MODEL 630
PRINTERS/TERMINALS

SPI INTERFACE

90449-01 Rev A November 1981

DIABLO SYSTEMS, INC.

A XEROX Company

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In either of the above cases, 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 are necessary to correct the interference.

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If equipment certified to meet the Class B limits does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: (a) Reorient the receiving antenna. (b) Relocate the computer with respect to the receiver. (c) Move the computer away from the receiver. (d) Plug the computer into a different outlet so that the computer and the receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. In addition, an FCC booklet, "How to Identify and Resolve Radio-TV Interference Problems", Stock No. 004-000-00345-4, is available from the U.S. Government Printing Office, Washington, D.C., 20402.

In those versions of this equipment labeled Class A or B Compliant a shielded and grounded I/O cable is necessary to achieve compliance with the FCC Rules regarding radio emissions from computers. Please consult your authorized Diablo sales representative for further details regarding the cable.

PREFACE

Diablo Systems, Inc., reserves the right to make changes and/or improvements to its products without incurring any obligation to incorporate such changes or improvements in units previously sold or shipped.

This manual describes interfacing and operating considerations pertaining to the Model 630 SPI interface configuration. This is one in a family of manuals covering the Model 630 printers and terminals. For a list of related publications, refer to the Model 630 Product Description manual, Publication No. 90442-XX; or to the Model 630 Communications Terminal Operator's Guide, Publication No. 90445-XX.

Comments on all Diablo publications or their use are invited. Address your comments to:

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WARRANTY

Diablo Model 630 Printers and Terminals are warranted against defects in materials and workmanship for 90 days from the date of shipment. Any questions regarding the warranty should be directed to your Diablo Sales Representative. All requests for repair should be directed to the Diablo Service Center in your area. This will assure you of the fastest possible service.

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	3-23 A				
2-1 A	3-24 A				
2-2 A	3-25 A				
2-3 A					
	4-1 A				
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3-2 A	4-3 A				
3-3 A	4-4 A				
3-4 A	4-5 A				
3-5 A	4-6 A				
3-6 A	4-7 A				
3-7 A	4-8 A				
3-8 A	4-9 A				
3-9 A	4-10 A				
3-10 A					
3-11 A					
3-12 A					
3-13 A					
3-14 A					

TABLE OF CONTENTS

SECTION 1 - GENERAL DESCRIPTION
1.1 General Information 1-1
1.2 Signal Conventions 1-2

SECTION 2 - INTERFACE HARDWARE AND SIGNALS
2.1 General 2-1
2.2 RS-232-C Serial Interface Cable 2-1
2.3 Input/Output Level Converter Circuits 2-1
2.3.1 Input Level Converter 2-1
2.3.2 Output Level Converter 2-2
2.4 Interface Signal Pin Assignments 2-2
2.5 Interface Signal Definitions 2-3

SECTION 3 - OPERATING CONSIDERATIONS
3.1 General 3-1
3.2 Control Codes 3-1
3.3 Escape Code Sequences 3-2
3.4 SPI Communication Protocols 3-3
3.4.1 DC1/DC3 Protocol 3-3
3.4.2 ETX/ACK Protocol 3-3
3.4.3 Printer Ready Protocol 3-4
3.5 SPI Operator Control Panel 3-4
3.5.1 Slide Switches 3-4
3.5.2 Command Switches 3-5
3.5.3 Indicator Lights 3-6
3.5.4 Control Panel Jumpers 3-6
3.6 Printing Format 3-7
3.6.1 Definition of Terms 3-7
3.6.2 Standard Printing Formats 3-9
3.6.3 Proportional Space Printing 3-9
3.6.4 Optional Printing Formats (Variable Indexing) . . . 3-10
3.6.4.1 Variable HMI 3-10
3.6.4.2 Variable VMI 3-11
3.6.4.3 Lines Per Page 3-11
3.7 Forward/Backward Printing 3-11
3.7.1 Auto Backward Printing 3-11
3.7.2 Programmed Backward Printing 3-12
3.8 Control Of Margins 3-12
3.8.1 Horizontal Margins 3-12
3.8.2 Vertical Margins 3-12
3.9 Tabbing 3-13
3.9.1 Absolute Horizontal Tab 3-13
3.9.2 Absolute Vertical Tab 3-13
3.10 Line Feed 3-13
3.11 Half Line Feed 3-14
3.12 Form Feed 3-14
3.13 Graphics 3-14
3.14 Two-Color Ribbon (Optional Feature) 3-14
3.15 Reset/Initialization 3-14
3.16 Carriage Settling Time 3-15
3.17 Program Mode 3-15
3.17.1 Spoke Postion Data (first character) 3-15
3.17.2 Hammer Energy/Ribbon Advance Data 3-16

3.18 Print Wheel Table Down-Load Feature 3-17
3.18.1 General 3-17
3.18.2 Down-Load Data Record Format 3-19
3.18.2.1 Record Start Character 3-19
3.18.2.2 Record Type Character 3-19
3.18.2.3 Byte Count 3-19
3.18.2.4 Load Address 3-19
3.18.2.5 Table Data 3-21
3.18.2.6 Checksum 3-22
3.18.3 Down-Load Procedure 3-22
3.18.4 Sample Down-Load Structure 3-23
3.19 Remote Diagnostics 3-24
3.19.1 ESC SUB I 3-24
3.19.2 ESC SUB R 3-24
3.19.3 ESC SUB 1 3-24
3.19.4 ESC SUB SO 3-24
3.20 Self-Test 3-25

SECTION 4 - OPERATING REFERENCES
4.1 Control Panel Jumpers And Switches 4-1
4.2 ASCII Coding System 4-2
4.3 Print Wheel Code Charts (Typical) 4-3
4.4 Decimal Value Tables 4-5
4.5 Tables For Character Proportional
Space Units & Print Wheel Program Mode 4-8

ILLUSTRATIONS

Figure
1-1 The Model 630 SPI Communications Terminal 1-1
1-2 Model 630 SPI Block Diagram 1-2
1-3 Model 630 SPI Circuit Board Locations 1-2
2-1 EIA RS-232-C Interface Cable 2-1
3-1 Model 630 SPI Control Panel 3-5
3-2 Page Layout And Printing Format 3-8
3-3 Down-Load Variations 3-18
3-4 Down-Load Record Format 3-18
3-5 Down-Load Table Memory Map 3-20
3-6 Sample Down-Load Structure 3-23
4-1 ASCII Code Chart 4-2
4-2 96-Character Print Wheel - Plastic 4-3
4-3 96-Character Print Wheel - Metal (Diablo) 4-4

TABLES

Table
2-1 EIA Interface Connector Pin Assignments 2-2
2-2 Cable Wiring From EIA Connector To SPI Circuit Board . . . 2-2
3-1 Standard Printing Formats 3-9
4-1 Control Panel Jumpers 4-1
4-2 Control Panel Switches 4-1
4-3 Decimal Values Of ASCII Characters 4-5

4-4 ASCII Values For ESC Sequences - Set HMI, Set VMI 4-6
4-5 ASCII Values For ESC Sequences - Set Lines/Page, Set Absolute Horizontal Tab, Set Absolute Vertical Tab . . 4-7
4-6 Character Proportional Space Units - Metal Print Wheels 4-8
4-7 Character Proportional Space Units - Plastic Print Wheels 4-9
4-8 Print Wheel Program Mode - Characters For Hammer Energy And Ribbon Advance 4-10

SECTION 1

GENERAL DESCRIPTION

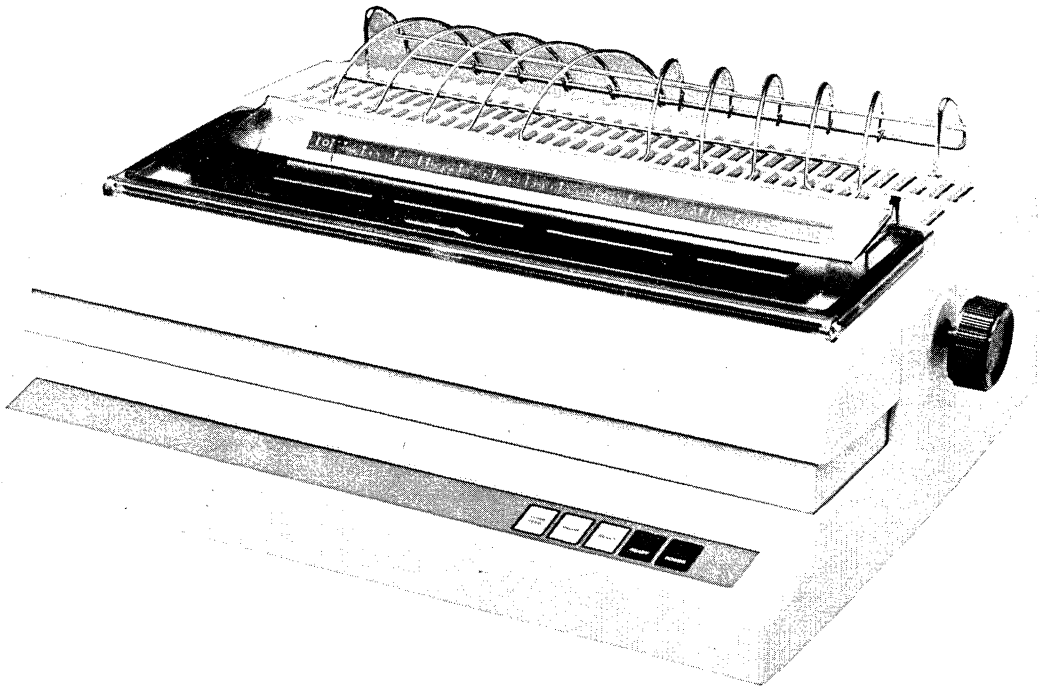


Figure 1-1. THE MODEL 630 SPI COMMUNICATIONS TERMINAL

1.1 GENERAL INFORMATION

In a typical application, the Model 630 SPI Communications Terminal communicates with a host computer or remote terminal through a data link comprised of telephone lines and a pair of modems. The SPI (Serial Printer Interface) is compatible with the Bell 103A modem and other modems compatible with the Bell 103A. It is capable of operating at data transfer rates of 300 and 1200 baud. The SPI communicates using the USA Standard Code for Information Interchange (ASCII) and conforms to EIA interface standard RS-232-C.

Figure 1-2 contains a block diagram depicting the major assemblies of the Model 630 SPI. There are two major circuit boards; the SCE and the SPI. The interface circuits are contained on the SPI circuit board. The SPI board acts as a system controller. It receives serial ASCII data via its RS-232-C interface, and processes the data into control signals to the SCE circuit board and into drive signals for some of the associated printer mechanism (paper feed and ribbon control).

The control panel interfaces directly to the SPI circuit board. A module of slide switches on the control panel permits selection of operating parameters (baud rate, spacing, parity, etc.), and three touch-action switches are used to command Reset, Pause or Form Feed. There is also an easily-accessible jumper strip located on the control panel circuit board to allow selection of page size and control of Auto Line Feed and Auto Carriage Return.

Figure 1-3 shows the location of the SPI and SCE circuit boards within the Model 630.

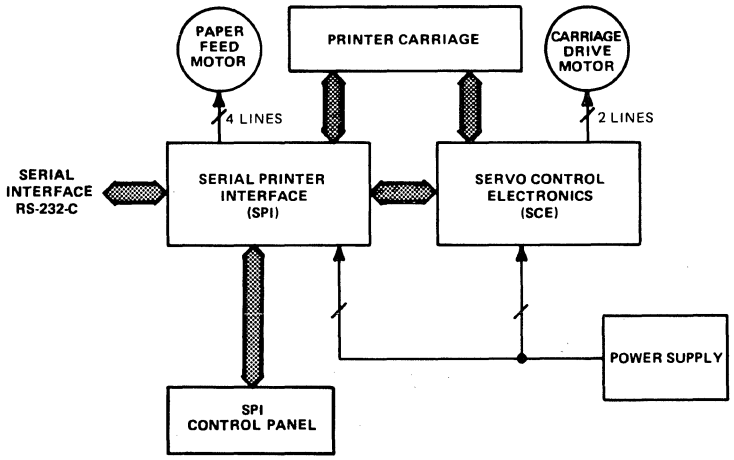


Figure 1-2. MODEL 630 SPI BLOCK DIAGRAM

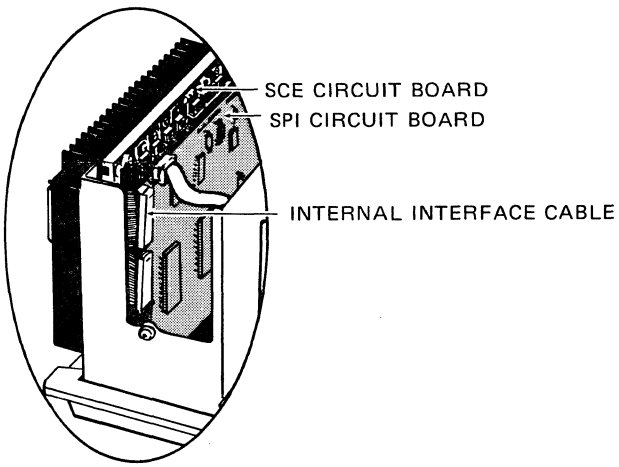


Figure 1-3. Model 630 SPI CIRCUIT BOARD LOCATIONS

1.2 SIGNAL CONVENTIONS

All signal designations used in this manual comply with the following conventions.

1) A signal name prefixed by a " - " symbol (as in -Rx DATA) identifies a signal whose active state is a low electrical level.

2) A signal name prefixed by a " + " symbol (as in +DTR) identifies a signal whose active state is a high electrical level.

3) Electrical levels are indicated by "H" (HI) or "L" (LO). HI indicates an electrical level greater than 2.4 volts. LO indicates an electrical level less than 0.8 volts.

4) The "true" state of a signal is indicated by a logical "1", and the "false" state by a logical "0", regardless of electrical levels. For example, -Rx DATA = 1 = LO; and +DTR = 1 = HI.

SECTION 2

INTERFACE HARDWARE AND SIGNALS

2.1 GENERAL

The information in this section pertains to the signal interface only. Information regarding power supplies, grounding requirements, ventilation and physical space requirements is contained in Section 2 of the Model 630 Product Description manual, Publication No. 90442-XX.

2.2 RS-232-C SERIAL INTERFACE CABLE

An accessory EIA RS-232-C compatible interface cable is available from Diablo for use with the Model 630 SPI. This cable is illustrated in Figure 2-1. Nominal cable lengths available are 6, 10, 15, 25 and 50 feet. This cable is terminated on both ends with a D-subminiature Cannon or Cinch DB-25P connector which mates with the connector found on most modems and with the EIA connector on the back of the Model 630. The Diablo part numbers for this cable are listed below:

320355-XX EIA interface cable - shielded for FCC compliance

(-XX)	Length (ft.)
-01	6
-02	10
-03	15
-04	25
-05	50

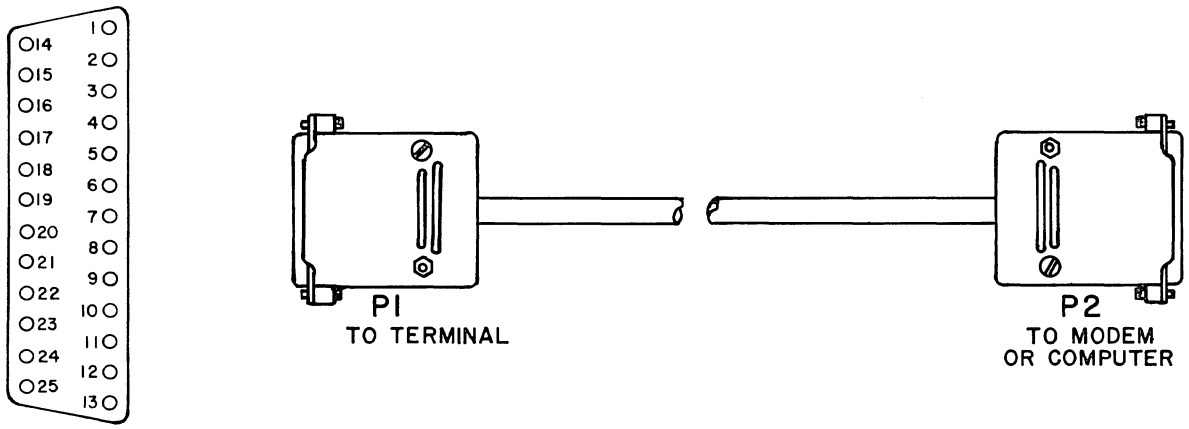


Figure 2-1. EIA RS-232-C INTERFACE CABLE

2.3 INPUT/OUTPUT LEVEL CONVERTER CIRCUITS

2.3.1 Input Level Converter

The Model 630's SPI circuit board uses type 75154 quad line receiver integrated circuits to convert the +/-12V modem signals into +5V and 0V for use by the TTL logic in the Model 630. These circuits are capable of handling the +/-25V maximum voltage swings allowed under EIA Standard RS-232-C. Input resistance is from 3K to 7K ohms, with 5K typical.

2.3.2 Output Level Converter

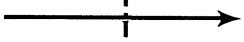
Type 75150 line driver integrated circuits are used to convert the TTL levels used within the Model 630 into +/-12V levels suitable for use on the RS-232-C interface. These circuits can withstand sustained output short circuits to any low-impedance voltage within the RS-232-C range (+/-25V).

2.4 INTERFACE SIGNAL PIN ASSIGNMENTS

Table 2-1 lists the EIA RS-232-C interface connector pin assignments that are used by the SPI. The direction of signal flow at the interface is indicated by the arrows in the Table.

Table 2-2 provides a pin-to-pin wiring list for the internal interface cable that connects from the EIA interface connector to connector J5 on the SPI circuit board. This internal cable is pointed out in Figure 1-2.

Table 2-1
EIA INTERFACE CONNECTOR PIN ASSIGNMENTS

Signal Direction Terminal	Signal Direction Modem	Pin Number	CCITT	TelCo	Signal
		1	101	AA	CHASSIS GROUND
		2	103	BA	-TRANSMITTED DATA *
		3	104	BB	-RECEIVED DATA *
		4	105	CA	+REQUEST TO SEND
		6	107	CC	+DATA SET READY *
		7	102	AB	SIGNAL GROUND
		20	108	CD	+DATA TERMINAL READY

* Notes: In those installations where the Model 630 is to be used with an input direct from the host system rather than thru a modem, the user must ensure the following conditions:

1. The +DATA SET READY input must be held HI during data input.
2. All status conditions required by the host system must be satisfied.
3. The transmitted data from the Model 630 must connect to the received data input of the host computer, and vice versa. In some cases, it may be necessary to alter the wiring at one end of the I/O cable to exchange the two wires connected to pins 2 and 3 of the I/O connector.

Table 2-2
CABLE WIRING FROM EIA CONNECTOR TO SPI CIRCUIT BOARD

EIA Pin	To SPI Pin	Signal Designation at SPI Board
1	1	CHASSIS GROUND
2	3	-Tx DATA
3	5	-Rx DATA
4	7	+RTS
6	11	+DSR
7	13	GND
20	14	+DTR

2.5 INTERFACE SIGNAL DEFINITIONS

CHASSIS GROUND - Connects to chassis ground within the Model 630.

-Tx DATA - This is the serial ASCII-coded digital data being transmitted by the Model 630. This line is in the "mark" state (LO) between characters, rises for logic 0 and drops for logic 1.

-Rx DATA - This is the serial ASCII-coded digital data being received by the Model 630. This line must be held in the "mark" state (LO) between characters. It should go HI for logic 0, and LO for logic 1.

+RTS - Held HI (+12V) whenever power is ON.

+DSR - Must be ON (HI) for Model 630 operation in Remote mode. If OFF (LO), no data can be received. (Also see "Notes" for Table 2-1.)

GND - Ground reference for all other interface signals.

+DTR - This signal from the Model 630 controls connection and disconnection of the data communication equipment (the modem) to and from the communication channel. The operation of this signal conforms to EIA RS-232-C specifications.

SECTION 3

OPERATING CONSIDERATIONS

3.1 GENERAL

This section of the manual contains a detailed discussion of the operating features of the Model 630 SPI. The procedures for routine operator duties, such as changing ribbons and print wheels, are given in detail in the Model 630 Operator's Guide and thus are not repeated here.

A few of the functions and operating parameters of the SPI are controlled by switches and jumpers on the SPI operator control panel. However, as an RO (Receive-Only) terminal, most of its functions and operating parameters are controlled by Control Codes received via the interface from the host computer or another remote terminal. Many of these Control Codes are 2- and 3-character ESCAPE sequences which are summarized in subsection 3.3.

3.2 CONTROL CODES

The Model 630 responds to a standard set of ASCII Control Codes. The standard ASCII Code Chart shown in subsection 4.2 lists the Control Characters and their corresponding ASCII codes (although the operator normally need not be concerned with the actual codes for the Control Characters). The Control Characters, as they apply to the Model 630 SPI, are defined below.

ACK - This code is used in conjunction with ETX for the ETX/ACK alternative communication protocol. (See subsection 3.4.2.)

BEL - Updates all summarized motion and suspends processing of further characters until all printer activity is complete.

BS - Backspaces the carriage one print position (HMI) in Normal mode, or 1/60 inch in Graphics mode. Direction of movement reverses in the Backward Print mode.

CR - Causes a carriage return. If Jumper #2 is installed on the control panel, a line feed operation also occurs (see subsection 3.5.4).

DC1 - This code is used in conjunction with DC3 for communication protocol. (See subsection 3.4.1.)

DC2 - Used in the sequence ESC SO DC2 to exit down-load mode.

DC3 - This code is used in conjunction with DC1 for communication protocol. (See subsection 3.4.1.)

DC4 - This character is used to cause exit from the print wheel down-load mode.

DEL - This character is ignored by the Model 630 SPI when received over the communications link. It can be used as a buffer or "sluff" code the same as NUL.

ETX - This code is used in conjunction with ACK for the ETX/ACK alternative communication protocol. (See subsection 3.4.2)

NAK - Transmitted by the terminal when an error condition is detected.

ESC - This code is always received as the first character of a 2- or 3-character command sequence. (See subsection 3.3.)

FF - Initiates form feed to the top of the next form (page), or to the top margin on the next form or page if one is set.

LF - Initiates movement of the paper up one line (one VMI). Movement changes to 1/48" per command in the Graphics mode.

NUL - This character is ignored by the Model 630 SPL. It can be used as a buffer or "sluff" code.

SI - Turns off program mode.

SP - Initiates movement of the carriage one print position (HMI) in Normal mode.

3.3 ESCAPE CODE SEQUENCES

The Escape mode is entered by receiving the ESC control code over the communications interface. This code is always received as the first character of a 2- or 3-character "Escape Code Sequence". The ESC code conditions the Model 630 to receive the next one or two characters, uninterrupted by a CR, as commands and not print data. Upon receiving the last character in the ESC code sequence, the Model 630 executes the command, and the Escape mode terminates.

The following list summarizes the ESC code command sequences.

Characters (1)	(2)	(3)	Description of Command
ESC	3		Graphics mode ON (clear with CR)
ESC	4		Graphics mode OFF
ESC	5		Forward Print mode ON
ESC	6		Backward Print mode ON*** (clear with CR)
ESC	9		Set Left Margin at current Carriage (print) position
ESC	0		Set Right Margin at current Carriage (print) position
ESC	HT	(n)	Initiate Absolute Horizontal Tab to print position (n)*
ESC	LF		Perform Negative Line Feed
ESC	VT	(n)	Initiate Absolute Vertical Tab to line (n)*
ESC	FF	(n)	Set lines per page to (n)*
ESC	CR	P	Initiate Remote RESET (Allow 1 sec for completion before next command)
ESC	RS	(n)	Set Vertical Motion Index (VMI)to (n-1)**
ESC	US	(n)	Set Horizontal Motion Index (HMI) to (n-1)**
ESC	A		Print in Secondary Color (red - ribbon down)
ESC	B		Print in Primary Color (black - ribbon up)
ESC	C		Clear Top and Bottom Margins
ESC	D		Perform Negative Half-Line Feed
ESC	U		Perform Half-Line Feed
ESC	L		Set Lower Page Margin at current paper position
ESC	T		Set Top Page Margin at current paper position
ESC	Y		Print the Print Wheel Character under ASCII Code 20_{16}
ESC	Z		Print the Print Wheel Character under ASCII Code $7F_{16}$
ESC	/		Enable Auto Backward Printing mode
ESC	\		Disable Auto Backward Printing mode

ESC	S		Set HMI to value defined by setting of SPACING switch
ESC	SYN	(n)	Select metal/plastic print wheel if no control panel is installed (n = @ for metal, and n = H for plastic)
ESC	P		Proportional Space ON (cleared by ESC S)
ESC	Q		Proportional Space OFF
ESC	%		Increase carriage settling time to 20 ms
ESC	N		Restore normal carriage settling time
ESC	SO	M	Program mode ON (cleared by ESC X or control character SI)
ESC	SUB	I	Initialize the Printer (allow 1 second for completion)
ESC	SUB	R	Remote Error Reset (allow 250 msec for completion)
ESC	SUB	1	Request Status Byte 1
ESC	SUB	SO	Execute Self Test and Report Status
ESC	SO	DC2	Enter Print Wheel Table Down-Load Mode (Exit by DC4)

* = See subsection 4.4, Table 4-5, to obtain ASCII values for setting Absolute Horizontal Tab, Absolute Vertical Tab, and Lines/Page.

** = See subsection 4.4, Table 4-4, to obtain ASCII values for setting HMI and VMI.

*** = See subsection 3.7.2 for prerequisite conditions.

3.4 SPI COMMUNICATION PROTOCOLS

The print buffer in the Model 630 SPI has a capacity of 320 bytes. The communication protocols prevent print buffer overflow when print data is being received faster than the print buffer is being emptied. A communication protocol is required by the Model 630 at all baud rates above 300, and in some applications may also be required at and below 300 baud.

A 2-position PROTOCOL switch on the SPI control panel enables selection of DC1/DC3 or Printer Ready communication protocol. ETX/ACK protocol can also be used simultaneous with either DC1/DC3 or Printer Ready. In addition to print buffer control, the DC1/DC3 and Printer Ready protocols also respond to error conditions within the Model 630.

3.4.1 DC1/DC3 Protocol

In DC1/DC3 protocol, a DC3 control code character is transmitted by the Model 630 when printing is attempted under any of the following conditions:

1. Print buffer nearly full (within 64 bytes)
2. Cover Open
3. Paper Out
4. End of Ribbon
5. Printer in Check condition

Once a DC3 has been transmitted, the Model 630 will transmit a DC1 character when the print buffer is nearly empty (within 64 bytes) and conditions 2 thru 5 do not exist. Conditions 2 thru 5 can be cleared by pressing the RESET switch on the control panel.

3.4.2 ETX/ACK Protocol

The Model 630 SPI will respond also to this protocol when the Protocol switch is set for either DC1/DC3 or Printer Ready protocol. When the host computer sends a string of print data to the terminal, it includes an ETX control code character at the end of the string. When the ETX character eventually is retrieved from the print buffer, the Model 630 transmits an ACK character back to the host to indicate that it is ready to accept more data. With this protocol, the host is burdened with the responsibility of ensuring that any data string transmitted does not exceed the capacity of the print buffer (320 bytes). This is necessary because the terminal does not send a response to indicate when the print buffer is nearly full.

3.4.3 Printer Ready Protocol

Printer Ready protocol uses a dedicated interface line instead of special control characters as used with DC1/DC3 and ETX/ACK. When the SPI's PROTOCOL switch is set for Printer Ready, the PRINTER READY signal controls the Data Terminal Ready (Pin 20) interface line. The +PRINTER READY signal goes LO when printing is attempted under any of the following conditions:

1. Print buffer becomes nearly full (within 64 bytes)
2. Cover open
3. Paper out
4. End of ribbon
5. Printer in Check condition

The +PRINTER READY signal returns HI when the print buffer becomes nearly empty (within 64 bytes) and all the other conditions are corrected.

When the PROTOCOL switch is not set for Printer Ready protocol, the Data Terminal Ready interface line (pin 20) is at a continuous HI level.

3.5 SPI OPERATOR CONTROL PANEL

The layout of the SPI control panel is illustrated in Figure 3-1. The switches and indicators on this control panel include a module of eight slide switches, three momentary-action membrane switches and two indicator lights. The eight slide switches are used to set some of the basic operating parameters of the unit. These parameters are: type of print wheel, character spacing, protocol, baud rate, parity and self-test. These switches are normally covered by the Model 630's access cover.

The three membrane switches are used to command form feed, pause and reset. The two lights indicate "power-on" and "ready".

In addition to these switches and indicators, there is an easily-accessible jumper strip on the control panel circuit board. This permits selection of certain semi-permanent operating parameters by installation of jumper plugs between appropriate pins on the jumper strip.

Each of the above-mentioned switches, indicators and jumpers is defined in the following paragraphs.

3.5.1 Slide Switches

The label located to the left of the switch module identifies each switch by number and function, and lists the various settings for each switch. The arrowheads denote the position of the corresponding switch slider for each function. Notice that switches 2-3 and 6-7 function as pairs.

PRINT WHEEL Select - This switch sets the SPI to operate with either a Metal or Plastic print wheel. The switch setting selects between two internal lookup tables containing parameter values (hammer energies, PS units, spoke addresses) directly suitable for the operation the presently available Diablo print wheels listed below with their Diablo part numbers (P/N).

P/N	Plastic	P/N	Metalized
38101-01	Pica 10	311900-01	Titan 10
38102-02	Elite 12	311901-01	Cubic PS
38107-01	Courier 72	311903-01	Elite 12
38147	Forms Gothic		

To accommodate print wheels that require parameter values different than those supplied by these two tables, a down-load procedure can be used to remotely load an appropriate print wheel table from the host computer to the Model 630. (See subsection 3.18)

SPACING - The four different combinations of settings of switches 2 and 3 provide selections for 10, 12 and 15 characters/inch, and for proportional spacing. If the Horizontal Motion Index (HMI) is changed from its standard value, the SPACING switches are ignored.

PROTOCOL - This switch selects between DC1/DC3 and Printer Ready protocols. (See subsection 3.4) ETX/ACK protocol is also recognized under either position of this switch.

BAUD - Selects either 300 or 1200 baud as the data transfer rate.

PARITY - There are four combination settings for switches 6 and 7. Two combinations select Parity-On: Odd or Even. The other two combinations select Parity Off: Mark or Space. The Mark and Space selections determine whether the parity bit of characters transmitted by the Model 630 is always a mark or always a space when parity is Off.

SELF-TEST - If this switch is in the ON position when power is applied, the unit enters the self-test mode. The self-test consists of a ROM test, a RAM test and 96 lines of swirl text. See subsection 3.20 for further information regarding Self-Test.

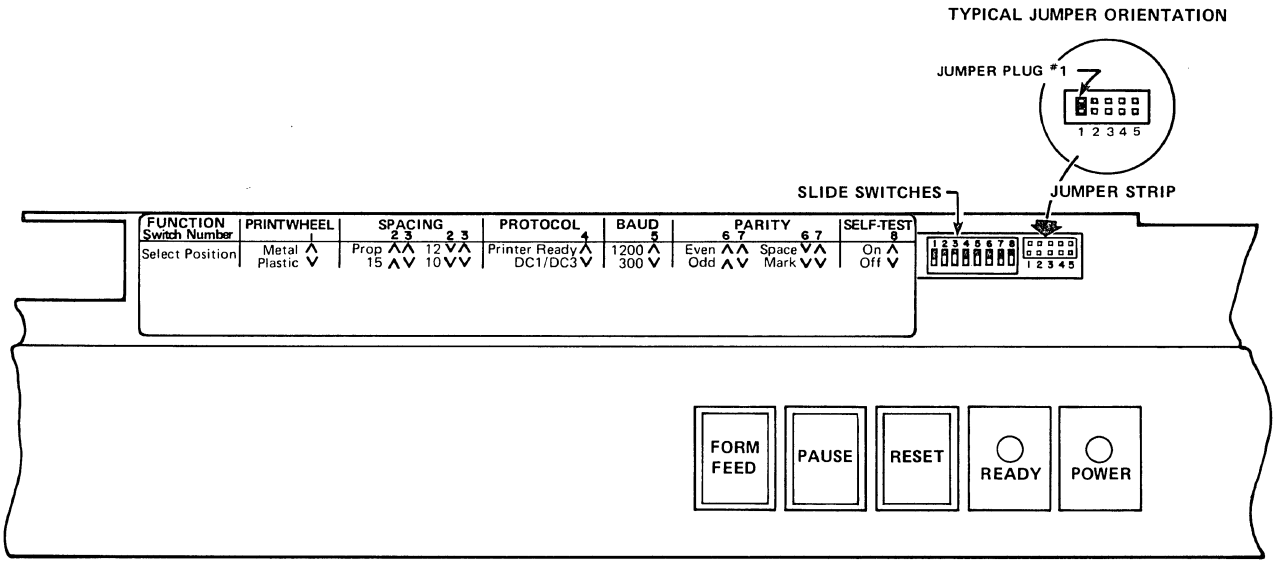


Figure 3-1. MODEL 630 SPI CONTROL PANEL

3.5.2 Command Switches

FORM FEED - When this switch is pressed, a local form feed operation occurs without causing a form feed code to be transmitted through the interface. The form feed operation causes the paper to be moved upward so that the print head is positioned at the first line of the next page, or at the top margin line if one has been set.

PAUSE - This switch allows the operator to interrupt printer operation without loss of data. Any command in process when this switch is pressed will be completed, but no new commands will be dequeued from the print buffer. No commands will be lost as long as communication protocols (ETX/ACK, DC1/DC3 or PRINTER READY) are observed. When the PAUSE switch is pressed, the READY light turns OFF. The printer will resume normal operation when the RESET switch is pressed if all error conditions have been cleared.

RESET - When pressed, this switch causes a restore operation if a Check condition is present. The flashing READY light, indicating an error condition, is cleared to its steady ON state.

3.5.3 Indicator Lights

POWER - ON when power is applied to the Model 630.

READY - ON when no error conditions are detected.
OFF when in pause mode, or when DATA SET READY is false.
FLASHING when any of the following error conditions are present:

1. The printer is in check and printing is attempted.
2. A cover-open condition has been detected.
3. A paper-out condition or end-of-ribbon condition has been sensed and printing is attempted.
4. Any of the following errors are detected:
   - Incorrect parity in received character.
   - A framing error (no stop bit) in received character.
   - UART overrun.
5. Print Buffer overflow.

3.5.4 Control Panel Jumpers

The jumper positions are shown in Figure 3-1, along with an enlarged view showing the proper orientation of an installed jumper plug. Jumper plugs are available from local Diablo Sales Representatives as Diablo part number 100398-01. In situations where a jumper is not subject to removal, a wire-wrapped jumper may be used in place of a jumper plug.

Position	Function	In/Out	
1 -	12" PAGE SIZE		
		In -	Page size defaults to 12" (72 lines per page) when unit is initialized by: Power-up, ESC CR P, or ESC SUB L
		Out -	Page size defaults to 11" (66 lines per page).
2 -	AUTO LINE FEED		
		In -	A line feed is performed with each carriage return (CR) character.
		Out -	Line feed occurs only on receipt of a line feed (LF) character.

3 - AUTO CR DISABLE

In - An automatic carriage return will not occur when attempting to print past the maximum right-hand horizontal position (i.e., 1572 1/120" increments).

Out - An automatic carriage return occurs when the carriage reaches the maximum horizontal position.

4 - RESERVED

5 - RESERVED

3.6 PRINTING FORMAT

Printing format is dependent on three main factors: horizontal character spacing, vertical line spacing, and number of lines per page. Each of these factors can be independently controlled. Any point on a page can be defined in terms of a "horizontal position" and a "vertical position". The number of lines per page can easily be changed when necessary.

3.6.1 Definition of Terms

Figure 3-2 and the text below describe some of the points associated with a simple page layout.

ORIGIN: The position of the print head after a form feed (with no top margin set) and an absolute horizontal tab to print position 1 (horizontal position 0). The first print position on the first line of a page.

HORIZONTAL MOTION INDEX (HMI): The distance that the carriage moves after printing a character (or when spacing). This distance is in multiples of 1/120 inch. Minimum HMI is 0, maximum is 125.

VERTICAL MOTION INDEX (VMI): The distance that the paper (platen) moves for each line feed, negative line feed, etc. This distance is in multiples of 1/48 inch. Minimum VMI is 0, maximum is 125. When VMI = 0, no paper movement occurs.

ABSOLUTE HORIZONTAL POSITION: The horizontal distance, in 1/120 inch increments, between the print head position and the origin. Minimum absolute horizontal position is 0, maximum is 1572 (13.1" x 120).

ABSOLUTE VERTICAL POSITION: The vertical distance, in 1/48 inch increments, between the current print line and the first line on the page (the origin). Minimum absolute vertical position is 0, maximum is 15,750 (125 x 126 lines per page).

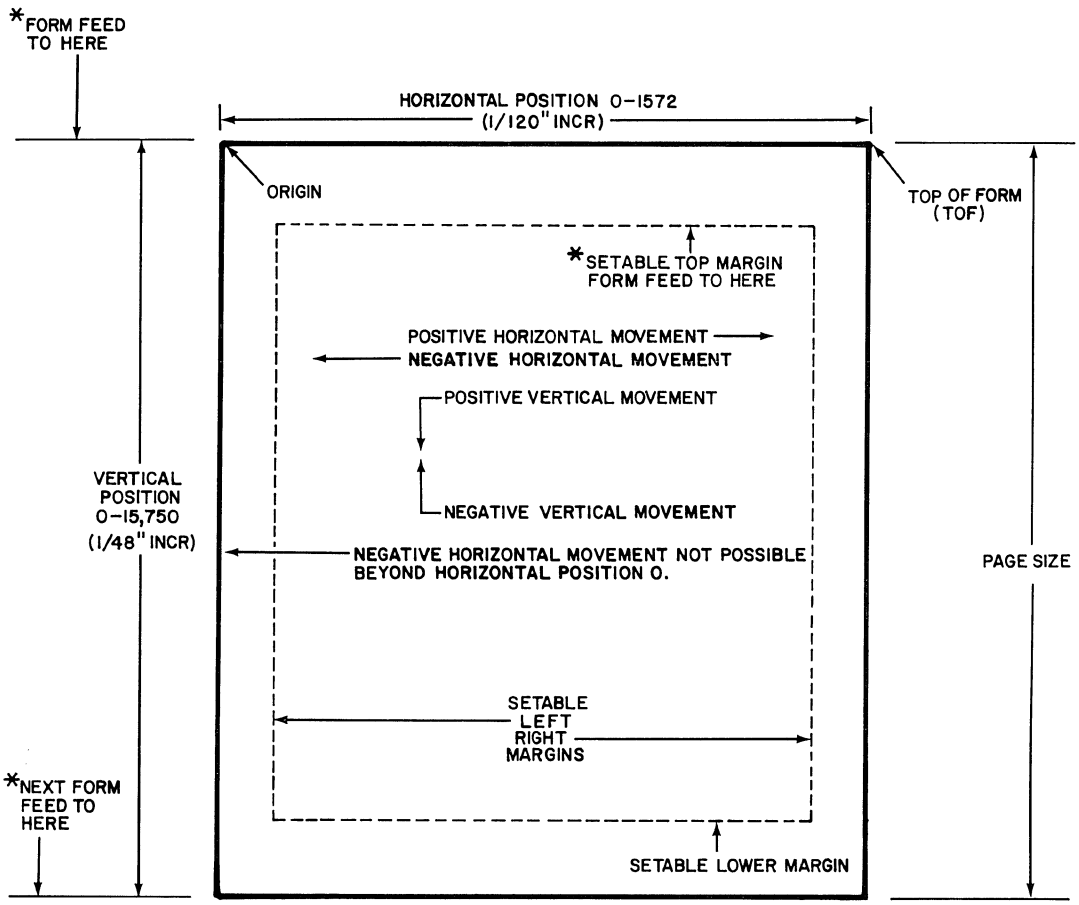
PRINT POSITION: The horizontal area capable of being occupied by a single printed character. This is similar to a print "column" on a line printer, except that it is variable. That is, the number of print positions per line is dependent on the HMI. The minimum number of print positions per line is 13 when HMI = 125, the maximum is 1573 when HMI = 1. The leftmost print position is position 1. Print position may be calculated as follows:

$$\text{Print Position} = \frac{\text{Horizontal Position}}{\text{HMI}} + 1$$

LINE: The vertical distance capable of being occupied by a row of printed characters. The height of the line is equal to VMI. Line number may be calculated as follows:

$$\text{Line Number} = \frac{\text{Vertical Position}}{\text{VMI}} + 1$$

LINES PER PAGE: The actual number of print lines per page of paper. Lines per page can be set to any number from 1 thru 126.



Width of Print Position = Horizontal Motion Index (HMI) and is variable from 0 to 125 (1/120") increments.

Print Position Number = $\frac{\text{Horizontal Position}}{\text{HMI}} + 1$ = Horizontal Tab Position. Tab Positions limited to first 160 Print Positions.

Height of Line = Vertical Motion Index (VMI) and is variable from 0 to 125 (1/48") increments.

Line Number = $\frac{\text{Vertical Position}}{\text{VMI}} + 1$ = Vertical Tab Position. Total number of lines can be specified from 1 to 126.

Page Size = Number of lines x VMI.

* If a top margin is set, the Form Feed will advance beyond the Top of Form to the top margin.

Note: *Movement* arrows depict carriage movement relative to paper and not actual paper movement direction.

Figure 3-2. PAGE LAYOUT AND PRINTING FORMAT

3.6.2 Standard Printing Formats

There are three "standard" printing formats that can be selected via the SPACING switches (2 and 3) on the control panel. These formats are summarized in Table 3-1.

Table 3-1
STANDARD PRINTING FORMATS

	Horizontal Spacing			Vertical Spacing		
SPACING Switch	Char/in.	Char/line	HMI	Lines/in.	Lines/page	VMI
10	10	132	12	6	66	8
12	12	158	10			
15	15	197	8			

Whenever the SPACING switches are repositioned and an optional format has not been selected, the newly-selected value listed in the table is used for horizontal spacing.

Although not listed as one of the "standard" formats in Table 3-1, the SPACING switches may also be set for proportional spacing.

Additional formats can be obtained by changing the HMI, VMI, or Lines Per Page. Such variable indexing of the HMI overrides the SPACING switch function. Control may be restored to the SPACING switches by issuing the ESC S sequence. The VMI and Lines Per Page are unaffected by ESC S.

3.6.3 Proportional Space Printing

Proportional space printing is a standard feature of the Model 630 SPI. The proportional space mode facilitates use of proportional space (PS) print wheels (Bold PS, Roman PS, etc.) on the Model 630. The print wheel lookup tables that are stored in the Model 630's memory include PS unit values. These PS unit values represent one-half the width required by each proportionally spaced character. Carriage movement during proportional space printing is controlled by printing each character as part of the sequence: Move-Print-Move; where the amount of "Move" is specified by the PS unit value assigned to that character. The letter "V", for example, has a PS value of 6, which is one-half of the 12/120" spacing a "V" requires. The "V", therefore, would be printed in the sequence: Move 6/120" - Print - Move 6/120". The sequence for printing an "i" (PS value 3) following the "V" would be: Move 3/120" - Print - Move 3/120". The total space between the "V" and the "i" would be 6/120" + 3/120" = 9/120".

In fixed pitch mode, the printing sequence is Print-before-Move. The size of the Move is determined by the current active HMI value, which is selected by the SPACING switches on the control panel or by remote HMI mode (see subsection 3.6.4.1).

The Model 630's resident (internal) print wheel table for metalized print wheels contains PS unit values appropriate for the Titan 10, Cubic PS and Elite 12 Diablo 96-character metalized print wheels. For print wheels that require different PS unit values, it is necessary for the host computer to down-load a print wheel table that contains appropriate PS unit values.

The proportional space mode is selected by the SPACING switches on the control panel, unless the terminal is in the Remote HMI mode (see subsection 3.6.4.1), in which case the SPACING switches are ignored. When proportional spacing is selected by the SPACING switches, the HMI automatically goes to 12 pitch.

The proportional space mode may also be selected by the sequence ESC P, and turned off by the sequence ESC Q. Once the ESC P sequence has been received, the SPACING switches will be ignored and proportional spacing is used. When the ESC Q sequence is received, the Model 630 exits the proportional space mode, and horizontal spacing is then determined by the current HMI value until an ESC S sequence is received. An ESC S sequence returns control to the SPACING switches.

Entering and exiting proportional space mode via the Escape sequences does not change the HMI to 12 pitch as happens when proportional space selection is made by means of the SPACING switches. During proportional space mode, the HMI affects only tabbing and word space size (space and backspace).

There are times when certain data needs to be printed nonproportionally spaced even though a PS print wheel is being used in the Model 630. For example, when the display from a video terminal is to be printed to illustrate a document; if it is printed proportionally spaced, the columnar alignment of the information is lost. To avoid this, issue the ESC Q sequence to exit the proportional space mode, then issue an ESC US DLE sequence to set the HMI to 15, which is adequate to print all characters on the PS print wheel without any characters touching. When the nonproportionally spaced printing has been completed, revert to normal HMI by executing the ESC S sequence, and return to proportional space mode by executing an ESC P sequence.

All numeric characters have the same PS unit value (5). This allows numeric data to be printed aligned in columnar form without having to turn off proportional space printing. The starting position of the columns can be established by using the absolute horizontal tab to move to the starting position (see subsection 3.9.1). If you are altering the value of the HMI during the print of each line, be sure that the HMI has the same value prior to each movement to the beginning of the column, to ensure that the starting position does not change.

Proportional space printing is accomplished by move, print, move. This differs from normal printing which is print before move. The size of the moves are equal to the ribbon advance data, which is assumed to be half of the character width. (In the normal space mode, ribbon advance is controlled by an internal ribbon advance lookup table.) The size of space is 10 units. The size of backspace is determined by the last printed character (or space if it was last).

3.6.4 Optional Printing Formats (Variable Indexing)

Any of the three main format factors (character spacing, line spacing and lines per page) can be altered by utilizing special escape (ESC) sequences. The ESC CR P (remote RESET) sequence may also be used here to cancel all optional format factors and return to the horizontal character spacing selected by the SPACING switches.

Execution of any of these sequences does not immediately alter the current horizontal or vertical position. It does, however, change subsequent operations by redefining the variable format factors. It is recommended that a Form Feed and an Absolute Tab (see subsection 3.9.1) to location 0 be performed prior to changing any format factors.

3.6.4.1 Variable HMI

The standard HMI can be altered by executing the 3-character sequence ESC US (ASCII character), where the binary value of the selected ASCII character is one (1) greater than the number of 1/120 inch increments the carriage will move after printing a character or when spacing. This places the terminal in the remote HMI mode, during which the SPACING switch is ignored.

HMI = (ASCII character - 1) x 1/120 inch

NUL and DEL characters cannot be used, therefore the minimum HMI is 0 increments, and the maximum is 125 increments. See subsection 4.4, Table 4-4, to determine the appropriate ASCII character for the ESC sequence. The 2-character sequence ESC S will return control of HMI to the SPACING switch.

3.6.4.2 Variable VMI

The standard VMI can be altered by executing the 3-character sequence ESC RS (ASCII) character), where the binary value of the ASCII character is one (1) greater than the number of 1/48 inch increments the paper is to move for each line feed, negative line feed, etc.

VMI = (ASCII character - 1) x 1/48 inch

Minimum VMI is 0, maximum is 125. See subsection 4.4, Table 4-4, to determine the appropriate ASCII character for the ESC sequence.

3.6.4.3 Lines Per Page

Lines per page is automatically set at 66 when the unit is initialized (see subsection 3.15). The number of lines per page can be altered by executing the 3-character sequence ESC FF (ASCII character) where the binary value of the ASCII character is equal to the number of lines per page desired. The minimum number of lines per page is 1; the maximum number is 126.

The following two formulas can be used to compute the desired number of lines per page:

Lines Per Page = Number of Lines Per Inch x Page Size in Inches

$$\text{Number of Lines Per Inch} = \frac{48}{\text{VMI}}$$

Once the desired number of lines per page is known, the information in subsection 4.4, Table 4-5, can be used to determine the appropriate character for the ESC sequence.

3.7 FORWARD/BACKWARD PRINTING

The Model 630 is capable of printing forward (left to right) or backward (right to left). It is capable of both Automatic and Programmed backward printing.

3.7.1 Auto Backward Printing

Auto backward printing is enabled by the sequence ESC /. It is disabled by the sequence ESC \. When the Model 630 is operating in the Auto Backward Printing mode, a line of text will be printed in the reverse direction only if all of the following conditions exist:

1. Auto backward printing is enabled.
2. Printing is at least one line behind print-queued data.
3. The line in question does not attempt to print beyond position 1572. In other words, a carriage return (CR) code is placed such that it will end the line before it would automatically wrap around and start a new line of print.
4. If it is a shorter distance for the carriage to move to the right-hand end of the next line than to move to the left-hand end.
5. No ESC sequences or control characters are embedded within the line of text.

Programmed Backward Print (ESC 6) temporarily overrides Auto Backward Printing.

3.7.2 Programmed Backward Printing

This mode is entered by receiving the sequence ESC 6 thru the interface. Prior to receiving the ESC 6, the last printed line must have been ended with a terminating character (LF, ESC LF or CR). If the Model 630 receives the ESC 6 prior to a terminator, it may enter an indeterminate mode where it will refuse to process further data. This requirement of a terminator before the ESC 6 exists only if option jumper 3 is not installed on the control panel; thus, existing system software that does not conform to the required sequence can be accomodated by installing the jumper. This jumper disables Auto CR, but, since normal system programming does not rely on Auto CR, in most cases installing the jumper is the preferred alternative.

An ESC 5 sequence or a Carriage Return will reestablish the forward printing mode.

During Backward Print, each character printed causes incremental carriage movement to the left, just opposite of carriage motion during forward printing. The action of the Space and Backspace codes are also reversed in Backward Print. Note, however, that tabbing operations, carriage return, and all paper movement functions are unaffected by being in the Backward Print mode.

3.8 CONTROL OF MARGINS

3.8.1 Horizontal Margins

Both the left and right margins can be adjusted by positioning the carriage to the desired print position, and then sending an ESC 9 (left margin) or ESC 0 (right margin) sequence through the communications link.

Altering the left margin causes the carriage to return to the new margin position following a carriage return (CR) command. The carriage can be moved to the left beyond the left margin by any of the following methods when the margin is set at some print position other than 1:

1. Absolute Horizontal Tab
2. Backspacing
3. Spacing in Backward Print Mode

A power-on or a remote RESET operation will automatically clear the left margin to horizontal position 0 and the right margin to horizontal position 1572.

3.8.2 Vertical Margins

Both top and bottom vertical margins can be adjusted by first placing the paper in the top-of-form position (print head level with top edge of page), and then moving the paper up with a series of LINE FEED operations to reach the desired top margin position. This "Top Margin" is then set by executing an ESC T sequence. Advancing the paper with LINE FEED operations to the desired "Bottom Margin" position, and then executing an ESC L sequence sets the bottom margin. The bottom margin must always be set below the upper margin, and both must be within the page size boundaries.

Whenever a lower page margin is crossed with a line feed, auto line feed or half line feed, paper movement automatically positions the print head at the top margin on the next page, eliminating the need for a form feed character. The area between the lower margin of one page and the top margin of the next page can be accessed through absolute vertical tabs, and through negative line feeds.

Top and bottom margins are reset to the top-of-form and bottom-of-page locations whenever page size is altered, or when a remote RESET is received. They are also reset whenever the unit is initialized, or upon receipt of a remote ESC C command.

3.9 TABBING

Tabbing can be done for both horizontal and vertical motion. The method of tabbing used by the Model 630 SPI is termed "Absolute Tab". This method is unique in that it does not require prior setting of tab stops. The carriage or paper is positioned directly to any one of 126 possible positions either horizontally or vertically from any other position. In the case of vertical tabbing, the paper should be moved "forward" only, unless the unit is equipped with optional bidirectional paper handling accessories.

Tabbing provides horizontal and vertical positioning to standard print positions or lines. This makes it possible, by using variable indexing, to print data out in any format desired without prior editing. For example, data that was originally formatted for 10 characters per inch, 6 lines per inch, can be printed out at 12 characters per inch, 4 lines per inch (or any other format), and all tabular material will remain in the same relative position.

Since tabbing provides positioning only to normal print positions and lines, finer positioning requires use of the Graphics mode. All tabbing functions are unchanged in Graphics mode.

3.9.1 Absolute Horizontal Tab

Using Absolute Tab, the carriage can be positioned directly to any of the first 126 print positions without the need for prior setting of tab stops. Also, Absolute Tab Stops are not retained in memory, so each stop must be commanded anew each time it is to be used. The command sequence for this is ESC HT (ASCII character), where the value of the (ASCII character) indicates the print position desired. See subsection 4.4, Table 4-5, to determine the appropriate ASCII character for the ESC sequence.

The leftmost print position is considered to be binary location 1. Any ASCII character other than NUL and DEL can be used, enabling direct tabbing to any of the first 126 print positions. Note that this method of tabbing also permits tabbing leftward. The horizontal position at the completion of an Absolute Tab operation is computed as follows:

Horizontal Position = (ASCII character - 1) x HMI

3.9.2 Absolute Vertical Tab

Using Absolute Vertical Tab, the paper can be moved to any of the 126 possible lines on the page. Absolute Vertical Tab is initiated by executing the sequence ESC VT (ASCII character), where the value of the ASCII character chosen determines the number of the line to be reached. See subsection 4.4, Table 4-5, to determine the appropriate ASCII character for the ESC sequence. NUL and DEL are not used. The top print line on the page is assigned the binary value of 1, with each succeeding line down the page assigned the next higher number. It is impossible to tab beyond the end of the page even if the number of lines per page is less than the maximum 126. The actual amount of paper movement is determined by; (a) the paper position before VT execution, (b) the ASCII character used, and (c) the Vertical Motion Index (VMI). The ultimate position reached is determined as follows:

Vertical Position = (ASCII character - 1) x VMI

3.10 LINE FEED

A LINE FEED (LF) command from the communications link will cause the form to be moved up one line (one VMI). An ESC LF sequence acts as a negative line feed, causing the paper to be moved down one line. A line feed is also performed automatically as a result of a carriage return operation when the Auto Line Feed jumper is installed on the control panel.

3.11 HALF LINE FEED

A Half Line Feed (ESC U) causes the paper to move up 1/2 line (1/2 of the VMI). A Negative Half Line Feed (ESC D) moves the paper down 1/2 line. These two commands are unchanged in Graphics mode. If the VMI is set to some odd number, the total paper movement will be one increment (1/48 inch) less than 1/2 line.

3.12 FORM FEED

A FORM FEED command, issued either remotely or from the control panel, will cause the paper to be moved upward so that the print head is positioned at the first line of the next page, or at the top margin line if one has been set.

3.13 GRAPHICS

An ESC 3 sequence received over the communications link will put the Model 630 into the Graphics mode. A carriage return or an ESC 4 sequence will return the unit to normal operation. While in the Graphics mode, carriage movement is completely divorced from printing; i.e., printing a character does not automatically move the carriage. The carriage can be moved only by executing a tab, space, carriage return, or backspace operation. The tab commands operate the same as they do in Normal mode; however, in Graphics mode, the space and backspace commands move the carriage only 1/60 inch, regardless of the selected Horizontal Motion Index (HMI).

For paper movement in Graphics mode, Vertical Tab (VT), Form Feed (FF), Half Line Feed (ESC U) and Negative Half Line Feed operate the same as they do in Normal mode. Line Feed (LF) and Negative Line Feed (ESC LF), however, cause only 1/48 inch of paper movement instead of the full line (VMI) movement they produce in Normal mode.

3.14 TWO-COLOR RIBBON (Optional Feature)

On units equipped with the two-color ribbon option, two-color printing can be achieved by installing a Diablo two-color ribbon cartridge. The system is initialized to print in the primary color (black). To print in the alternate color (red), execute an ESC A sequence. To return to the primary color, execute an ESC B sequence.

If red is selected with a single-color ribbon installed, all printing operations other than ribbon lift occur. In this case, due to the narrower width of the ribbon, the print wheel character will strike above the ribbon. The character may or may not print, depending on the amount of ink on the type face.

The ribbon position should not be changed at a rate exceeding 3 times per second.

Note: Factory adjustment optimizes performance using a 5/16" multi-strike ribbon. Subsequent adjustment may be necessary if two-color ribbon is going to be used.

3.15 RESET/INITIALIZATION

The various forms of reset and initialization in the Model 630 SPI are summarized below.

Limited Reset

Initiated by: (any one of these)

- RESET switch on control panel
- ESC SUB R sequence

Results:

- Resets any error conditions.
- Causes a Restore operation if printer is in Check condition.

Initialize

Initiated by: (any one of these)

- Power-up
- ESC CR P sequence ("Remote Reset" - queued command)
- ESC SUB I sequence ("Remote Initialize" - unqueued command)

Results:

Causes the terminal's operating parameters to be set to the default conditions listed below.

- Normal Print Mode (not Graphics)
- Forward Print Mode
- Print Head reset to print position 0
- Vertical Position cleared to 0 (paper does not move)
- VMI set to 8 (6 lines per inch)
- Lines per page set to 66 (11" page size) or 72 (12" page size) depending on whether Jumper #1 on control panel is OUT (11" page) or IN (12" page).
- Print in Black
- Auto backward printing enabled
- Left margin set to position 0
- Right margin set to position 1572
- Top margin set to position 0 (line 1)
- Bottom margin set to position 528 (line 66) for 11" page or position 576 (line 72) for 12" page
- Send and Print buffers cleared

3.16 CARRIAGE SETTLING TIME

The carriage settling time can be increased to 20 msec by the sequence ESC %. This will allow more time for mechanical vibrations to damp out after a carriage movement before printing. Thus, it produces improved print quality at a small sacrifice in print speed. The sequence ESC N will restore the normal carriage settling time.

3.17 PROGRAM MODE

Program Mode permits user control of spoke position, hammer energy, and ribbon advance, thus allowing the use of special print wheels without modifications to the terminal. In Program Mode, two characters are sent for each character to be printed. The first character selects the print wheel spoke; the second character establishes the hammer energy and ribbon advance. See subsection 4.5, Table 4-8, for Hammer Energy and Ribbon Advance units. Also, the technical data contained in Diablo's Print Wheel Data Book (Publication No. 90044-XX) will prove very useful for operating the Model 630 in Program Mode.

Fixed-pitch spacing is controlled by HMI. If the Model 630 is in proportional space mode, spacing is controlled by the ribbon advance units for each character (move RA, print, move RA), as described in subsection 3.6.3.

Program Mode is initiated by the sequence ESC SO M. It is turned off by the control character SI.

3.17.1 Spoke Position Data (first character)

The first character received is tested to determine if it is a control character or a spoke position character. If it is a control character, the normal processing of control characters

will occur. If it is not a control character, it is assumed to be a spoke position character. The next character then will not be tested for control character parameters. The proper value to be sent for the first character is selected by applying the following formula according to the example given below:

Formula:

First Character = Binary equivalent of the decimal sum of: (Electrical Spoke Position Number + 32)

Example: Addressing character "A" on 96-Character Metalized print wheel

1) Refer to Figure 4-3 in this manual to determine the spoke position number of the desired character (A). In this case, the spoke position number is 18.

2) Apply formula: 18 + 32 = 50

3) Refer to Table 4-3 in this manual to determine the ASCII character that has a binary equivalent of decimal 50. For this example, that is the ASCII character "2". The ASCII "2" then is the proper character to send for addressing an "A" when operating in Program Mode with a Diablo 96-character metalized print wheel.

Note from Figure 4-3 that there are only 94 ASCII codes directly available for spoke addressing, since codes 20 hex and 7F hex are preempted by "Space" and "Delete". However, two additional spokes can be accessed by ESC Y and ESC Z, for a total of 96 spokes, as shown in Figure 4-3.

3.17.2 Hammer Energy/Ribbon Advance Data

The second character in the sequence is the hammer energy/ribbon advance character. This character contains 4 bits (0 - 3) for ribbon advance and 3 bits (4 - 6) for hammer energy. This provides 16 different size ribbon advances (0 to 15 steps) and 5 different hammer energy levels (0 to 4). The hammer energy level definitions are as follows:

Level 0 - Do not fire hammer
Level 1 - Lowest hammer energy
Level 2 - Low hammer energy
Level 3 - High hammer energy
Level 4 - Highest hammer energy

CAUTION: Level 4 should be used only when it has been determined that the lower energy levels are inadequate for printing a particular character.

The Hammer Energy/Ribbon Advance character provides a means for the user to tailor print quality and ribbon economy as desired. The general criteria for selecting the amount of hammer energy and ribbon advance is to use the lowest hammer energy and the minimum ribbon advance that will produce a level of print quality suitable for the intended application. The use of excessive hammer energies will unnecessarily shorten the useful life of the affected print wheels.

The Print Wheel Data Book (Diablo Publication No. 90044-XX) will prove to be an indispensible aid for determining proper hammer energies and ribbon advance units for any of the Diablo or Xerox print wheels suitable for use on the Model 630. The Data Book lists a specific recommended hammer energy for each print character on each of the different print wheels listed in the Data Book. For each of the metalized print wheels, the

Data Book also lists a recommended proportional space (PS) unit for each character on the print wheel. In general, the recommended PS unit value for a particular character is also the appropriate ribbon advance unit value to use after printing that character. For the plastic print wheels, which are not assigned PS unit values, a standard ribbon advance unit value of 6 will prove satisfactory in most cases.

3.18 PRINT WHEEL TABLE DOWN-LOAD FEATURE

3.18.1 General

The Down-Load Feature of the Model 630 SPI provides a means by which the host computer can write a temporary print wheel "lookup table" into the read-write (RAM) memory of the SPI. The SPI contains two resident print wheel lookup tables permanently stored in read-only memory (ROM), and will accept one temporary print wheel table from the host computer. One of the resident tables supports certain plastic print wheels, and the other supports certain metalized print wheels (see subsection 3.5.1). The temporary table can be tailored by the host to specifically support any print wheel available for the Model 630.

The function of the selected print wheel table is to provide proper print data for each of the 96 possible character positions on the particular print wheel being used. The print data required is:

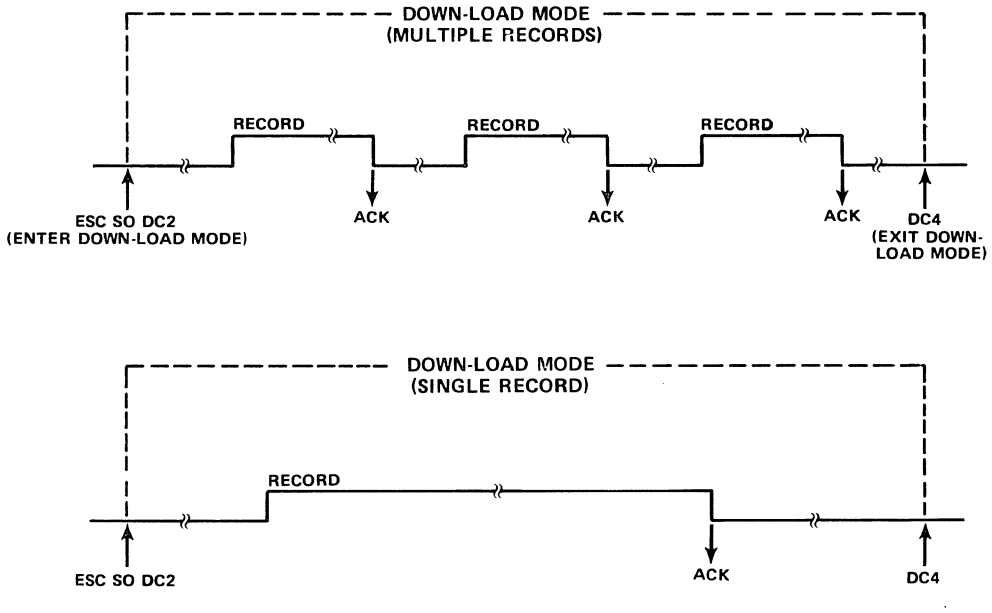
- hammer energy
- proportional space units
- spoke position
- ribbon up or down
- whether or not it is a printable spoke position on this wheel

Each time one of the 96 potentially-printable ASCII characters is received over the interface in the normal printing mode, the SPI's microprocessor refers to a particular location in the selected lookup table to obtain the proper print data for that character. Although every print wheel table used in the SPI contains 96 table entries, for the 88- and 92-character print wheels some of the table positions will specify a nonprinting status, corresponding to the nonexistent spoke positions on those wheels.

The descriptions given here regarding the Down-Load feature prescribe the format and protocol necessary for down-loading a print wheel table to the SPI; however, host system design to assemble the table and implement actual down-loading will vary with the system and with user preferences.

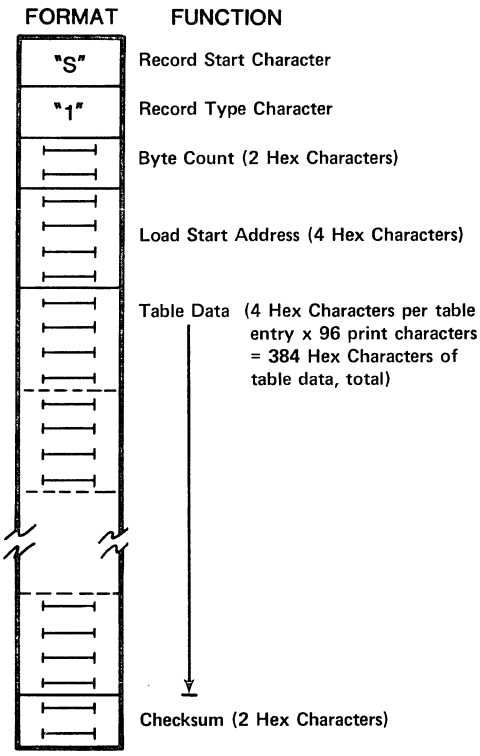
The diagrams in Figure 3-3 represent two variations of the down-load procedure: down-loading the table by a single record, and down-loading by multiple records. The required record format is described in subsection 3.18.2 below. Subject to user preference, the complete print wheel table can be down-loaded within a single record, or the table can be loaded in segments by a series of records. Smaller records are more easily debugged if errors in data format occur, but otherwise the multiple-record method has no significant advantage over single-record down-loading.

The down-load mode is entered with the sequence ESC SO DC2, and can be exited with the single control character DC4. Once the down-load procedure has been completed successfully, the down-loaded table is automatically selected for print wheel support. Reselection of one of the resident tables can be made by initializing the terminal (power off-on or remote reset), or by reentering the down-load mode and sending an invalid record. (See subsection 3.18.2.2 to determine an appropriate invalid record.)



NOTE: The total amount of Table Data stored by either a Single-Record Down-Load or Multiple-Record Down-Load is 192 bytes (2 bytes for each of the 96 possible spoke positions).

Figure 3-3. DOWN-LOAD VARIATIONS



Notes:

1. ⊢⊣ = One Hex Character
2. The "Hex" characters designated in this diagram are ASCII characters, from the host, representing Hexadecimal values 0-9 and A-F.

Figure 3-4. DOWN-LOAD RECORD FORMAT

3.18.2 Down-Load Data Record Format

The table is down-loaded using a hexadecimal blocked record structure as depicted in Figure 3-4. This format is similar to other common down-load structures. A "record" consists of a record start character, a record type character, a byte count, a load address, the table data, and a checksum. Each of these elements is described in detail below, and demonstrated in subsection 3.18.4 by the printout of an actual down-load structure.

If no error in data format is detected while receiving the record, the terminal will transmit an ACK character immediately following receipt of the end of the record. An error in data format is detected if the terminal receives any character other than the hex characters 0 thru 9 and A thru F, or if the checksum does not compare correctly against the data received. If an error in data format is detected, the terminal immediately transmits a NAK character, exits down-load mode, and defaults table selection to one of the two resident print wheel tables as selected by the print wheel switch on the control panel.

Note: The "hex characters" referred to throughout this description are represented by standard 7-bit ASCII characters 0 - 9 and A - F from the host computer. These characters are translated internally by the SPI into standard 4-bit hexadecimal characters.

3.18.2.1 Record Start Character

The record start character is an ASCII "S". Any data encountered before the "S" will be ignored. This allows carriage returns and line feeds, or other characters, to be embedded before, after or between data records. These embedded characters will not affect the down-load process, but do allow appropriate formatting of the printout if a hard-copy reference of the down-load records is outputted through the printer (see subsection 3.18.4).

3.18.2.2 Record Type Character

The record type character must be an ASCII "1". In other similar down-load structures, the record type character may also be a "0" ("header record") or a "9" ("end-of-file record"). In the SPI, a record identified as type 0 or 9 will simply be ignored. Any character other than a 0, 1 or 9 is detected as a down-load error, which causes the SPI to transmit a NAK and terminate the down-load mode. Print wheel table selection then defaults to the resident print wheel table selected on the control panel.

3.18.2.3 Byte Count

The byte count consists of two hex characters that specify the number of data bytes to follow, including the address and checksum. Because the byte count is based on a system of two 4-bit hex characters per byte, the record will contain twice as many hex characters as the number specified by the byte count.

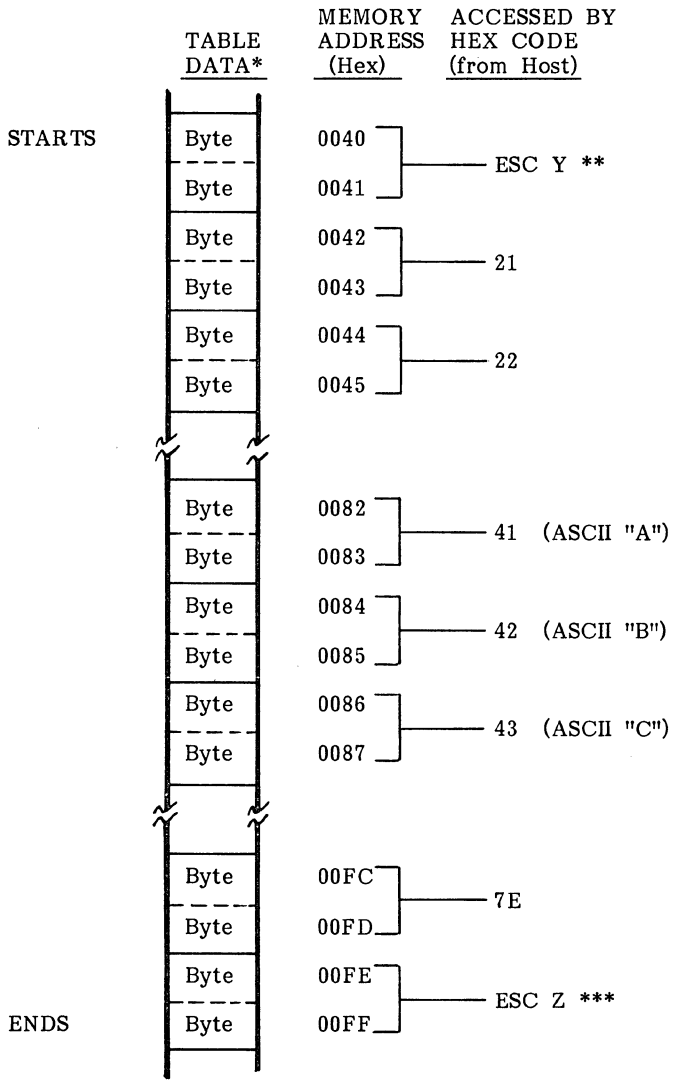
3.18.2.4 Load Address

The load address consists of four hex characters (two bytes) that specify the starting location in memory where the table data in this record is to be loaded. The most significant address byte (the two most significant hex characters) must be sent first. The diagram in Figure 3-5 defines the print wheel table memory layout.

The block of memory addresses allocated for the print wheel table extends from 0040 hex thru 00FF hex. If a Load Address outside this range is specified, it is interpreted as an error in data format and causes the SPI to abort the Down-Load mode. The data in each

table entry occupies two byte locations of storage, and the data is loaded in ascending order of hex value of the corresponding ASCII characters.

The load address specified in the record must be equal to two times the hex value of the first ASCII character whose print data will be loaded in the table by this record. For example, if this is the second record of a multiple-record down-load and the first table entry to be loaded by this record is for the ASCII character "B" (hex 42), the Load Address for this record is 0084 (hex). The two bytes of table data associated with printing the "B" will actually occupy locations 0084 and 0085, followed by the two bytes of data



NOTES:

* Each table entry is stored in memory as four 4-bit hex characters, comprising two 8-bit bytes as depicted above.

** Table data for character under ASCII code 20 (hex) is accessed by ESC Y over the interface during normal print mode.

*** Table data for character under ASCII code 7F (hex) is accessed by ESC Z over the interface during normal print mode.

Figure 3-5. DOWN-LOAD TABLE MEMORY MAP

associated with the ASCII character "C" (hex 43) in memory locations 0086 and 0087, and so on for all subsequent characters in ASCII hex order. The Load Address for a single-record down-load, and for the first record of a multiple-record down-load, is always 0040 hex; corresponding to two times the lowest hex code (20) that represents a printable character in the Model 630 SPI.

Note: In the SPI, the table data in memory locations 0040 and 0041 hex is the data accessed by an ESC Y sequence through the interface. Similarly, the table data in memory locations 00FE and 00FF hex is the print data for the character accessed by ESC Z.

3.18.2.5 Table Data

Each print wheel table entry requires two bytes of data (four hex characters). The four hex characters comprising these two bytes are recognized in the following order:

First hex character	- represents -	First byte, high 4 bits
Second hex character	-	First byte, low 4 bits
Third hex character	-	Second byte, high 4 bits
Fourth hex character	-	Second byte, low 4 bits

The format of the two bytes is defined below.

	BIT							
	7	6	5	4	3	2	1	0
1st Byte -	P	H	H	H	ps	ps	ps	ps
2nd Byte -	R	S	S	S	S	S	S	S

Where:
- P = 1 if this is a printable position on this print wheel; 0* if this is a nonprinting position (such as with certain positions on 88- and 92-character print wheels).
- H = hammer energy 1 to 4 (0 = no hammer fire).
- ps = proportional space value 0 to 15.
- R = 1 if ribbon up at print time is desired; 0 if ribbon down desired. (Normally, R=1 for all characters)
- S = absolute electrical spoke position 0 thru 95. (Spoke position specified greater than 95 will select spoke 0 and inhibit hammer fire.)

* CAUTION: Failure to assign nonprinting status (P=0) when needed may result in print wheel damage by allowing the hammer to fire against the print wheel flag on 88- and 92-character print wheels.

Diablo publishes a Print Wheel Data Book (Publication No. 90445-XX) which contains the print wheel data that must be inserted by the host system when assembling a down-load print wheel table.

All of the 96 locations in the table must be loaded. For any nonprinting print wheel positions, the "P" bit shown in the table data format (the highest bit in the first byte) must be a "0". The states of all other bits associated with that position are then irrelevant except for the "ps" bits (low 4 bits of the first byte). If this nonprinting position

should ever be addressed in normal printing mode, the SPI will default to a space mode, in which the value specified by the "ps" bits for this character determines the amount of carriage movement that occurs.

Any down-loaded table that will be used in a telecommunications environment must conform to the internationally accepted ASCII/ISO conventions regarding the specific hex code assigned to each ASCII character (see Fig. 4-1).

3.18.2.6 Checksum

The checksum consists of one data byte (two hex characters) produced by the host computer. It is the negation (i.e., the "2's" complement) of the modulo 256 sum of all data bytes, starting with the byte count. When all of the data bytes starting with the byte count are added together as received by the SPI, and the checksum is then added, the result should be zero. No end-around carry is used when the check is calculated.

If the check calculation results in a nonzero sum, it is detected as an error in data format, a NAK is transmitted by the SPI, and the down-load mode is aborted. In this situation, print wheel selection defaults to the control panel switch setting.

3.18.3 Down-Load Procedure

Described below is the general sequence of events that comprises a proper down-load procedure. The diagrams in Figure 3-3 will aid the reader in understanding the procedure described here.

1) At power-up, remote reset (ESC CR P), or initialize (ESC SUB I), the down-load table memory locations are initialized to all zeroes, and the resident default print wheel table is used, as selected by the PRINT WHEEL switch on the control panel.

2) The operator must set the PRINT WHEEL switch for Metal for Plastic according to the type of print wheel table that is going to be down-loaded. Although the down-loaded table will supply the print data for subsequent printing, the switch still controls the critical servo timing differences required between plastic and metalized print wheels.

3) The host sends the sequence ESC SO DC2 to put the SPI into the down-load mode.

4) The host sends the properly-formatted record(s) containing the table data. If this is being done as a single-record down-load, the entire table will be loaded by one record. If it is being done as a multiple-record down-load, subsequent records must be sent to load the remaining portions of the table data.

   - After each correctly-received record, the SPI sends an ACK character back to the host, and then awaits the "S" character at the start of the next record, or the DC4 character that terminates the down-load mode. Any other characters received during this waiting period are simply ignored by the SPI.

   - Any error in data format detected while a record is being received, or as a result of the checksum calculation, will cause the SPI to transmit a NAK character and immediately abort the down-load mode. In this situation, table selection reverts to the PRINT WHEEL switch on the control panel.

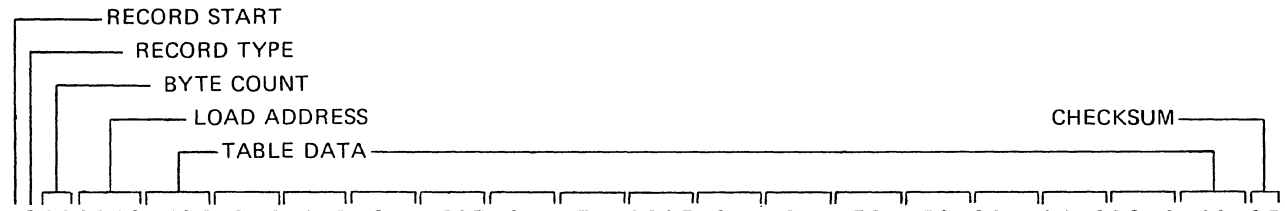
5) After the ACK from the last record has been received, the host sends a DC4 character to take the SPI out of the down-load mode. The Model 630 will now use the down-loaded print wheel data for all ASCII-to-spoke translation. Meanwhile, the

PRINT WHEEL switch on the control panel still controls the servo timing differences for plastic and metalized print wheels.

3.18.4 Sample Down-Load Structure

Figure 3-6 shows a printout of the group of records comprising an actual print wheel down-load structure. Following the printout, each element of the first record is separated and defined. As stated earlier, this printout serves only as a hard-copy reference of the assembled down-load elements—it does not actually occur as part of the down-load process.

In this example, seven separate records are used to down-load the table data for a Pica 10 88-character Xerox metalized print wheel. The number and length of the records in this example has no general significance; it is simply the way the down-load was structured by this particular host system.




```
S1230040B585A3A5A4A1C6DCC587C8CFC7CD9297A3CCA3CAB58FA58B93CE94A393D0A49F05
S1230060C5D6A5D2B5D3B5D4B5D5B5D7B5D8B5D9C5DAB5DBA39DA39BC6D1A589C6C9A591F1
S1230080C8CBC792C688B7A4C7A0C690C696C7A8C79AB399B595C7AEB694C8A6C798C79E57
S11E00A0C68AC7B4C79CC58EB693C7A2C68CC8AAC7B2C7ACB686058005800513
S12300BB800580958D93A9B5BBB5C4B5BEB5BCB5BAB4ADC5C1B5BDA3AFB3B1B5C5A3ABC8E3
S12300DBB0B5B9B5B8C5C3C5C8A4B7B4B3B4B5B5BFB5C0B7B6B5C6B5C2B5C793A7058005AE
S10800FB800580058072
```

FIRST RECORD:

S = Record Start
1 = Record Type
23 = Byte Count = $23_{16} = 35_{10}$
0040 = Load Address (Hex)

TABLE DATA: (First two entries)

B585
= 1011 = PRINTABLE CHARACTER
= 0101 = HAMMER ENERGY (3)
= 1000 = PS UNITS (5)
= 0101 = RIBBON UP
= SPOKE POSITION (5)

A3A5
= 1010 = PRINTABLE CHARACTER
= 0011 = HAMMER ENERGY (2)
= 1010 = PS UNITS (3)
= 0101 = RIBBON UP
= SPOKE POSITION (37)

05 = CHECKSUM

Figure 3-6. SAMPLE DOWN-LOAD STRUCTURE

3.19 REMOTE DIAGNOSTICS

The Remote Diagnostics feature allows the host computer to initiate certain diagnostic type operations within the terminal by command through the serial interface. The diagnostic commands included in this feature are listed below, along with the ESC codes that initiate the commands. These commands are defined in the subsections that follow:

ESC SUB I	Initialize the terminal
ESC SUB R	Remote error reset
ESC SUB 1	Request status byte 1
ESC SUB SO	Perform self test

3.19.1 ESC SUB I

This command will cause the Model 630 SPI to unconditionally execute an initialize sequence regardless of any error conditions that may exist within the printer. Unlike the corresponding sequence, ESC CR P, which is a queued command, this command is executed immediately when received over the interface. The terminal will be initialized to the same conditions specified for ESC CR P (see subsection 3.15). Prior to sending this command, the host should send a nonprinting character to cause the terminal to abort any multiple character sequence that may be in progress.

3.19.2 ESC SUB R

This command, which is essentially the same as pressing the RESET switch on the control panel, causes the terminal to reset any error conditions. If the terminal is in check, it will execute a restore. Due to internal program latency, the minimum time necessary to reset all errors is 250 msec.

In a situation where the terminal is being operated without a control panel (not typical), a series of up to eight automatic restores occurs if the terminal goes into a check condition. The ESC SUB R sequence has the effect of resetting the automatic restore counter to enable another series of automatic restore operations.

3.19.3 ESC SUB 1

This command will cause the terminal to send a status report byte (STATUS 1) over the interface. The true-state bit definitions of this status byte are:

Bit	Status
0	End of Ribbon
1	10 Pitch (This bit false if any other pitch is selected)
2	Paper Out
3	Auto Line Feed enabled
4	Cover Open
5	Printer Idle (print buffer empty and all printer motion complete)
6	Printer in Check
7	**Parity Bit**

3.19.4 ESC SUB SO

This command causes the terminal to execute a self-test. This self-test consists of the RAM Test and ROM CRC Test that are a part of the basic self-test routine of the Model 630 SPI. This command should not be issued when the terminal is busy, since it may cause data loss in some situations. No indication of test pass or failure is printed by the terminal. At the end of the self-test, the terminal sends a report byte to the host computer. The true-state bit definitions for this byte are:

Bit	Status
0	8041 internal RAM Bad
1	8041 internal ROM Bad
2	6803 external RAM Bad (Device at location A65 on the SPI board)
3	6803 external ROM #1 (4K) Bad — upper half of 8K ROM memory *
4	6803 external ROM #2 (4K) Bad — lower half of 8K ROM memory *
5	(unassigned)
6	(unassigned)
7	UART Parity Bit

* The 8K of ROM memory associated with the 6803 processor consists of either two 4K EPROMS or one 8K masked ROM. The locations of these devices on the SPI circuit board can be determined from the SPI schematic that will be contained in the Model 630 Maintenance Manual (editions 90443-01 and later).

3.20 SELF-TEST

The self-test mode is entered when the SELF TEST switch on the control panel is ON at power-on. The self-test consists of a ROM test, a RAM test and 96 lines of swirl text. The character spacing during self-test corresponds to the selection made by the SPACING switches on the control panel. A sample of self-test printout is shown below. The self-test repeats continuously until the power is turned OFF.

```
        selftest!
        romok
        ramok
96 LINES ¢!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
        !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`
        "#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`a
        #$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`ab
        $%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abc
        %&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcd
        &'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcde
        '()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdef
        ()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefg
        )*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefgh
        132 COLUMNS
```

If the ROM test fails, "ROM BAD" is printed, and the self-test stops; if the RAM test fails, "RAM BAD" prints, and the test stops. The tested ROM area comprises the internal ROM of the UPI 8041A; and either one or two EPROM's, or one masked ROM. The tested RAM includes the internal RAM of the UPI 8041A and the single RAM device on the SPI circuit board. All of this tested ROM and RAM is located on the SPI circuit board, and specific locations are identified on the SPI circuit board schematic in the Model 630 Maintenance Manual.

SECTION 4

OPERATING REFERENCES

This Section contains various charts and tables supporting Section 3, OPERATING CONSIDERATIONS.

4.1 CONTROL PANEL JUMPERS AND SWITCHES

Table 4-1
CONTROL PANEL JUMPERS

Jumper	In/Out	Function
1	In	12" page size
	Out	11" page size
2	In	Auto line feed enable
3	In	Auto carriage return disable
4		(Reserved)
5		(Reserved)

Table 4-2
CONTROL PANEL SWITCHES
(Location A22)

(Note: 1 = ON, 0 = OFF)

S1:

1 = Metal Print Wheel
0 = Plastic Print Wheel

S2	S3	
1	1 =	Proportional Spacing
1	0 =	15 pitch
0	1 =	12 pitch
0	0 =	10 pitch

S4:

1 = Printer Ready
0 = DC1/DC3

S5:

1 = 1200 Baud
0 = 300 Baud

S6	S7	
1	1 =	Parity Checking/Even
1	0 =	Parity Checking/Odd
0	1 =	No Parity; Transmit Space
0	0 =	No Parity; Transmit Mark

S8:

1 = Self Test On
0 = On Line (Remote)

4.2 ASCII CODING SYSTEM

The ASCII Coding System is based on the American National Standard Code for Information Interchange, Standard No. X3.4-1977 of the American National Standards Institute, Inc.

Bits b_7 b_6 b_5 →		0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4 b_3 b_2 b_1 ↓	COLUMN → / ROW ↓	0	1	2	3	4	5	6	7
0 0 0 0	0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1	1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	2	STX	DC2	"	2	B	R	b	r
0 0 1 1	3	ETX	DC3	#	3	C	S	c	s
0 1 0 0	4	EOT	DC4	$	4	D	T	d	t
0 1 0 1	5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	6	ACK	SYN	&	6	F	V	f	v
0 1 1 1	7	BEL	ETB	'	7	G	W	g	w
1 0 0 0	8	BS	CAN	(	8	H	X	h	x
1 0 0 1	9	HT	EM	)	9	I	Y	i	y
1 0 1 0	10	LF	SUB	*	:	J	Z	j	z
1 0 1 1	11	VT	ESC	+	;	K	[	k	{
1 1 0 0	12	FF	FS	,	<	L	\	l	|
1 1 0 1	13	CR	GS	-	=	M	]	m	}
1 1 1 0	14	SO	RS	.	>	N	^	n	~
1 1 1 1	15	SI	US	/	?	O	_	o	DEL

All characters in these two columns and SP (Space) are nonprinting. DEL (Delete) does not print in Remote mode. When a character is received with parity or framing error, the print wheel character addressed by ASCII code 3F (HEX) is printed in place of the received character.

Figure 4-1. ASCII CODE CHART

4.3 PRINT WHEEL CODE CHARTS (Typical)

These charts provide a general sample of technical data for the two different groups of print wheels supported by the two permanent print wheel tables of the SPI. Specific technical data for all print wheels available for the Model 630 SPI is contained in the Diablo Print Wheel Data Book, Publication No. 90044-XX.

The codes 20 (Hex) and 7F (Hex) are interpreted as "space" and "delete" respectively by the Model 630 and thus are not available for print wheel addressing. In place of these two codes, the ESC sequences ESC Y and ESC Z are used to address certain characters and thus provide a complete set of 96 codes for print wheel addressing. ESC Y and/or ESC Z are listed on the following charts where applicable.

ESC Y			ESC Z		
¢	2	94	¬	1	95
	3			1	

(MSB) b_7	0	0	1	1	1	1
b_6	1	1	0	0	1	1
b_5	0	1	0	1	0	1
b_4 b_3 b_2 b_1						
0 0 0 0	SP 37 59 / 3	0 37 59 / 3	@ 62 34 / 4	P 26 70 / 4	` 56 40 / 1	p 90 6 / 4
0 0 0 1	! 68 28 / 2	1 33 63 / 2	A 11 85 / 3	Q 27 69 / 4	a 84 12 / 2	q 92 4 / 4
0 0 1 0	" 70 26 / 2	2 34 62 / 3	B 8 88 / 4	R 13 83 / 4	b 78 18 / 4	r 81 15 / 2
0 0 1 1	# 46 50 / 3	3 35 61 / 2	C 10 86 / 3	S 14 82 / 3	c 79 17 / 2	s 88 8 / 3
0 1 0 0	$ 44 52 / 3	4 36 60 / 3	D 22 74 / 4	T 16 80 / 3	d 76 20 / 3	t 86 10 / 2
0 1 0 1	% 47 49 / 3	5 36 58 / 3	E 15 81 / 4	U 23 73 / 4	e 83 13 / 2	u 91 5 / 3
0 1 1 0	& 69 27 / 3	6 39 57 / 3	F 9 87 / 4	V 30 66 / 4	f 89 7 / 3	v 73 23 / 2
0 1 1 1	' 54 42 / 1	7 40 56 / 2	G 24 72 / 4	W 4 92 / 4	g 74 22 / 4	w 0 0 / 3
1 0 0 0	(60 36 / 2	8 41 55 / 3	H 17 79 / 4	X 32 64 / 4	h 87 9 / 3	x 75 21 / 3
1 0 0 1	) 58 38 / 2	9 42 54 / 3	I 20 76 / 2	Y 25 71 / 4	i 85 11 / 2	y 94 2 / 4
1 0 1 0	* 61 35 / 3	: 12 84 / 1	J 29 67 / 3	Z 7 89 / 3	j 72 24 / 3	z 95 1 / 3
1 0 1 1	+ 45 51 / 2	; 31 65 / 2	K 28 68 / 4	[53 43 / 2	k 93 3 / 3	{ 49 47 / 2
1 1 0 0	, 3 93 / 1	< 57 39 / 2	L 21 75 / 4	\ 63 33 / 2	l 77 19 / 2	¦ 59 37 / 2
1 1 0 1	— 43 53 / 1	= 48 48 / 3	M 6 90 / 4	] 51 45 / 2	m 71 25 / 4	} 67 29 / 2
1 1 1 0	. 5 91 / 1	> 50 46 / 2	N 19 77 / 4	^ 64 32 / 1	n 82 14 / 3	~ 52 44 / 1
1 1 1 1	/ 66 30 / 2	? 65 31 / 2	O 18 78 / 3	_ 55 41 / 2	o 80 16 / 3	DEL

CHARACTER
ELECTRICAL POSITION
SPOKE POSITION
ENERGY LEVEL RECOMMENDED

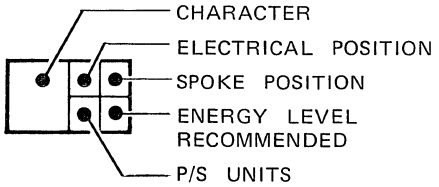
NOTES:

1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.
2. ◩ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure 4-2. 96-CHARACTER PRINT WHEEL - PLASTIC

ESC Y			ESC Z		
ç	0	0	'	39	57
	5	3		5	1

b4	b3	b2	b1	(MSB) b7	0		0		1		1		1		1	
				b6	1		1		0		0		1		1	
				b5	0		1		0		1		0		1	
0	0	0	0		SP		0	86 10 / 5 4	@	75 21 / 8 4	P	10 86 / 6 4	`	95 1 / 5 1	p	67 29 / 5 4
0	0	0	1		!	37 59 / 3 2	1	82 14 / 5 2	A	18 78 / 7 4	Q	52 44 / 7 4	a	59 37 / 5 3	q	72 24 / 5 4
0	0	1	0		"	33 63 / 4 2	2	83 13 / 5 3	B	8 88 / 6 4	R	28 68 / 7 4	b	68 28 / 5 3	r	55 41 / 4 2
0	0	1	1		#	92 4 / 6 4	3	84 12 / 5 3	C	36 60 / 7 3	S	14 82 / 5 4	c	62 34 / 5 3	s	51 45 / 4 3
0	1	0	0		$	7 89 / 5 4	4	85 11 / 5 3	D	32 64 / 7 4	T	19 77 / 6 3	d	60 36 / 5 3	t	53 43 / 4 3
0	1	0	1		%	79 17 / 8 4	5	87 9 / 5 3	E	16 80 / 6 4	U	34 62 / 7 4	e	58 38 / 5 3	u	63 33 / 5 3
0	1	1	0		&	77 19 / 7 4	6	88 8 / 5 3	F	22 74 / 6 4	V	12 84 / 6 4	f	45 51 / 4 3	v	64 32 / 5 3
0	1	1	1		'	23 73 / 2 1	7	89 7 / 5 3	G	40 56 / 7 4	W	42 54 / 8 4	g	65 31 / 5 4	w	54 42 / 7 3
1	0	0	0		(	76 20 / 3 2	8	90 6 / 5 4	H	26 70 / 7 4	X	50 46 / 7 4	h	61 35 / 5 3	x	70 26 / 5 3
1	0	0	1		)	74 22 / 3 2	9	91 5 / 5 3	I	25 71 / 3 3	Y	44 52 / 7 4	i	47 49 / 3 2	y	66 30 / 5 3
1	0	1	0		*	15 81 / 5 3	:	29 67 / 3 2	J	21 75 / 5 3	Z	6 90 / 6 3	j	49 47 / 3 3	z	71 25 / 5 3
1	0	1	1		+	11 85 / 5 2	;	27 69 / 3 2	K	46 50 / 7 4	[	81 15 / 3 2	k	69 27 / 5 3	{	4 92 / 3 2
1	1	0	0		,	78 18 / 3 1	<	41 55 / 5 2	L	20 76 / 6 3	\	3 93 / 5 2	l	43 53 / 3 2	|	73 23 / 3 2
1	1	0	1		–	35 61 / 4 1	=	9 87 / 5 2	M	38 58 / 8 4	]	1 95 / 3 2	m	48 48 / 8 4	}	93 3 / 3 2
1	1	1	0		.	80 16 / 3 1	>	5 91 / 5 2	N	24 72 / 7 4	^	2 94 / 5 1	n	57 39 / 5 3	~	94 2 / 5 1
1	1	1	1		/	31 65 / 4 2	?	17 79 / 5 2	O	30 66 / 7 4	_	13 83 / 5 1	o	56 40 / 5 3	DEL	



NOTES:

1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK,
2. ☐ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure 4-3. 96-CHARACTER PRINT WHEEL - METAL (Diablo)

4.4 DECIMAL VALUE TABLES

The Decimal Value Tables are used to determine the third character (n) to use in 3-character sequences for setting format factors and for absolute tabbing. The associated procedures are covered in the following subsections:

Setting HMI is covered in subsection 3.6.4.1;
Setting VMI is covered in subsection 3.6.4.2;
Lines Per Page is covered in subsection 3.6.4.3;
Absolute Horizontal Tab is covered in subsection 3.9.2;
Absolute Vertical Tab is covered in subsection 3.9.4.

The following list summarizes the corresponding ESC code sequences:

ESC	US	(n)	Set HMI
ESC	RS	(n)	Set VMI
ESC	FF	(n)	Lines Per Page
ESC	HT	(n)	Absolute Horizontal Tab
ESC	VT	(n)	Absolute Vertical Tab

Table 4-3 contains a listing of decimal values for ASCII characters.

Table 4-3
DECIMAL VALUES OF ASCII CHARACTERS

		Units									
		0	1	2	3	4	5	6	7	8	9
	0		SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT
	10	LF	VT	FF	CR	SO	SI	DLE	DC1	DC2	DC3
	20	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS
T	30	RS	US	SP	!	"	#	$	%	&	'
	40	(	)	*	+	,	–	.	/	0	1
e	50	2	3	4	5	6	7	8	9	:	;
	60	<	=	>	?	@	A	B	C	D	E
n	70	F	G	H	I	J	K	L	M	N	O
	80	P	Q	R	S	T	U	V	W	X	Y
s	90	Z	[	\	]	^	_	`	a	b	c
	100	d	e	f	g	h	i	j	k	l	m
	110	n	o	p	q	r	s	t	u	v	w
	120	x	y	z	{	|	}	~			

Table 4-4
ASCII VALUES FOR ESC SEQUENCES
Set HMI
Set VMI

HMI/VMI	ASCII Character
0	CTRL A (SOH)
1	CTRL B (STX)
2	CTRL C (ETX)
3	CTRL D (EOT)
4	CTRL E (ENQ)
5	CTRL F (ACK)
6	CTRL G (BEL)
7	CTRL H BACKSPACE
8	CTRL I TAB
9	CTRL J LINEFEED
10	CTRL K (VT)
11	CTRL L (FF)
12	CTRL M RETURN
13	CTRL N (SO)
14	CTRL O (SI)
15	CTRL P (DLE)
16	CTRL Q (DC1)
17	CTRL R (DC2)
18	CTRL S (DC3)
19	CTRL T (DC4)
20	CTRL U (NAK)
21	CTRL V (SYN)
22	CTRL W (ETB)
23	CTRL X (CAN)
24	CTRL Y (EM)
25	CTRL Z (SUB)

HMI/VMI	ASCII Character
26	CTRL [ESC
27	CTRL \ (FS)
28	CTRL ` (GS)
29	CTRL = (RS)
30	CTRL – (US)
31	SPACE
32	!
33	"
34	#
35	$
36	%
37	&
38	'
39	(
40	)
41	*
42	+
43	,
44	-
45	.
46	/
47	0
48	1
49	2
50	3

HMI/VMI	ASCII Character
51	4
52	5
53	6
54	7
55	8
56	9
57	:
58	;
59	<
60	=
61	>
62	?
63	@
64	A
65	B
66	C
67	D
68	E
69	F
70	G
71	H
72	I
73	J
74	K
75	L

HMI/VMI	ASCII Character
76	M
77	N
78	O
79	P
80	Q
81	R
82	S
83	T
84	U
85	V
86	W
87	X
87	Y
89	Z
90	[
91	\
92	]
93	^
94	_
95	`
96	a
97	b
98	c
99	d
100	e

HMI/VMI	ASCII Character
101	f
102	g
103	h
104	i
105	j
106	k
107	l
108	m
109	n
110	o
111	p
112	q
113	r
114	s
115	t
116	u
117	v
118	w
119	x
120	y
121	z
122	{
123	|
124	}
125	~

Table 4-5
ASCII VALUES FOR ESC SEQUENCES
Set Lines/Page
Set Absolute Horizontal Tab
Set Absolute Vertical Tab

Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character
1	CTRL A (SOH)	26	CTRL Z (SUB)	51	3	76	L	101	e
2	CTRL B (STX)	27	CTRL [ESC	52	4	77	M	102	f
3	CTRL C (ETX)	28	CTRL \ (FS)	53	5	78	N	103	g
4	CTRL D (EOT)	29	CTRL ` (GS)	54	6	79	O	104	h
5	CTRL E (ENQ)	30	CTRL = (RS)	55	7	80	P	105	i
6	CTRL F (ACK)	31	CTRL – (US)	56	8	81	Q	106	j
7	CTRL G (BEL)	32	SPACE	57	9	82	R	107	k
8	CTRL H BACKSPACE	33	!	58	:	83	S	108	l
9	CTRL I TAB	34	"	59	;	84	T	109	m
10	CTRL J LINEFEED	35	#	60	<	85	U	110	n
11	CTRL K (VT)	36	$	61	=	86	V	111	o
12	CTRL L (FF)	37	%	62	>	87	W	112	p
13	CTRL M RETURN	38	&	63	?	88	X	113	q
14	CTRL N (SO)	39	'	64	@	89	Y	114	r
15	CTRL O (SI)	40	(	65	A	90	Z	115	s
16	CTRL P (DLE)	41	)	66	B	91	[	116	t
17	CTRL Q (DC1)	42	*	67	C	92	\	117	u
18	CTRL R (DC2)	43	+	68	D	93	]	118	v
19	CTRL S (DC3)	44	,	69	E	94	^	119	w
20	CTRL T (DC4)	45	-	70	F	95	_	120	x
21	CTRL U (NAK)	46	.	71	G	96	`	121	y
22	CTRL V (SYN)	47	/	72	H	97	a	122	z
23	CTRL W (ETB)	48	0	73	I	98	b	123	{
24	CTRL X (CAN)	49	1	74	J	99	c	124	¦
25	CTRL Y (EM)	50	2	75	K	100	d	125	}
								126	~

Table 4-6
CHARACTER PROPORTIONAL SPACE UNITS - METAL PRINT WHEELS

PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT
1	(⌋)	(3)	25	I	3	49	j	3	73	½	6
2	(⁀)	(5)	26	H	7	50	X	7	74	)	3
3	⅔ (\ )	6 (5)	27	;	3	51	s	4	75	@	8
4	£ ({)	5 (3)	28	R	7	52	Q	7	76	(	3
5	¢ ( ))	5	29	:	3	53	t	4	77	&	7
6	Z	6	30	O	7	54	w	7	78	,	3
7	$	5	31	/	4	55	r	4	79	%	8
8	B	6	32	D	7	56	o	5	80	.	3
9	=	5	33	"	4	57	n	5	81	¼	6
10	P	6	34	U	7	58	e	5	82	1	5
11	+	5	35	–	4	59	a	5	83	2	5
12	V	6	36	C	7	60	d	5	84	3	5
13	_	5	37	!	3	61	h	5	85	4	5
14	S	5	38	M	8	62	c	5	86	0	5
15	*	5	39	.	3	63	u	5	87	5	5
16	E	6	40	G	7	64	v	5	88	6	5
17	?	5	41	'	3	65	g	5	89	7	5
18	A	7	42	W	8	66	y	5	90	8	5
19	T	6	43	I	3	67	p	5	91	9	5
20	L	6	44	Y	7	68	b	5	92	#	6
21	J	5	45	f	4	69	k	5	93	⅓ (})	6 (3)
22	F	6	46	K	7	70	x	5	94	¾ (~)	6 (5)
23	'	2	47	i	3	71	z	5	95	(`)	(5)
24	N	7	48	m	8	72	q	5	0 (HOME)	(¢)	(5)

NOTES:
1. Units = 1/120 inch (.212mm) carriage movement.
2. Characters and PS unit values listed in this table represent 88-character "Titan 10", 92-character "Titan 10" (UK), and 96-character "Titan 10" print wheels. Parentheses ( ) are used where characters and/or PS units of the 96-character wheel differ from those of the 88 and 92-character wheels. PW POSITION utilization is 5 thru 92 for 88-character wheels, 3 thru 94 for 92-character wheels, and 1 thru 0 for 96-character wheels. For similar data on other fonts refer to the Diablo Print Wheel Data Book, Publication No. 90044-XX.

Table 4-7
CHARACTER PROPORTIONAL SPACE UNITS - PLASTIC PRINT WHEELS

PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT
1	¬	4	25	Y	6	49	{	3	73	v	5
2	¢	5	26	P	5	50	>	5	74	g	5
3	,	3	27	Q	6	51	]	4	75	x	5
4	W	7	28	K	6	52	~	5	76	d	5
5	.	3	29	J	4	53	[	4	77	l	3
6	M	7	30	V	6	54	'	2	78	b	5
7	Z	5	31	;	3	55	_	6	79	c	5
8	B	5	32	X	6	56	`	5	80	o	5
9	F	5	33	1	5	57	<	5	81	r	4
10	C	6	34	2	5	58	)	3	82	n	5
11	A	6	35	3	5	59	¦	2	83	e	5
12	:	3	36	4	5	60	(	3	84	a	5
13	R	6	37	0	5	61	*	4	85	i	3
14	S	5	38	5	5	62	@	7	86	t	4
15	E	5	39	6	5	63	\	4	87	h	5
16	T	5	40	7	5	64	^	5	88	s	4
17	H	6	41	8	5	65	?	5	89	f	4
18	O	6	42	9	5	66	/	4	90	p	5
19	N	6	43	-	5	67	}	3	91	u	5
20	I	3	44	$	5	68	!	3	92	q	5
21	L	5	45	+	5	69	&	6	93	k	5
22	D	6	46	#	5	70	"	4	94	y	5
23	U	6	47	%	5	71	m	7	95	z	5
24	G	6	48	=	5	72	j	2	0	w	7

NOTES:

1. Units = 1/120 inch (.212mm) carriage movement.
2. Characters and PS unit values listed in this table represent a 96 character plastic print wheel.

Table 4-8
PRINT WHEEL PROGRAM MODE - CHARACTERS FOR HAMMER ENERGY AND RIBBON ADVANCE

HAMMER ENERGY	RIBBON ADVANCE 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Q	R	S	T	U	V	W	X	Y	Z	[	/	]	^	_
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
	q	r	s	t	u	v	w	x	y	z	{	¦	}	~	DEL

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