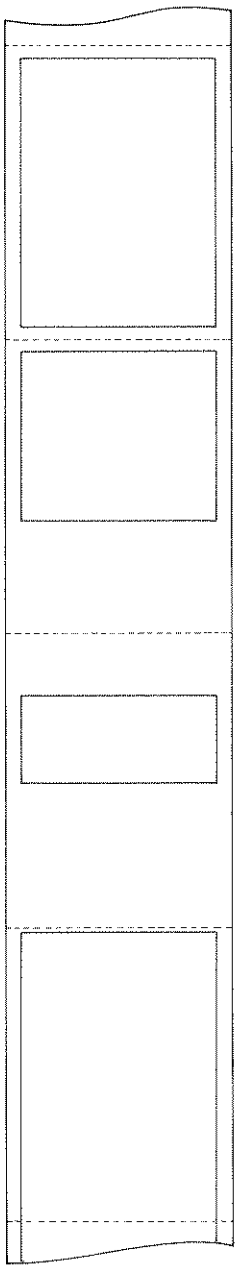
Text length specified in millimetres, however, is not affected by vertical line spacing since this form does not depend upon a line count to define the text area.

Whenever either the specified text length, the number of lines or the bottom perforation of the form (assuming a top margin other than 0) passes the print head, the paper is advanced to the top margin line of the next form.

When the printer is first switched on or reset, it sets a text length of 256 millimetres which is approximately 66 lines per page (assuming default line spacing). This establishes a bottom margin of 11 millimetres for 8½ by 11 inch paper or 29 millimetres for 210 by 297 millimetre paper.

The bottom margin area that is left on each page is the length of the paper being used minus the top margin width and the text length. Thus 8½x11 inch paper with a 13mm top margin (default) and a 230mm text length will have a 37mm (1.46 inch) bottom margin.

For example, the following figure shows four forms that have been printed and the escape sequences that selected the various top margins and text lengths are shown.



Default Conditions
Top Margin of 13mm
Text length of 256mm

E C &l 160 G
(Form feed automatically occurs after text length of 160mm is exceeded.

E C &l 56 T
(Top margin of 56mm)
E C &l 20 F
(Form feed automatically occurs after 20 lines of text are printed.)

E C &l 0T
E C &l 300G
(Ignors paper perforations)

Figure 3-6: Example Top Margins and Text Lengths

Character Position Instruction

E_C & a (Character Position: 0 thru 79) C

The character position escape sequence (above) can be used to set the printer to a specific character position. The character position value corresponds to a position referenced from the left margin of the form. Thus the value 0 corresponds to the first character position on the left end of the paper and 79 corresponds to the last character position on the right.

If you specify a character position that is to the left of the current character position (e.g. specifying position 15 when the current character position is 60), any data that is in the buffer between the specified position and the current position will be lost.

This instruction is useful when you need to set the printer to specific character positions for operations such as setting or clearing horizontal tabs or setting a print position.

REMEMBER

This instruction begins counting character positions at the left margin with 0.

Tab Control

E_C 1– Sets a horizontal tab at the current character position.
E_C 2– Clears the horizontal tab from the current character position.
E_C 3– Clears all horizontal tabs set on the printer.

The escape sequences shown above are used to set and clear horizontal tab locations on the printer.

E_C 1 sets the current character position as a horizontal tab location. The printer can be set to a character position by a using character position instruction.

E_C 2 clears the current character position as a tab location if one is set. The printer is typically set to a character position to clear a tab set at that position by sending an H_T character or characters to the printer.

E_C 3 clears all horizontal tab locations currently set on the printer.

All tab locations are cleared whenever the printer is first switched on or reset.

For example, the following strings of characters will produce the print out shown:

```
   1          2      3          4
E C &a10C E C 1 E C &a60C E C 1
   5          6
E C &a40C E C 1 C R

 1          2          3
H T 9876A H T 9876A H T 9876A C R L F
E C 3
```

Resulting Printout

```
9876A                    9876A                    9876A
```

The first escape sequence sets the printer to the 10th character position and the second escape sequence sets a tab position at that location. The third escape sequence sets the printer to the 60th character position and the fourth sequence sets a tab position at that location. The fifth and sixth escape sequences set a tab position at character column 40. The C_R character resets the printer to character position 0.

The series of characters that follow position the printer first at the tab position set at character position 10 and print "9876A". Next, the second H_T character sets the printer to the tab at character position 40 and "9876A" is printed. The third H_T character sets the printer to character position 60 and "9876A" is printed again. The C_R and L_F characters set the printer back to character position 0 and advance the paper one line. The final escape sequence clears all of the tab positions that have been set.

Character Set Designation

The US ASCII character set is always designated as the Primary set and the European Extended character set is designated as the default secondary set whenever the printer is first switched on or reset.

Any of the nine character sets in the printer can be designated as the secondary character set by using the escape sequence shown next.

E (C) character set designator

This escape sequence is used to designate the character set that you want for the secondary set. The character set designator values are listed in the table below with the character set that each designates.

Character Set Designated	Character Set Designator
Danish / Norwegian Set	0D
European Extended Set	0E
French Set	0F
German Set	0G
Katakana Set	1K
Spanish Set	1S
Swedish / Finnish Set	0S
United Kingdom	1E
US ASCII	0U

The default secondary character set can be changed to be any of the character sets. However, this procedue requires internal modifications of one of the printer's assemblies and should be done only by qualified service personel. Contact your local Sales and Service Office for assistance.

NOTE

The Character Set Designator instructions only designate the character set that will be the secondary set. The Shift In (S_I) or Shift Out (S_O) characters (7 bit ASCII Mode) or the 8th bit of the ASCII character code (8 bit ASCII Mode) are used to select either the primary or secondary character set for printing.

The following pages contain listings of the seven complete character sets and the two extension sets. Each of the sets below is shown with the 7 bit decimal value of its characters. If you are using the 8 bit ASCII mode, add 128 to each decimal value shown to obtain the 8 bit decimal value.

			U.S. ASCII	Danish-Norwegian	French	German	Spanish	Swedish-Finnish	United Kingdom		U.S. ASCII	Danish-Norwegian	French	German	Spanish	Swedish-Finnish	United Kingdom
0	^@	32								64	@	@	à	@	@	@	@	96	`	`	`	`	`	é	`
1	^A	33	!	!	!	!	!	!	!	65	A	A	A	A	A	A	A	97	a	a	a	a	a	a	a
2	^B	34	"	"	"	"	"	"	"	66	B	B	B	B	B	B	B	98	b	b	b	b	b	b	b
3	^C	35	#	#	#	#	#	#	£	67	C	C	C	C	C	C	C	99	c	c	c	c	c	c	c
4	^D	36	$	$	$	$	$	¤	$	68	D	D	D	D	D	D	D	100	d	d	d	d	d	d	d
5	^E	37	%	%	%	%	%	%	%	69	E	E	E	E	E	E	E	101	e	e	e	e	e	e	e
6	^F	38	&	&	&	&	&	&	&	70	F	F	F	F	F	F	F	102	f	f	f	f	f	f	f
7	^G	39	'	'	'	'	'	'	'	71	G	G	G	G	G	G	G	103	g	g	g	g	g	g	g
8	^H	40	(	(	(	(	(	(	(	72	H	H	H	H	H	H	H	104	h	h	h	h	h	h	h
9	^I	41	)	)	)	)	)	)	)	73	I	I	I	I	I	I	I	105	i	i	i	i	i	i	i
10	^J	42	*	*	*	*	*	*	*	74	J	J	J	J	J	J	J	106	j	j	j	j	j	j	j
11	^K	43	+	+	+	+	+	+	+	75	K	K	K	K	K	K	K	107	k	k	k	k	k	k	k
12	^L	44	,	,	,	,	,	,	,	76	L	L	L	L	L	L	L	108	l	l	l	l	l	l	l
13	^M	45	-	-	-	-	-	-	-	77	M	M	M	M	M	M	M	109	m	m	m	m	m	m	m
14	^N	46	.	.	.	.	.	.	.	78	N	N	N	N	N	N	N	110	n	n	n	n	n	n	n
15	^O	47	/	/	/	/	/	/	/	79	O	O	O	O	O	O	O	111	o	o	o	o	o	o	o
16	^P	48	0	0	0	0	0	0	0	80	P	P	P	P	P	P	P	112	p	p	p	p	p	p	p
17	^Q	49	1	1	1	1	1	1	1	81	Q	Q	Q	Q	Q	Q	Q	113	q	q	q	q	q	q	q
18	^R	50	2	2	2	2	2	2	2	82	R	R	R	R	R	R	R	114	r	r	r	r	r	r	r
19	^S	51	3	3	3	3	3	3	3	83	S	S	S	S	S	S	S	115	s	s	s	s	s	s	s
20	^T	52	4	4	4	4	4	4	4	84	T	T	T	T	T	T	T	116	t	t	t	t	t	t	t
21	^U	53	5	5	5	5	5	5	5	85	U	U	U	U	U	U	U	117	u	u	u	u	u	u	u
22	^V	54	6	6	6	6	6	6	6	86	V	V	V	V	V	V	V	118	v	v	v	v	v	v	v
23	^W	55	7	7	7	7	7	7	7	87	W	W	W	W	W	W	W	119	w	w	w	w	w	w	w
24	^X	56	8	8	8	8	8	8	8	88	X	X	X	X	X	X	X	120	x	x	x	x	x	x	x
25	^Y	57	9	9	9	9	9	9	9	89	Y	Y	Y	Y	Y	Y	Y	121	y	y	y	y	y	y	y
26	^Z	58	:	:	:	:	:	:	:	90	Z	Z	Z	Z	Z	Z	Z	122	z	z	z	z	z	z	z
27	^[	59	;	;	;	;	;	;	;	91	[	Æ	°	Ä	¡	Ä	[	123	{	æ	é	ä	¿	ä	{
28	^\	60	<	<	<	<	<	<	<	92	\	Ø	ç	Ö	Ñ	Ö	\	124	|	ø	ù	ö	ñ	ö	|
29	^]	61	=	=	=	=	=	=	=	93	]	Å	§	Ü	¿	Å	]	125	}	å	è	ü	}	à	}
30	^^	62	>	>	>	>	>	>	>	94	^	^	^	^	°	Ü	^	126	~	~	¨	ß	~	ü	~
31	^_	63	?	?	?	?	?	?	?	95	_	_	_	_	_	_	_	127	▒	▒	▒	▒	▒	▒	▒

The European Extension character set (shown below) contains all of the characters that are in the seven European character sets shown on page 3-19, as well as some additional characters. This character set was designed to function with the 8-bit character set coding used by the HP Desktop Computers. Thus, HP Desktop Computers with language option keyboards (except the Katakana Option) will function with the 9876A since the European Extension set is the default secondary character set.

9876A EUROPEAN EXTENSION CHARACTER SET

(with U.S. ASCII)

0		32		64	@	96	`	128	Ω	160		192	À
1		33	!	65	A	97	a	129	Ω	161	À	193	É
2		34	"	66	B	98	b	130	Ω	162	Í	194	Ô
3		35	#	67	C	99	c	131	Ω	163	Ô	195	Ù
4		36	$	68	D	100	d	132	♭	164	Ù	196	à
5		37	%	69	E	101	e	133	♭	165	Ã	197	é
6		38	&	70	F	102	f	134	♭	166	É	198	ó
7		39	'	71	G	103	g	135	♭	167	Ó	199	ú
8		40	(	72	H	104	h	136	Ω	168	´	200	à
9		41	)	73	I	105	i	137	Ω	169	`	201	è
10		42	*	74	J	106	j	138	Ω	170	^	202	ò
11		43	+	75	K	107	k	139	Ω	171	¨	203	ù
12		44	,	76	L	108	l	140	♭	172	~	204	ä
13		45	-	77	M	109	m	141	♭	173	Ë	205	ë
14		46	.	78	N	110	n	142	♭	174	Ø	206	ö
15		47	/	79	O	111	o	143	♭	175	£	207	ü
16		48	0	80	P	112	p	144	Ω	176	¯	208	Å
17		49	1	81	Q	113	q	145	Ω	177	Ã	209	î
18		50	2	82	R	114	r	146	Ω	178	ã	210	Ø
19		51	3	83	S	115	s	147	Ω	179	°	211	Æ
20		52	4	84	T	116	t	148	♭	180	Ç	212	à
21		53	5	85	U	117	u	149	♭	181	ç	213	í
22		54	6	86	V	118	v	150	♭	182	Ñ	214	ø
23		55	7	87	W	119	w	151	♭	183	ñ	215	æ
24		56	8	88	X	120	x	152	Ω	184	¡	216	Ä
25		57	9	89	Y	121	y	153	Ω	185	¿	217	ì
26		58	:	90	Z	122	z	154	Ω	186	¤	218	Ö
27		59	;	91	[	123	{	155	Ω	187	£	219	Ü
28		60	<	92	\	124	|	156	♭	188	¤	220	É
29		61	=	93	]	125	}	157	♭	189	§	221	ï
30		62	>	94	^	126	~	158	♭	190	Ω	222	ß
31		63	?	95	_	127	※	159	♭	191	♭	223	

NOTE

The Ω and ♭ characters are special control characters that correspond to the keyboard selectable auto-underline function used with the System 35 and 45 CRT display. The ♭ character selects auto-underline and the Ω character cancels auto-underline.

The Katakana Extension character set (shown below) is the 8 bit version that adds the Katakana characters to U.S. ASCII. This version is designed to function with HP Desktop Computers that have an optional Katakana keyboard.

9876A KATAKANA EXTENSION CHARACTER SET

(with U.S. ASCII)

0		32		64	@	96	`	128	Ω	160		192	タ
1		33	!	65	A	97	a	129	Ω	161	。	193	チ
2		34	"	66	B	98	b	130	Ω	162	「	194	ツ
3		35	#	67	C	99	c	131	Ω	163	」	195	テ
4		36	$	68	D	100	d	132	ｬ	164	、	196	ト
5		37	%	69	E	101	e	133	ｭ	165	・	197	ナ
6		38	&	70	F	102	f	134	ｮ	166	ヲ	198	ニ
7		39	'	71	G	103	g	135	ｯ	167	ァ	199	ヌ
8		40	(	72	H	104	h	136	Ω	168	ィ	200	ネ
9		41	)	73	I	105	i	137	Ω	169	ゥ	201	ノ
10		42	*	74	J	106	j	138	Ω	170	ェ	202	ハ
11		43	+	75	K	107	k	139	Ω	171	ォ	203	ヒ
12		44	,	76	L	108	l	140	ｬ	172	ャ	204	フ
13		45	-	77	M	109	m	141	ｭ	173	ュ	205	ヘ
14		46	.	78	N	110	n	142	ｮ	174	ョ	206	ホ
15		47	/	79	O	111	o	143	ｯ	175	ッ	207	マ
16		48	0	80	P	112	p	144	Ω	176	ー	208	ミ
17		49	1	81	Q	113	q	145	Ω	177	ア	209	ム
18		50	2	82	R	114	r	146	Ω	178	イ	210	メ
19		51	3	83	S	115	s	147	Ω	179	ウ	211	モ
20		52	4	84	T	116	t	148	ｬ	180	エ	212	ヤ
21		53	5	85	U	117	u	149	ｭ	181	オ	213	ユ
22		54	6	86	V	118	v	150	ｮ	182	カ	214	ヨ
23		55	7	87	W	119	w	151	ｯ	183	キ	215	ラ
24		56	8	88	X	120	x	152	Ω	184	ク	216	リ
25		57	9	89	Y	121	y	153	Ω	185	ケ	217	ル
26		58	:	90	Z	122	z	154	Ω	186	コ	218	レ
27		59	;	91	[	123	{	155	Ω	187	サ	219	ロ
28		60	<	92	¥	124	|	156	ｬ	188	シ	220	ワ
29		61	=	93	]	125	}	157	ｭ	189	ス	221	ン
30		62	>	94	^	126	~	158	ｮ	190	セ	222	゛
31		63	?	95	_	127	※	159	ｯ	191	ソ	223	゜

This character set can also be accessed with 7 bit code by using the shift-out character. The 7 bit version of Katakana is shown below. The control characters (0-31) are not shown since they are the same in all character sets.

32		40	ィ	48	-	56	ク	64	タ	72	ネ	80	ミ	88	リ
33	。	41	ゥ	49	ア	57	ケ	65	チ	73	ノ	81	ム	89	ル
34	「	42	ェ	50	イ	58	コ	66	ツ	74	ハ	82	メ	90	レ
35	」	43	ォ	51	ウ	59	サ	67	テ	75	ヒ	83	モ	91	ロ
36	、	44	ャ	52	エ	60	シ	68	ト	76	フ	84	ヤ	92	ワ
37	・	45	ュ	53	オ	61	ス	69	ナ	77	ヘ	85	ユ	93	ン
38	ヲ	46	ョ	54	カ	62	セ	70	ニ	78	ホ	86	ヨ	94	゛
39	ァ	47	ッ	55	キ	63	ソ	71	ヌ	79	マ	87	ラ	95	゜

Print Highlighting

The 9876A Printer can highlight characters by printing them with either auto-underlining, auto-overlining, both or neither. These highlights are selected by executing the following instruction code sequnce with the highlight character that selects the highlighting combination that you want.

Highlight
E C & d Character

The Highlight characters that select the combinations of auto-underline and auto-overline are shown in the table below. Only one of the characters shown for a particular highlighting function needs to be sent. The extra characters are available to provide compatibility with a wider variety of Graphic Terminals and controllers.

Highlights	Characters
Auto-underline Only	DorEorForGorLorMorNorO
Both auto-underline and auto-overline	TorUorVorWor\or]or^or—
Auto-overline Only	PorQorRorSorXorYorZor[
Neither auto-underline or Auto-overline	@orAorBorCorHorIorJorK

The printer selects neither the auto-underline or the auto-overline highlights when it is first switched on or reset.

The following figure shows the underline and overline highlights in the character matrix. The underline fills across the bottom descender row and the overline fills across the top ascender row. The underline will always line up across a line containing both normal and expanded character heights. The overline, however, will vary with the character height selected.

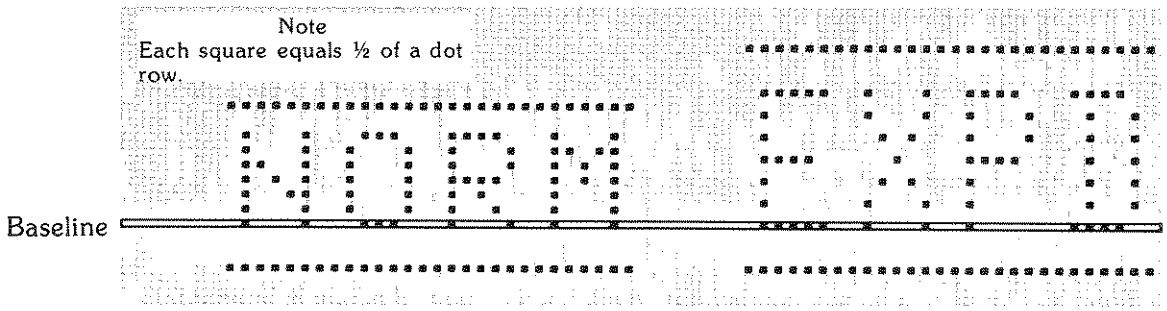


Figure 3-7: Underline and Overline Highlights

Any of the highlight instruction codes can be sent to the printer whenever needed in a string of characters to be printed. Once a highlight type has been selected, it remains selected until it is either changed by a new escape sequence code or the printer is switched off or reset.

Example:

These characters are received by the printer:

The 9876A Printer can E C & dD Underline characters, E C & d P Overline characters, E C & d T or do both.

This is the resulting printout.

New Character Generation

You can generate new character shapes or patterns to suit your application needs by using the New Character escape sequence. This allows you to replace a character from the primary or the secondary character sets with one of your own design. After an existing character has been replaced by a new character pattern, the new pattern will be printed whenever the printer receives the replaced character's ASCII code unless the replaced character was a control character (e.g., C_R, L_F, S_O, etc.). Control characters that are redefined will print their new pattern only in the print control codes mode.

E C & n	Decimal value of character replaced	c	Sequence of Decimal values that define the New Character's Pattern

As shown in the New Character escape sequence above, the character that the new character pattern will replace is specified as the decimal equivalent value of the character's ASCII code. This value can be found in the ASCII character tables in the Appendix.

NOTE

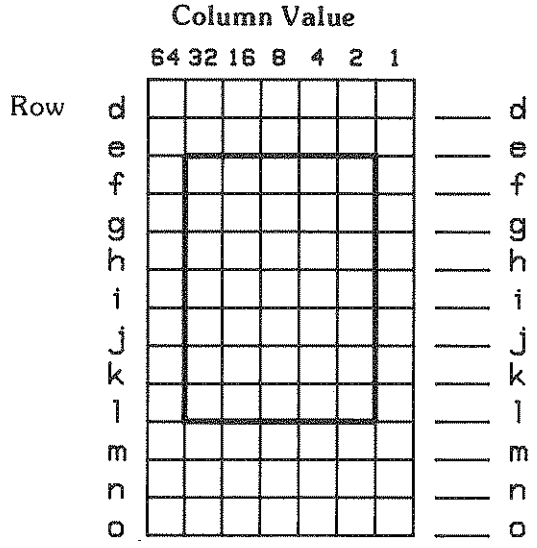
When the 8 bit ASCII mode is selected, a character from either the primary character set (decimal 1 thru 127) or the secondary character set (decimal 128 thru 255) may be replaced by a new character pattern.

In the 7 bit ASCII mode, however, specifying a character value between 1 thru 127 replaces that character in both the primary and the secondary character sets with the new character pattern.

The sequence of decimal values that define the dot pattern of the new character can be selected according to the following steps:

Step 1

Select the dot pattern that will create the new character' shape or pattern. This can be done by filling in a seven by twelve matrix (similiar to the one shown below) with the new character's pattern. Additional copies of this matrix form are provided in the Appendix for you to copy and use for designing new character patterns.



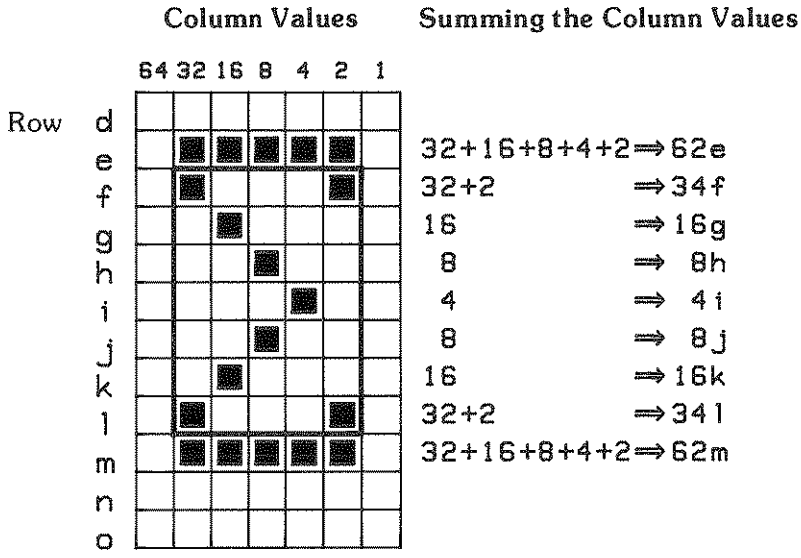
The 5x7 area outlined in the matrix, represents the area in which a normal sized character is printed. The new character, however may utilize the entire area shown.

Step 2

Once you have defined a new character pattern on the matrix, add the column values for the columns that contain dots across each row. Each summed value, followed by the character that designates the row position of the value, is used in the instruction code to define the new pattern. Only rows containing dots need to be specified since the printer assumes that any row not specified is blank.

The following example defines the dot pattern and the sum values for each row to replace the $ character (decimal value 36) with the summation symbol Σ.

The dot pattern is defined on the matrix and the columns containing dots are added across each row.



The escape sequence that would replace the $ character with the Σ character defind above is as follows:

E C & n 36c 62e 34f 16g 8h 4i 8j 16k 34 l 62M

Note that rows d,n and o were not specified since they do not contain any dots. Also note that the last row designator (M) in the escape sequence must be capitilized to terminate the instruction. Each value and corresponding row designator pair can be sent to the printer in any order. Thus, the following escape sequence results in the same redefination of $ with Σ as the previous code.

E C & n 62m 34l 16k 8j 4i 8h 16g 34f 62e 36C

Each new character pattern that is defined is stored in a memory area within the printer in the form of 12 bytes of data. The memory area can hold a maximum of 84 bytes. Thus a maximum of 7 new character patterns can be stored at one time.

A character may be cleared and returned to its original character definition by the character clear instruction code described on page 3-27.

The following table lists selected Greek characters and mathematic symbols with the instruction code that defines each one. Note that in each instruction code, the space that has been left before the c (---c) is where you put the decimal value of the character to be replaced.

Table of Character Redefinitions

Symbol		Escape Sequence
Summation Sigma	Σ	E_C &n---c 62e 34f 16g 8h 4i 8j 16k 34l 62M
Integral	∫	E_C &n---c 4e 10f 10g 8 h 8i 8j 8k 40l 40m 16N
Large Left Bracket	[	E_C &n---c 60e 32f 32g 32h 32i 32j 32k 32l 60M
Large Right Bracket	]	E_C &n---c 30e 2f 2g 2h 2i 2j 2k 2l 30M
Large Left Parenthesis	(	E_C &n---c 12e 16f 32g 32h 32i 32j 32k 16l 12M
Large Right Parenthesis	)	E_C &n---c 24e 4f 2g 2h 2i 2j 2k 4l 24M
Root Sign	√	E_C &n---c 7d 4e 4f 4g 4h 4i 100j 20k 12l 4M
Plus or Minus	±	E_C &n---c 8f 8g 62h 8i 8j 62L
Approximate	≈	E_C &n---c 51g 76h 51j 76K
Element	∈	E_C &n---c 30f 32g 64h 126i 64j 32k 30L

Symbol		Escape Sequence
Intersects	∩	E_C &n---c 28e 34f 65g 65h 65i 65j 65k 65l 65M
Union	∪	E_C &n---c 65e 65f 65g 65h 65i 65j 65k 34l 28M
Implies	⇒	E_C &n---c 8f 4g 126h 1i 126j 4k 8L
Gamma	ɣ	E_C &n---c 34i 82j 10k 4l 8m 16n 32O
Delta	δ	E_C &n---c 28e 18f 8g 28h 34i 34j 34k 28L
Theta	θ	E_C &n---c 28f 34g 34h 62i 34j 34k 28L
Mu	μ	E_C &n---c 34h 34i 34j 50k 46l 33m 32N
Pi	π	E_C &n---c 30h 52i 20j 20k 20L
Rho	ρ	E_C &n---c 28h 34i 34j 60k 32l 32m 32n 64O
Tau	τ	E_C &n---c 30h 40i 8j 8k 8L
Upislon	υ	E_C &n---c 34h 82i 18j 20k 8L
Chi	χ	E_C &n---c 16e 42f 12g 8h 8i 8j 20k 34L
Phi	Φ	E_C &n---c 28e 8f 28g 42h 42i 42j 28k 8l 28M
Psi	ψ	E_C &n---c 8f 8g 8h 107i 42j 42k 28l 2m 8N

Clearing a Redefined Character

E_C & n (Decimal value of the character being cleared) C

The escape sequence shown above clears a character of any redefination that it may have had. The character being returned to its original definition is specified as its decimal equivalent value. Refer to the character set tables in the Appendix for the decimal equivalent values of the characters in each character set.

All new character redefinitions are cleared when the printer is first switched on or reset.

Graphic Mode Instructions

The printer has a graphics mode that allows you to control each of the 560 dots that can be printed across the full width of the print head. This mode is set by the following escape sequence that is a subset of the Hewlett-Packard Raster Scan Standard.

E C * b	Number of bytes to be interpreted as graphic data 0 thru 70.	W	Specified number of 8-bit bytes of data that define the dots to be printed immediatly follow W.

The escape sequence sets the graphics mode and specifies the number of data bytes that are to be received as 8-bit graphic data. The 8-bit graphic data bytes then define which dots across a line are to be printed. These bytes are interpreted in binary form rather than ASCII code. The binary 1's specify that a dot is to be printed and a binary 0 specifies that a dot is not to be printed.

The printer receives graphic data bytes and interprets their binary form as the dots to be printed starting with the first byte's most significant bit at the printer's left-most dot position. Thus the first byte contains the dot pattern for the first 8 dots from the left edge of the print head. The second byte contains the dot pattern for the next 8 dots and so on across the print head until either the specified number of bytes have been received or the maximum number of bytes (70) have been received. If more than 70 bytes are specified and sent to the printer, the printer takes the first 70 bytes as the graphic data and then ignors those in excess of 70.

The order and significance of each byte of graphic data received by the printer is shown in the next figure.

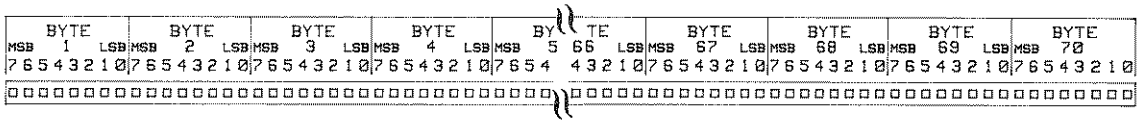


Figure 3-8: The Printer's Interpretation of Graphic Data

After the printer has received the number of bytes of graphic data that were specified by the graphic mode escape sequence, the row of dots defined by the graphic data bytes is printed. The printer does not require either carriage return or linefeed characters to print a row of graphic data. The C_R and L_F characters, if sent at the end of a string of graphic data bytes, will result in the printer advancing the paper a full line (1 line = 12 rows of dots). **Thus, it is important that the carriage return and linefeed characters that are typically sent with the data by most controllers, be eliminated.** Refer to your Controller's I/O Programming Manual for the parameters and statements used to send data to the printer with the C_R and L_F characters suppressed.

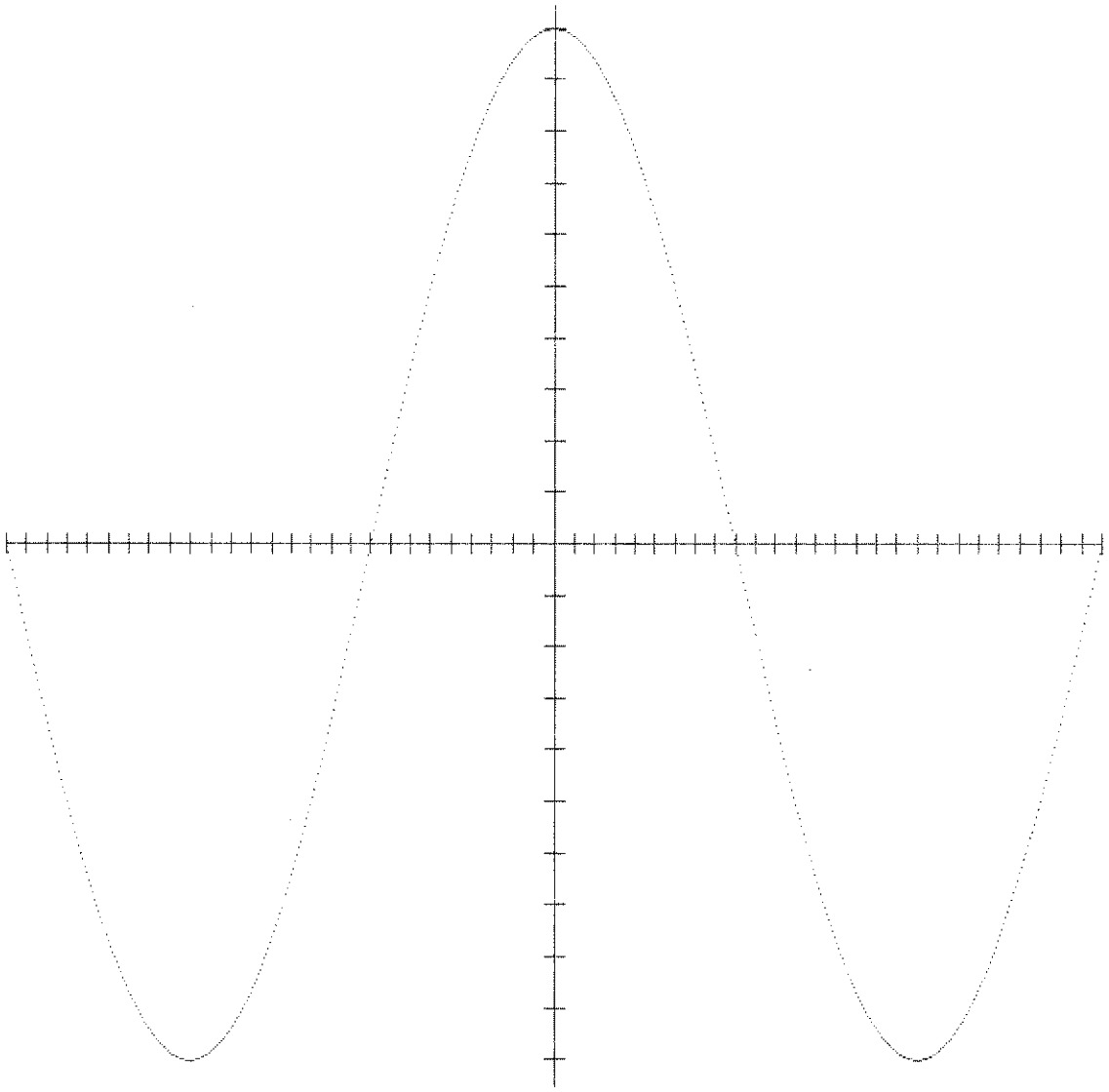
NOTE

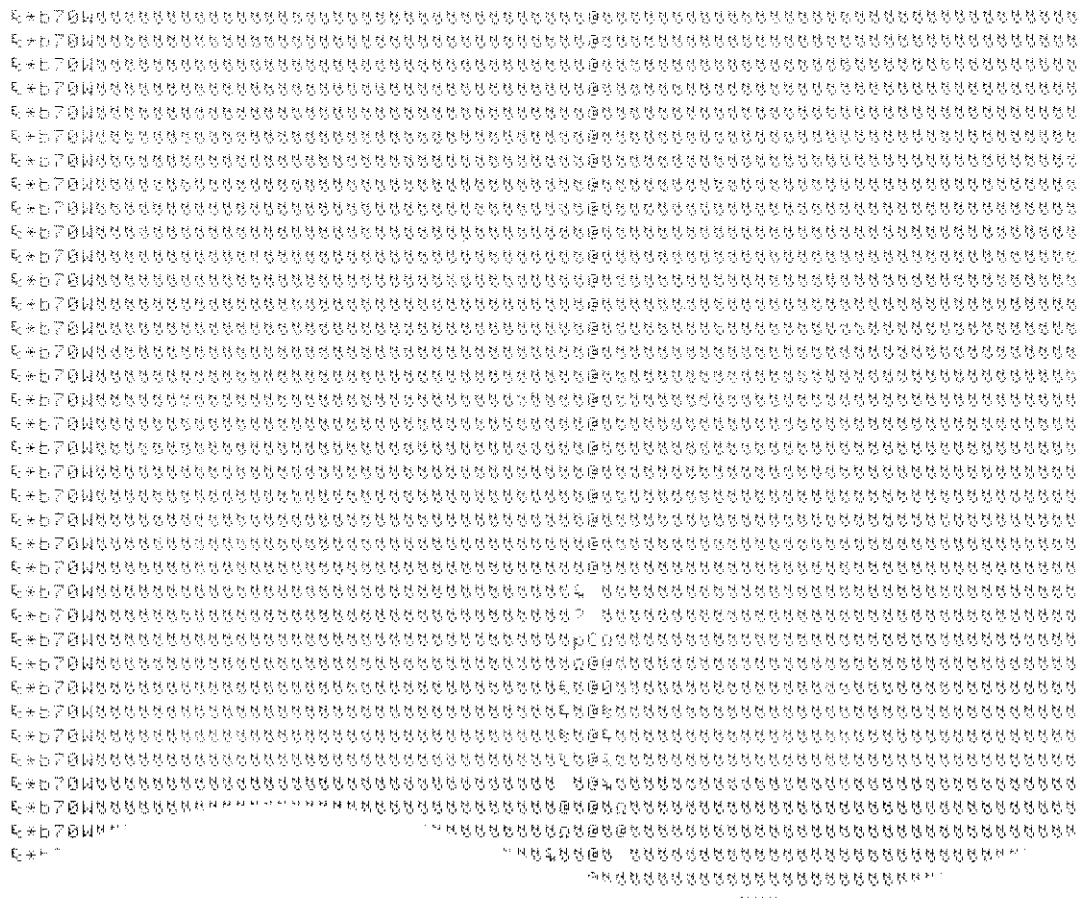
The printer must receive the specified number of graphic data bytes. If more bytes than were specified are received, the excess bytes are printed as data characters. If fewer bytes than were specified are received, the printer will interpret subsequent data characters as graphic data until the specified number of bytes have been received. Either case can cause a graphic printout that may be different from the intended result.

The following example shows the plot of a cosine function, with X and Y axes, that was printed using graphics mode escape sequences.

The full plot shown prints 440 dot rows of data which requires 440 escape sequences with their associated graphic data bytes. The printout shown next shows a portion of the escape sequences that print the cosine plot. This printout utilizes the printer's Display Control Codes (E_C Y) mode that causes the printer to print the escape sequences rather than to execute them. Only a portion of the 440 lines are shown here. The printout line that are shaded, print the dot rows that have been shaded in the plot printout.

Note that null characters (N_U) typically comprise a large portion of a graphic sequence since they represent most of the areas where dots are not to be printed. Only the bytes that contain dots that either plot the function or print the axes, contain bits that are 1's and are characters other than null (null has all bits that are 0's). These characters have been shaded in the escape sequence printout to help you see them and their relationship to the dots that were printed on the plot.





Since the printer, in the graphics mode, interprets the graphic data bytes as 8-bit binary rather than ASCII code, you will generally find that the most effective means of sending this data to the printer will be using some form of the binary output statement for your controller. Refer to your Controller's I/O Programming Manual for the specific statements and parameters that it uses to send 8-bit binary data to the printer.

NOTE

If your application must print graphic data over the form perforations (e.g., strip charts, multiple page plots or figures, etc.) you must set the top margin to 0 prior to sending the graphics dots to the printer. The escape sequence, E C &l0T, sets the top margin length to 0.

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CHAPTER 4

Interfacing

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Chapter 4
Interfacing

Introduction

This chapter describes the interfacing area of the printer. The HP-IB (standard) interface option is briefly discussed at the beginning of this chapter. Reference is made to other documents describing the technical parameters of this interface.

The bulk of this chapter describes interfacing the 8-bit parallel (Option 001) and RS-232-C (Option 002) versions of the printer. Line description with loading and timing requirements are presented. This is followed with a suggested driver and receiver circuit configuration used with the 8-bit parallel option. Serial I/O is explained last. Character cell configuration as well as interface protocols are explained.

The different printer options require different A1 assemblies. The standard printer (HP-IB) uses the 09876-66501 assembly; the Option 001 printer (8-bit parallel) uses the 09876-66506 assembly and the Option 002 printer (RS-232-C) uses the 09876-66507 assembly. These assemblies are interchangeable providing you have the proper filler plate for the rear dress panel.

HP-IB (Standard)

The HP-IB I/O utilizes a Motorola 68488 GP-IA chip to perform all of the implemented HP-IB control and handshake protocol. The data input/output lines and the bus management and control lines are driven by bidirectional transceivers (A1U4, U6, U7 and U8). See the A1 (09876-66501) Circuit Diagram. At power-on or whenever the printer is reset, the interface chip reads the Address Code and Listen Always switches (enabled by a low on the ASE line). This data is stored in the interface chip as either the printer's address code (if the Listen Always switch is set to 0) or as the Listen Always Mode (if the Listen Always switch is set to 1).

The printer implementes the following bus functions of the interface chip.

Table 4-1: Implemented Bus Functions

Message		Implemented
Source Handshake	(SH1)	Complete capability
Acceptor Handshake	(AH1)	Complete capability
Talker	(T6)	All capabilities except the Talk-Only Mode
Talker Extended	(TE0)	No capability
Listener	(L3)	Complete capability
Listener Extended	(LE0)	No capability
Service Request	(SR1)	Complete capability
Remote Local	(RL0)	No capability
Parallel Poll	(PP0)	No capability
Device Clear	(DC0)	No capability
Device Trigger	(DT0)	No capability
Controller	(C0)	No capability

See the MOTOROLA data sheet for the MC 68 488 GENERAL PURPOSE INTERFACE ADAPTER and the IEEE Standard 488-1975.

HP-IB Printer Control

Introduction

This chapter describes the capabilities of the 9876A HP-IB Printer that are in addition to the capabilities described in Chapter 3.

Overview of the HP-Interface Bus

The following is a definition of the terms and concepts used to described HP-IB (bus) system operations.

HP-IB System Terms

1. **Byte** – A unit of information consisting of 8 binary digits (bits).
2. **Device** – Any unit that is compatible with the IEEE Standard 488-1975.
3. **Device Dependent** – A response to information sent on the HP-IB that is characteristic of an individual device's design and may vary from device to device.
4. **Operator** – The person that operates either the system or any device in the system.
5. **Addressing** – The characters sent by a controlling device to specify which device will send information on the bus and which device(s) will receive that information.
6. **Polling** – The process typically used by a controller to locate a device that needs to interact with the controller. There are two types of polling:

- **Serial Poll** – This method obtains one byte of operational information about an individual device in the system. The process must be repeated for each device from which information is desired.
- **Parallel Poll** – This method obtains information about a group of devices simultaneously.

Interface Bus Concepts

Devices which communicate along the interface bus can be classified into three basic categories:

1. **Talkers** – Devices which **send** information on the bus when they have been addressed.
2. **Listeners** – Devices which **receive** information sent on the bus when they have been addressed.
3. **Controllers** – Device that can specify the talker and listeners for an information transfer. Controllers can be categorized as one of two types:

- **Active Controller** – The current controlling device on the bus.
- **System Controller** – The controller that can take priority control of the bus even if it is not the current active controller. Although each bus system can have only one system controller, the system can have any number of devices capable of being the active controller.

A typical HP-IB System is shown below.

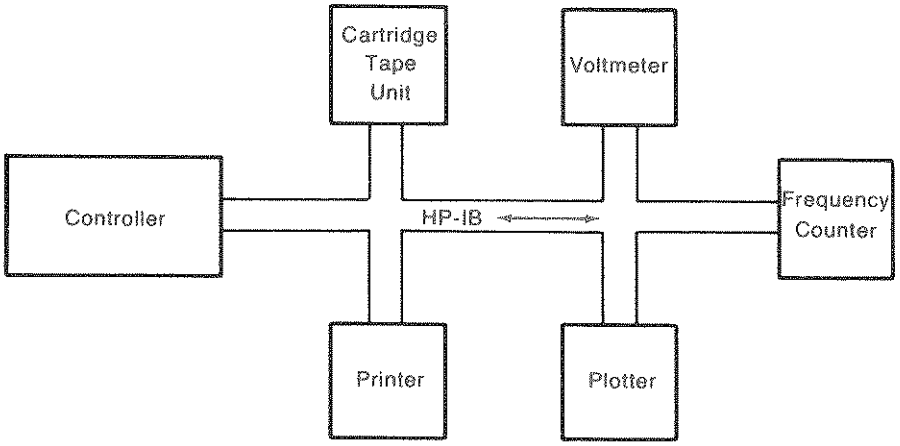


Figure 4-1: Typical HP-IB System

Message Concepts

Devices which communicate along the interface bus are transferring quantities of information. The transfer of information can be from one device to another device, or from one device to several devices. These quantities of information can easily be thought of as "messages". Typically, each message consists of two basic parts; the address specified by the controller and the information that comprises the message.

In turn, the message can be classified into twelve types. The twelve types of messages are defined as follows with the messages that pertain to the printer shown highlighted in color.

1. **The Data Message.** This is the actual information (binary bytes) which are sent from one talker to one or more listeners along the interface bus. Data can be either in numeric form, or it can be a string of characters.
2. **The Trigger Message.** This message causes the listening device(s) to perform a device-dependent action.
3. **The Clear Message.** This message causes either the listening device(s) or all of the devices on the bus to return to their predefined device-dependent states.
4. **The Remote Message.** This message causes listening devices to switch from local front-panel control to remote program control.
5. **The Local Message.** This message clears the Remote Message from the listening device(s) and returns the device(s) to local front-panel control.
6. **The Local Lockout Message.** This message prevents a device operator from manually inhibiting remote program control.
7. **The Clear Lockout and Set Local Message.** This message causes all devices on the bus to be removed from **Local Lockout** and revert to **Local**. This message also clears the **Remote Message** for all devices on the bus.
8. **The Require Service Message.** A device can send this message at any time to signify that the device needs some type of interaction with the controller. This message is cleared when the device sends its **Status Byte Message** if the device no longer requires service.
9. **The Status Byte Message.** A byte that represents the status of a single device on the bus. One bit indicates whether the device sent a **Require Service Message** and the remaining bits indicate operational conditions defined by the device. The byte is sent from a talking device in response to a serial poll operation performed by a controller.
10. **The Status Bit Message.** A byte that represents the operational conditions of a group of devices on the bus. Each device responds on a particular bit of the byte thus identifying a device-dependent condition. This bit is typically sent by devices in response to a parallel poll operation.

The Status Bit Message can also be used by a controller to specify the particular bit and logic level that a device will respond with when a parallel poll operation is performed. Thus more than one device can respond on the same bit.

11. **The Pass Control Message**. This transfers the bus management responsibilities from the active controller to another controller.

12. **The Abort Message**. The system controller sends this message to unconditionally assume control of the bus from the active controller. This message terminates all bus communications but does not implement a **Clear Message**.

These messages represent the fulll implementation of all HP-IB system capabilities. Each device in a system, however, may be designed to use only the messages that are applicable to its purpose in the system. It is important for you to be aware of the HP-IB functions implemented on each device connected to your HP-IB system to ensure the operational compatibility of the system.

Data Messages

The data message refers to the ASCII coded data and the 8-bit graphic data bytes that are sent to the printer on the HP-IB. Most of the data forms and the printer's response to them are described in Chapter 3.

Clearing the Printer

The printer does not respond to the HP-IB message Device Clear or Select Device Clear. The printer can be cleared or reset, however, by using the Reset escape sequence (E $_{C}$ E).

Service Requests and Polling

The printer can send the Require Service Message (SRQ) to the controller when any of the following conditions occur:

- Out of paper.
- Hardware failure.
- Printhead or power supply overheated.

The Require Service message can only be sent if switch 8 on the printer's rear panel is set "on" as described in the Installation Note.

Since the printer does not have parallel poll capability implemented, it therefore can not respond to a parallel poll when it has sent the Require Service message.

It can respond to a serial poll which obtains the Status Byte message from the printer. When the printer is addressed during a serial poll operation, it sends the controller a status byte that defines the condition of the printer. Additionally, the service request line (SRQ) is cleared when the printer responds to a serial poll operation. The following is the definition of the printer's status byte.

MSB Bit 7 128	Bit 6 64	Bit 5 32	Bit 4 16	Bit 3 8	Bit 2 4	Bit 1 2	LSB Bit 0 1
Not Used	Require Service Message Sent	Not Used	Hardware Failure	Printhead Overheated	Out of Paper	Confidence Test In Process	Not Used
Always 0	64=True 0=False	Always 0	16=True 0=False	8=True 0=False	4=True 0=False	2=True 0=False	Always 0

The status byte is sent to the controller as the decimal equivalent sum of the conditions that are true. For example, a status byte with a summed value of 68 would indicate the following printer conditions:

Bit Value	Meaning
0	Not used.
+64	Require Service Message Sent.
+0	Not used.
+0	The printer does not have a hardware failure.
+0	The printer is not overheated.
+4	The printer is out of paper.
+0	There is not a confidence test in process.
+0	Not used.

The Abort Message

When the printer receives the Abort Message that is sent on the interface clear (IFC) line, it returns to an unaddressed state and waits until it is addressed again before continuing any operations. Any data that is in the printer's buffer when the abort message was received remains there. When the printer is re-addressed after an abort, it continues filling the buffer at the point that it stopped for the abort. The printer is not cleared or reset by an Abort message.

The Listen Always Mode

If the printer is set to the Listen Always mode, it does not use the HP-IB device addressing protocol. Instead, the printer will print all data sent on the bus regardless of which device was addressed to receive the data.

The Listen Always mode can be extremely useful as a data monitor to print all data transfers that occurred on the bus while not affecting bus operation. Thus a backup record of bus operation can be created or the operation of a bus system can be monitored as a program debugging aid.

NOTE

The printer does not have an HP-IB address when it is in the Listen Always mode. Therefore, a Serial Poll operation cannot be directed to the printer while it is in the Listen Always mode.

HP-IB Worksheet

The worksheet at the end of this chapter is provided for you to use in operating and programming the devices in your HP-IB system. Each device's HP-IB implementation should be filled in an appropirate column of the form. For each of the 12 messages listed, either an R (for receive only), an S (for Send only), an SR (for Send and Receive) or an N (for Not Implemented) should be lettered in the appropriate box to show each device's response to the message.

The printer's response to the various HP-IB Messages has been printed in the appropriate place on the worksheet in the second column. The first column has been left blank for your controller. The remaining columns can be used for other devices connected to the bus.

Once the worksheet has been filled in for all of the devices in your HP-IB system, you can use the information as an aid in programming your application. When your program makes use of an HP-IB message, you can read across the columns for that message and check that the appropriate devices have the necessary capability to respond properly to the message. The worksheet also helps you make sure that each device has a unique address code.

For example, in a program application that utilizes service requests and polling, the printer can send the Require Service message and respond to a serial poll (Status Byte message) but it cannot respond to a parallel poll operation (Status Bit message). Therefore your program design would have to reflect this situation when preparing service request routines.

In addition, the back of the worksheet provides a place to list the status byte (serial poll) information for the devices in your system. The printers status byte has been filled in for you. This reference can be useful if you have any service request routines in your program application on the HP-IB.

8-Bit Parallel (Option 001)

The 8-bit parallel (Option 001) assembly allows a great deal of flexibility in the design of an interface. The following information is presented to aid you in the design of your interface. Incidentally, if you are using an HP Controller that uses the 98032A Interface, a factory interface is available (98032A Opt. 076).

Interface Flexibility

The printers logic sense (negative true or position true) must be determined.

- The condition of signal line GND TRUE (pin 7) configures the logic sense of the 8 data lines (I0 thru I7). If GND TRUE is allowed to float to +5 volts (default), the printer logic is defined as ground true or negative true. If pin 7 (GND TRUE) is shorted to ground (jumper to pin 26), the printer's logic is set to positive true.
- The interface control lines and their complements are available: CI and $\overline{\text{CI}}$ (CYCLE INITIATE sometimes called Control), BUSY and $\overline{\text{BUSY}}$ (sometimes called Flag), OTP and $\overline{\text{OTP}}$ (OUT OF PAPER).

Control line timing must be established between your controller and the printer.

- Data can be latched by the printer's buffers on the ready to busy transition of the BUSY or $\overline{\text{BUSY}}$ signal lines.
- In the transparent mode the data can be copied directly from the data lines 25 μs or more after a cycle is initiated.

The A1 assembly (66506 board) provides two possible line terminations. This is accomplished with two jumper packages that are installed at the factory.

- With the jumper packages installed capacitive termination is added to the data lines (2200pf in series with 82.5 ohms).
- With the jumpers unplugged the load on the data lines consists of a 74LS14 inverter in parallel with 1K ohms to +5 volts and 2.2K ohms to ground.
- Capacitive termination is also provided for CI, $\overline{\text{CI}}$, and Reset.

All of the above alternatives are set at the interface connector except for line termination. In addition, the wake-up secondary character set (unless it is U.S. ASCII), automatic carriage return, and the method of choosing the secondary character set (shift out or eight bit can also be selected at the connector.

Interface Signal Lines

While reading the rest of this section refer to the "Pin Numbers & Signal Names" table and connector drawing at the end of this chapter and the 66506 Assembly Circuit Diagram in Chapter 8.

Data Lines

The eight input data lines to the printer are I0 thru I7. Each of the eight input receivers is a 74LS14 schmidt trigger receiver. Each 74LS14 is paralleled with a 1K ohm resistor to +5 volts and 2.2K ohms resistor to ground. Additionally, the 66506 board contains a set of jumpers which adds capacitive line termination. The addition of the 2200pf in series with 82.5 ohms to ground does a fair job of preventing line reflections for longer interface cables.

NOTE

Some data sources may not have line drivers capable of driving these terminations and meeting the printer's timing requirements. For these cases the capacitive line terminations should be disconnected and signal quality assured in some other manner. A possible way is to use a shorter interface cable.

GROUND TRUE

The signal line GND TRUE (pin 7) is used to configure the logic sense of the eight data lines. If GND TRUE is allowed to float high (+5), the data logic is negative true (i.e. true = 0 = low). If pin 7 (GND TRUE) is shorted to ground (jumpered to pin 26), the printer understands positive true logic (i.e. true = 1 = high). GND TRUE is a printer input loaded with a 1K ohm pullup resistor to +5 volts in parallel with a 74LS14 inverter.

BUSY

The BUSY signal line (sometimes called Flag) is a printer output driven by a 7437. When it is low the printer is ready to take a data byte. BUSY is discussed in the section titled "Timing".

$\overline{\text{BUSY}}$

This signal line is the complement of BUSY. It is a printer output driven by a 7438 with a 330 ohm pullup resistor to +5 volts.

CYCLE INITIATE (CI)

CI (sometimes called Control) is a printer input loaded with 500 ohms to +5 volts, 1100 ohms to ground and a 74LS132 input. It has the same capacitive line termination as the eight data lines. This capacitive termination is initiated via jumpers also.

$\overline{\text{CYCLE INITIATE}}$ ($\overline{\text{CI}}$)

$\overline{\text{CYCLE INITIATE}}$ ($\overline{\text{CI}}$) is the printer input that initiates a printer read data cycle. This signal is the complement of CI and loaded and terminated in the same manner.

Timing

Data is transferred from the controller to the printer under the control of the CI and BUSY signal lines. These lines operate in a "handshake" sequence. This handshake sequence allows the printer to respond to controllers with different output speeds.

The printer indicates that it is ready to accept data by letting the BUSY line go low (logical "0"). The controller indicates that it has data for the printer by setting the CI line high (logical "1"). If the BUSY line is not low, the controller need not set the CI line low. After the CI line goes low, the printer indicates that the data has been accepted by setting the BUSY line high. The BUSY line remains high until the printer is funished processing the input data and the controller returns the CI line high. When the printer sets the BUSY line back to a low level, the handshake sequence can be repeated for the next data byte.

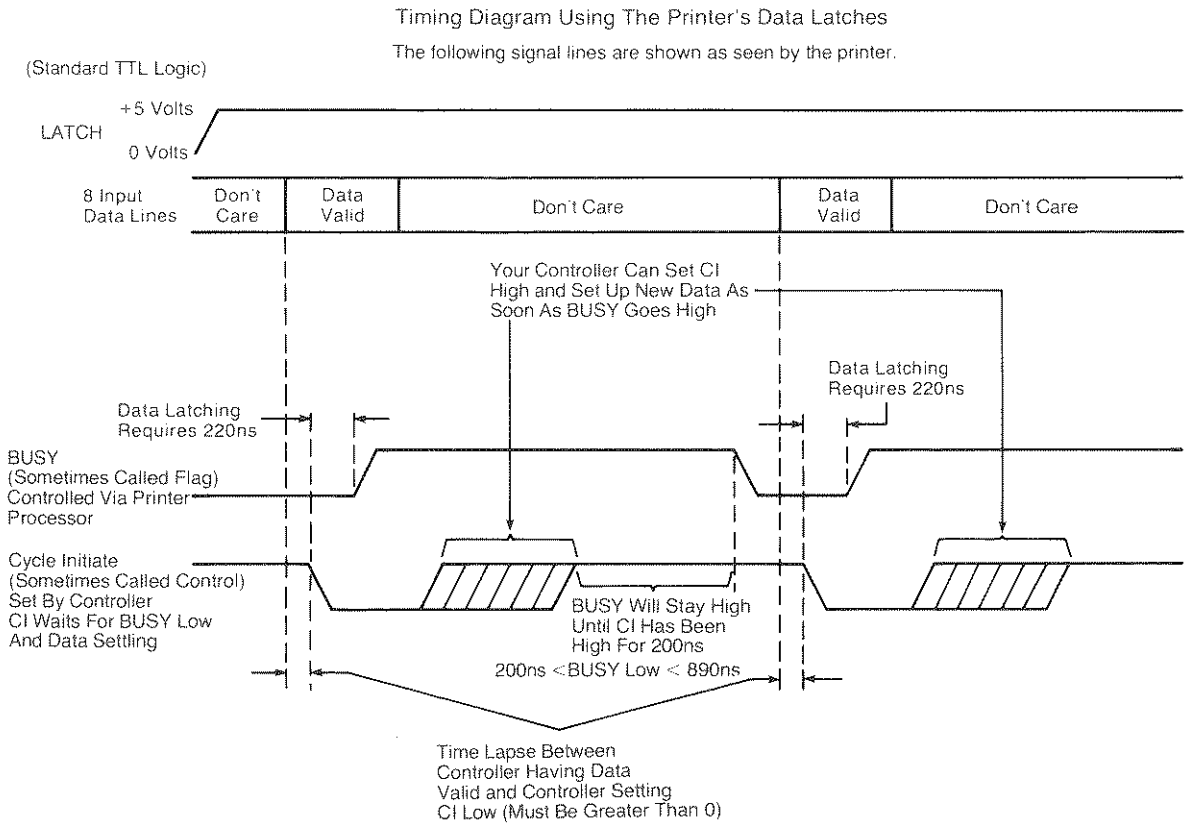


Figure 4-2: Timing Diagram Using the Printer's Data Latches

The response for the BUSY line will be less than the sum of the following:

- 220ns for printer gating.
- The excess delay of a 7438 high-low transistion due to driving more than 45 pf. See the 7438 specifications.
- The line delay from the source to the printer and back again.

The response for the $\overline{\text{BUSY}}$ line will be less than the sum of the following:

- 220ns for printer gating.
- The excess delay of a 7438 high-low transistion due to driving more than 45 pf. See the 7438 specifications.
- The line delay from the source to the printer and back again.

NOTE

It is not necessary for the controller to drive both CI and $\overline{CI}$. The unused line should be set true (CI allowed to float, $\overline{CI}$ grounded) and left.

To improve the printer's tolerence to reflection on the CI and $\overline{CI}$ lines a 200ns time delay has been initiated. Before the printer makes the busy to ready transistion the following two things must happen:

- The data is processed.
- CI (set via the controller) must have been high (cleared) for at least 200ns.

LATCH

LATCH is a printer input loaded in the same manner as the data lines. This signal line causes the data latches of the A1 assembly to latch the data. If LATCH is allowed to float high (default), the data latches trap the data within 220ns after the controller sets CI low. See the timing diagram titled "Timing Diagram Using the Printer's Data Latches".

NOTE

If this timing option is used, data must be valid before the controller sets CI low and kept valid until after the printer signals it is busy.

If LATCH is tied low (jumpered to pin 6), the printer latches do not trap the data. Here the data latches become transparent and the processor must read the data essentially from the data lines. See the timing diagram titled "Controller Holding Data". This timing option allows additional data setting time after the controller sets CI low.

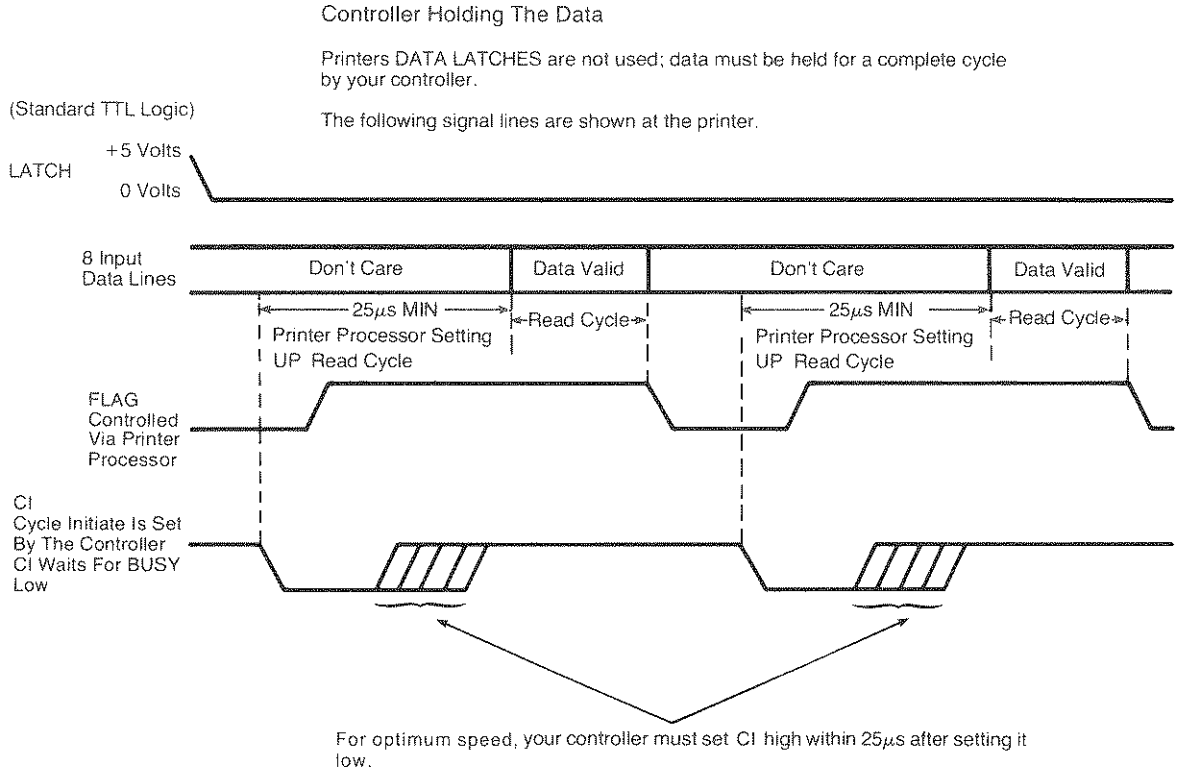


Figure 4-3: Controller Holding Data

NOTE

If this timing option is used, your controller must hold the data. Data must be valid 25μs after setting CI low and held valid until the printer signals it is not busy.

If the LATCH signal is set high (+5 volts) during the first 25μs after setting CI low the current data will be latched and the controller is not required to hold the data. A possible timing configuration might be to tie the LATCH signal to CI. This would cause the trailing edge of $\overline{CI}$ to trap the data.

$\overline{\text{ACK}}$

ACKNOWLEDGE ($\overline{\text{ACK}}$) is a printer output driven by a 7437. This signal line pulses low for a nominal 4μs starting when the processor does a read cycle. If CI has been cleared at this point in time, then the low-high transition of $\overline{\text{ACK}}$ occurs after the printer becomes ready. CI and $\overline{\text{ACK}}$ can be used in this manner to control the interface. See the timing option titled "CI and $\overline{\text{ACK}}$".

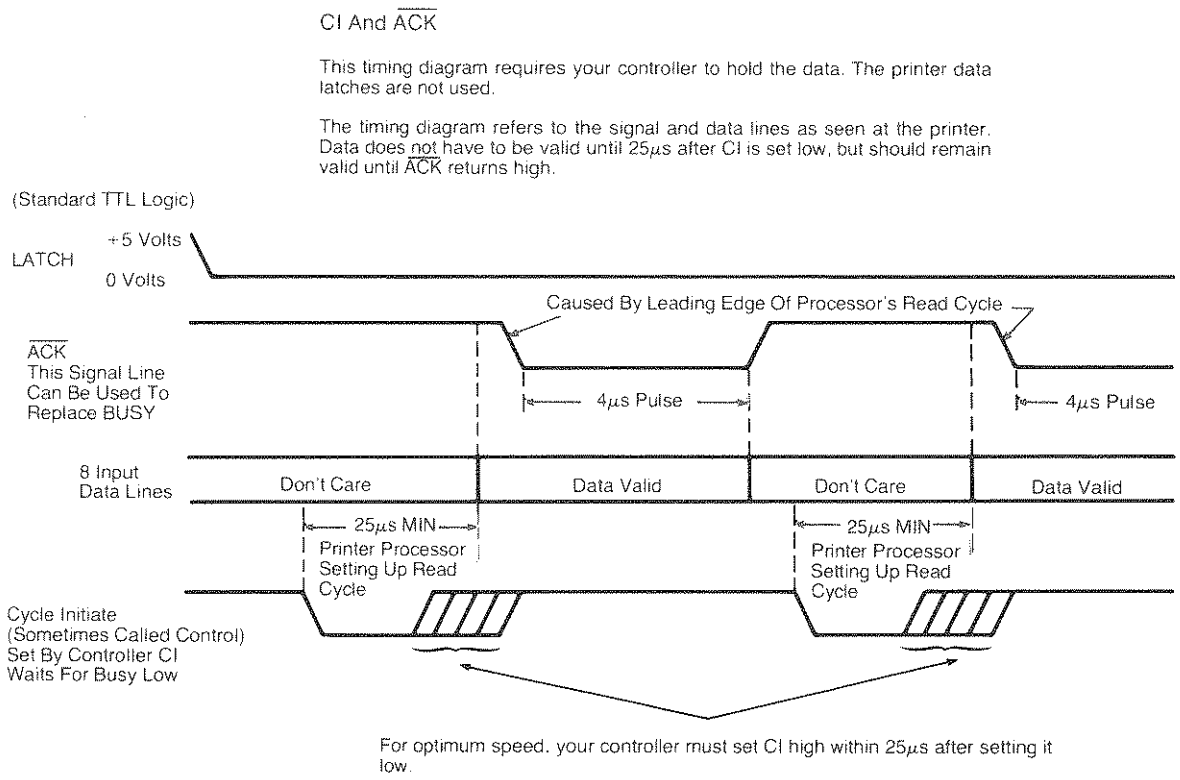


Figure 4-4: CI and $\overline{\text{ACK}}$

OTP

OUT OF PAPER is a printer output driven by a 7437. This signal line is driven high when the printer senses it is out of paper.

$\overline{\text{OTP}}$

$\overline{\text{OUT OF PAPER}}$ is the complement of OTP. This printer output is driven by a 7438 paralleled with a 330 ohm pullup resistor to +5 volts. It is set low when OTP is set high.

PREADY

PREADY is a printer output driven by a 7438 paralleled with a 330 ohm pullup to +5 volts. This line is set high when the power supply indicates that it is ready to print. Here are some reasons why PREADY would stay low:

- Power supply failure.
- Low line voltage.
- Print head is overheating.
- Power supply is overheating.
- Settling time at power on not complete.
- Processor shutdown due to wakeup or reset.
- Processor shutdown due to selftest failure.
- Print head burn time too long.

Reset

Reset is a printer input line loaded like the data lines. Reset sets the printer to its power on state if it is held low for at least 50 milliseconds and then let up.

7-Bit/8-Bit ASCII (PB5)

The printer can be configured to accept either 7 or 8-bit ASCII coded data by either connecting pin 20 to pin 1 (7-bit) or not connecting pin 20 to any other pin (8-bit).

The type of ASCII determines the method used to select between the primary and secondary character sets.

7-bit ASCII uses the Shift In and Shift Out characters to select character sets. Shift In selects the primary set and Shift Out selects the secondary character set. The 8th bit of each character code is ignored in the 7-bit ASCII mode.

8-bit ASCII uses the 8th bit of each character code to select the character set. If the bit is a logical 0 (false or clear), the primary set is selected for that character. If the bit is a logical 1 (true or set), the secondary set is selected for that character. The Shift In and Shift Out characters are ignored in the 8-bit ASCII mode.

Default Character Set Designation

Pins 21, 22 and 23 of the printer's connector are used to select the default secondary character set. Any one of the available character sets may be selected as the default set by connecting or disconnecting combinations of pins 21, 22 and 23 with pins 2, 3 and 4.

Table 4-2: Secondary Character Set Selection

Pin(s)	Condition	Character Set
21,22,23	Float High	Danish/Norwegian
23	Grounded	German
22	Grounded	Spanish
21	Grounded	Swedish/Finish
22,23	Grounded	European Extended
21,23	Grounded	French
21,22	Grounded	United Kingdom
21,22,23	Grounded	Katakana

Auto Carriage Return

The printer can be configured to perform a carriage return automatically whenever a linefeed character is received. This is necessary for controllers that send only a linefeed character at the end of each line of data. Allowing pin 24 to float high causes the printer to execute a carriage return/linefeed each time a linefeed is received. Grounding pin 24 (connecting pin 24 to pin 6) causes the printer to execute a carriage return only when told to by the controller.

Recommended Driver Circuits

Each of the data input lines to the printer is connected to an inverting buffer. These eight inverting buffers are each paralleled with a 1K ohm pull up resistor to +5 volts and a 2.2K ohm pull down resistor to ground. Additionally, there is a removable jumper that adds capacitive line termination of 2200pf in series with 82.5 ohms to ground. If you are using interface lengths less than five feet and desire faster data transfer, the jumper adding capacitive termination should be removed.

Here are typical specifications required by the printer's data receivers:

- V max 5.5 V
- V high > 2 V
- V low < .8 V
- The receivers sink 20 microamps for a high.
- The receivers sink .4 milliamps for a low.

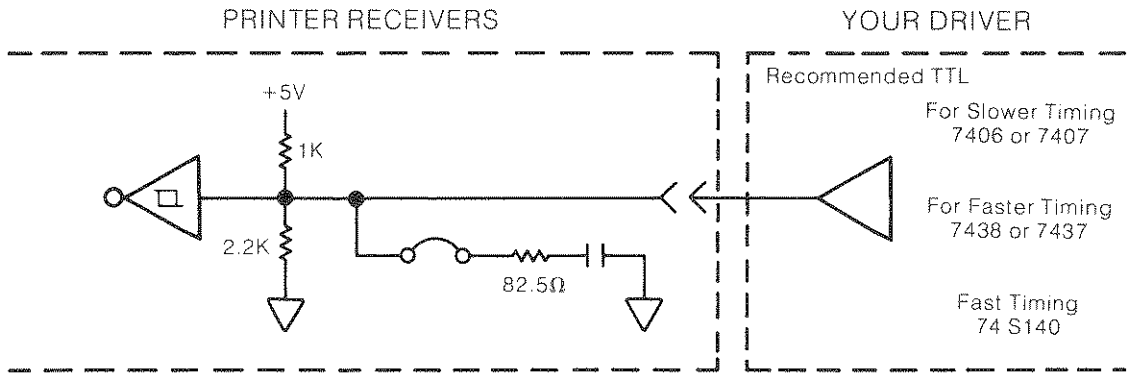


Figure 4-5: Recommended Driver Circuits

Recommended Receiver Circuits

Each output from the printer is driven by a 7437 or 7438. The 7437 is capable of sinking 48 milliamps and sourcing 1.2 milliamps (Low ≤ .4 < 2.4 ≤ High). The 7438 is capable of sinking 29 milliamps and sourcing 12 milliamps.

As a recommendation you might consider the receiving circuits of the printer (74LS14 and associated hardware) for your receivers. The 82.5 ohm resistor and 2200pf capacitor should not be used for interface cables less than 5 feet in length if extremely fast data transfer is desired.

The recommended receiver circuit shown below with the following circuit configuration requires .6 microseconds for a low to high transition (0 volts to 2.54 volts).

- Using the 7438 with a 330 ohm pullup.
- Using an interface cable length that adds 100pf to the circuit.

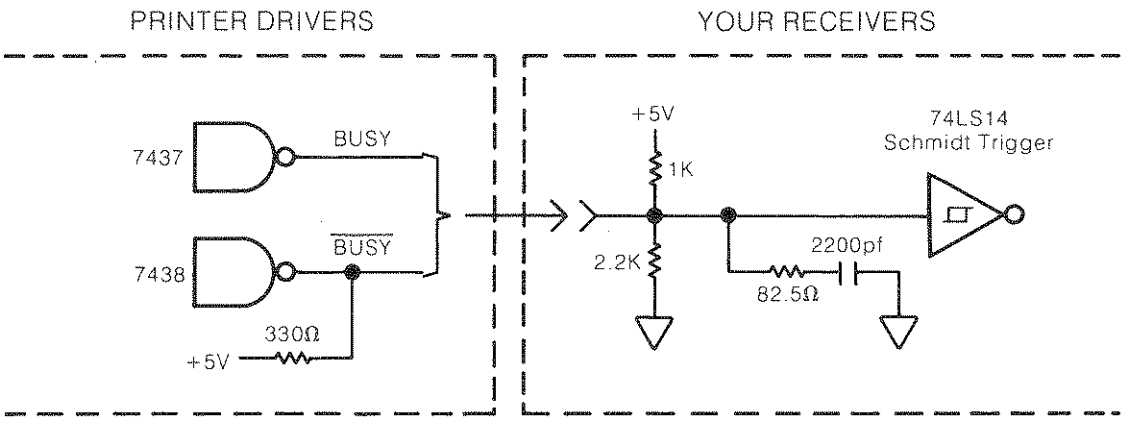


Figure 4-6: Recommended Receiver Circuit

The 8-Bit Connector

The 8-Bit Parallel connector as viewed from the back of the printer is shown in Figure 4-6. The pin numbers and signal names follow in Table 4-3.

Figure 4-7: 8-Bit Parallel Connector

The recommended mating connector for the above connector is Cannon or Cinch (DCM 37S)

Table 4-3: Pin Numbers and Signal Names

Signal Name	Pin Number	Pin Number	Signal Name
PB5 7-Bit/8-Bit ASCII	20.	1.	GND
PA3 FR,SW,UK,KA	21.	2.	GND
PA4 SP,EE,UK,KA	22.	3.	GND
PA5 FR,EE,GE,KA	23.	4.	GND
PA7 AUTO CR	24.	5.	GND
LATCH	25	6.	GND
GND	26	7.	GND TRUE
GND	27	8.	GND
GND	28	9.	I0
GND	29	10.	I5
+5	30	11.	I4
OTP	31	12.	I6
$\overline{\text{ACK}}$	32	13.	I2
GND	33	14.	$\overline{\text{CI}}$
BUSY	34	15.	CI
PREADY	35	16.	$\overline{\text{RESET}}$
$\overline{\text{BUSY}}$	36	17.	I7
$\overline{\text{OTP}}$	37	18.	I3
		19.	I1

RS-232-C Serial I/O (Option 002)

The Option 002 assembly allows communication to the printer through the use of a full duplex RS-232-C Serial I/O interface and a full or half duplex current loop interface. The following information is presented to aid you in establishing compatibility with your existing system or to aid you in designing your interface drivers. The information presented first is a brief but complete list describing the printer's flexibility. This is followed with an explanation on data format, baud rate selection, and interface protocol selection.

The printer is designed and wired to appear in the Data Terminal Equipment (DTE) category. DTE generally appears with a standard male EIA 25 pin connector, but the printer contains a standard female EIA 25 pin connector which is wired the same as the male connector. A prewired cable is available (contains two male connectors) and when it is used allows the printer to qualify as a DTE. The cable can be ordered under P/N 8120-3097. See the section titled "Connector Pin Numbers".

Printer Flexibility

The option 002 assembly implements the following features:

- Enquiry/Acknowledge handshake for preventing data from overrunning the printer.
- XON/XOFF interface protocol.
- Hardware handshake through the use of the CD (Data Terminal Ready) circuit.
- A 255 character input buffer.
- Seven or eight bit character length.
- Optional parity checking (odd or even).
- Null characters can be removed from the data stream before insertion into the input buffer.
- Remote status readback.
- Eight baud rates (between 110 and 9600) are available through back panel switches.
- 19200 baud rate plus six other rates are accessible internally.
- Passive twenty milliamp current loop operation in either full or half duplex mode.
- Internal self tests that include complete interface testing.

Data Format

Information is transmitted over the data lines using two voltage levels to represent two possible states. The following table shows the voltage levels for these two states and the meaning assigned to each.

State	LOW	HIGH
Voltage Range	−3 to −25V	+3 to +25V
Binary State	logic 1	logic 0
Level Names	mark	space

Character Cell

When the transmitting device has information ready to send, it merely puts the information on the data lines, expecting the receiving device to be ready to take it. If the first bit of the character cell (see Figure 4-8) happens to be in the low state, the receiver could not distinguish this bit from the quiet line, which is also a LOW state. Therefore, each character cell begins with a start bit, which is defined to be in the HIGH state. This transition from the LOW state (idle line) to the HIGH state (start bit) lets the receiver (printer) know that a character cell is being transmitted.

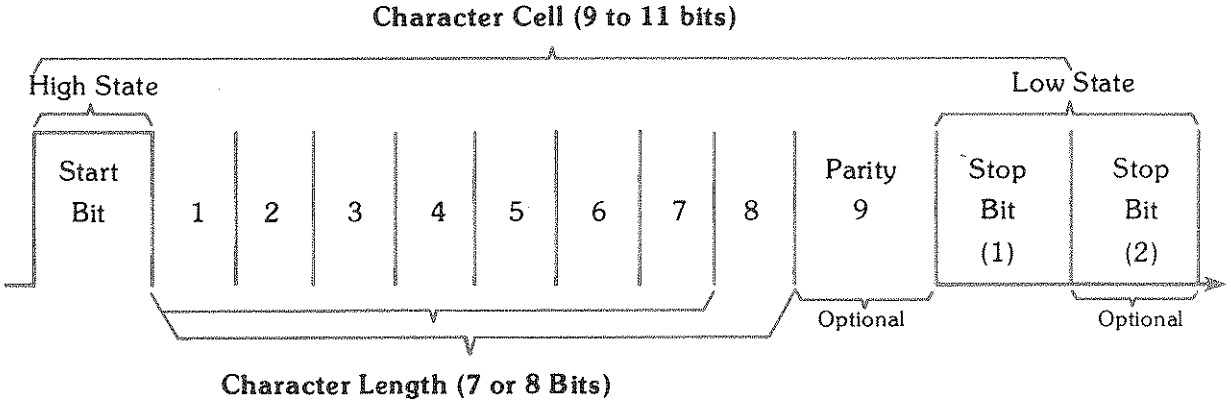


Figure 4-8: Data Format

The printer's data format for the communication of a character cell must be set to match the format of your output device (driving device). The data format switches are located on the rear panel of the printer. The switches are shown in Figure 4-2.

Start and Stop Bits

The printer's data format for both transmission and reception will always have one start bit and one stop bit. This makes it compatible with drivers sending one or more stop bits.

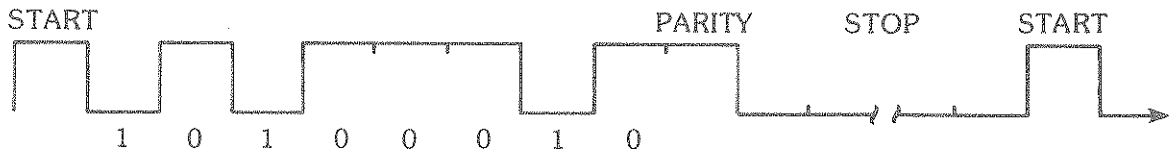
Character Length

The printer can interpret either 7-bit or 8-bit ASCII characters. 7-bit or 8-bit characters are selected via rear panel switches.

Parity

In a noisy environment serial data on the line is susceptible to "dropping bits", that is, having a bit sent as a 0 or a 1 being received as a 1 or a 0. In order to detect when this happens, a scheme called parity checking is often used with each character. The transmitter sends an extra bit that is not part of the data itself (parity bit). This parity bit is set in such a way that the total number of bits set to a logical "1" (data + parity) is always even or always odd. Each character that the data receiver (printer) gets is checked to make sure that the received data has the proper parity. For example, the following figure shows the bit pattern used for sending an ASCII "E" character. Since there is an odd number of 1's (three) in the ASCII representation of an "E", and the parity bit is a zero, this particular example is using odd parity. If even parity were being used, the parity bit would be set to a "1" bringing the total number of 1's to an even number (four).

ASCII "E" = 69 (Decimal) = 01000101 (Binary)



It is important to note that if parity is not being used, the parity bit is not transmitted. Switch S5 (Figure 4-7) must be set in the up position to enable parity. Switch S4 selects even or odd parity (up position = even parity). The above example is odd parity.

Data Format Switches

On the rear panel of the printer there is a group of miniature switches (S1 thru S8). S1 is the left most switch as viewed looking at the back of the printer. Switches S4 thru S8 are used to configure the data format. See the following drawing.

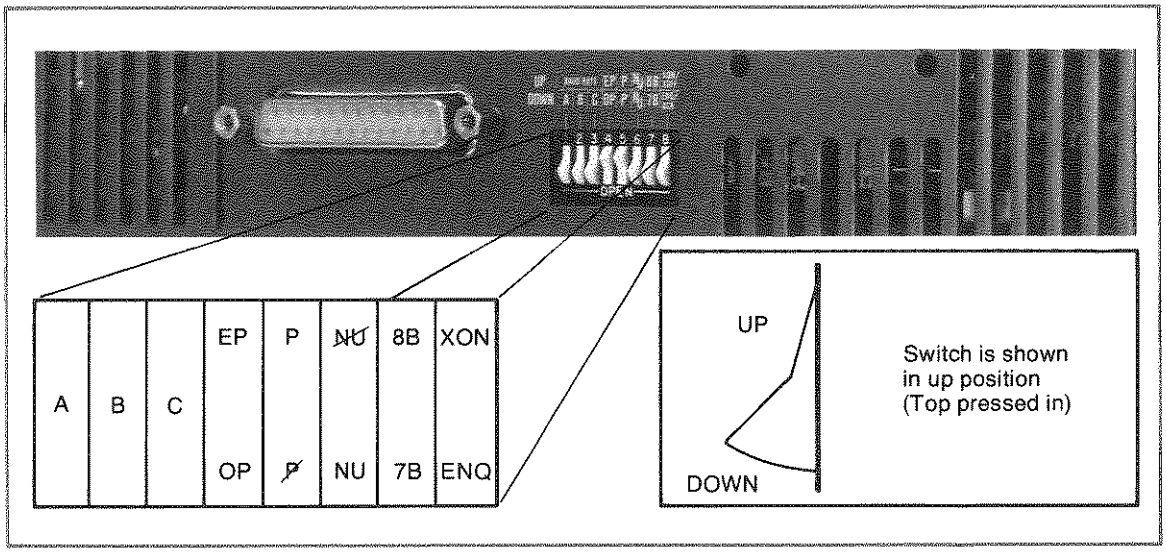


Figure 4-9: Rear Panel Switches

The data format switch (S4 thru S8) definitions are listed in the following table.

Table 4-4: Format Switches

Switch No.	Switch Position	
	UP (Top pressed in)	**DOWN (Bottom pressed in)**
S8	XON/XOFF Protocol	ENQ/ACK Protocol
S7	8-Bit Characters	7-Bit Characters
S6	Strip Nulls	Keep Nulls
S5	Parity Check	No Parity Check
S4	Even Parity	Odd Parity

NOTE

The use of seven or eight bit characters maintains all of the features, constraints, and operating characteristics of the HP-IB (standard) printer.

Stripping Nulls from Data

Some drivers for the RS-232-C can be configured to insert a predetermined number of "Null" characters after each control character passed to the printer. Since this can cause the loss of much of the benefit gained through the use of the 255 character input buffer, it is sometimes desirable to strip these characters from the data stream before they are placed in the input buffer.

Placing switch S6 in the up position causes the nulls to be removed from the data stream and not placed into the input buffer. See the S6 setting in Table 4-4.

NOTE

If the printer has been selected to strip nulls, the nulls will be stripped even when the printer is in the graphics mode. For graphic output the nulls are required.

Baud Rate

With the printer and your driver or controller configured with the same data format, another very important item must be considered. This item is the rate at which the data is sent across the interface (the baud rate.)

The baud rate is determined by multiplying the numbers of bits in a character cell (9 to 11) by the data rate. Data Rate = the number of character cells/second.

See the following example:

Character Length = 7-bits
Character Cell (7+START+PARITY+2 STOP) = 11
Data Rate 10 character cells/second
Baud Rate (10 character cells/sec.)(11 bits/char) = 110

Baud Rate Switches

More commonly used baud rates are selected with the three switches labeled A, B, and C located on the rear panel. See Figure 4-9. In addition there is jumper JS1 internal to the printer, which when moved, gives each switch combination another baud rate. See Figure 4-10 for the normal/secondary jumper configuration.

Switches			Baud Rate	JS1 in Secondary Configuration
A	B	C		
Dn	Dn	Dn	110	2400
Up	Dn	Dn	150	600
Dn	Up	Dn	300	200
Up	Up	Dn	2400	133
Dn	Dn	Up	1200	75
Up	Dn	Up	1800	50
Dn	Up	Up	4800	19200
Up	Up	Up	9600	19200

Figure 4-10 shows the location of the JS1 jumper socket and JS2 jumper socket. Both jumper sockets are located on the component side of the control board. Access to the control board is described in Chapter 6.

The JS2 jumper socket is used to determine the RS-232-C/Current Loop mode of operation. JS1 is shown with standard baud rate and full duplex enabled. Current Loop is explained after the self test section.

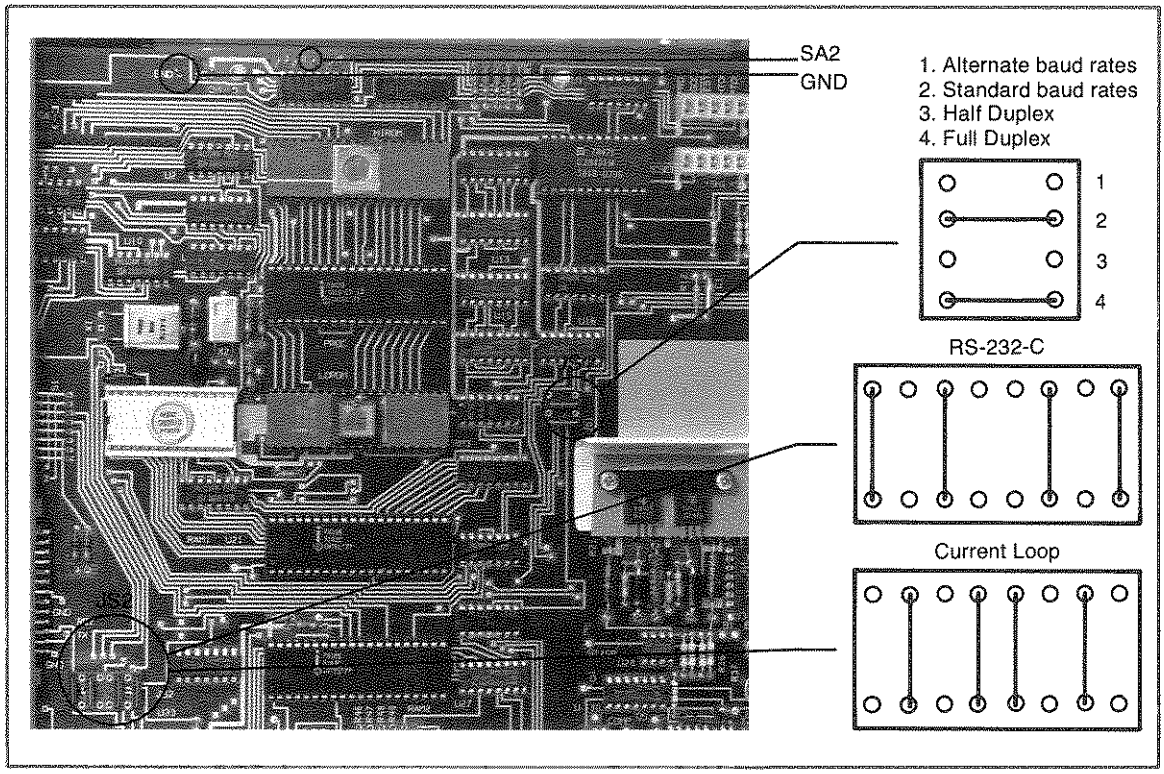


Figure 4-10: Normal/Secondary Jumper Configuration

Handshake Protocols

There are four ways of controlling data flow into the printer buffer: the ENQ/ACK mode, the XON/XOFF mode, the Hardwire mode, and the Nulls mode. The modes are explained in this section.

The Printer Buffer

The input buffer is a 255 character buffer. It is organized as a first in/first out buffer with the lower and upper limit controlled by the printer's processor. Prior to putting characters into this buffer the following operations are performed:

- Checks for parity, overrun, and framing errors.
- Strips nulls from the data stream if selected.
- Checks for the presence of handshake characters.
- Checks for a status request sequence.

ENQ/ACK Mode

In this mode your computer or interface driver sends a maximum of 83 characters including the carriage return, linefeed, and ENQ character (ASCII Decimal 5). When the printer sees the ENQ character, it checks the buffer and determines the remaining space. If the printer has 83 or more character spaces left in its buffer, it responds with an "ACK" character (ASCII Decimal 6). Once the buffer is full (less than 83 character spaces available), the printer will not respond with the ACK character until it has printed all but 40 characters. The printer then sends the ACK character. See Table 4-4 for switch setting.

See the following summary.

- The computer or interface driver sends up to 82 characters, and the ENQ character (Decimal 5) and then waits for the printer to send an ACK character (Decimal 6).
- The printer sends an "ACK" character if there are at least 83 characters spaces available in the buffer.
- The computer or host detects the ACK character and repeats the sequence.
- Receiving the "ACK" character guarantees that the printer has space for 83 data characters.

NOTE

When the printer is in graphics mode and receives the decimal 5 character, the following two things occur:

The decimal 5 character is mapped into the graphics field.

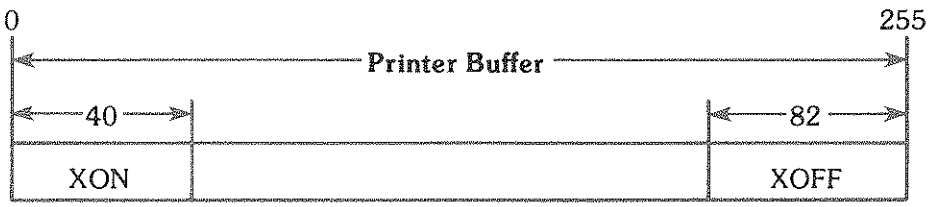
The decimal 5 character (ENQ) generates the decimal 6 (ACK) response which is output from the printer if the buffer space is available.

XON/XOFF Mode

This is the most versatile mode, especially for graphics. In this mode the printer tells the controller to stop sending data by sending the XOFF (ASCII Decimal 19). This is done when there is less than 82 characters spaces left in the buffer. When the printer's buffer contains less than 40 characters, the printer sends the XON (ASCII Decimal 17) character signaling the controller to resume data transmission.

See the following text and drawing.

- The controller sends data until it receives the XOFF character. When the controller receives the XON character, it resumes transmission.



NOTE

The printer does not send the XON character after a reset or power on condition. It is suggested that when using the XON/XOFF mode that status be checked prior to printing.

To BASIC Language Machine Users

It is suggested that you don't output more than 82 characters at a time so as not to overrun the printer. The reason for this is that the majority of the machines available that use interpreted BASIC have uninterruptable instructions. Example, OUTPUT 11; RPT$("A",100). No interrupts will be recognized until all 100 "A"s are sent. This prohibits the printer from stopping transmission when its buffer becomes full.

Hardwire Mode

This is the simplest method. The Data Terminal Ready (DTR) line (pin 20) goes low (−12V) when the buffer is full (same limits as XON/XOFF mode). This same signal line goes high (+12V) when the printer is ready to accept more data. If this mode is not used, it is recommended that pin 20 is not connected to anything (DTR allowed to float).

Strip Nulls Mode

In this mode the controller sends some specified number of nulls between every line of text (i.e. after every linefeed). The nulls are not processed, but immediately dumped at the interface. This dumping gives the printer time to print the previous line before the next line arrives.

NOTE

If the printer receives a null character between the CR character and LF character at the end of a line of text, it prints the contents of its buffer and backs up expecting to overstrike. This is time consuming and seriously affects the print speed.

Modem Operation

If the printer is used in conjunction with a modem, you must insure that protocol requirements of both the modem and the printer are met. Hardware modifications, if required, should be accomplished in the interface and not in the printer.

Status

At any time during printer operation, the controller or interface driver can request an I/O status readback from the printer. This readback of the status word is requested by sending the sequence "EC ∧" ASCII Decimal 27 and 94. After receiving this sequence the printer responds within 500 milliseconds (unless forced into a power down condition by a hardware failure) with the status word. **The controller should not send any other characters to the printer until this status word is received.**

NOTE

Sending characters before the status word is received will result in loss of transmitted data.

The seven significant bits of the status word are defined as follows:

Table 4-5: Printer Status Word

Bit	Value When Set	Meaning if in Logic "1" State
0	1	Buffer is Full
1	2	Out of Paper
2	4	Printhead Overheat
3	8	Parity Error
4	16	Overrun Error
5	32	Framing Error
6	64	Always "One"

Self Test

The Option 002 assembly has extended self tests that pertain mainly to the interface. When internal test point (SA2) is grounded and the confidence test in initiated (either front panel or ESC z), the printer starts the interface test (see Figure 4-10 and the section titled "Printer Confidence Test). The printer first reads the back panel switches and prints the results (e.g., ENQ/ACK or ENQ/ACK).

The next test is a RAM test printing the component designators of each RAM chip and the result (e.g., "U12 GOOD").

See the following completed test printout.

```
ENQ/ACK
7-BITS
NULLS
PARITY
ODD PAR
FULL DP

 U12   U21   U25
GOOD  GOOD  GOOD

UART GOOD
```

Interface Tests

The interface test is designed to test the interface and output section of the 002 assembly. The printer outputs the following character sequence: AA ,00, FF , 55 (see the following table). The printer waits (indefinitely) to receive the first character before sending the next. If you short the transmit and receive pins (2 and 3 repectively) together at the printer connector or the far end of your cable, the test will run to completion. The printer sends this sequence 128 times for a total of 512 transmissions and receptions. The characters are sent at the selected baud rate using 2 stop bits, even parity, and 8-bit characters. They are expected to be received with these same properties. If everything is good, the printer prints "UART GOOD". If an error is discovered, the printer prints "UART ERROR".

NOTE

Another function of this test would be to have the controller or host display the transmissions before echoing them back to the printer.

Interface Test Character

Decimal	Hexidecimal	Bit Pattern
170	AA	10101010
0	00	0000 0000
255	FF	1111 1111
85	55	01010101

Current Loop

Current loop is another method of communication with the printer. This method of communication is very noise immune and is fully floating which allows it to be used effectively at greater distances.

Current loop is a substitution for voltage driven communication. The following shows the current states and the meanings assigned to each.

Current Flowing

State	15 to 30 Milliamps	Less Than 3 Milliamps
Binary State	logic 1	logic 0
Level Name	mark	space

Maximum allowable operating current is 40 milliamps. Maximum open circuit voltage is 20 volts.

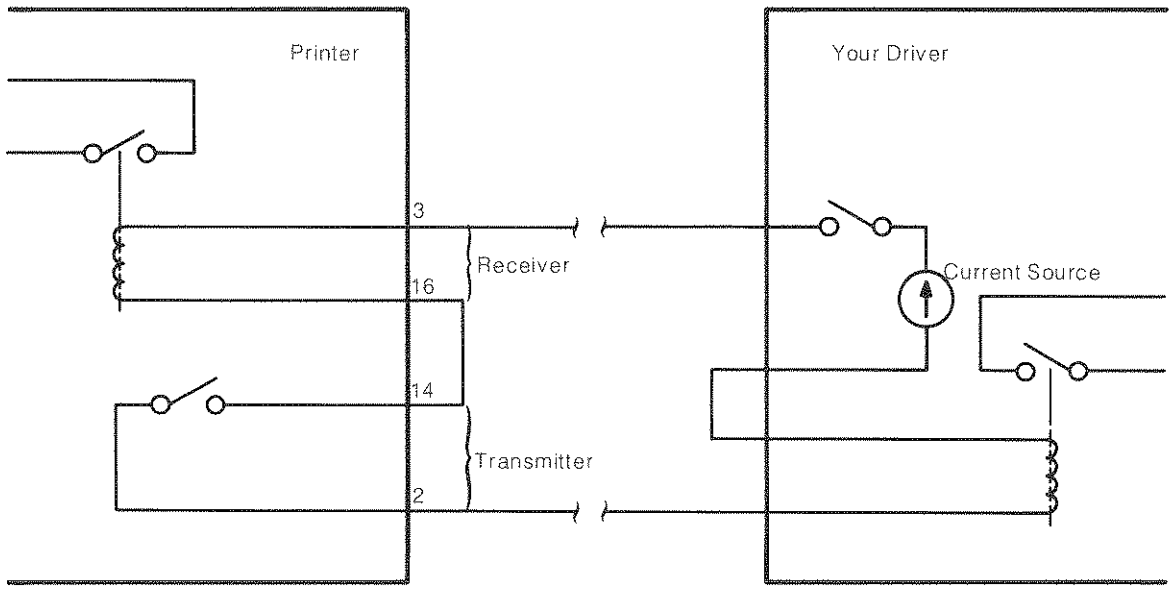
NOTE

The printer is a passive device and does not contain a current source. Your controller (or interface drivers) must supply the current.

Half Duplex

This mode of operation requires only two lines for communication. With this mode, the printer handshake characters are not available (the ACK with ENQ/ACK or the XON/XOFF characters). If these characters were not disabled, the printer could possibly be outputting one of these characters while your driver is outputting to the printer. Printer status, however, is available and should be used to determine the printer's condition (buffer's condition). Your driver should request the printer status periodically then wait for the status return.

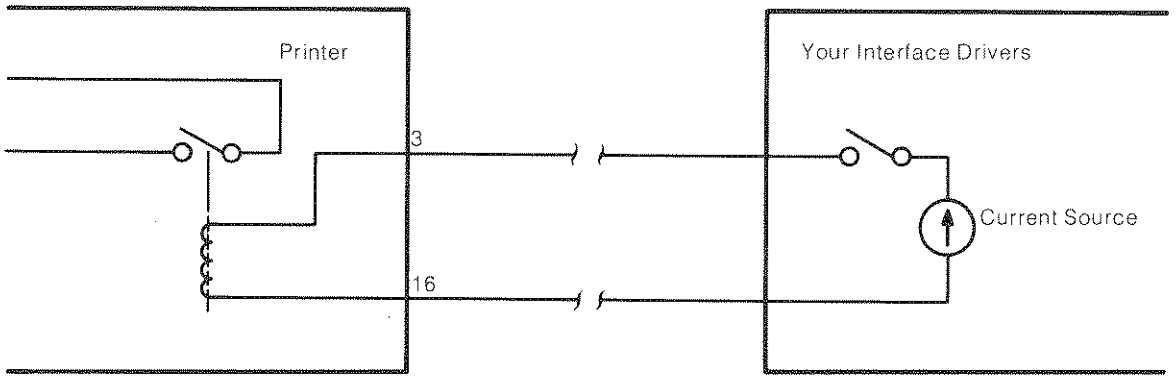
The following is the half duplex representation.



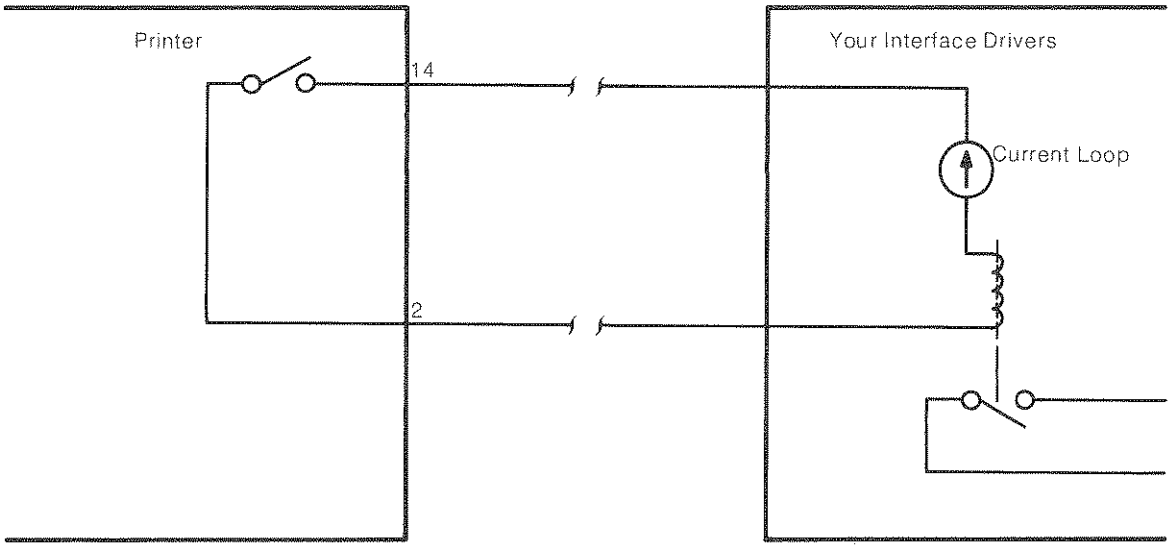
Half Duplex

Full Duplex

The printer can be set to operate in full duplex operation. See the jumper configuration of JS2 in Figure 4-10 and the full duplex configuration shown next.



Transmitting to the Printer



Printer Transmitting Status

A full duplex operation requires that four lines be used in your interface.

NOTE

The printer will never transmitt in half duplex except on a status request (EC ∧, ASCII Decimal 127 and 94).

Padding with nulls is allowed with current loop as well as with RS-232-C.

Baud rate and word length are the same with current loop as with RS-232-C.

The Data Terminal Ready (DTR) signal line is active in XON/XOFF mode, half duplex operation. See the section titled "Hardwire Mode".

Connector Pin Numbers

The following shows the connector as viewed from the back of the printer.

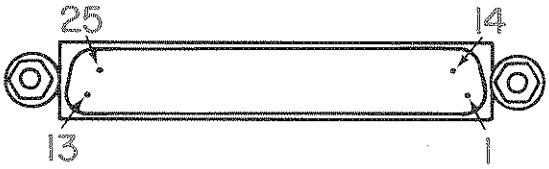


Figure 4-11: Interface Connector

The following table shows the signal names for the above connector.

Table 4-6: Connector Signal Names

Signal Names	Circuit RS-232-C	Pin Numbers	Current Loop
Protective Ground	AA	1	
Transmit Data	BA	2	Transmit Current Out
Receive Data	BB	3	Receive Current In
		4	
		5	
		6	
Signal Ground	AB	7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	Transmit Current In
		15	
		16	Receive Current Out
		17	
		18	
		19	
Data Terminal Ready	CD	20	
		21	
		22	
		23	
		24	
		25	

The following table is the wiring diagram for the prewired cable (P/N 8120-3097).

Table 4-7: Prewired Cable Diagram

Standard Male Connector		Standard Male Connector
Pin	**Signal Name**	**Pin**
1	Protective Ground (shield)	1
2	Transmit Data	2
3	Receive Data	3
4		4
5		5
6		6
7	Signal Ground	7
8		8
9		9
10		10
11		10
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20	Data Terminal Ready	20
21		21
22		22
23		23
24		24
25		25