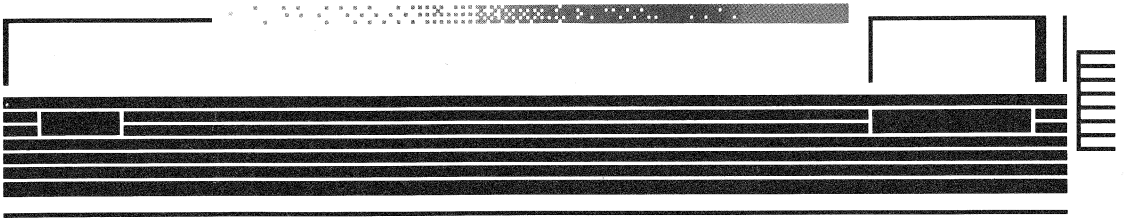
EK-LJ250-RM-001

LJ250/LJ252 Companion Color Printer

Programmer Reference Manual



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UPDATE NOTICE

LJ250/LJ252 Companion Color Printer Programmer Reference Manual

EK-LJ250-RM-CN1

September 1987

The original *LJ250/LJ252 Companion Color Printer Programmer Reference Manual* is wire-o bound and cannot accommodate inserted update pages. This update notice directs the document user in the changes that must be made to correct errors. This update should be pasted on the reverse of the front cover in order to maintain a record of changes to the document.

CORRECTIONS

Make the following pen and ink corrections to the *LJ250/LJ252 Companion Color Printer Programmer Reference Manual.*

- Page 1-3, last line of Section 1.1.4, change from "See Appendix E ..." to "See Appendix D ..."
- Page 3-14, after the second sentence of Section 3.7, add the following sentence "Font selection is controlled only by the selection of horizontal pitch (DECSHORP)."
- Pages D-27, D-28, and D-29, Table D-4, the ROW/COLUMN specifiers for five of the colors are incorrect. Change the ROW/COLUMN specifier for each occurrence of the colors listed below to the correct ROW/COLUMN specifier.

Color	Change ROW/COLUMN	to ROW/COLUMN
Blue	22/4	0/9
Cyan	20/6	22/7
Green	14/1	18/1
Magenta	5/5	6/7
Red	8/6	8/7

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Programmer Reference Manual

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This equipment generates and uses radio frequency energy and if not installed properly, that is in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. If this equipment 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.

- Reorient the receiving antenna.
- Relocate the receiver with respect to the printer.
- Move the printer away from the receiver.
- Plug the printer into a different outlet so that the printer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the booklet *How to Identify and Resolve Radio/TV Interference Problems*, prepared by the Federal Communications Commission, helpful. This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

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FIGURES

TABLES

EXAMPLES

INTRODUCTION

WHO SHOULD READ THIS MANUAL

This manual contains reference information for users with programming experience in color graphics. Programmers can use this information to design or modify application software to take advantage of the printer's features.

Your application software determines your ability to select printer functions and the extent to which you can use them. For example, word processing applications should have menus that let you select bold, underline, margins, tabs, and related features for those applications.

This manual does not explain how to use these application-specific menus, send the control sequences from a particular host computer, or run a given operating system or application package.

This manual contains interface, communication, character processing, color mapping, and escape and control sequence information.

Appendix C contains examples of how to use the control functions in this manual. The sample programs are written in a generic version of BASIC. They may require modification for operating systems or applications that use other versions of BASIC.

OTHER COMPANION COLOR PRINTER MANUALS

Your printer comes with one other manual, *LJ250/LJ252 Companion Color Printer User's Guide,* which describes how to install, operate, and maintain the printer.

Two other Companion Color Printer manuals are available from Digital: the *LJ250/LJ252 Companion Color Printer Pocket Service Guide* (EK-LJ250-PS) and the *LJ250/LJ252 Companion Color Printer Technical Manual* (EK-LJ250-TM).

MANUAL ORGANIZATION

This manual has seven chapters and four appendixes that cover the following topics.

Part 1 General Information

Chapter 1 gives an overview of the printer and its features.

Chapter 2 describes how the Companion Color Printer communicates with a computer. This chapter describes the printer's serial and parallel interfaces, communication signals, configuration switches, and required data format. It also contains a description of operator controls and indicators.

Part 2 Companion Color Printer in DEC-Compatible Mode

Chapter 3 describes how the printer processes received text mode characters.

Chapter 4 describes the text mode escape and control sequences used to select printing functions.

Chapter 5 describes the status and test features of the printer.

Chapter 6 describes the color mapping and the processing of color graphic mode control and printable characters.

Part 3 Companion Color Printer in HP PCL Mode

Chapter 7 gives an overview of the Hewlett-Packard Printer Command Language (HP PCL) mode. It describes the features, text mode character processing, characters sets, and color raster graphics mode control and escape sequences.

Appendixes

Appendix A shows the character sets used with the Companion Color Printer in DEC-compatible and HP PCL environments.

Appendix B shows examples of vertical grid size and image scale size, and the relationship between image scale size and aspect ratio.

Appendix C contains several BASIC programming examples that use the commands defined in Chapter 4.

Appendix D has the printer test patterns and the color palettes.

Warnings, Cautions, and Notes

The warnings, cautions, and notes in this manual have specific purposes.

WARNINGS	Contain important information relating to personal safety
CAUTIONS	Contain information to prevent damage to the equipment
NOTES	Contain general information

PART 1 GENERAL FEATURES

CHAPTER 1
FEATURES

1.1 GENERAL

The Companion Color Printer is a compact color, dot matrix printer that uses ink-jet technology. It is designed for use in personal computer systems, office workstations, and small-sized business computer systems where color graphics are needed.

The printer receives characters and commands through an asynchronous serial interface or a parallel interface. The serial interface operates baud rates of 4800 and 9600.

The printhead is incorporated in the ink cartridge and mounts on a carriage that scans horizontally across the paper. The printer is capable of bidirectional printing in text mode to optimize printer throughput. The ink cartridges are a consumable item.

The printer has a protocol selection feature that allows the printer to operate in either DEC or HP PCL (Hewlett-Packard Printer Command Language) mode.

In DEC mode (Part 2 of this manual), the printer can perform like the LA50, LA75, or LA210 printer, except for the device attribute (DA) reply. This means that the Companion Color Printer is compatible with most operating systems and applications written to support these printers in both text and graphics mode. Color applications written for sixel graphics protocol are supported.

In HP PCL mode (Part 3 of this manual), the Companion Color Printer allows you to run many "off-the-shelf" industry-standard software applications written to support the HP PCL protocol.

You can select DEC or HP PCL modes by using the protocol switch on the front panel, using the power-up default switch (LJ250 only), or sending the appropriate control sequence from the host system.

In DEC protocol, the printer has two fundamental printing modes: text mode and sixel graphics mode. A transparency mode can be selected for increasing the print density when generating transparency slides.

1.1.1 Text Mode

In the text mode (black ink), the printer uses three offset groups of 10 ink-jet nozzles to print 10 pitch Courier characters at 90 characters per second. Line length on 8 1/2 inch paper is 80 characters per line. Both 12 pitch Courier and 18 pitch Gothic styles are also available.

You can select normal- or double-width characters. Normal-width character spacing can be selected at 10, 12, and 18 characters per inch for line lengths of 80, 96, and 144 characters respectively. Double width character spacing can be selected at 5, 6, and 9 characters per inch for line lengths of 40, 48, and 72 characters respectively.

You can print from many different built-in character sets to select different languages, line drawing, or scientific characters. The text may also be printed in color by using the appropriate escape sequence. Eight text colors are available and each line is printed in three passes of the printhead.

1.1.2 Sixel Graphic Mode

In the graphic mode, the Companion Color Printer uses an internal color map to let the user print up to 256 colors.

In DEC sixel graphic mode, the Companion Color Printer can print bit map data in accordance with the sixel graphic protocol. You can choose different combinations of aspect ratios and grid sizes. Each printable sixel character is printed from 64 possible 1 $\times$ 6 dot combinations.

The HP raster graphic mode is described in Part 3 of this manual.

1.1.3 Transparency Mode

The Companion Color Printer can be used to create transparency slides for projection. Transparencies require the use of more ink (two passes of the printhead) to increase the intensity of the colors. The transparency mode is entered from the control panel (Section 2.3.3) or software control. See Section 4.4.6.2 for DEC protocol and Section 7.5.1.9 for PCL protocol.

1.1.4 Color Mapping

Color mapping achieves the best possible color matching to the Digital Equipment Corporation's existing color products. The Companion Color Printer can print color images from a palette of 256 colors in both DEC and PCL mode. See Section 2.3.2.4 to get a color palette disply.

The color maps provide a 256 color mode and a 64 color mode. The 64 color maps are identical to the VT241 terminal's HLS and RGB color maps.

NOTE: While the Companion Color Printer prints color images, it is intended primarily for the business color graphics market.

See Appendix E for the complete Companion Color Printer color maps.

1.1.5 Companion Color Printer Features

Some of the main features of the LJ250 and LJ252 printers are:

- Compact size suitable for desk-top location
- Very quiet operation
- 256 color palette
- Transparency creation
- DIGITAL and HP PCL compatibility
- ASCII and national character sets
- VT100 Special Graphic character set
- ISO Supplemental and DEC Supplemental character sets
- DEC Technical character set
- Graphic printing
- Serial (LJ250) or parallel (LJ252) configuration
- Bold, underline, italics, superscript, and subscript

1.2 SPECIFICATIONS FOR THE LJ250 AND LJ252

Print method	Inkjet technology, incremental with bidirectional look-ahead
Print speed	
	Black text
	90 characters/second – throughput 167 characters/second – burst speed
	Color text
	36 characters/second – throughput 40 characters/second – burst speed
	Sixel color graphics
	16.7 inches per second at 180 dpi
Character format (dots)	18 × 30 cell matrix at 10 pitch
Dot size	0.0085 inch diameter
Dot spacing	180 dots per inch

Color mode

Sixel graphics (DEC mode)

- 180 × 180 dpi gives 8 colors

  Black
  Yellow
  Magenta
  Cyan
  Red
  Green
  Blue

- 90 × 90 dpi gives up to 256 colors

- Aspect ratios

  1 to 1
  2 to 1
  2.5 to 1

Raster graphics (HP PCL mode)

- 180 × 180 dpi gives 8 colors

  Black
  Yellow
  Magenta
  Cyan
  Red
  Green
  Blue

- 90 × 90 dpi gives 256 colors

Character sets	DEC mode ASCII DEC Supplemental VT100 Line Drawing DEC Technical ISO 8-bit Supplemental 14 National Replacement Character (NRC) sets HP PCL mode PC-8 Roman-8 ECMA-94 PC-8 (Danish/Norwegian)
Character pitch	Courier - 10 pitch (10 characters/inch), 80 characters/line Double width - 5 characters/inch, 40 characters/line Courier - 12 pitch (12 characters/inch), 96 characters/line Double width - 6 characters/inch, 48 characters/line Gothic font - 18 characters/inch, 144 characters/line Double width - 9 characters/inch, 72 characters/line

Character attributes	DEC mode
	Overline Double underline Underline Bold Color text True descenders Strike through Subscript Superscript Italics
	HP PCL mode
	Underline Bold Color text True descenders
Line spacing	DEC mode
	12,8,6,4,3, or 2 lines/inch Partial line up and down, 1/12 inch
	HP PCL mode
	6,8,9 lines/inch 1/2 Line feed (1/12, 1/16, or 1/18 inch)

Line feed speed	727 ms/inch

Media

NOTE: The Companion Color Printer media is designed specifically for use in this printer. For the best print quality and truest colors, use the recommended ink-jet paper. Other papers can cause the ink to be absorbed incorrectly resulting in poor print quality when printing text, and faint or incorrect colors when printing in graphics mode. Adhesive labels cannot be used in this printer.

Recommended media	A size pinfeed paper – LJ25X-AC A4 size pinfeed paper – LA25X-AD Transparency film – LJ25X-AE
Dimensions	210 × 297 mm (ISO A4) 8.5 × 11 inches (ANSI A)
Thickness	Single part only .05
Feed method	Single sheet – friction feed Pinfeed – tractor feed
Forms loading	Single sheet paper – top Pinfeed forms – rear

Environment	
Operating temperature	15°C to 30°C (59°F to 86°F)
Storage temperature	–40°C to 75°C (–40°F to 167°F)
Relative humidity	20% to 80%
Power requirements	LJ250-CA 100-120 Vac, 50/60 Hz LJ252-CA 100-120 Vac, 50/60 Hz LJ250-A6 220-240 Vac, 50/60 Hz LJ252-A6 220-240 Vac, 50/60 Hz
Power consumption	40 watts
Weight	4.5 kg (10 lb)
Dimensions	
Width	425 mm (16.7 in)
Depth	260 mm (10.2 in)
Height	90 mm (3.5 in)
Data Interface	
Serial (LJ250)	DEC423 with MMJ adapter 2,560 character input buffer
Parallel (LJ252)	Centronics™

*Centronics is a trademark of Centronics Data Computer Corporation.

CHAPTER 2
PRINTER COMMUNICATION AND CONTROLS

This chapter describes the LJ250 serial interface, the LJ252 parallel interface, required data format, operating controls, available self-tests, configuration, and terminal set-up information.

2.1 SERIAL DATA INTERFACE

The LJ250 works as part of your computer system, providing hardcopy output of text or graphics. Before you can use the printer, you must establish a communication link between the printer and the computer. The communication link you must provide is a serial data interface. For hardware interface requirements, refer to the *LJ250/LJ252 Companion Color Printer User's Guide.*

The following sections describe these communication characteristics:

- EIA serial interface connector and interface signals
- Baud rates
- Data character format
- Data buffering requirements

2.1.1 EIA Interface Connector

The interface connector on the printer is a 25-position EIA RS-232-C DTE plug. The LJ250 uses the H8571-E MMJ adapter for Digital Equipment Corporation's DEConnect applications.

2.1.2 Interface Signals

The signals conform to DEC423 standard. Table 2-1 shows pin assignments in the MMJ connector for the interface signals.

2.1.2.1 Shield (AA) – The cable's shield provides the protective ground.

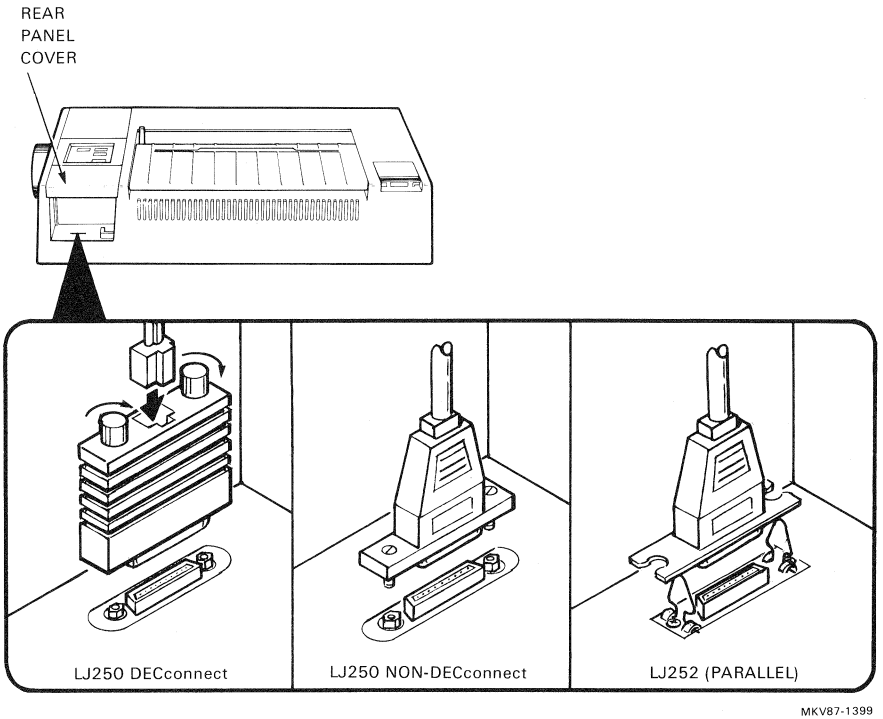


Figure 2-1 Data Interface Connections

Table 2-1 Serial Interface Signals

DTE Pin	Direction	RS423 Name	Function	RS232-C Name
1	From printer	AA	Shield	AA
3	To printer	BB	Receive Data	BB
2	From printer	BA	Send Data	BA
20	From printer	CD	Terminal Ready	CD
4	From printer	CA	Request to Send	CA
7	Common	AB	Signal Ground	AB

2.1.2.2 Receive Data (BB) – The printer receives serial encoded characters from the computer on this line.

2.1.2.3 Send Data (BA) – The printer sends serial encoded characters to the computer on this line.

The bit rate within a character can be 4800 or 9600 bits per second. However, the character transmission rate from the printer to the computer over any two characters does not exceed 100 characters per second. This limit helps to ensure that multiuser systems have sufficient time to process data sent from the printer.

2.1.2.4 Terminal Ready (CD) – When the printer is ready to send and receive data, it uses this line to tell the computer.

The ON condition indicates the printer is ready to send and receive data. The OFF condition indicates that the printer is not ready.

After the power-up initialization, the printer is ready to send and receive data. The printer remains ready to communicate indefinitely.

NOTE: If the DTR switch on the rear panel is set to DTR, then DTR is used for buffer control.

2.1.2.5 Request to Send (CA) – At powerup this line is set to active.

2.1.2.6 Busy or Ready – This line is not used.

2.1.2.7 Signal Ground (AB) – This circuit establishes a point common ground reference potential for the send data and terminal ready interface circuits.

2.1.3 Data Format (Parity/Word Length)

The LJ250 requires data transmission in a bit serial, asynchronous character format. This format consists of:

- A start bit (space)
- Seven or eight data bits (1 = mark, 0 = space)
- A selectable parity bit
- At least one stop bit (mark)

You select the number of data bits and parity through rear panel selection switches (Section 2.4). The LJ250 must use the same data bits and parity as your computer. Figures 2-2 and 2-3 show the printer-to-computer and computer-to-printer character formats.

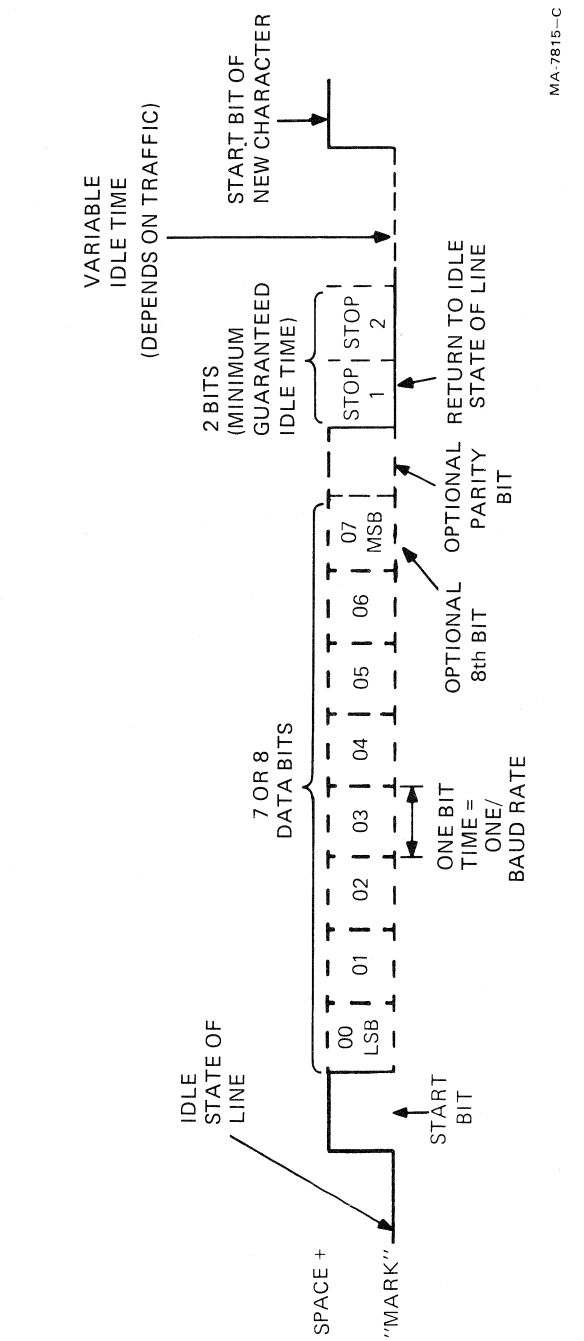


Figure 2-2 Serial Character Format (Printer-to-Computer)

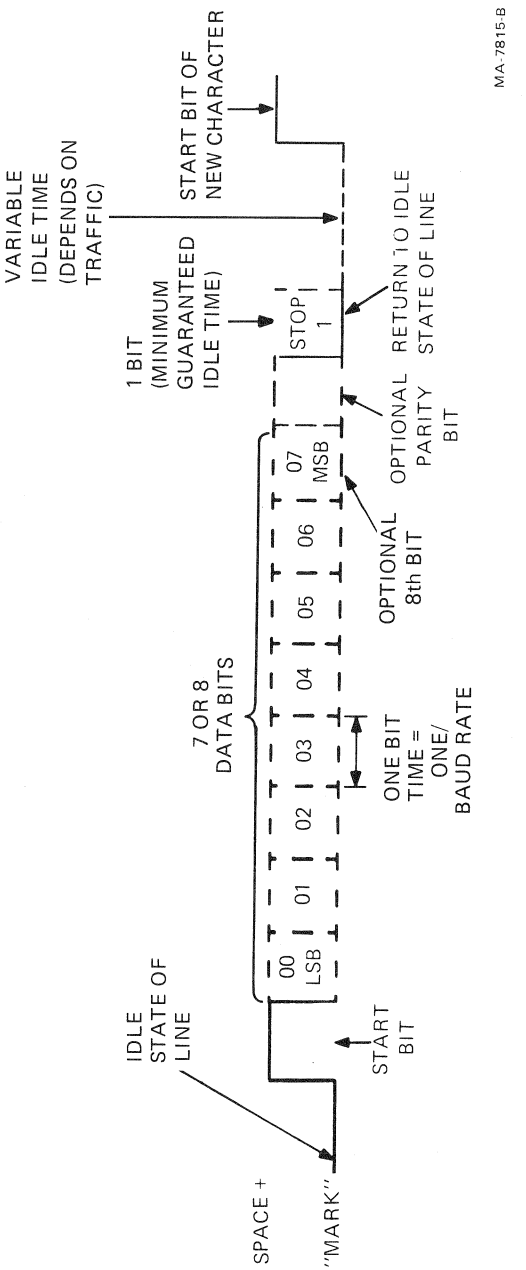


Figure 2-3 Serial Character Format (Computer-to-Printer)

The printer sends two stop bits between characters to the computer. Stop bits provide a minimum idle time between two characters. The printer communicates with equipment that requires 1 or 2 stop bits.

The data bits define 7- or 8-bit characters with the least significant bit leading. Parity is set together with a number of data bits by the rear panel switches (Section 2.4).

2.1.4 Baud Rates

Baud rate is the speed at which data is sent and received, usually expressed in bits per second. The LJ250 must use the same baud rate as your computer. You can select a printer baud rate of 4800 or 9600 bits per second. You select the baud rate with a switch on the rear panel. (Figure 2-7)

2.1.5 Input Buffer Control

The LJ250 input buffer can be controlled by the DTR handshake or by XON/XOFF control. The desired buffer control is selected by the rear panel switches (Section 2-4). The input buffer holds up to 2,560 characters.

2.1.5.1 XON/XOFF Control – After the printer is turned on and ready to receive data, it sends one XON control character to the computer. The XON character tells the computer to start sending data.

To avoid input buffer overflow, the printer constantly monitors the number of empty character positions in the input buffer. When the input buffer fills to 2432 characters, the printer sends an XOFF control character. This first XOFF character tells the computer to stop sending data.

If the computer misses the first XOFF character, the printer sends a second XOFF control character when the input buffer fills to 2496 characters.

Meanwhile, the printer continues to print or process characters from the input buffer. When the input buffer drops to 2304 characters, the printer sends an XON character, which tells the computer to resume sending data.

If you run out of paper while printing, the printer continues to buffer data the usual way. (An XOFF is sent when the input buffer fills to 2432 characters.) When you reload paper, the printer sends an XON character only when the input buffer falls below 2304 characters.

The printer temporarily stores all received characters in its input buffer before processing. The input buffer can hold 2560 characters without losing data.

As the printer processes data from the input buffer, it moves characters into the print buffer. The LJ250 does not start printing until one of the following conditions is met:

- A line terminator character (LF, FF, VT, CR, or any control function that causes vertical motion) is received (Section 3.5).
- In text mode, the autowrap feature is set and printing occurs beyond the right margin.
- In text mode, the printer has not received data for 500 milliseconds.

Table 2-2 XON/XOFF Summary

Remaining Buffer Space (Characters)	LJ250 Actual	Codes Sent
0	2560	N/A
–64	2496	2nd XOFF
–128	2432	1st XOFF
–256	2304	XON

If the printer receives characters faster than it can process or print them, the input buffer may overflow. The LJ250 uses the XON/XOFF protocol to avoid the input buffer overflow. However, if the host computer ignores the XON/XOFF protocol, data may be lost. The printer inserts the SUB character in the input buffer at the point of loss. SUB prints as an error character (reverse question mark).

The printer uses the same method to replace characters received with a parity or framing error.

Unlike all other control codes and sequences, the device status request (DSR) control sequence is processed out of sequence and as soon as it is received (Sections 5.3 and 5.4). The printer immediately responds to the DSR without placing the code into the buffer, even when the buffer is full and an XOFF has been sent to the host computer.

2.1.5.2 DTR Handshake – When data terminal ready (DTR) handshaking is selected (Section 2.4), the DTR line (pin 20) on the serial interface is used for input buffer control. An ON state starts data transfer, and the OFF state stops data transfer.

2.2 PARALLEL INTERFACE

The LJ252 has a Centronics* parallel interface. Characters are transferred to the printer in 8-bit us ASCII format.

2.2.1 Parallel Connector

The parallel interface connector on the printer is a 36-position female Centronics* connector. The interface signals are at TTL levels.

2.2.2 Parallel Interface Signals

The parallel interface signals are all TTL levels.

Table 2-3 Parallel Interface Signals

Pin	Direction	Name	Active State	Function
1	To printer	STROBE	Low	Clock pulse for data; transfers data on high-to-low transition.
2	To printer	DATA BIT 1	High	Data
3	To printer	DATA BIT 2	High	Data
4	To printer	DATA BIT 3	High	Data
5	To printer	DATA BIT 4	High	Data
6	To printer	DATA BIT 5	High	Data
7	To printer	DATA BIT 6	High	Data
8	To printer	DATA BIT 7	High	Data
9	To printer	DATA BIT 8	High	Data

*Centronics is a trademark of Centronics Data Computer Corporation.

Table 2-3 Parallel Interface Signals (Cont)

Pin	Direction	Name	Active State	Function
10	From printer	ACKNLG	Low	Acknowledge pulse that indicates data has been received and printer is ready for more data (Low active.)
11	From printer	BUSY	High	Indicates the printer cannot accept data
12	From printer	PE	High	Indicates the printer is out of media
13	From printer	SLCT	High	Indicates the printer is in the READY state
14	To printer	AUTO FEED	Low	Causes a single line feed after printing
15	Not Used			
16	From printer	0 volts	–	Logic ground
17	From printer	Chassis Gnd	–	Chassis ground (Logic and chassis ground are isolated.)
18	From printer	+5 V	–	Vcc
19-29	From printer	0 volts	–	Twisted pair returns
30	From printer	0 volts	–	Input prime return
31	From printer	INIT	Low	Input prime, initializes printer, clears input buffer
32	From printer	ERROR	Low	Indicates the printer is out of paper, not ready, or in an error state

Table 2-3 Parallel Interface Signals (Cont)

Pin	Direction	Name	Active State	Function
33	From printer	0 volts	–	Twisted pair returns
34,35	Not Used			
36	To Printer	SLCT IN	Low	Must be low for printer to receive data

2.3 CONTROL PANEL AND OPERATING MODES

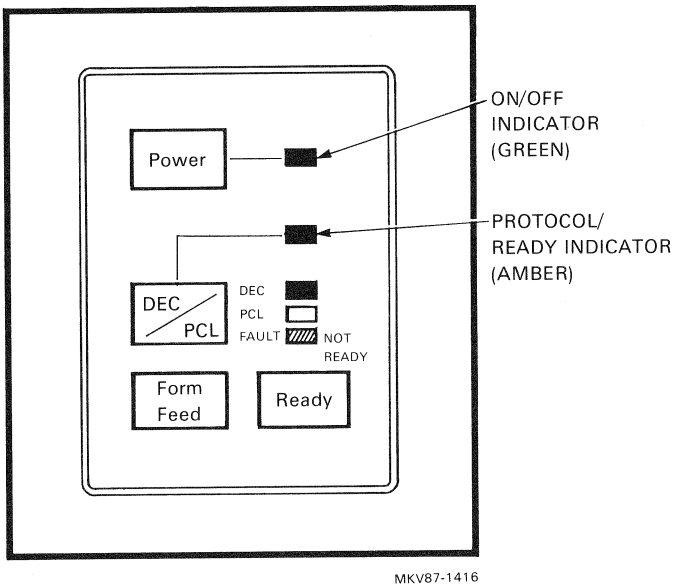


Figure 2-4 Companion Color Printer Control Panel

2.3.1 Printer Operating Controls and Indicators

Operating Controls		Indicators
[Power]	**POWER** switch	Turns power on to the printer. When power module is attached, 20 Vac is applied to the printer.
■	**ON/OFF** indicator (green)	Indicates that the printer is on when lit.
[Ready]	**READY** switch	Puts the printer in the selected state; pressing again deselects the printer. (A flashing PROTOCOL/READY indicates the printer is off-line.)
[DEC/PCL]	**PROTOCOL** switch	Selects the printer protocol (the way the printer communicates with your computer system). To change between "DEC" and "PCL", press the switch once. The PROTOCOL/READY indicates the selected protocol (see below).
■	**PROTOCOL/READY** indicator (amber)	Is interpreted as follows: ON – Printer ready (DEC Protocol) OFF – Printer ready (PCL Protocol) BLINKING – Paper out, printer deselected, or hardware error.
[Form Feed]	**FORM FEED** switch	Advances the printer paper by one form-length at a time.

POWER Switch
This momentary switch energizes the printer. The power module and some of the power supply components are always energized.

ON/OFF Indicator
The green LED indicator lights when the printer is powered up. The power module and some of the power supply components are always energized.

READY Switch
The READY switch puts the printer in the deselected or off-line state; pressing it again places the printer in the selected or on-line state. A flashing PROTOCOL/READY LED indicates the printer is not ready (off-line) and will not print.

If you press the READY switch while the printer is printing (putting it "off-line"), the printer completes only the line currently printing, then stops, and the PROTOCOL/READY indicator flashes.

If the printer runs out of paper, the PROTOCOL/READY indicator flashes.

PROTOCOL/READY Indicator
The amber LED indicator shows the protocol and READY status of the printer. When the LED is steadily lit, the printer is in the DEC protocol. When it is off, the printer is in HP PCL protocol. A blinking PROTOCOL/READY LED indicates that the printer is out of paper, is not in a ready condition (READY switch was pressed), or has experienced a hardware error.

PROTOCOL Switch
The PROTOCOL switch, which is labeled "DEC/PCL", allows you to select DEC protocol or HP PCL protocol. (The protocol allows the printer to communicate with your computer system.) To change between DEC and PCL, press the switch once. The protocol selected is indicated by the PROTOCOL/READY indicator. The PROTOCOL switch is active only when no data is in the input buffer.

FORM FEED Switch
A momentary switch that advances the printer paper in by one form-length when it is depressed. The FORM FEED switch is not active when the printer is printing or when there is data in the print buffer.

2.3.2 Self-Tests

The LJ250 has five built-in self-tests to help the user confirm correct printer operation.

2.3.2.1 Power-up Self-Test – When power is applied to the printer, the internal diagnostics are run. Successful completion is indicated by the illumination of the PROTOCOL/READY indicator.

Procedure:

1. Power on the printer *with the paper installed.*

2. Observe the PROTOCOL/READY indicator. A flashing PROTOCOL/READY indicates that the printer has failed the test.

2.3.2.2 Printing Self-Test – This self-test prints all text characters in an 80-column swirling test pattern and provides a color test pattern. All print nozzles are tested.

Detected logic failures are indicated by a flashing PROTOCOL/READY indicator on the control panel. See Appendix D for a sample printout.

Procedure:

1. Insert the paper.

2. With the power OFF, press the FORM FEED switch while momentarily pressing the POWER switch.

3. Release the FORM FEED switch.

4. After several lines have been printed, compare the printout to the sample in Appendix D.

2.3.2.3 Loopback Self-Test – This self-test checks the serial interface, logic, carriage mechanism, paper handling, and print heads. An optional loopback connector (P/N 12-25083-01) is required. Detected failures are indicated by a flashing PROTOCOL/READY light.

Procedure:

1. Disconnect the MMJ communications cable.
2. Connect the loopback connector (P/N 12-25083-01).
3. Insert the paper.
4. With the power OFF, press and hold the FORM FEED and READY switches while momentarily pressing the POWER switch.
5. Release the FORM FEED and READY switches.
6. Observe the printout.
7. Turn the printer power OFF to terminate the test.
8. Remove the loopback connector and reattach the communications cable.

2.3.2.4 Color Palette Display – This self-test prints all 256 colors that the Companion Color Printer is capable of printing. The palette can be used for verifying the colors and as a reference to the color numbers. The number on the side and top of the display indicate the color numbers. See Appendix D for more details on using the color palette to choose colors.

Procedure:

1. Insert the paper.
2. With the power OFF, press the READY and DEC/PCL switches while momentarily pressing the POWER switch.
3. Release the READY and DEC/PCL switches.
4. The printer takes several minutes to print all 256 colors and stops after one page.

NOTE: Keep a Color Palette Display printout with the printer documentation for reference.

2.3.2.5 Remote Self-Test (PCL Mode only) – Remote self-test is initiated by sending an ESC z when the printer is in the PCL protocol mode (Section 7.5.1.3).

The Companion Color Printer prints all data preceding the self-test and moves the paper to top of form. The self-test is printed and an internal diagnostic is performed.

If no error is detected, the printer remains on-line, moves to the top of the next form, and continues processing data.

If the printer detects an error, it flashes the PROTOCOL/READY indicator.

The input buffer is preserved, but programmable features such as underlining may be lost; downloaded characters may be lost.

Table 2-4 Self-Test Summary

Test	Activation	Deactivation	Pass Indication	Fail Indication
Powerup Self-Test	Power up	N/A	POWER on	Flashing PROTOCOL/READY*
Printing Self-Test	Power up/ FF	Power off	Observe Printout	Printout/ Flashing PROTOCOL/READY*
Loopback Self-Test	Power up/ READY	Power off	Observe Printout	Printout/ Flashing PROTOCOL/READY*

* A flashing PROTOCOL/READY light can indicate a hardware error. See Table 4-2 Hardware Error Indications (Flashing PROTOCOL/READY).

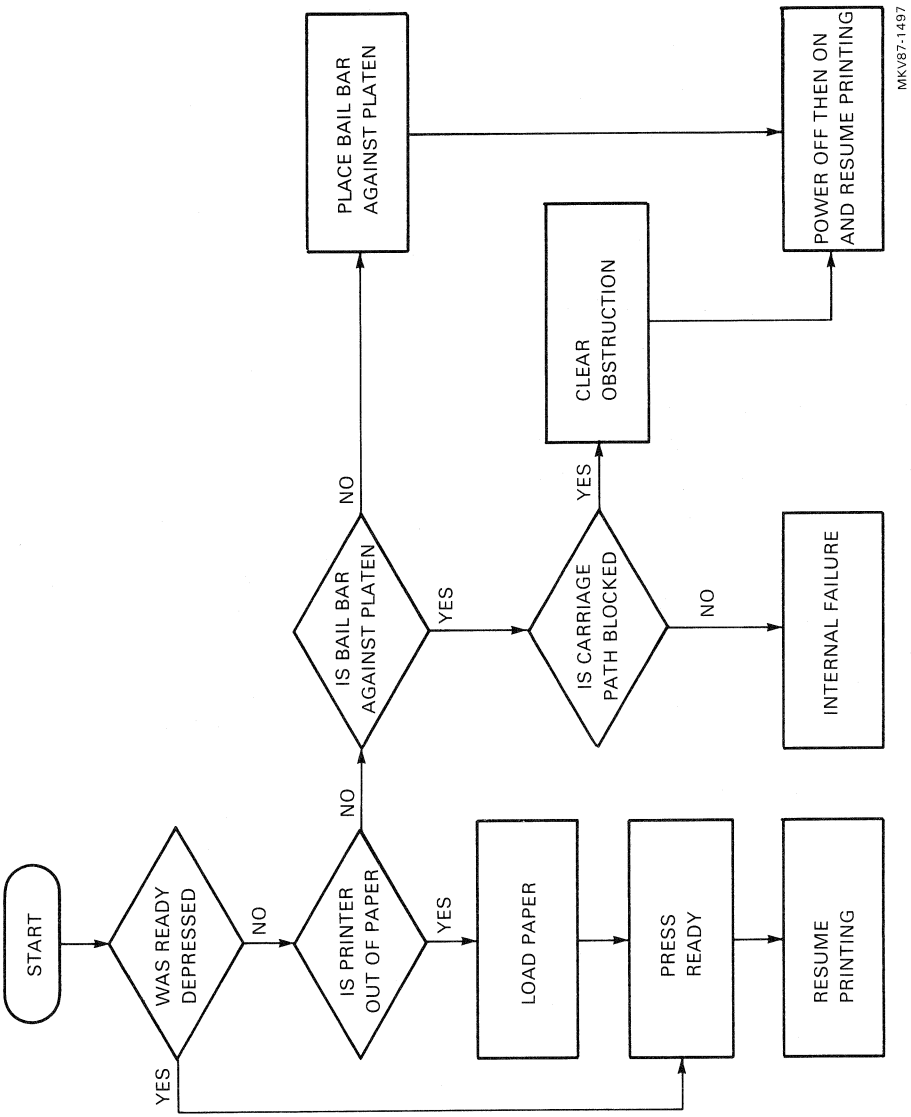


Figure 2-5 Flashing PROTOCOL/READY Analysis

2.4 CONFIGURING YOUR PRINTER

The power-up configuration switches are on the rear panel of the printer. The switches are only read by the printer on powerup.

2.4.1 Configuration Printout

The Companion Color Printer prints out its current configuration and firmware version number. The printout is obtained as follows:

1. Ensure that paper is in the printer.

2. Hold down the READY and FORM FEED switches while turning the printer ON.

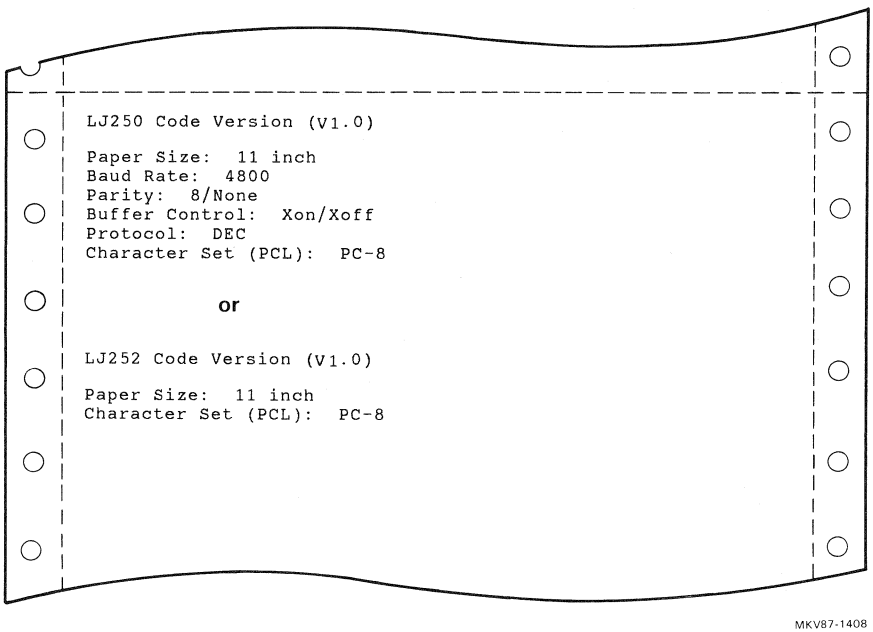


Figure 2-6 Configuration Printout

2.4.2 Configuration Switches For LJ250 (Serial) Printer

The configuration switches for the LJ250 are found on the printer rear panel. After a switch setting is changed, the printer power must be cycled off and then back on for the switch to be read.

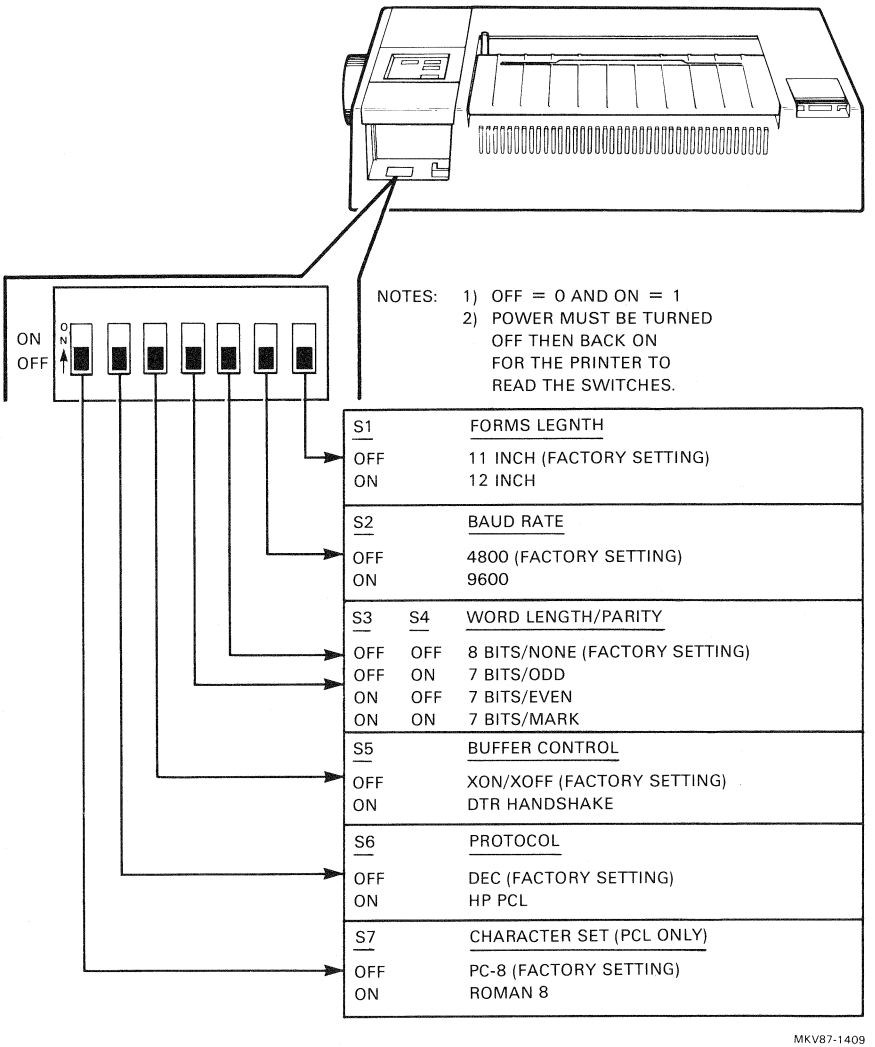


Figure 2-7 LJ250 Configuration Switches

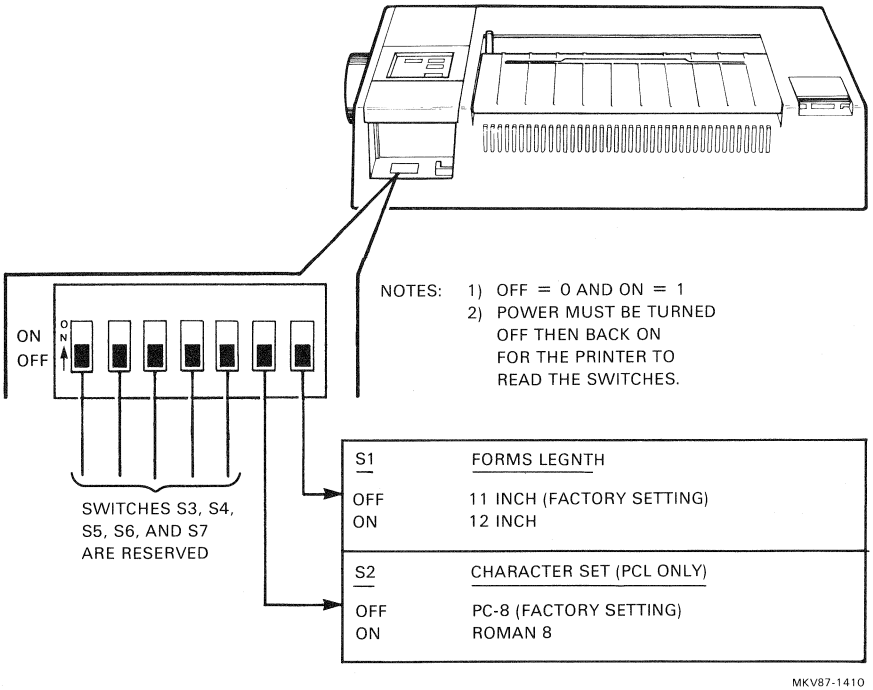


Figure 2-8 LJ252 Configuration Switches

2.4.3 Configuration Switches For LJ252 (Parallel) Printer

The configuration switches for the LJ252 are found on the printer rear panel. After a switch setting is changed, the printer power must be cycled off and then back on for the switch to be read.

2.5 CONNECTION AND SETUP FOR SOME SPECIFIC COLOR SYSTEMS

The print parameters can be changed from the print menu of your system. Refer to the application software documentation to change the settings on systems not listed here.

NOTE: If you are a VAX/VMS user and are printing color sixel files through your terminal in printer controller mode, set your VMS terminal to NOBROADCAST. Setting your terminal to NOBROADCAST prevents messages from interfering with the sixel output. Use the following VMS command:

$ SET TERMINAL/NOBROADCAST

2.5.1 VT241

Use the following steps to connect and set up the VT241:

1. Attach the printer cable using one of the two following methods:

   a. Connect the 25-pin connector end of the printer cable (P/N BCC20-10) to the printer interface connector and tighten the connector attaching screws.

   b. Connect the 9-pin connector end of the printer cable to the printer port (marked PR) on the VT241 and tighten the connector screws.

   or

   a. Connect the MMJ adapter (H8571-E) to the printer interface connector and tighten the attaching screws.

   b. Connect an MMJ adapter (H8571-B) to the printer port of the VT241 and tighten the attaching screws.

   c. Connect the printer and terminal using a BC16E flatwire cable.

2. Power up the VT241 monitor and system unit.

3. Go to the Printer Setup Screen on the VT241 terminal. Ensure that the baud rate, number of bits and parity, and XOFF match the configuration switches on the printer rear panel.

4. Go to the Graphics Setup Screen on the VT241 terminal and set the following:

Set-up Choices		Select
Color Print/Mono Print	=	Color Print
HLS Print/RGB Print	=	(User's Preference)
Print/No Print background	=	No Print Background

5. Exit Setup Screens and print a color file to verify configuration.

For further information on changing print parameters see the *VT241 Owner's Manual*, Chapter 4, Terminal Setup, (EK-VT240-UG).

2.5.2 VT340

The DEConnect printer cable (P/N BC16E) and the MMJ adapter (P/N H8571-E) supplied with the printer are used to connect the LJ250 printer to the VT340.

Use the following steps to connect and set up the VT340:

1. Install the MMJ adapter on the interface connector and tighten the screws.
2. Insert one end of the printer cable into the MMJ adapter.
3. Insert the other end of the printer cable into the printer port (marked with the printer logo) on the VT340.
4. Power up the VT340.
5. Go to the Printer Setup menu on the VT340. Ensure that the print speed (baud rate), character format (number of bits and parity), and flow control (XON/XOFF) match the configuration switches on the printer rear panel.
6. While still in the Printer Setup menu on the VT340, set the following:

Setup Choices		Select
Graphics Printing	=	Enabled
Background Printing	=	Disabled
Sixel Graphics Level	=	Level 2
Sixel Print Option	=	(User's Preference)
Color Printing	=	Color
Color Specification	=	(User's Preference)

7. Exit the Printer Setup menu and print a color file to verify configuration.

For further information on changing print parameters and setup, see *Installing and Using the VT300 Series Video Terminal*, Chapter 11, Printers and Modems, (EK-VT3XX-UG).

2.5.3 VAXstation 2000

To obtain color hardcopy output from a VAXstation, Version 3.2 of the VAX Workstation Software (VWS) must be loaded.

Procedure:

1. Display the Workstation Options menu.
2. Choose "Set Up The Workstation" from the Workstation Options menu.
3. Choose "Printer Setup" from the "Workstation Setup" menu.
4. Choose "8-colors" under the "Color Conversions Method".
5. Now use the Print Screen key to print.

You can also obtain color hardcopy output with Hardcopy UIS V3.2 bundled into VAX Workstation Software (VWS) Version 3.2. Use the /DEVICE _TYPE=LJ250 qualifier on the RENDER command to create a color sixel file that can be sent to the printer.

EXAMPLE

```
$ RENDER CLOWN/DEV=LJ250
```

2.6 USING THE COMPANION COLOR PRINTER

Procedure:

1. Load the paper now or anytime during operation.

2. Position the paper to the first printable line and press the power switch. This action powers on the printer and sets the top-of-form position.

   If printing transparencies, enter the transparency mode by holding down the DEC/PCL switch while turning the power on. Hold the DEC/PCL switch one second longer than the power switch.

3. The green POWER indicator will light. The red PROTOCOL/READY indicator is lit to indicate that the printer is ready (on-line) with DEC protocol. An unlit PROTOCOL/READY indicator indicates that the printer is ready (on-line) with PCL protocol.

4. Change the protocol, if necessary, by pressing the protocol switch. The power-up default setting is on the rear panel (Section 2.4.3).

NOTE: The PROTOCOL (DEC/PCL) switch does not work if the printer is off-line and there is data in the input buffer.

5. Your Companion Color Printer is now ready to print.

PART 2 COMPANION COLOR PRINTER IN DEC – COMPATIBLE MODE

CHAPTER 3
CHARACTER PROCESSING

This chapter describes how the Companion Color Printer processes printable and control characters when operating in DEC text mode.

3.1 DEC CONFORMANCE LEVEL INTRODUCTION

The printer's ability to perform certain printing and control functions depends on the conformance level setting. Both the LJ250 and the LJ252 can be set to two conformance levels: Level 1 or Level 2.

NOTE: The Companion Color Printer powers up in Level 2.

Level 1 functions are always active in the companion Color Printer. Level 2 functions are active only if the printer is set as a Level 2 device.

Level 1 provides basic functionality similar to the DIGITAL LA50 printer (except for the reply to the DA sequence). Level 2 supports expanded functionality and is similar to the DIGITAL LA75 and LA210 printers.

For more information on Level 1 and 2 functions, refer to Sections 4.4 and 4.5.

3.2 CODING STANDARDS

The Companion Color Printer processes characters according to the American National Standards Institute (ANSI) standard X3.4-1977. The ANSI standard is based on the character's category, either printable or control. Categories are defined by the American Standard Code for Information Interchange (ASCII).

3.3 7-BIT AND 8-BIT ENVIRONMENTS

The LJ250 (serial version) is set to send and receive 7- or 8-bit data by the rear panel switch (Section 2.4). In a 7-bit environment, 128 control and printable character codes are available. Figure 3-1 shows the standard ASCII character set table.

B7 B6 B5 / BITS B4 B3 B2 B1	ROW	COLUMN 0 (0 0 0)	COLUMN 1 (0 0 1)	COLUMN 2 (0 1 0)	COLUMN 3 (0 1 1)	COLUMN 4 (1 0 0)	COLUMN 5 (1 0 1)	COLUMN 6 (1 1 0)	COLUMN 7 (1 1 1)
0 0 0 0	0	NUL 0 0 0	20 16 10	SP 40 32 20	0 60 48 30	@ 100 64 40	P 120 80 50	` 140 96 60	p 160 112 70
0 0 0 1	1	1 1 1	DC1 (XON) 21 17 11	! 41 33 21	1 61 49 31	A 101 65 41	Q 121 81 51	a 141 97 61	q 161 113 71
0 0 1 0	2	2 2 2	22 18 12	" 42 34 22	2 62 50 32	B 102 66 42	R 122 82 52	b 142 98 62	r 162 114 72
0 0 1 1	3	3 3 3	DC3 (XOFF) 23 19 13	# 43 35 23	3 63 51 33	C 103 67 43	S 123 83 53	c 143 99 63	s 163 115 73
0 1 0 0	4	4 4 4	24 20 14	$ 44 36 24	4 64 52 34	D 104 68 44	T 124 84 54	d 144 100 64	t 164 116 74
0 1 0 1	5	5 5 5	25 21 15	% 45 37 25	5 65 53 35	E 105 69 45	U 125 85 55	e 145 101 65	u 165 117 75
0 1 1 0	6	6 6 6	26 22 16	& 46 38 26	6 66 54 36	F 106 70 46	V 126 86 56	f 146 102 66	v 166 118 76
0 1 1 1	7	BEL 7 7 7	27 23 17	' 47 39 27	7 67 55 37	G 107 71 47	W 127 87 57	g 147 103 67	w 167 119 77
1 0 0 0	8	BS 10 8 8	CAN 30 24 18	(50 40 28	8 70 56 38	H 110 72 48	X 130 88 58	h 150 104 68	x 170 120 78
1 0 0 1	9	HT 11 9 9	31 25 19	) 51 41 29	9 71 57 39	I 111 73 49	Y 131 89 59	i 151 105 69	y 171 121 79
1 0 1 0	10	LF 12 10 A	SUB 32 26 1A	* 52 42 2A	: 72 58 3A	J 112 74 4A	Z 132 90 5A	j 152 106 6A	z 172 122 7A
1 0 1 1	11	VT 13 11 B	ESC 33 27 1B	+ 53 43 2B	; 73 59 3B	K 113 75 4B	[133 91 5B	k 153 107 6B	{ 173 123 7B
1 1 0 0	12	FF 14 12 C	34 28 1C	, 54 44 2C	< 74 60 3C	L 114 76 4C	\ 134 92 5C	l 154 108 6C	| 174 124 7C
1 1 0 1	13	CR 15 13 D	35 29 1D	- 55 45 2D	= 75 61 3D	M 115 77 4D	] 135 93 5D	m 155 109 6D	} 175 125 7D
1 1 1 0	14	SO 16 14 E	36 30 1E	. 56 46 2E	> 76 62 3E	N 116 78 4E	^ 136 94 5E	n 156 110 6E	~ 176 126 7E
1 1 1 1	15	SI 17 15 F	37 31 1F	/ 57 47 2F	? 77 63 3F	O 117 79 4F	_ 137 95 5F	o 157 111 6F	DEL 177 127 7F

KEY

ASCII CHARACTER: ESC | 33 OCTAL | 27 DECIMAL | 1B HEX

MA-7247T

Figure 3-1 7-Bit ASCII Character Set

In an 8-bit environment, 256 control and printable character codes are available. Figure 3-2 is the 8-bit DEC Multinational character set. The 8-bit character set has twice as many characters as the 7-bit set. The left half of the 8-bit set is identical to the 7-bit set.

Figure 3-3 is the ISO Multinational (ISO Latin-1) character set.

A character set table shows all the characters in a character set. The table also shows the codes for each character. You can represent a character by its position (column/row) in a table. For example, you can represent the character H in Figure 3-1 as 4/8 (column 4/row 8). This manual uses this notation.

You can tell whether a character is a printable character or a control character by looking at its position in the character set table.

There are two sets of control characters, C0 and C1. C0 characters are 7-bit (that is, the eighth bit is set to 0) control characters. The characters from 0/0 to 1/15 in both tables are C0 control characters. C1 characters are 8-bit (the eighth bit is 1) control characters and are located in the positions from 8/0 to 9/15 in the 8-bit table. You can use C1 characters only in an 8-bit environment.

You can use two sets of printable characters at one time. The printer stores the two active sets in areas called GL (graphic left) and GR (graphic right). GL characters are 7-bit printable characters. The characters from 2/1 to 7/14 in both tables are GL characters. GR characters are 8-bit printable characters. The characters from 10/1 to 15/14 in the 8-bit table are GR characters. You can use GR codes only in an 8-bit environment.

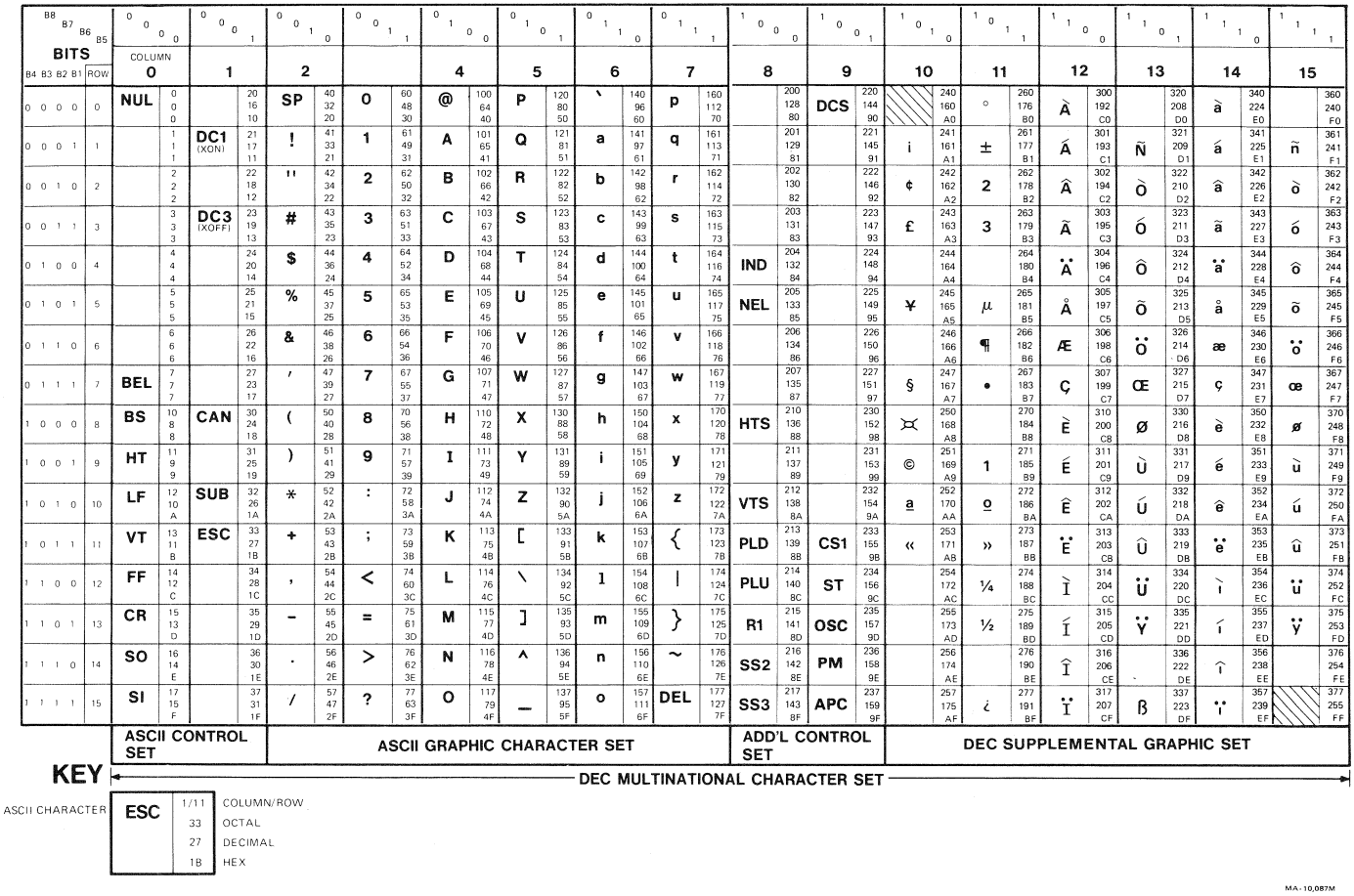


Figure 3-2 8-Bit DEC Multinational Character Set

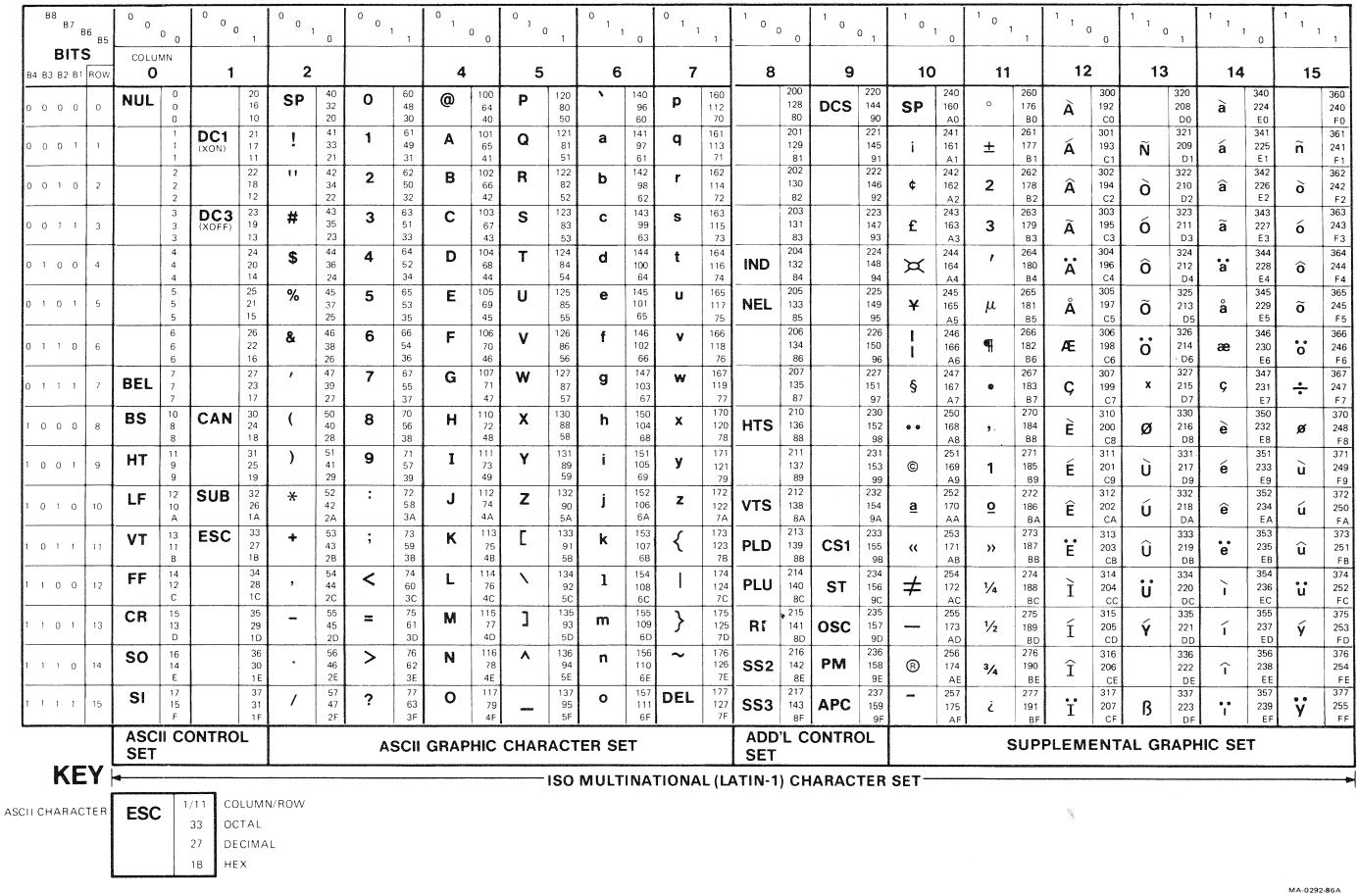


Figure 3-3 8-Bit ISO Multinational Character Set

3.4 CHARACTER SET MAPPING

The printer lets you use one GL set and one GR set at a time. Each set has 94 character codes reserved. In a 7-bit environment, you can use the 94 GL set codes (2/1 to 7/14). In an 8-bit environment, you can use the 94 GL set codes plus the 94 GR set codes (10/1 to 15/14).

Printable characters are usually grouped into sets of 94. You can map any two available sets into GL and GR. If your application requires more than 188 printable characters, you can designate up to four sets as G0, G1, G2, and G3. Then, you can map one of those sets into GL or GR for printing.

Figure 3-4 shows how to designate and map character sets in an 8-bit environment. Figure 3-5 shows how to designate and map character sets in a 7-bit environment. To select specific character sets, see the commands described in Section 4.4.5.

NOTE: There are 96 printable characters in the ISO Supplemental character set. All 96 characters can be accessed from the GR set by using locations 10/0 and 15/15 as printable characters. (See Appendix A.)

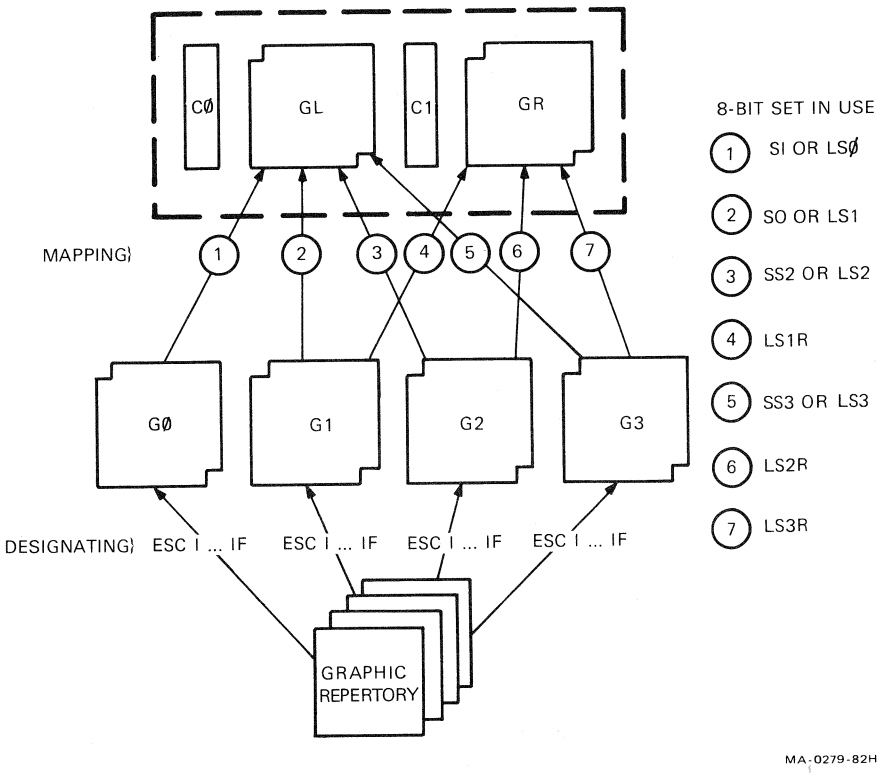


Figure 3-4 Designating and Mapping Character Sets (8-Bit Environment)

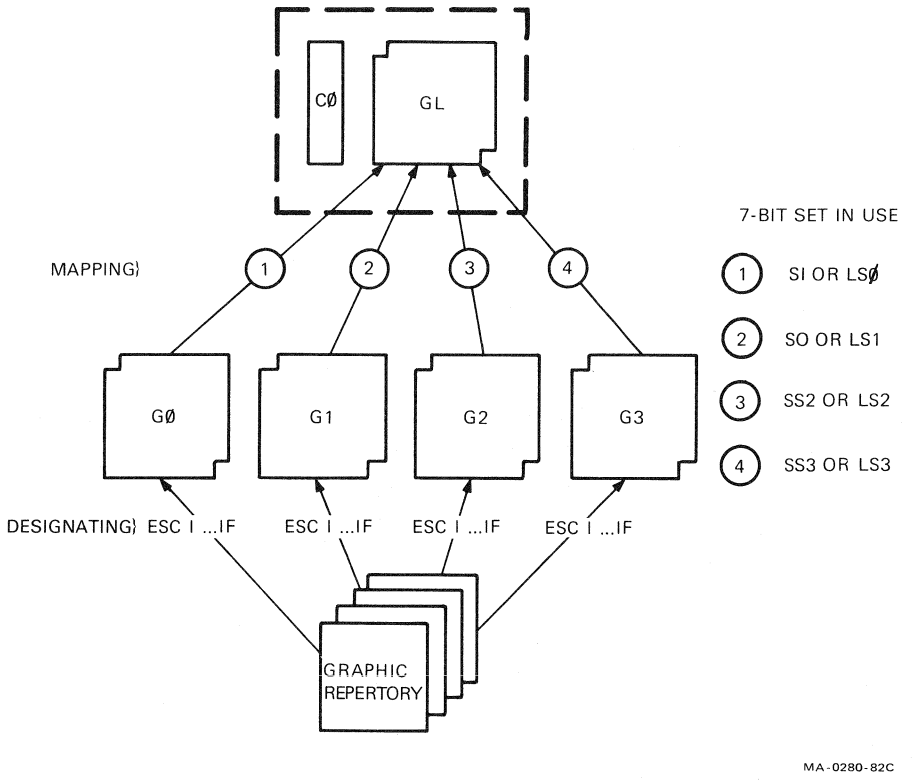


Figure 3-5 Designating and Mapping Character Sets (7-Bit Environment)

3.5 DEC CONTROL CHARACTERS

A control character is a single character that starts, modifies, or stops a printer function. Control characters do not print; they affect how the printer processes, sends, and prints characters.

The Companion Color Printer recognizes two sets of control characters: C0 and C1 (Figure 3-2). The following paragraphs describe the function of each control character.

NOTE: Each control character is assigned a mnemonic (abbreviation of the control function name).

3.5.1 C0 (7-Bit) Control Characters

Table 3-1 C0 (7-Bit) Text Mode Control Characters

Column/Row	Mnemonic	Function
Printer control functions		
0/8	BS	Backspace
0/9	HT	Horizontal tab
0/10	LF	Line feed
0/11	VT	Vertical tab
0/12	FF	Form feed
0/13	CR	Carriage return
Character set control functions		
0/14	SO	Shift out
0/15	SI	Shift in
Communication control functions		
0/0	NUL	Null
1/1	DC1	XON
1/3	DC3	XOFF
1/8	CAN	Cancel
1/10	SUB	Substitute
1/11	ESC	Escape

NOTE
The printer ignores all other ASCII C0 control characters.

3.5.1.1 Backspace (BS) – This character decreases the active column by one column space at the current horizontal pitch (Section 4.4.1). If the active column is at the left margin, the BS character is ignored.

If the active column is one column beyond the right margin, you can use a BS character to print or overprint at the right margin.

3.5.1.2 Horizontal Tab (HT) – A horizontal tab is a preselected print position on a line. When the printer receives an HT character, the print head advances to the next tab position on the line. The printer has default horizontal tab stops every 8 columns. Starting at column 9, each time you change the horizontal pitch (Section 4.4.1), the horizontal tab positions change also.

NOTE: Horizontal tab stops can be changed only if you activate Level 2 (Level 2/LA210) functions.

When there are no more tab stops to the right of the active column, the right margin feature selection controls the effect of an HT character (Section 4.5.6.3).

- If the right margin is set to wrap and an HT is received, a printable character (including a space) causes the printer to perform a carriage return and line feed.

- If the right margin is set to truncate and an HT is received, the printer ignores printable characters (including spaces) until the active column returns to the printable area.

3.5.1.3 Line Feed (LF) – This character increases the active line by one line at the current vertical pitch (Section 4.4.2). If less than one line remains unprinted on the current page, the LF character sets the active line to the top-of-form position on the next page.

3.5.1.4 Vertical Tab (VT) – A vertical tab is a preselected line setting on a page. When the printer receives a VT character, the active line moves to the next tab position on the page. The printer has default vertical tab stops at every line. This effectively causes the VT character to be processed as an LF character.

Each time you change the vertical pitch (Section 4.4.2), vertical tab positions change also.

NOTE: You can set and reset the vertical tab stops only if the printer is set to Level 2 conformance (Section 4.5.5).

3.5.1.5 Form Feed (FF) – This character advances the active line to the next top-of-form position (Section 4.5.6)

3.5.1.6 Carriage Return (CR) – This character sets the active column to the left margin.

3.5.1.7 Shift Out (SO) – This character selects the G1 character set as the GL active character set.

3.5.1.8 Shift In (SI) – This character selects the G0 character set as the GL active character set.

3.5.1.9 Null (NUL) – This character does not affect the printer's operation.

3.5.1.10 XON (DC1) – This character performs no action. It is sent by the printer for input buffer control.

3.5.1.11 XOFF (DC3) – This character performs no action. It is sent by the printer for input buffer control.

3.5.1.12 Cancel (CAN) – The CAN control character immediately cancels (without executing) any escape sequence, control sequence, or control string currently being processed.

3.5.1.13 Substitute (SUB) – This character immediately stops the processing of any escape or control sequence. The SUB character prints as the error character (reverse question mark).

3.5.1.14 Escape (ESC) – This character introduces an escape sequence (Chapter 4).

3.5.2 C1 (8-Bit) Text Control Characters

Table 3-2 C1 (8-Bit) Text Mode Control Characters

Column/Row	Mnemonic	Function
Printer control functions		
8/11	PLD	Partial line down
9/12	PLU	Partial line up
8/4	IND	Forward index (Level 2)
8/5	NEL	Next line (Level 2)
8/8	HTS	Horizontal tab set (Level 2)
8/10	VTS	Vertical tab set (Level 2)
Character set control functions		
8/14	SS2	Single shift 2
8/15	SS3	Single shift 3
Communication Control Functions		
9/0	DCS	Device control string
9/11	CSI	Control sequence introducer
9/12	ST	String terminator
9/13	OSC	Operating system command
9/14	PM	Privacy message
9/15	APC	Application program command

NOTE
The printer ignores all other C1 control characters.

3.5.2.1 Partial Line Down (PLD) – This character advances the paper 1/12 inch (Section 4.4.4).

3.5.2.2 Partial Line Up (PLU) – This character reverses the paper 1/12 inch (Section 4.4.4).

3.5.2.3 IND, NEL, HTS, and VTS – These control characters are Level 2 functions (Section 4.5).

3.5.2.4 Single Shift 2 (SS2) – This character selects the next printable character from the G2 character set (Section 4.4.5).

3.5.2.5 Single Shift 3 (SS3) – This character selects the next printable character from the G3 character set (Section 4.4.5).

3.5.2.6 Device Control String (DCS) Introducer – This character introduces a device control string. See Section 4.1 for a description of DCS format and functions.

3.5.2.7 Control Sequence Introducer (CSI) – This character introduces a control sequence. See Section 4.1 for a description of the control sequence format.

3.5.2.8 String Terminator (ST) – This character terminates a control string. See Section 4.1 for a description and a list of control strings.

3.5.2.9 OSC, PM, and APC – These control characters introduce unused control strings. See Section 4.1 for more information on unused control strings.

3.6 PRINTABLE, SPACE, AND SPECIAL CHARACTERS

The Companion Color Printer usually interprets characters in the column/row range of 2/0 to 7/14 (GL) and 10/1 to 15/14 (GR) as printable characters. The space (SP) character is 2/0.

The Companion Color Printer prints a character at the active position on a page as defined by the active column and active line. Each printable or space character then increases the active column by one active column, advancing the printhead one column at the current horizontal pitch (Section 4.4.4.1).

The DEL character (7/15) is normally ignored.

The characters at 10/0 and 15/15 have a special effect on printer operation. In text mode, the printer normally processes the 10/0 character as an error character (reverse question mark) and ignores the 15/15 character. However, if the 96-character set resides in the GR, these characters are processed as normal printable characters.

3.7 CHARACTER CELL

The Companion Color Printer prints "near letter quality" characters by printing vertically up to 30 dots that are spaced 1/180 inch apart. Table 3-3 describes the Companion Color Printer fonts.

Table 3-3 Font Characteristics

Characteristic	Font1 Courier 12	Font2 Letter Gothic 18
Horizontal pitch	10 or 12 cpi	18 cpi
Vertical pitch (Normally Used)	6 lpi	8 lpi
Point size	12 point	8 point
Full cell width	18 pixels or 15 pixels (12 cpi)	10 pixels
Full cell height	30 pixels	23 pixels
Actual printhead elements used	1 thru 30	6 thru 28
Baseline	Cell pixel 23 (element 23)	Cell pixel 15 (element 23)

NOTE
The baseline is the bottom pixel used by capital letters.

The following table identifies vertical positions for special horizontal scan line characters and underlining functions. Note that in Font 1, the ink cartridge element number is the same as the character cell pixel number. However, in Font 2, pixel 1 begins at ink cartridge element 6. See Figure 3-6.

Table 3-4 Scan Line and Underlining Elements

Character/Function	Font1 Courier 12	Font2 Gothic 18
Underline character and SGR function	Elements 29,30	Element 28
Double underline SGR function (See note 2)	Elements 25,26 & 29,30	Elements 20 & 23
VT100 horiz. scan #1	Elements 3,4	Element 9
VT100 horiz. scan #3	Elements 9,10	Element 14
VT100 horiz. scan #5	Elements 15,16	Element 19
VT100 horiz. scan #7	Elements 21,22	Element 23
VT100 horiz. scan #9	Elements 27,28	Element 28

Table 3-5 Print Head Elements

Print Head Elements		10 & 12 Pitch Character Cell Pixel			18 Pitch Character Cell Pixel		
	1	1	0				
	2	2	0				
	3	3	X	Scan			See Note 1
	4	4	X	Line 1			
	5	5	0				
	6	6	0		1	0	
	7	7	0		2	0	See Note 2
	8	8	0		3	0	
	9	9	X	Scan	4	X	Scan Line 1
	10	10	X	Line 3	5	0	
	11	11	0		6	0	
	12	12	0		7	0	
	13	13	0		8	0	
	14	14	0		9	X	Scan Line 3
	15	15	X	Scan	10	0	
	16	16	X	Line 5	11	0	
	17	17	0		12	0	
	18	18	0		13	0	
	19	19	0		14	X	Scan Line 5
	20	20	0		15	0	
	21	21	X	Scan	16	0	
	22	22	X	Line 7	17	0	
Baseline	23	23	0		18	X	Scan Line 7
	24	24	0		19	0	
	25	25	0		20	0	
	26	26	0		21	0	
	27	27	X	Scan	22	0	
	28	28	X	Line 9	23	X	Scan Line 9
	29	29	0				See Note 1
	30	30	0				See Note 1

NOTES

1) Elements 1 to 5, 29, and 30 are not used at 18 pitch.
2) At 18 pitch, elements 6, 7, and 8 are used only by DEC Special Line Drawing characters to provide line-to-line connection at 8 LPI.

CHAPTER 4
ESCAPE AND CONTROL SEQUENCES FOR TEXT MODE

This chapter describes the text mode control functions and their use in controlling text printing in DEC mode. These control functions are grouped into two categories: Conformance Level 1 and Conformance Level 2 functions.

4.1 ESCAPE SEQUENCE, CONTROL SEQUENCE, AND CONTROL STRING FORMATS

The LJ250 and LJ252 use escape and control sequences standardized by the American National Standards Institute (ANSI) to control many functions. Other Companion Color Printer functions have escape sequences defined within the parameters of the ANSI standard. ANSI standards X3.4-1977 and X3.32-1973 define many of the escape and control sequences used in this chapter. The remaining escape and control sequences have been defined by Digital Equipment Corporation in compliance with ANSI standards.

4.1.1 Escape Sequence Format

The Companion Color Printer format for an escape sequence follows:

ESC	**I**	**F**
1/11	2/0 to 2/15	3/0 to 7/14
Escape Sequence Introducer	Intermediate Characters (0 or more characters)	Final Character (1 character)

The escape sequence introducer is the ESC control character (1/11). When the printer receives the ESC character, the printer processes the following characters as part of the escape sequence, rather than printing them. The characters must be in the correct escape sequence format to be processed correctly.

A character received after ESC in the 2/0 to 2/15 range is an intermediate character. (The numbers 2/0 and 2/15 indicate a position in a character set table, such as Figure 3-1.) The printer may process zero, one, or more intermediate characters in a valid Companion Color Printer escape sequence.

A character received after ESC in the 3/0 to 7/14 range is a final character. The final character indicates the end of the escape sequence. The intermediate and final characters together define the function of the sequence. The printer performs the action specified by the sequence, then continues to process received characters as specified.

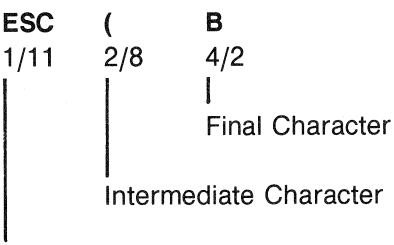
The printer ignores sequences that it does not recognize.

EXAMPLE

Action:

Assign the U.S. ASCII character set as the G0 set.

Sequence:



4.1.2 Control Sequence Format

The Companion Color Printer format for a control sequence follows:

CSI	**P...P**	**I**	**F**
9/11	3/0 – 3/15	2/0 – 2/15	4/0 – 7/14
Control Sequence Introducer	Parameter Characters (0 or more characters)	Intermediate Characters (0 or more characters)	Final Character (1 character)

The *control sequence introducer* (CSI) is the 8-bit C1 control character (9/11). You can also use the equivalent 7-bit sequence ESC [(1/11, 5/11). See Section 4.2 for C1 control characters and their equivalent 7-bit sequences. After receiving the CSI, the printer stores (but does not print) the next received characters as part of the sequence. The characters must be in the correct format, which is described in the following paragraphs.

Parameter characters are characters received after the CSI in the 3/0 to 3/15 range. A parameter character (usually an ASCII digit) modifies the action or interpretation of the sequence. All parameters are interpreted as unsigned decimal integers, with the most significant digit sent first. Leading zeros are allowed but are not necessary. Plus and minus signs are not allowed in parameter characters. You must separate parameters with a semicolon (;) (3/11).

The printer processes two types of parameters: numeric and selective. A numeric parameter (Pn) indicates an actual numeric value, such as a tab or margin location. A selective parameter (Ps) indicates a numeric value associated with a specific action. For example, in the Companion Color Printer device status report sequence (Section 5.4), the Ps value of 21 indicates a hardware failure.

*NOTE: This manual uses Pn, Ps, or P plus another letter to represent parameter characters (except when their actual value is shown). Since parameter values vary, their column/row positions will sometimes appear as asterisks ***.*

If you do not specify a decimal value for a parameter character in a sequence, the printer assumes a value of 0. There is a limit of 16 numeric parameters per string. The printer stores the first 16 parameters received and ignores those that follow.

If the printer receives an out-of-range parameter in a string of parameters, the printer ignores the out-of-range parameter and processes the other parameters.

When all parameters in a sequence are out of range or the sequence is invalid, the printer performs no action.

If the printer receives the question mark character (?) (3/15) at the beginning of a string of parameters, the printer notes the event for later reference. When the final character of the string is received, the presence or absence of this event determines the validity and meaning of the sequence.

If the printer receives the colon (:) (3/10), left angle bracket (<) (3/12), equals symbol (=) (3/13), or right angle bracket (>) (3/14) character while processing a parameter string, or if the question mark (?) (3/15) character is received after the first character of a parameter string, the printer recognizes the sequence, but performs no action.

Characters received after the CSI in the 2/0 to 2/15 range are *intermediate characters.* The printer may process zero, one, or more intermediate characters in a valid Companion Color Printer control sequence.

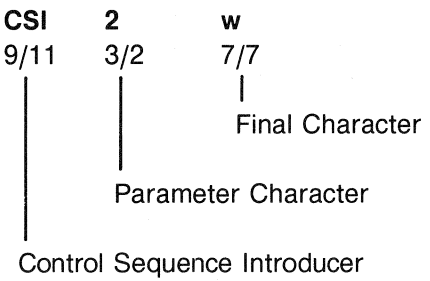
A character received after the CSI in the 4/0 to 7/14 range is a *final character.* The final character indicates the end of a control sequence and defines the function of the sequence. After receiving the final character, the printer performs the action specified by the sequence. The printer ignores sequences it does not recognize.

EXAMPLE

Action:

Set horizontal pitch to 12 characters per inch.

Sequence:



4.1.3 Control String Format

A device control string is a delimited string of characters that is used in a data stream as a logical entity for control purposes.

Control string format is as follows:

String Introducer	Protocol Selector	Data String	String Terminator
DCS	P...P I...I F	D...D	ST
OSC		D...D	ST
PM		D...D	ST
APC		D...D	ST

Where:

P...P	are parameters
I...I	are intermediate characters
F	is a final character
D...D	is data
ST	is a string terminator

Companion Color Printer recognizes four types of control strings. The string introducers are the C1 control characters:

- Device control string (DCS)
- Operating system command (OSC)
- Privacy message (PM)
- Application program command (APC)

The OSC, PM, and APC characters introduce unused control strings that are ignored.

In the Companion Color Printer the DCS character introduces two control strings (described later in this manual).

- Sixel graphic mode
- Assignment of User-Preference Supplemental Character Set (DECAUPSS)

DCS (9/0) is an 8-bit control character. You can also express it as ESC P when coding in a 7-bit system. ST (9/12) can also be expressed in a 7-bit environment as ESC \.

Table 4-1 describes Companion Color Printer processing of the DCS and unused control string data.

Table 4-1 Control Strings

Name	8-bit Mnemonics	7-bit Sequence	Processing After String Introducer is Received
Device Control String	DCS 9/0	ESC P 1/11 5/0	Processing begins. When a C0 is received, the printer processes it if applicable. If ESC, CAN, SUB, ST, or a C1 character is received, the printer enters text mode and processes the control command. If the final character is "q", the printer enters the sixel graphic mode (Chapter 6). If the final character is "u", the printer begins loading the DECAUPSS data command string. If the final character is other than "q" or "u", the DCS data string is ignored until ESC, CAN, ST, SUB, or a C1 character is received.

Table 4-1 Control Strings (Cont)

Name	8-bit Mnemonics	7-bit Sequence	Processing After String Introducer is Received
Operating System Command	OSC 9/13	ESC] 1/11 5/13	If ESC, CAN, SUB, ST, or a C1 character is received, the printer enters text mode and processes the control command. Otherwise, the data string is ignored.
Privacy Message	PM 9/14	ESC ^ 1/11 5/14	Same as above.
Application Program Command	APC 9/15	ESC _ 1/11 5/15	Same as above.

4.1.4 Error Handling

This section describes what happens when the printer receives invalid parameters, invalid sequences, or sequences with embedded control characters. The printer generally recovers from such errors by performing as much of the sequence as possible.

- Sequences not recognized by the printer are ignored.
- If a sequence has an invalid selective parameter, the printer ignores the sequence (unless otherwise specified in this manual).
- If a numeric parameter exceeds its numeric limit, the printer uses the maximum allowable value for that parameter (unless otherwise specified in this manual).

- If a sequence includes any C0 control characters, except for cancel (CAN), substitute (SUB), or escape (ESC), the printer processes those characters as if they were received before the sequence. The printer then continues to process the sequence.

  A CAN (1/8) or SUB (1/10) character in a sequence cancels that sequence and returns the printer to text mode character processing. The CAN or SUB is then processed.

  An ESC (1/11) character in a sequence cancels that sequence. The printer then starts processing another escape sequence.

- If the printer receives a C1 control character within an escape sequence, the sequence is aborted. The C1 character is processed if it is applicable to the printer. If the 10/0 character is received, it is treated as a SPACE (2/0) character within the sequence. The 15/15 character is processed as a DELETE (7/15) character, and it is ignored if it is received within an escape or control sequence.

- If the printer receives a GR character during an escape or control sequence, this character is stripped of the eighth bit and processed as a GL character.

- The C0 and C1 control characters do not change the status or processing of a single shift (SS2 or SS3) control character (Section 3.5.2). The printer processes control characters in the sequence received.

4.2 7-BIT AND 8-BIT CONVERSIONS

You do not need to convert from 7-bit to 8-bit coding. However, conversion could improve data transmission rate. If you need to operate in a 7-bit environment, you must convert 8-bit codes into 7-bit equivalents.

4.2.1 7-Bit Sequence to 8-Bit C1 Control Character

The 7-bit C1 control functions are coded as two-character sequences of the ESC Fe form. Fe is a final character from columns four and five on the standard 8-bit character chart (Figure 3-2). The following steps convert 2-byte escape sequences to 1-byte C1 control characters:

1. Remove the ESC character.
2. Set the eighth bit of the final character.
3. Clear the seventh bit of the final character.

4.2.2 8-Bit C1 Control Character to 7-Bit Sequence

The 8-bit C1 control characters are coded as single characters from columns eight and nine on the standard 8-bit character chart (Figure 3-2).

You can convert C1 control characters to equivalent 2-character ESC Fe sequences as follows:

1. Insert an ESC character.
2. Clear the eighth bit of the C1 code.
3. Set the seventh bit of the C1 code.

Table 4-2 summarizes valid Companion Color Printer C1 control characters and their 7-bit escape sequence equivalents. (You can also refer to Section 3.5.2)

Table 4-2 Control Function Equivalents

8-Bit 7-Bit Control Character	Escape Sequence
PLD (8/11)	ESC K (1/11 4/11)
PLU (8/12)	ESC L (1/11 4/12)
SS2 (8/14)	ESC N (1/11 4/14)
SS3 (8/15)	ESC O (1/11 4/15)
DCS (9/0)	ESC P (1/11 5/0)
CSI (9/11)	ESC [(1/11 5/11)
ST (9/12)	ESC \ (1/11 5/12)
OSC (9/13)	ESC] (1/11 5/13)
PM (9/14)	ESC ^ (1/11 5/14)
APC (9/15)	ESC _ (1/11 5/15)
Level 2 Only	
IND (8/4)	ESC D (1/11 4/4)
NEL (8/5)	ESC E (1/11 4/5)
HTS (8/8)	ESC H (1/11 4/8)
VTS (8/10)	ESC J (1/11 4/10)

4.2.3 Converting 8-Bit GR Selection To 7-Bit Equivalent

Use the character set designation sequences in this chapter (Section 4.4.5) to designate the desired set as G2. Then, for any GR code, send an SS2 function followed by the code with the eighth bit set to 0.

4.2.4 C1 Control Character Transmit and Receive

You can specify processing of C1 control codes (C1 Transmit or Receive – S8C1T, S7C1T, S8C1R, S7C1R) only if Conformance Level 2 is selected. If you select Level 1, the printer transmits and receives C1 codes according to the noted power-up defaults (S7C1T and S8C1R).

C1 Transmit (LJ250 Only)

ESC	**SP**	**G**	**(S8C1T)**
1/11	2/0	4/7	

Transmits C1 control codes as 8-bit C1 codes. If you are in the 7-bit environment, the printer ignores this sequence.

ESC	**SP**	**F**	**(S7C1T)** – power-up default
1/11	2/0	4/6	

Transmits C1 control codes as equivalent 7-bit ESC Fe sequences.

C1 Receive

ESC	**SP**	**7**	**(S8C1R)** – power-up default
1/11	2/0	3/7	

Enables processing of 8-bit C1 control characters. Equivalent 7-bit ESC Fe sequences are also processed.

ESC	**SP**	**6**	**(S7C1R)**
1/11	2/0	3/6	

Disables processing of 8-bit C1 control characters in an 8-bit environment. The eighth bit of a received C1 character is stripped. The printer processes it as a C0 character. ESC Fe sequences are processed normally.

4.3 DEC CONFORMANCE LEVELS

The Companion Color Printer can be set for one of two conformance levels that provide basic or enhanced operating and printing capabilities, interface features, and compatibility with appropriate software.

A conformance level is a fixed group of functions common to a class of devices that satisfies certain hardware/software compatibility requirements. New functions require the creation of new conformance levels, which are supersets of the levels below it. Each level has functions that must be included in all products that implement that level of conformance.

The Companion Color Printer can operate as a Level 1 or a Level 2 device.

Level 1 provides basic printing and interface functions that are always active in the Companion Color Printer.

Level 2 adds expanded printing functions that can be activated by selecting the Level 2 from the host computer with a control sequence. The Level 2 device always has the Level 1 functions active plus a subset of additional functions.

Conformance levels are selected from the host computer by using the control sequence as specified in Section 5.2.

4.3.1 Level 1 and Level 2 Function Summary

Table 4-3 lists Level 1 and 2 functions and differentiates between the two devices. The functions are described in detail in Chapters 4, 5, and 6.

NOTE: The Companion Color Printer powers up to Conformance Level 2 functionality.

Table 4-3 Level 1 and 2 Functions

Level 1	Level 2
Horizontal form handling	
Horizontal pitch (DECSHORP)	Set page width alignment (DECHPWA) Set left and right margins (DECSLRM) Horizontal tab set control code (HTS) Set horizontal tab stops (DECSHTS) Horizontal tab set (DECHTS) Tabulation clear (TBC) Clear all horizontal tabs (DECCAHT)
Vertical form handling	
Vertical pitch (DECVERP) Page length (DECSLPP)	Set top and bottom margins (DECSTBM) Vertical tab set control code (VTS) Vertical tab set (DECVTS) Set vertical tab stops (DECSVTS) Tabulation clear (TBC) Clear all vertical tabs (DECCAVT)
Active position control	
Partial line down (PLD) Partial line up (PLU)	Forward index control code (IND) Next line control code (NEL) Autowrap mode (DECAWM) Carriage return new line mode (DECCRNLM) Linefeed new line mode (LNM) Horizontal position absolute (HPA) Horizontal position relative (HPR) Vertical position absolute (VPA) Vertical position relative (VPR)

Table 4-3 Level 1 and 2 Functions (Cont)

Level 1	Level 2
Character set selection	
Single and locking Shifts (SS2, SS3, SI, SO, LS2, LS3, LS1R, LS2R, LS3R)	NA
Select character set sequence (SCS)	
Assign user-preference supplemental character set (DECAUPSS)	
ANSI announcer sequence	
Print speed and highlighting selection	
Selection of graphic rendition (SGR)	Select unidirectional/bidirectional printing (DECUPM)
DEC Private Select Graphic Rendition (DECSGR)	
Status, report, and reset requests (Chapter 5)	
Set conformance level (DECSCL)	
HP PCL emulation mode (DECHPPCL)	
Product identification (DA)	
Printer status request (DSR)	
Printer status report (DSR)	
Reset to initial state (RIS)	
Soft terminal reset (DECSTR)	
Graphics	
Sixel graphics (Chapter 6)	

4.3.2 Factory-Set Power-On Status

Table 4-4 lists initial power-on conditions for printer operating parameters.

Table 4-4 Power-On Status

Program Selectable Parameters	Control Function	Power-on Status
Printing status	READY	Ready to print
Horizontal pitch	DECSHORP	10 char/inch
Vertical pitch	DECVERP	6 lines/inch
Forms length	DECSLPP	66 lines
Right margin text mode	DECAWM	Truncate (ignores characters beyond the right margin)
Perf skip	DECSTBM	No top or bottom margin selected
Line length	DECSLRM	80 column (8 inch) line (no left or right margin selected)
Line termination	LNM	No auto CR (LF code does not terminate the line.)
	DECCRNLM	No auto LF (CR code terminates the line, but does not cause a line feed.)
Text color	SGR	Black
Active position		Column 1, line 1

Table 4-4 Power-On Status (Cont)

Program Selectable Parameters	Control Function	Power-on Status
Compatibility mode	DECHPPCL/ROCS	Set by rear panel switch to DEC or PCL (*LJ250*)
		PCL protocol (*LJ252*)
Transparency mode	SGR	Disabled
Bolding	SGR	Disabled
Italics	SGR	Disabled
Superscript	SGR	Disabled
Subscript	SGR	Disabled
Unsolicited status	DSR	Disabled
GL character set		Same as G0
GR character set		Same as G2
Character sets		
	G0	ASCII
	G1	DEC Line Drawing
	G2	DEC Supplemental
	G3	ASCII

Table 4-4 Power-On Status (Cont)

Program Selectable Parameters	Control Function	Power-on Status
Horizontal tabs	HTS, DECSHTS, DECHTS	Set at every eighth column
Vertical tabs	VTS, DECSVTS, DECVTS	Set at every line
C1 Transmit	S7C1T	7-bit ESC Fe sequences
C1 Receive	S8C1R	8-bit C1 allowed

4.4 LEVEL 1 FUNCTIONS

The following sections describe the Companion Color Printer Level 1 escape and control sequences for text processing.

4.4.1 Horizontal Pitch (DECSHORP)

Horizontal pitch determines the width and spacing of printed characters. It is specified in characters per inch. The Companion Color Printer has ten horizontal pitch selections: 5, 6, 8.25 (defaults to 9), 8.55 (defaults to 9), 9, 10, 12, 16.5 (defaults to 18), 17.1 (defaults to 18), and 18 characters per inch (Figure 4-1). You can use any combination of pitch selections on a single print line.

When the horizontal pitch changes (Figure 4-2), the printer converts the active column to the grid of the new horizontal pitch. If the conversion yields a fraction, it is rounded to the next highest integer. This rounding allows printing on the correct column grid for the new pitch.

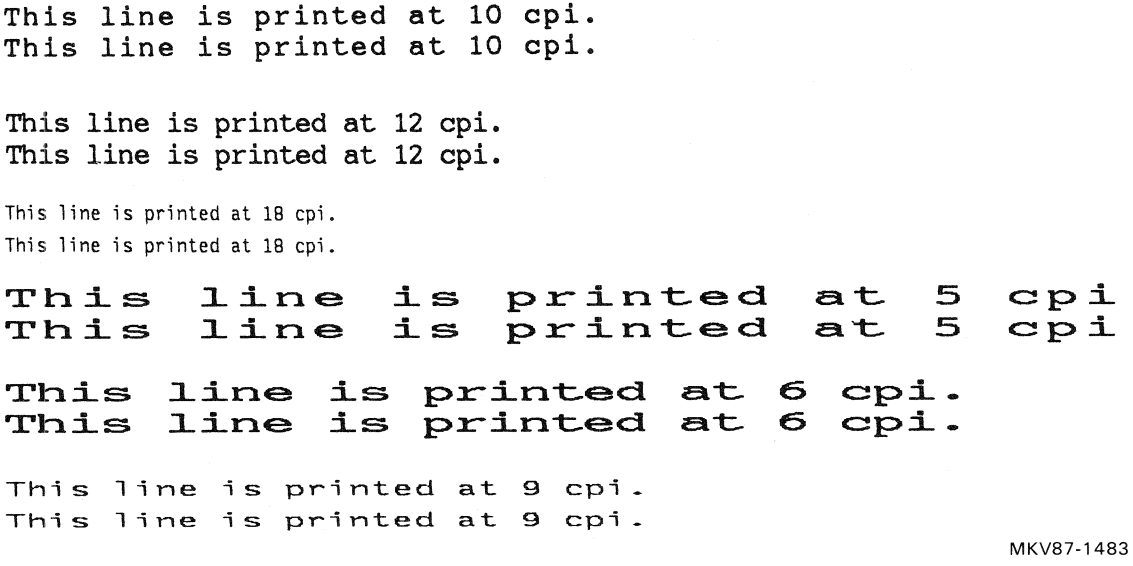


Figure 4-1 Horizontal Pitch Selections

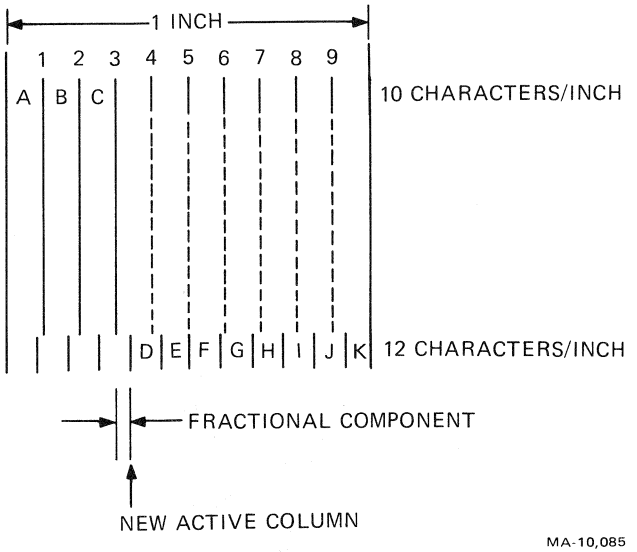


Figure 4-2 Changing Horizontal Pitch

You can use the following formula to determine the precise location of the active column when the horizontal pitch changes.

$$\text{Newcol} = 1 + \frac{\text{Newpitch} \times (\text{Oldcol-1})}{\text{Oldpitch}}$$

Where:

Newcol	=	New active column
Newpitch	=	New pitch in characters per inch
Oldcol	=	Old active column
Oldpitch	=	Old pitch in characters per inch

NOTES: The division performed above is integer division. Any nonzero remainder is rounded to the next higher integer.

A change in horizontal pitch may result in a change in the character font. The 9 and 18 pitches are letter Gothic, while the 5, 6, 10, and 12 pitches are Courier. See Figure 4-1.

A change of horizontal pitch sets the left margin to column 1 and right margin to the maximum column at the new horizontal pitch.

Horizontal pitch also determines if single- or double-width character printing occurs.

The printer considers double-width characters to be one column wide (not two columns wide). Therefore, tab stops are reset to the appropriate double-width column grid when horizontal pitch is changed (as with all pitches).

Control sequences that set single-width horizontal pitches are described in Table 4-5.

Table 4-5 Setting Single-Width Horizontal Pitch

Name	Mnemonic	Sequence	Function
Set horizontal pitch	DECSHORP	**CSI w** 9/11 7/7	Defaults to 10 char/ inch
		CSI 0 w 9/11 3/0 7/7	Defaults to 10 char/ inch
		CSI 1 w 9/11 3/1 7/7	Sets pitch to 10 char/inch
		CSI 2 w 9/11 3/2 7/7	Sets pitch to 12 char/inch
		CSI 4 w 9/11 3/4 7/7	Defaults to 18 char/ inch
		CSI 1 1 w 9/11 3/1 3/1 7/7	Default to 18 char/ inch
		CSI 1 3 w 9/11 3/1 3/3 7/7	Sets pitch to 18 char/inch

Control sequences that set double-width horizontal pitches are listed in Table 4-6.

Table 4-6 Setting Double-Width Horizontal Pitch

Name	Mnemonic	Sequence				Function
Set horizontal pitch	DECSHORP	**CSI**	**5**	**w**		Sets pitch to 5 char/inch
		9/11	3/5	7/7		
		CSI	**6**	**w**		Sets pitch to 6 char/inch
		9/11	3/6	7/7		
		CSI	**8**	**w**		Defaults to 9 char/inch
		9/11	3/8	7/7		
		CSI	**1**	**2**	**w**	Defaults to 9 char/inch
		9/11	3/1	3/2	7/7	
		CSI	**1**	**4**	**w**	Sets pitch to 9 char/inch
		9/11	3/1	3/4	7/7	

NOTE: If you use any other parameter values, the printer ignores them.

4.4.2 Vertical Pitch (DECVERP)

Vertical pitch determines the spacing between lines of text. It is specified in lines per inch. Changing vertical pitch does not change the height of the printed character or top-of-form position. The printer has six vertical pitch selections: 2, 3, 4, 6, 8, and 12 lines per inch (Figure 4-3).

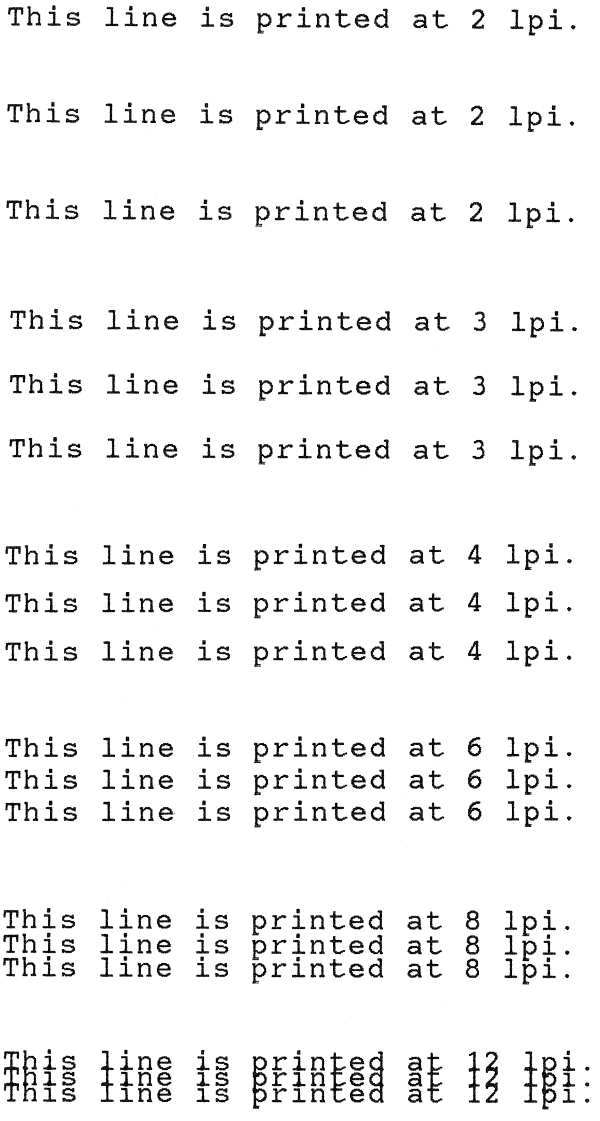


Figure 4-3 Vertical Pitch Selections

When you change vertical pitch, the printer converts the active line to the grid of the new vertical pitch. If the conversion yields a fraction, the active line is rounded to the next integer. After receiving a paper motion command, the printer advances the paper to the next line on the new vertical grid.

The control sequences in Table 4-7 set vertical pitch.

Table 4-7 Setting Vertical Pitch

Name	Mnemonic	Sequence	Function
Set vertical pitch	DECVERP	**CSI z** 9/11 7/10	Sets pitch to default of 6 lines/inch
		CSI 0 z 9/11 3/0 7/10	Same as above
		CSI 1 z 9/11 3/1 7/10	Sets pitch to 6 lines/inch
		CSI 2 z 9/11 3/2 7/10	Sets pitch to 8 lines/inch
		CSI 3 z 9/11 3/3 7/10	Sets pitch to 12 lines/inch
		CSI 4 z 9/11 3/4 7/10	Sets pitch to 2 lines/inch
		CSI 5 z 9/11 3/5 7/10	Sets pitch to 3 lines/inch
		CSI 6 z 9/11 3/6 7/10	Sets pitch to 4 lines/inch

4.4.3 Page Length (DECSLPP)

You can select the default page length by the Form Length switch on the rear panel (Section 2.4). The factory setting is 11 inches. An 11 inch page gives you 66 lines at the default vertical pitch of 6 lines per inch.

The page length control sequence lets you set the page length by selecting the number of lines (0 to 252) per page at the current vertical pitch.

You can select any page length from 1/12 inch to 21 inches with the number of lines at the current vertical pitch. If the page length is set to 0, the printer ignores paging and treats all form feed characters as line feed characters.

Table 4-8 shows the lines per page and page length as a function of vertical pitch.

Table 4-8 Page Length and Vertical Pitch

Page Length (Inches)	Vertical Pitch Selected (Lines per Inch)					
	2	3	4	6	8	12
	Lines per page					
3.67	n/a	11	n/a	22	n/a	44
4.25	n/a	n/a	17	n/a	34	51
8.5	17	n/a	34	51	68	102
11.0	22	33	44	66	88	132
14.0	28	42	56	84	112	168
21.0	42	63	84	126	168	252

NOTE: Where n/a is indicated, the particular page length is not available for that vertical pitch selection.

If vertical pitch changes after page length has been set, the page may contain a nonintegral number of lines. In this case, the fractional line portion is added to the last full line on that page. For example, suppose you select 22 lines per page at 6 lines per inch, then change the vertical pitch to 8 lines per inch. The form length is 29 lines per page now, with 28 lines at 8 lines per inch and 1 line at 6 lines per inch preserving the selected physical form length of 3.67 inches.

The following control sequence sets the page length.

Table 4-9 Setting Page Length

Name	Mnemonic	Sequence	Function
Set page length	DECSLPP	**CSI Pn t** 9/11 *** 7/4	Sets the active line to the top-of-form position and sets the page length to Pn units of the current vertical pitch

4.4.4 Partial-Line Paper Motion (PLD and PLU)

The escape sequences in Table 4-10 let you advance or reverse paper in 1/12 inch increments. These sequences modify the printer's active line counter.

Table 4-10 Using PLD or PLU

Name	Mnemonic (8-bit)	Sequence (7-bit)	Function
Partial Line Down	PLD 1/11	**ESC** 4/11 **K**	Advances paper 1/12 inch
Partial Line Up	PLU	**ESC** 1/11 **L** 4/12	Reverses paper 1/12 inch

NOTE: Be careful that PLU doesn't release paper (last 5 lines). It is recommend that PLD and PDU be limited to sub- and superscripting of normal size characters. PLU and PLD are ignored if positioning is off the page.

4.4.5 Character Set Selection

This section describes how to select character sets in both the 7-bit and 8-bit environments. You can assign and select any of the available character sets in the printer.

Power-up default: G0 = ASCII
G1 = VT100
G2 = DEC Supplemental
G3 = ASCII

4.4.5.1 Select Character Set Sequences (SCS)

The Select Character Set (SCS) escape sequences are used to assign any of the Companion Color Printer character sets (see Table 4-11) to the G0, G1, G2, and G3 character set designators. These designators define the contents of the GL and GR printable sets and may be controlled with the single and locking shift command (Section 4.4.5.2).

Table 4-11 Assigning Character Sets

G0	G1	G2	G3	Character Set
ESC (B	ESC) B	ESC * B	ESC + B	ASCII
ESC (A	ESC) A	ESC * A	ESC + A	ISO British
ESC (5	ESC) 5	ESC * 5	ESC + 5	DEC Finnish
ESC (R	ESC) R	ESC * R	ESC + R	ISO French
ESC (9	ESC) 9	ESC * 9	ESC + 9	DEC French-Canadian
ESC (K	ESC) K	ESC * K	ESC + K	ISO German
ESC (Y	ESC) Y	ESC * Y	ESC + Y	ISO Italian
ESC (J	ESC) J	ESC * J	ESC + J	JIS Roman
ESC (6	ESC) 6	ESC * 6	ESC + 6	DEC Norwegian/Danish
ESC (Z	ESC) Z	ESC * Z	ESC + Z	ISO Spanish
ESC (7	ESC) 7	ESC * 7	ESC + 7	DEC Swedish
ESC (<	ESC) <	ESC * <	ESC + <	User-Preference Supplemental
ESC (0	ESC) 0	ESC * 0	ESC + 0	DEC Special Graphics
ESC (>	ESC) >	ESC * >	ESC + >	DEC Technical
ESC (`	ESC) `	ESC * `	ESC + `	Norwegian/Danish
ESC (4	ESC) 4	ESC * 4	ESC + 4	DEC Dutch
ESC (=	ESC) =	ESC * =	ESC + =	DEC Swiss
ESC (% 6	ESC) % 6	ESC * % 6	ESC + % 6	DEC Portuguse
N/A	ESC - A	ESC . A	ESC / A	ISO Supplemental
ESC (% 5	ESC) % 5	ESC * % 5	ESC + % 5	DEC Supplemental

NOTE: The SCS escape sequences in Table 4-12 select a DEC character set as an error fallback. The Digital Equipment Corporation reserves the right to redefine these sequences in the future to agree with new ISO standards. Use the sequences above in new application software, rather than the fallback sequences.

The fallback sequences in Table 4-12 are provided for compatibility with previous products. The sequences may not be supported by future products. Use of these sequences is not recommended.

Table 4-12 Fallback Escape Sequences

G0	G1	G2	G3	Character Set
ESC (C	ESC) C	ESC * C	ESC + C	DEC Finnish
ESC (Q	ESC) Q	ESC * Q	ESC + Q	DEC French-Canadian
ESC (E	ESC) E	ESC * E	ESC + E	DEC Norwegian/Danish
ESC (H	ESC) H	ESC * H	ESC + H	DEC Swedish

4.4.5.2 Single and Locking Shifts

In a 7-bit environment, only the GL active character set is available. Sequences that refer to the GR active character set have no effect in a 7-bit character environment.

In an 8-bit environment, the printer uses the GL active character set if a character's eighth bit is 0 and the GR active character set if the character's eighth bit is 1.

Table 4-13 lists the escape sequences and control characters that assign the available character sets to the active character set (GL or GR).

Table 4-13 Selecting an Active Character Set

Name	Mnemonic	Sequence		Function
Single shift 2	SS2*	**ESC** 1/11	**N** 4/14	The character following SS2 is selected from the G2 character set.
Single shift 3	SS3*	**ESC** 1/11	**O** 4/15	The character following SS3 is selected from the G3 character set.
Shift In	SI†	n/a		The G0 character set becomes the active GL character set.
Shift Out	SO†	n/a		The G1 character set becomes the active GL character set.
Locking shift 2	LS2†	**ESC** 1/11	**n** 6/14	The G2 character set becomes the active GL character set.
Locking shift 3	LS3†	**ESC** 1/11	**o** 6/15	The G3 character set becomes the active GL character set.
Locking shift 1 right	LS1R†	**ESC** 1/11	~ 7/14	The G1 character set becomes the active GR character set.

Table 4-13 Selecting an Active Character Set (Cont)

Name	Mnemonic	Sequence	Function
Locking shift 2 right	LS2R†	**ESC** } 1/11 7/13	The G2 character set becomes the active GR character set.
Locking shift 3 right	LS3R†	**ESC** | 1/11 7/12	The G3 character set becomes the active GR character set.

* SS2 and SS3 affect only the first printable character following the single-shift sequence. The printer executes nonprintable characters (such as the space character, control characters, escape sequences, and control sequences) as usual.

In an 8-bit environment, the eighth bit of the printable character following the single shift (SS2 or SS3) is ignored, thus providing a character code in the range of 2/1 to 7/14. The 10/0 character clears the single shift code and is processed as an error character (?).

† A locking shift (SI, SO, LS2, LS3, LS1R, LS2R, OR LS3R) remains in effect until the printer receives another locking shift.

4.4.5.3 User Supplemental Character Set (DECAUPSS)

When the printer receives the DECAUPSS control string, it assigns the User-Preference Supplemental (UPS) character set as defined by the parameter and data in the string. By using the appropriate SCS sequence (Table 4-6), this character set is designated as G0, G1, G2, or G3. On powerup, the UPS character set is set to DEC supplemental.

The DECAUPSS sequence is as follows:

DCS	**Ps**	**!**	**u**	**D ..... DST**
9/0	***	2/1	7/5	**..** 9/12

Ps = 0 or none — 94 character set
= 1 — 96 character set

D.....D is the data that includes the intermediate and final characters of the SCS sequence used to explicitly select the supplemental character set. Possible data values are:

% 2/5	**5** 3/5	DEC Supplemental	(Ps must be 0.)
A 4/1		ISO Supplemental	(Ps must be 1.)
> 3/14		DEC Technical	(Ps must be 0.)

4.4.5.4 ANSI Announcer Sequence

The following escape sequences conform to the draft ANSI standard dpANS X3.134.1-19XX, 8-Bit Structures and Rules, and can be used to load ASCII and ISO character sets.

ESC 1/11	**SP** 2/0	**L** 4/12	Load ASCII set into G0 and invoke it into GL. Load ISO Supplemental set into G1 and invoke it into GR.
ESC 1/11	**SP** 2/0	**M** 4/13	Same as above.
ESC 1/11	**SP** 2/0	**N** 4/14	Load ASCII set into G0 and invoke it into GL only.

4.4.6 Highlighting Your Printing (SGR)

There are two Select Graphic Rendition (SGR) sequences that you can use to highlight printed text. The ANSI-standard SGR sequence highlights with bolding, underlining, double underlining, color, strike-through, and italics. DEC Private SGR controls superscript, subscript, overline printing, and transparency mode.

4.4.6.1 Select Graphic Rendition (SGR) Sequence

One or more SGR highlight attributes may be specified in one sequence. All printable characters following the SGR sequence are printed by using the selected highlighting features, until the next SGR sequence. The printer evaluates Ps parameters sequentially from left to right.

When you enter graphic mode, the printer stores the current parameter values for the SGR sequence. When you return to text mode, the printer uses these parameters.

The printer ignores all other parameter values received in this control sequence, but executes the valid parameter values. The printer executes the parameters in the order received.

Table 4-14 Selecting a Graphic Rendition

Name	Mnemonic	Sequence						
Select Graphic Rendition	SGR	**CSI** 9/11	**Ps** ***	; 3/11	... ...	; 3/11	**Ps** ***	**m** 6/13

Ps	Function
0 or none (3/0)	Turns off all attributes selectable by the SGR sequence
1 (3/1)	Turns on bold printing
3 (3/3)	Turns on italic printing
4 (3/4)	Turns on underline printing
	Turns off double underline printing if selected

Table 4-14 Selecting a Graphic Rendition (Cont)

Name	Mnemonic	Sequence
	9 (3/9)	Turns on strike-through attribute
	21 (3/2 3/1)	Turns on double underline printing
		Turns off underline printing if selected
	22 (3/2 3/2)	Turns off bold printing
	23 (3/2 3/3)	Turns off italics printing
	24 (3/2 3/4)	Turns off underline and double underline printing
	29 (3/2 3/9)	Turns off strike-through attribute
	30 (3/3 3/0)	Prints in black
	31 (3/3 3/1)	Prints in red (yellow and magenta)
	32 (3/3 3/2)	Prints in green (yellow and cyan)
	33 (3/3 3/3)	Prints in yellow
	34 (3/3 3/4)	Prints in blue (magenta and cyan)
	35 (3/3 3/5)	Prints in magenta
	36 (3/3 3/6)	Prints in cyan
	37 (3/3 3/7)	No printing (space/white)
	39 (3/3 3/9)	Selects default color (black)

Restrictions:

1. Printing in italics is slower than nonitalic printing.

2. The italic rendition should be disabled when imaging line drawing characters from the DEC Technical and VT100 Line Drawing character sets.

3. Leave enough space between normal text and italicized text so that the characters do not run together.

4.4.6.2 DEC Private SGR Sequence

You can use the DEC Private SGR sequence to print superscript and subscript characters or to highlight with an overline.

Table 4-15 Printing Superscript, Subscript, and Overline

CSI	?	Ps	;	...	Ps	m
9/11	3/15	***	3/11		***	6/13

Ps =	0 or none	Turns off all attributes selectable by this sequence
=	4 (3/4)	Turns on superscripting and turns off subscripting if selected
=	5 (3/5)	Turns on subscripting and turns off superscripting if selected
=	24 (3/2 3/4)	Turns off super/subscripting (return to normal script)
=	6 (3/6)	Turns on overline
=	26 (3/2 3/6)	Turns off overline
=	8 (3/8)	Turns on transparency mode
=	28 (3/2 3/8)	Turns off transparency mode

NOTE: All DEC Private SGR parameters are retained while in the graphic mode. When you enter this mode, the printer stores the current parameter values for the SGR sequence and restores them when you return to the text mode.

Restrictions:

1. The subscript and double underline renditions cannot be used at the same time. Choose either subscripting or double underlining.

2. The overline rendition should not be used when the preceding line has underline or double underline renditions enabled.

3. Do not use the overline rendition when upper case characters with accents are being printed.

Superscripted and subscripted text characters are printed at half-height on the active line. The printer does not change horizontal and vertical pitch in this case.

4.5 LEVEL 2 FUNCTIONS

The following sections describe Companion Color Printer's Level 2 functions: escape and control sequences for text processing. When set as a Level 2 device (LA210-compatible), the Companion Color Printer provides all Level 1 and Level 2 functions.

4.5.1 Set Page Width Alignment (DECHPWA)

The user may define the limits of the print area. This limit does not change, unless modified by this command.

The print area (Figure 4-4) provides users with absolute limits for centering text on the platen. This area is the base reference for horizontal positioning and is expressed in inches.

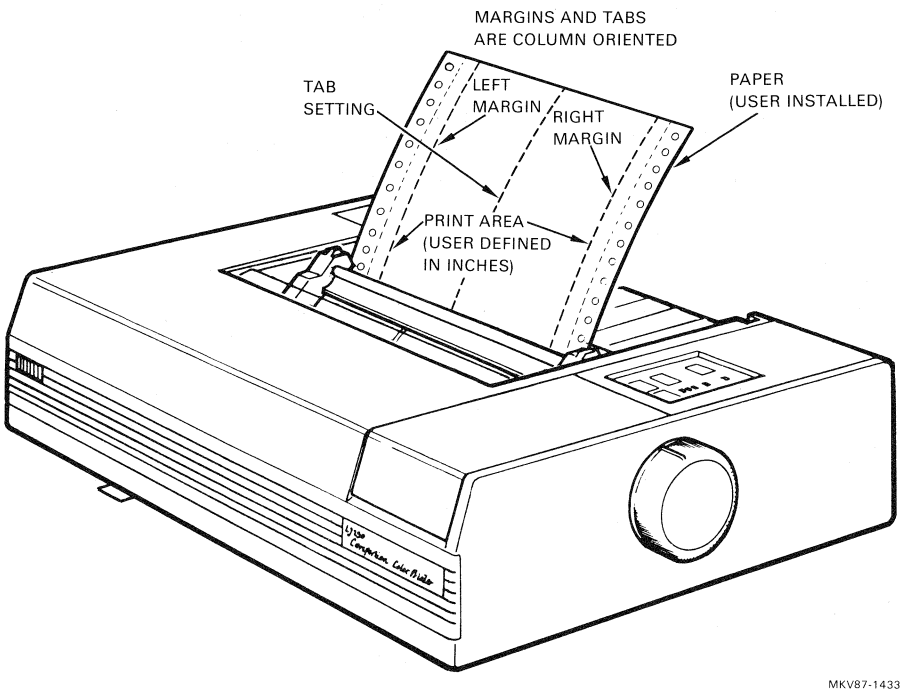


Figure 4-4 Print Area and Horizontal Settings

The following DECHPWA sequence sets the left reference and print area width.

CSI	**Pn1**	**;**	**Pn2**	**"**	**s**
9/11	***	3/11	***	2/2	7/3

The first parameter (Pn1) defines the absolute left reference in 1/12 inch increments (measured from the leftmost position of the printhead). The second parameter (Pn2) defines the absolute width of the print area in 1/12 inch increments.

Limits on Pn1 and Pn2 are as follows:

Pn1 = 0 to 95

If Pn1 is greater than 95, the value of 95 is used.

Pn1 changes the physical location of column 1 and tabs.

Pn2 = 1 to 96

(Pn1 + Pn2) must not be greater than 96 (8 inches).
If Pn1 + Pn2 is greater than 96, the Pn2 value is limited to 96 minus the Pn1 value.

Pn2 must be at least 1 to define a printable area.
Pn2 defines the new rightmost printable position.

The column value of the horizontal tabs remains unchanged by DECHPWA. The physical locations of the horizontal tabs shift by the same amount as the left reference shift.

If the active position is less than the new column 1, the printer sets the active position to the new column 1. If the active portion is greater than the new rightmost printable position, the action of the next printable character is determined by the right margin (Autowrap/Truncate) setting.

NOTE: This sequence clears the previously set left and right margins. The left margin is set to the new column 1, while the right margin is set to the rightmost position defined by Pn1 and Pn2 (left reference and width).

4.5.2 Set Left and Right Margins (DECSLRM)

The left and right margins define the limits for the carriage return and end-of-line (wrap/truncate) functions (Figure 4-4). These left and right margins are column-oriented and modified by the following explicit and implicit commands.

Explicit

1. Set margins.
2. Reset to the factory default.

Implicit

1. Set horizontal pitch (clears margins).
2. Set print width alignment (clears margins).

The following sequence sets the left and right margins:

CSI	**Pl**	**;**	**Pr**	**s**
9/11	***	3/11	***	7/3

The left margin specifies the first printable position on a line; the right margin specifies the last printable position on a line. The Companion Color Printer prints only within the left and right margins. Therefore, the active position may not be placed outside the left and right margins.

Pl is the left margin setting. This is a numeric value representing the column number at the left margin. At power on, the printer sets Pl to the leftmost position (column 1).

Pr is the right margin setting. This is a numeric value representing the column number to which the right margin is to be set. On power-on, the printer sets Pr to the rightmost position (column 80 at 10 characters/inch).

If Pl = 0 or none, no change is made to the left margin.
If Pr = 0 or none, no change is made to the right margin.
If Pr > the rightmost printable position, the printer sets the right margin at the rightmost printable position.
If Pl > Pr, the printer ignores the command.

If the active position is less than the left margin specified by this command, the printer sets the active position to the new left margin.

If the active position is greater than the right margin specified by this command, the action of the next printable character is determined by the right margin (Autowrap/Truncate) setting.

If you change the horizontal pitch, the left and right margin reset to their printable limits (column 1 and rightmost position, respectively).

4.5.3 Horizontal Tabs

Horizontal tabs are column-oriented, predefined positions on the print line (Figure 4-4). The printer has a maximum of 144 possible horizontal tab stops, one for each column at 18 characters/inch. Tab stops are associated with column numbers in the print area, not physical positions on the paper. So, when you change the horizontal pitch, the physical positions of the tab stops also change.

You can set or clear tab stops independently or in groups. You can set stops or clear them, regardless of margins or horizontal pitch. However, setting a stop already set has no effect; the same is true for clearing a stop already cleared. At powerup, there is one horizontal tab setting at every eighth column.

4.5.3.1 Horizontal Tabulation Set Control Code (HTS)

ESC	**H**	HTS C1 control code is 8/8.
1/11	4/8	

This sequence sets a horizontal tab stop at the active column.

4.5.3.2 Horizontal Tabulation Set (DECHTS)

ESC	**1**
1/11	3/1

4.5.4 Set Top and Bottom Margins (DECSTBM)

The top vertical margin specifies the first printable line. The bottom vertical margin specifies the limit for the last printable line (Figures 4-5 and 4-6). The Companion Color Printer prints only on the lines between the top and bottom margins, inclusive. Depending on vertical pitch, printing may or may not be allowed exactly at the bottom margin.

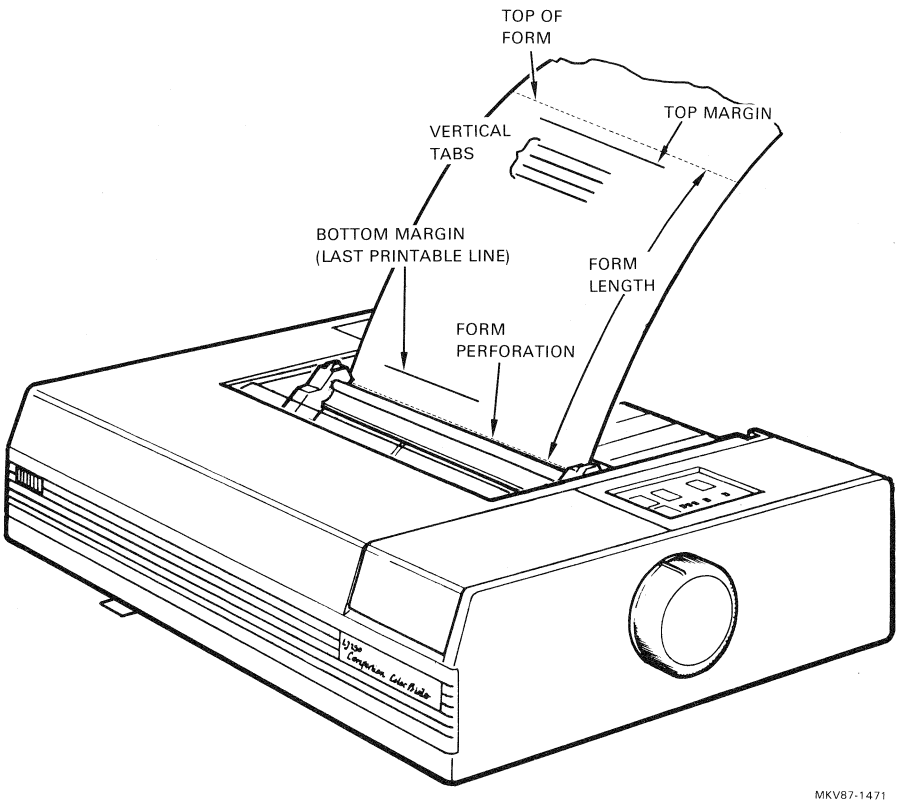
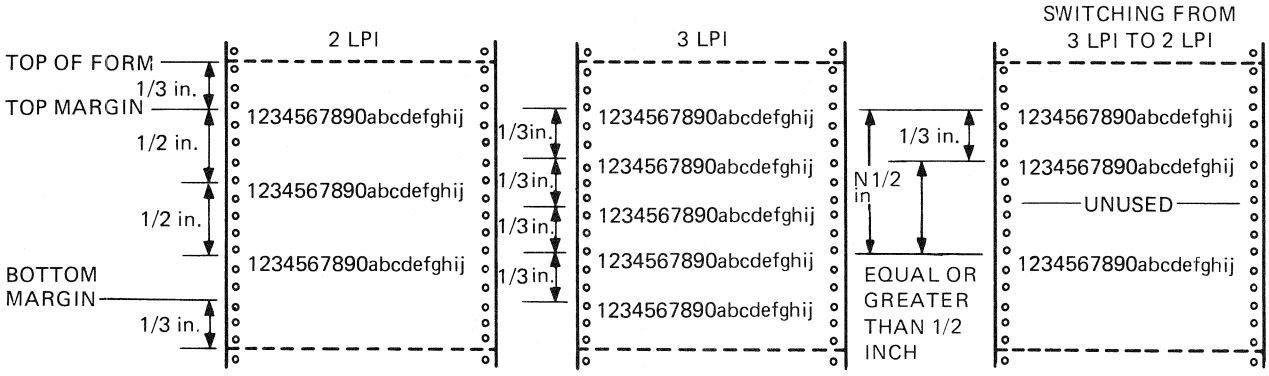


Figure 4-5 Form Length and Vertical Settings



NOTE:
ALWAYS START PRINTING AT TOP MARGIN OR AT SOME DISTANCE FROM TOP MARGIN THAT IS A MULTIPLE OF THE CURRENT VERTICAL PITCH. NEVER PRINT BELOW BOTTOM MARGIN.

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Figure 4-6 Vertical Margins and Pitches

If you try to set the active line above the top margin or below the bottom margin, the active line may advance automatically to the top margin of the next page. For example, a line feed (LF) received at the bottom margin causes the printer to perform a form feed.

When you set the top and bottom margins, first make sure the distance between the top of form and the desired margins are a multiple of the vertical pitch selected. If not, change the vertical pitch.

The following sequence sets the top and bottom margins:

CSI	**Pt**	**;**	**Pb**	**r**
9/11	**	3/11	**	7/2

Pt is the top margin setting. This is a line number representing the number of lines from the top of form at which to set the top margin. At powerup, Pt is equal to top of form (line 1).

Pb is the bottom margin setting. This is a line number representing the number of lines from the topmost position on a page at which to set the bottom margin. At powerup, Pb is equal to the bottom-most position (line 66 at 6 lpi) when the Paper Size switch on the rear panel is set to 11 inches.

- If Pt equals 0 or none, no change is made to the top margin.
- If Pb equals 0 or none, no change is made to the bottom margin.
- If Pb is greater than the current form length, the Companion Color Printer sets the bottom margin to the last print line of the form.
- If Pt is greater than Pb, the printer ignores this command.

If the active position is less than Pt, the printer sets the active position to the new top margin specified by the Pt value. If the active position is greater than the new bottom margin the active line immediately moves to the top margin on the next page.

If the VPA and VPR commands (Section 4.5.6.8 and 4.5.6.9) cause the active position to move off the current page, the next printable character moves the active line to the top margin of the next page.

If the printer receives an LF while at the bottom margin, or when less than one line remains on the page, the printer sets the active line to the top margin of the next page.

When you change the page length, the top margin is reset to line 1 and the bottom margin is set to the bottom-most position of the new page length.

When the Pt is greater than 1, only one PLU is allowed above the top margin for the purpose of superscripting.

When (Form Length minus Pb) is greater than 0, only one PLD is allowed below the bottom margin for the purpose of subscripting. If an attempt is made to position the active line off the page by using PLU or PLD, the command is ingored.
When you change the vertical pitch, the physical position of the top and bottom margins do not change relative to the new vertical pitch. Line spacing, beginning with the top margin, corresponds to the new vertical pitch.

4.5.5 Vertical Tabs

The printhead advances to a preselected line when the printer receives a vertical tab control character (Figure 4-5). The printer has a maximum of 252 possible vertical tab positions. Set and clear vertical tabs the same way as horizontal tabs.

Vertical tab stops are associated with specific line numbers, not physical positions on the paper. A change in vertical pitch changes the printing position of vertical tabs on the paper. At powerup, vertical tabs are set at every line. The sequences in the following sections set or clear vertical tab stops.

4.5.5.1 Vertical Tab Set Control Code (VTS)

ESC	**J**	VTS C1 control code is 8/10.
1/11	4/10	

This sequence sets a vertical tab stop at the active line.

NOTE: If the active line is not positioned at an integer line number due to a PLU or PLD command, the printer sets the tab stop at the next integer line.

4.5.5.2 Vertical Tab Set (DECVTS)

ESC	**3**
1/11	3/3

This sequence sets a vertical tab stop at the active line. (See the Note in Section 4.5.5.1.)

NOTE: This sequence is provided for compatibility with previous products. It may not be supported in future products and its use is not recommended.

4.5.5.3 Set Vertical Tab Stops (DECSVTS)

CSI	**Pn**	**;**	**...**	**;**	**Pn**	**v**
9/11	***	3/11	...	3/11	***	7/6

This sequence sets a vertical tab stop at the specified Pn.

You can specify up to 16 vertical tab stops in one sequence; the maximum number of vertical tab stops is 252. If Pn is greater than 252, the printer ignores this parameter.

4.5.5.4 Tabulation Clear (TBC)

CSI	**1**	**g**
9/11	3/1	6/7

This sequence clears one vertical tab at the active line (Note in Section 4.5.5.1).

CSI	**4**	**g**
9/11	3/4	6/7

This sequence clears all vertical tab stops.

4.5.5.5 Clears All Vertical Tabs (DECCAVT)

ESC	**4**
1/11	3/4

This sequence clears all vertical tab stops.

NOTE: This sequence is provided for compatibility with previous products. It may not be supported in future products and its use is not recommended.

4.5.6 Active Column And Active Line Commands

In addition to the Level 1 control characters listed in Chapter 3, the following Level 2 control functions affect active column and active line.

4.5.6.1 Forward Index Control Code (IND)

ESC	**D**	IND C1 control code is 8/4
1/11	4/4	

This sequence performs a line feed (LF) function.

This sequence is not affected by the line feed new line mode (LNM) or automatic carriage return settings.

4.5.6.2 Next Line Control Code (NEL)

ESC	**E**	NEL C1 control code is 8/5
1/11	4/5	

This sequence sets the active column to the left margin and increments the active line.

4.5.6.3 Autowrap Mode (DECAWM)

CSI	?	7	h
9/11	3/15	3/7	6/8

This sequence sets autowrap mode.

CSI	?	7	l
9/11	3/15	3/7	6/12

This sequence resets to truncate mode.

The power-up status of this function is truncate mode.

If the autowrap mode is set and the active position is beyond the right margin, printable characters that follow this command are printed on the next line starting at the left margin. If the autowrap mode is reset (off), printable characters received beyond the right margin are ignored (truncated).

4.5.6.4 Carriage Return New Line Mode (DECCRNLM)

CSI	?	4	0	h
9/11	3/15	3/4	3/0	6/8

This sequence sets CR new line mode.

CSI	?	4	0	l
9/11	3/15	3/4	3/0	6/12

This sequence resets CR new line mode.

The power-up status of this function is no new line on CR.

The carriage return new line mode defines the function of carriage return (CR). If this function is set and a CR is received, the printer sets the active position at the left margin of the next line. If the function is reset and a CR is received, the printer returns the active position to column 1 of the current line.

4.5.6.5 Linefeed New Line Mode (LNM)

CSI	2	0	h
9/11	3/2	3/0	6/8

This sequence sets LF new line mode.

CSI	2	0	l
9/11	3/2	3/0	6/12

This sequence resets LF new line mode.

The power-up status of this function is set to no CR with LF.

The linefeed new line mode defines the function of line feed (LF). If LNM is set and an LF character is received, the printer advances the active position to the left margin of the next line. If LNM is reset and a LF is received, the printer advances the active position to the same column on the next line.

4.5.6.6 Horizontal Position Absolute (HPA)

CSI	Pn	
9/11	***	6/0

This sequence sets the active column to column Pn.

If Pn is greater than the right margin, the active position moves to the right margin, but sets an internal flag to designate that motion beyond the right margin has been made. If Pn is less than or equal to the left margin, the active column moves to the left margin.

4.5.6.7 Horizontal Position Relative (HPR)

CSI	Pn	a
9/11	***	6/1

This sequence advances the active column by Pn columns.

If the active column plus Pn is greater than the right margin, the active position moves to the right margin, but sets an internal flag. This flag designates that motion beyond the right margin has been made.

4.5.6.8 Vertical Position Absolute (VPA)

CSI	Pn	d
9/11	***	6/4

This sequence sets the active line to line Pn.

If the Pn position is below the bottom margin, the next printable character causes the active line to move to the top margin of the next page. If the Pn position is less than the active line, the next printable character advances the active line to the top margin of the next page.

NOTE: Reverse motion commands, other than PLU are not supported by this printer.

4.5.6.9 Vertical Position Relative (VPR)

CSI	Pn	e
9/11	***	6/5

This sequence advances the active line by Pn lines.

If the active line plus Pn is greater than the bottom margin, the next printable character causes the active line to move to the top margin of the next page.

4.5.7 Unidirectional/Bidirectional Printing (DECUPM)

In text mode, printing occurs in either a unidirectional (left-to-right) or bidirectional pattern. In graphic mode, printing is done unidirectionaly ONLY. The following sequences control printing direction.

CSI	?	4	1	h
9/11	3/15	3/4	3/1	6/8

This sequence sets to unidirectional (left to right) printing.

CSI	?	4	1	l
9/11	3/15	3/4	3/1	6/12

This sequence sets to bidirectional printing.

Power-up status is set to bidirectional printing.

4.5.8 Automatic Sheet Feeder Control (DECASFC)

Although this printer does not support a sheet feeder option, the sheet feeder control is processed as follows:

DECASFC	CSI	Ps	1	V
	9/11	***	2/1	5/16

If Ps = 0 or none, this command is ignored.
If Ps $\geq$ 1, this command is processed as a form feed.

CHAPTER 5
STATUS, REPORT, AND RESET SEQUENCES

This chapter describes the escape and control sequence you can use to select certain compatibility modes, request status reports, and reset the printer. It also describes printer self-tests.

5.1 HEWLETT-PACKARD PCL EMULATION MODE (DECHPPCL)

You can set the Companion Color Printer to run in Hewlett-Packard Printer Command Language (PCL) protocol (see Part 3 of this manual for HP PCL emulation mode description). The READY indicator on the control panel always shows the current mode.

There are three ways to enter HP PCL mode:

- Power-up default switch on rear panel (LJ250 only)
- DEC/PCL switch on the control panel
- Escape sequence from the host system

You can enter and exit this emulation mode by using the following control sequences:

Enter PCL Control Sequence (DECHPPCL)

ESC	**%**	**8**
1/11	2/5	3/8

Enter HP PCL emulation mode.

The printer does not reset to its initial conditions in the HP PCL emulation mode, but maintains the same conditions that were present when HP PCL emulation mode was last exited.

NOTE: Do NOT use the CSI control character when the printer is in PCL mode.

Exit PCL Control Sequence (ROCS)

ESC	**%**	**@**
1/11	2/5	2/6

Exit HP PCL emulation mode and return to DEC mode.

The printer returns to DEC-compatible text mode while maintaining the same conditions present before DEC-compatible mode was exited.

These conditions include the following:

Horizontal and vertical pitch
(SGR) attributes
Form length
Horizontal and vertical tabs
DSR solicited/unsolicited
Bidirectional/unidirectional

When you enable the HP PCL emulation mode or return to the DEC mode, the paper advances to the next top-of-form if no printing occurred on the current page and the active print position is set at column 1, line 1.

Restriction: After sending the exit control sequence, the LJ250 may still be in HP PCL mode processing buffered data.

Recommendations:

LJ250 – Send a DA request sequence (Section 5.3) after the ROCS sequence. The reply to the DA will indicate that the printer has entered DEC mode and is ready to accept DEC protocol commands.

LJ252 – Wait 15 seconds after sending the ROCS sequence before sending DEC commands. Some applications may require more or less time.

5.2 SET CONFORMANCE LEVEL (DECSCL)

You can select the functional conformance level (Level 1 or Level 2) that provides interface compatibility with other DIGITAL printers. Section 4.3 gives a description of the Level 1 and 2 functions.

The DECSCL control sequence is as follows:

CSI	**Ps**	**"**	**p**
9/11	***	2/2	7/0

Ps =	7	1	Resets the printer to initial state and
	3/7	3/1	enables the conformance Level 1 functions only
=	7	2	Resets the printer to initial state and
	3/7	3/2	enables Level 1 and Level 2 functions

All other Ps values are ignored.

Power-up status is Level 2.

5.3 PRODUCT IDENTIFICATION: (DA) SEQUENCES (LJ250 Only)

When it is requested by the computer, the printer sends a reply with the primary or secondary device attributes. The printer sends the reply after printing all data received before the DA request. The printer responds with one of the three appropriate DA reply sequences.

5.3.1 Primary Device Attributes

DA Request Sequence from Computer

CSI	Ps	**c**
9/11	***	6/3

Ps = 0 or none

DA Reply Sequence From Printer

ESC	**[**	**?**	**Ps1**	**;**	**Ps2**	**c**
1/11	5/11	3/15	3/7 3/2	3/11	3/1	3/11

Ps1 = 72 Indicates that this printer meets conformance Level 2 requirements

Ps2 = 1 Indicates the printer can print 8 colors

5.3.2 Secondary Device Attributes

The secondary device attribute response provides the printer model ID and the firmware revision level.

DA Request Sequence from Computer

CSI	>	**Ps**	**c**
9/11	3/14	***	6/3

Ps = 0 or none

DA Reply Sequence From Printer

ESC	**[**	>	**Ps1**	;	**Ps2**	**c**
1/11	5/11	3/14	3/2 3/3	3/11	3/1	6/3

Ps1 = 23 Identifies the printer as an LJ250

Ps2 = 1 Firmware revision level

At first customer ship Ps2 = 1 (3/1).

NOTE: The DA sequence is not supported on the LJ252 printer.

5.4 DEVICE STATUS REQUEST (DSR)

The printer (LJ250 only) sends an answer to a device status request sequence from the computer. The following sequences control the printer status reports and enable or disable unsolicited reports.

Name	Mnemonic	Sequence	Function
Device status request	DSR	**CSI n** 9/11 6/14	
		CSI 0 n 9/11 3/0 6/14	
		or	
		CSI 5 n 9/11 3/5 6/14	Sends extended status report
		CSI ? 1 n 9/11 3/15 3/1 6/14	Disables all unsolicited status reports
		CSI ? 2 n 9/11 3/15 3/2 6/14	Enables unsolicited brief status report and send extended status report
		CSI ? 3 n 9/11 3/15 3/3 6/14	Enables unsolicited extended status reports and send extended status report

NOTE: The DA sequence is not supported on the LJ252 printer.

5.5 DEVICE STATUS REPORT (DSR)

Status reports are supported by the LJ250 only.

- SOLICITED reports are sent immediately upon request. When solicited, DSR is processed on its way into the input buffer. Therefore, the printer immediately responds to DSR, even when the buffer is full and an XOFF has been sent to the host computer. The printer may receive and answer an unlimited number of status requests.

- UNSOLICITED reports (if enabled) are sent when there is a change in any reportable status condition (such as a failure and subsequent printer's reset). Unsolicited status reports are initially disabled.

The control sequences and contents of the brief and extended printer status reports are as follows:

Name	Mnemonic	Sequence				Function
BRIEF REPORT						
Device status report (brief)	DSR	**ESC** 1/11	**[** 5/11	**0** 3/0	**n** 6/14	No malfunction detected
		ESC 1/11	**[** 5/11	**3** 3/3	**n** 6/14	Malfunction detected
EXTENDED REPORT						
Device status report	DSR	**ESC** 1/11	**[** 5/11	**0** 3/0	**n** 6/14	No malfunction detected

(extended) followed by:

DSR

ESC	**[**	**?**	**2**	**0**	**n**		
1/11	5/11	3/15	3/2	3/0	6/14		
ESC	**[**	**3**	**n**			Malfunction	
1/11	5/11	3/3	6/14			detected	

followed by:

ESC	**[**	**?**	**Pn**	**;**	**...**	**Pn**	**n**
1/11	5/11	3/15	***	3/11	...	***	6/14

"Pn" can be any valid combination of the following values:

Pn	**Failure**
21 (3/2 3/1)	Hardware failure*
22 (3/2 3/2)	Communication failure†
23 (3/2 3/3)	Input buffer overflow‡
24 (3/2 3/4)	Printer deselected
27 (3/2 3/7)	Paper out

NOTE: The DA sequence is not supported on the LJ252 printer.

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* The only reportable hardware failure is a printhead position failure. This occurs when the printhead loses track of a position.

† A communication failure can be a parity or framing error, or an erroneous character received by the printer.

‡ Failures designated as events (communication failure and buffer overflow) are automatically reset when an extended report is sent. These failures are only reported when they occur–not when they are reset.

5.6 RESET TO INITIAL STATE (RIS)

This sequence resets all DEC-compatible features to the initial state without running the power-up self-test. Data in the buffer is preserved and the paper advances to the next top-of-form.

Name	Mnemonic	Sequence	Function
Reset to initial state	RIS	**ESC c** 1/11 6/3	Resets printer to its DEC-compatible initial state

RIS does not reset HP PCL settings. If the RIS command is received while the printer is in HP PCL mode, the RIS is honored and the printer is reset to DECmode.

5.7 SOFT TERMINAL RESET (DECSTR)

This sequence resets all features to the DEC-compatible initial state (as with RIS) without running the power-up self-test. Data in the buffer is preserved and the paper advances to the next top-of-form.

Name	Mnemonic	Sequence	Function
Soft terminal reset	DECSTR	**CSI ! p** 9/11 2/1 7/0	Resets printer to its DEC-compatible initial state

If the DECSTR command is received while the printer is in HP PCL mode, the DECSTR is honored and the printer is reset to DECmode.

5.8 BUSINESS COLOR MATCHING MODE (DECBCMM)

The business color matching mode is a DEC private selectable mode and is used to provide color compatibility with the DIGITAL VT241 terminal in sixel graphics mode. This map is only available at 90 × 90 and 90 × 45 grid sizes. See Section 6.3.2.2 for more details.

When DECBCMM is reset, the printer uses a 256-color map. See Table D-3 in Appendix D.

Name	Mnemonic	Sequence					Function
Business Color Matching Mode	DECBCMM	**CSI** 9/11	**?** 3/15	**6** 3/6	**5** 3/5	**h** 6/8	Set – Limits internal color generation by 64 colors for business graphics applications and for compatibility with the Digital VT241 terminal (See Appendix D.)
		CSI 9/11	**?** 3/15	**6** 3/6	**5** 3/5	**1** 3/1	Reset – Enables internal color generation. The number of colors supported is device dependent; the LJ250/LJ252 printer can generate 256 colors. (See Appendix D.)

Default = Reset

CHAPTER 6
SIXEL GRAPHIC MODE

This chapter describes how to send sixel graphic data, including color data, to the Companion Color Printer set in the DEC mode.

6.1 OVERVIEW

To print graphics or color graphics, you must use *sixel* data. A sixel is a column of six vertical pixels. Pixels are the smallest elements of a picture – the individual dots on a video terminal screen or a dot matrix printer. See Figure 6-1.

A sixel represents bit map data. Each pixel of a sixel represents one bit of information. A bit value of 1 means to print a pixel, while a bit value of 0 means to leave a space. The printer decodes the sixel data into bits of information and maps them to the appropriate printhead elements for printing.

Sixel data consists of characters each represented by a binary bit pattern. To encode picture data into valid sixel data, first convert each six-bit binary sixel to a hexadecimal value. In each sixel column, the least significant bit corresponds to the top pixel, and the most significant bit corresponds to the bottom pixel. Because sixel column codes are restricted to characters in the range from ? (3/15) through ~ (7/14), you must then add the hexadecimal offset 3/15 (decimal 63) to each sixel column value. For example, the binary value of 000000 is converted to hexadecimal 3/15, binary 110101 is converted to hexadecimal 7/4 (3/5 plus 3/15), and binary 111111 is converted to hexadecimal 7/14 (3/15 plus 3/15).

After this binary to hexadecimal conversion, you can convert the hexadecimal values for each sixel into the equivalent characters using the ASCII table (Figure 3-1).

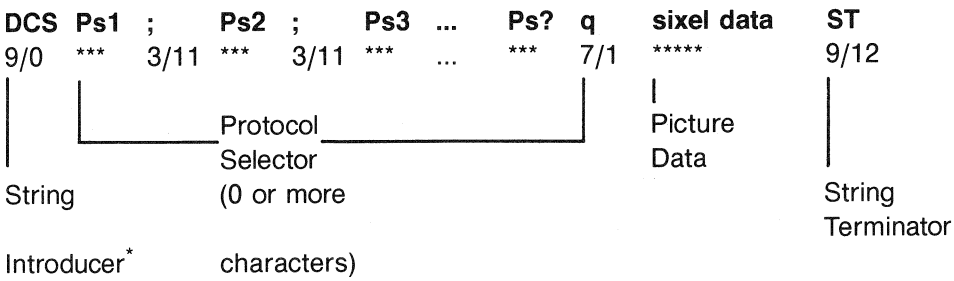
6.2 SELECTING GRAPHIC MODE: THE SIXEL PROTOCOL

You select sixel graphic mode by sending a special device control string (DCS). You include all your sixel graphic data and formatting information in the device control string.

The formatting section of the device control string is called the sixel protocol selector. The rest of this section describes the features you can select within the sixel protocol selector.

The device control string starts with the DCS control code, called a string introducer*. Next comes the protocol selector, which contains your formatting information. The protocol selector is followed by the sixel graphic data. Finally, the string terminator (ST) control code ends the string. The ST code also ends Graphic mode.

Device Control String (DCS) Format



6.2.1 String Introducer

When you send the string introducer in text mode, you identify the start of the device control string. In the Companion Color Printer sixel graphic mode is one of the two valid uses of the device control strings. You can use the 8-bit DCS (9/0) control code or the 7-bit ESC P (1/11 5/0) escape sequence for the string introducer.

*In the 7 bit mode ESC P (1/11 5/0) is used.

6.2.2 Protocol Selector

The protocol selector can contain a string of 0, 1, or more selective parameters (Ps), each separated by a ; (3/11). A valid selective parameter can have 0, 1, or more digits in the column/row range of 3/0 to 3/9. When you send any selective parameter with the final character q (7/1), the printer enters the graphic mode.

The protocol selector has the following format.

Ps1	**;**	**Ps2**	**;**	**Pn3**	**...**	**Ps**	**q**
***	3/11	***	3/11	***	...	***	7/1

The results of receiving control characters within the protocol selector sequence are shown in Table 6-1.

Table 6-1 Control Characters in the Protocol Selector Sequence

Control Code	Results
SUB (1/10)	Terminates protocol selector sequence, places printer in text mode, and then processes SUB.
CAN (1/8)	Terminates protocol selector sequence, places printer in text mode, and then processes CAN.
ESC (1/11)	Terminates protocol selector sequence, places printer in text mode, and then processes ESC.
Other CO control codes (other than SUB,CAN & ESC)	Honored without terminating the protocol selector sequence.
C1 control codes	Terminates protocol selector sequence and causes printer to enter text mode. C1 control codes are then processed.

6.2.2.1 Macro Parameter (Ps1) – The Ps1 parameter selects the fixed horizontal grid size (pixel width) and aspect ratio. This parameter provides for backward compatibility with existing software.

NOTE: For new software, you should set Ps1 to 0, and explicitly define the horizontal grid size (by using Pn3), and the aspect ratio numerator and denominator. (Use Pn1 and Pn2 of the "Set Raster Attributes" control sequence in Section 6..3.2.2.)

Ps1	Horizontal Grid Size (Inches)	Pixel Aspect Ratio (Vertical:Horizontal)
0 or none	1/144 (0.0069)	200:100 (2:1)
1	1/144 (0.0069)	200:100 (2:1)
2, default to:	1/180 (0.0056)	250:100 (2.5:1)
3, default to:	1/180 (0.0056)	250:100 (2.5:1)
4	1/180 (0.0056)	250:100 (2.5:1)
5, default to:	1/144 (0.0069)	200:100 (2:1)
6, default to:	1/144 (0.0069)	200:100 (2:1)
7, default to:	1/144 (0.0069)	200:100 (2:1)
8, default to:	1/144 (0.0069)	200:100 (2:1)
9	1/72 (0.0139)	100:100 (1:1)

If Ps1 is greater than 9, default Ps1 = 0

NOTE: The ; (3/11) marks the end of the current parameter.

6.2.2.2 Background Select (Ps2) – This parameter is not used on the Companion Color Printer. The printer ignores this parameter.

6.2.2.3 Horizontal Grid Size (Pn3) – The Pn3 parameter defines the horizontal grid size (pixel width) in decipoints. A decipoint is 1/720 inch. This parameter and the aspect ratio define the grid size.

The printer has horizontal grid size defaults for some decipoint values. The following shows the horizontal grid size specified for each Pn3 value.

Pn3 Decipoints (1/720 Inch Units)	**Horizontal Grid Size (Inches)**
0 or none	No change to grid size (defined by Ps1)
1, 2, and 3*	1/180 (0.0056)
4	1/180 (0.0056)
5	1/144 (0.0069)
6*	1/144 (0.0069)
7*	1/144 (0.0069)
8	1/90 (0.0111)
9*	1/90 (0.0111)
10	1/72 (0.0139)
11 to 19*	1/72 (0.0139)
20	1/36 (0.0278)
21 and up*	1/36 (0.0278)

If Pn3 is 0 or not present, the horizontal grid size is determined by the macro parameter (Ps1). Otherwise, Pn3 overrides the horizontal grid size portion of the Ps1, while attempting to preserve the aspect ratio (A/R) as follows.

*Defaults to horizontal grid size listed.

- When Ps1 selects a 2:1 aspect ratio

Pn3 Selection	**Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)**
1/180 in	2:1 A/R and change to HGS = 1/180 in
1/144	2:1 A/R and HGS = 1/144 in
1/90	2:1 A/R and HGS = 1/90 in
1/72	2:1 A/R and change to HGS = 1/72 in
1/36	2:1 A/R and change to HGS = 1/72 in

- When Ps1 selects a 1:1 aspect ratio

Pn3 Selection	**Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)**
1/180 in	1.1 A/R and change to HGS = 1/180 in
1/144 in	1:1 A/R and change to HGS = 1/180 in
1/90 in	1:1 A/R and change to HGS = 1/90 in
1/72 in	1:1 A/R and HGS of 1/72 in
1/36 in	1:1 A/R and change to HGS = 1/36 in

- When Ps1 selects a 2.5:1 aspect ratio

Pn3 Selection	**Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)**
1/180 in	2.5:1 A/R and HGS = 1/180 in
1/144 in	2.5:1 A/R and HGS = 1/180 in
1/90 in	2.5:1 A/R and change to HGS = 1/90 in
1/72 in	2.5:1 A/R and change to HGS = 1/90 in
1/36 in	2.5:1 A/R and change to HGS = 1/90 in

6.2.2.4 Additional Parameters (Ps?) – Additional parameters may be supported in future products. The Companion Color Printer ignores other parameters without affecting the current sixel protocol sequence.

6.2.2.5 Final Character (q) – The final character q (7/1) identifies this sequence as a sixel protocol selector and places the printer in Graphic mode.

6.2.3 Picture Data

Picture data includes sixel printable characters and sixel control characters. All picture data is processed while in sixel graphics mode instead of standard ASCII text mode. The printer processes picture data as defined in Section 6.3. In sixel graphic mode, printing is always performed unidirectionally.

6.2.4 String Terminator (ST)

The string terminator (ST) control code causes the printer to exit sixel graphic mode and enter text mode. You can use the 8-bit control code ST (9/12) or for the 7-bit escape sequence ESC \ (1/11, 5/12) for the string terminator.

6.3 CHARACTER PROCESSING IN SIXEL GRAPHIC MODE

In sixel Graphic mode, printable character codes define specific columns of dots to print.

6.3.1 Sixel Printable Characters

In sixel graphic mode, the printer interprets GL (graphic left) characters in the column/row range of 3/15 to 7/14 as printable characters. Each of these 64 values represents a code of 6 vertical pixels (1 sixel) to print. The actual pixel size is defined by the horizontal grid size (HGS) parameter and the aspect ratio (Section 6.2.2.3).

The printer subtracts a hexadecimal offset of $3F_H$ (3/15) from each graphic printable character received, resulting in a binary value in the range of 0/0 to 3/15. The 6-bit binary value obtained represents a sixel column definition.

For each bit set to 1, the printer activates a printhead element or group of elements to print a dot. The least significant bit (bit 0) is the top pixel of a sixel.

The printer processes GR (graphic right) characters in the 11/15 to 15/14 range as GL characters, by setting the eighth bit to 0 and subtracting the 3F hexadecimal offset (3/15) from the graphic printable character.

Column/ Row	ASCII Character	Binary Value	Pixels Activated	Action Performed
3/15	?	000000	None	Advances by a sixel space
4/0	@	000001	Top	Prints top pixel only
5/15	_	100000	Bottom	Prints bottom pixel only
7/14	~	111111	All	Prints one full column

If you try to print past the right margin, the printer truncates all remaining sixel data until it receives the next graphic carriage return ($) or graphic new line (-) character.

6.3.2 Sixel Control Codes

Sixel control codes are GL characters in the 2/0 to 3/14 range. Note that this range also includes the parameter separator (;) (3/11) and parameter digits 0 to 9 (3/0 to 3/9).

The printer processes GR characters in the 10/0 to 11/14 range as GL characters, by setting the eighth bit to 0.

The following sixel control characters are recognized.

Column/ Row	ASCII Character	Function
2/1	!	Repeat introducer
2/2	"	Set raster attributes
2/3	#	Color introducer
2/4	$	Graphic carriage return
2/13	–	Graphic new line
3/0 to 3/9	0 to 9	Numeric parameters
3/11	;	Parameter separator

A control sequence in Graphic mode begins with a sixel control character (not including the 0 to 9 and ; characters) and ends with a printable character or another sixel control character.

The printer ignores unassigned sixel control characters (along with parameters or parameter separators) until receiving the next valid sixel control character, printable character, or string terminator (ST).

6.3.2.1 Repeat Introducer (!) and Sequence – You can use the following sequence to consecutively print the same character a number of times.

!	Pn	Printable character
2/1	***	***

Pn specifies the number of times to print the character that follows.

The numeric parameter is a string of characters in the 3/0 to 3/9 range that the printer interprets as a decimal number, from 0 to 65,535. If you omit Pn or set Pn to 0, the printer uses 1. If you use a Pn value larger than 65535, the printer uses the maximum value of 65535.

NOTE: Sixel control characters received during a repeat sequence cancel the repeat sequence. The printer then processes these control characters.

The Companion Color Printer prints the printable character (in the 3/15 to 7/14 range) as many times as specified by Pn. The printable character terminates the repeat sequence.

EXAMPLES

Repeat Sequence	**Function**
! **1** **0** **?** 2/1 3/1 3/0 3/15	Repeats 10 graphic spaces
! **6** **@** 2/1 3/6 4/0	Repeats 6 patterns of top dot

6.3.2.2 Set Raster Attributes Sequence – This sequence defines the pixel aspect ratio. This aspect ratio applies to all sixel data that follow. After entering sixel graphic mode, the printer must immediately receive this sequence before the first sixel printable character.

If the printer receives the sequence after any other valid sixel data, the printer recognizes this sequence but ignores its parameters. The printer continues to process all following sixel data.

If the sequence is received before any other valid sixel data, the printer processes the sequence.

The set raster attributes sequence format is as follows:

"	**Pn1**	;	**Pn2**	;	**Pn3**	;	**Pn4**
2/2	***	3/11	***	3/11	***	3/11	***

where:

" = Set raster attributes control character,

Pn1 = Pixel aspect ratio numerator, and

Pn2 = Pixel aspect ratio denominator.

Pn1 and Pn2 are numeric parameters. A numeric parameter is a string of characters in the 3/0 to 3/9 range, which the printer evaluates as decimal numbers. If the parameter is a value larger than the maximum 65,535, the printer uses 65,535. If Pn1 or Pn2 is 0, missing, or set to 0, a value of 1 is assumed.

Pn3, Pn4, and all other parameters received in this sequence are ignored by the printer.

Pixel aspect ratio defines the shape of the pixel needed to reproduce the picture without distortion. This ratio is defined by two numbers: a numerator and a denominator. The pixel aspect ratio is the ratio of the pixel's vertical size to its horizontal size.

For example, an aspect ratio of 2:1 represents a pixel twice as high as it is wide. The pixel aspect ratio (A/R) multiplied by the horizontal grid size (HGS) yields the ideal vertical grid size (VGS).

This printer supports only the following three aspect ratios.

Aspect Ratio	HGS (inch)	Horizontal Dots/Pixel	VGS (inch)	Vertical Dots/Pixel	# of Colors
1:1	1/180	1	1/180	1	8
	1/90	2	1/90	2	256*
	1/72	2 or 3	1/72	2 or 3	8
	1/36	5	1/36	5	8
2:1	1/180	1	1/90	2	8
	1/144	1 or 2	1/72	2 or 3	8
	1/90	2	1/45	4	256*
	1/72	2 or 3	1/36	5	8
2.5:1	1/180	1	1/72	2 or 3	8
	1/90	2	1/36	5	8

Other aspect ratios specified by Pn1 and Pn2 are processed as follows.

- If the aspect ratio is less than 1.5:1, the printer uses 1:1.
- If the aspect ratio is greater than or equal to 1.5:1 and less than 2.25:1, the printer uses 2:1.
- If the aspect ratio is greater than 2.25:1, the printer uses 2.5:1.

*When DECBCMM is set, color selection is by special 64 entry color map.

The printer attempts to preserve the specified aspect ratios at each horizontal grid size as follows:

- When the selected aspect ratio is 2.5:1

Horizontal Grid Size	**Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)**
1/180 in	2.5:1 A/R and HGS = 1/180 in
1/144 in	2.5:1 A/R and change to HGS = 1/180 in
1/90 in	2.5:1 A/R and HGS = 1/90 in
1/72 in	2.5:1 A/R and change to HGS = 1/90 in
1/36 in	2.5:1 A/R and change to HGS = 1/90 in

- When the selected aspect ratio is 2:1

Horizontal Grid Size	**Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)**
1/180 in	2:1 A/R and HGS = 1/180 in
1/144 in	2:1 A/R and HGS = 1/144 in
1/90 in	2:1 A/R and HGS = 1/90 in
1/72 in	2:1 A/R and HGS = 1/72 in
1/36 in	2:1 A/R and change to HGS = 1/72 in

- When the selected aspect ratio is 1:1

Horizontal Grid Size	Resulting Aspect Ratio (A/R) And Horizontal Grid Size (HGS)
1/180 in	1:1 A/R and HGS of 1/180 in
1/144 in	1:1 A/R and change to HGS = 1/144 in
1/90 in	1:1 A/R and HGS of 1/90 in
1/72 in	1:1 A/R and HGS of 1/72 in
1/36 in	1:1 A/R and HGS of 1/36 in

By following these rules, the only possible vertical grid sizes the printer can use are 1/180, 1/90, 1/72, 1/45, or 1/36 of an inch.

Vertical Grid Size	Sixel Height	Pixel Construction (Vertical Dots per Pixel)
1/180 in	1/30 in	1 vertical dot per pixel
1/90 in	1/15 in	2 vertical dots per pixel
*1/72 in	1/12 in	Alternate 3 then 2 vertical dots per pixel
1/45 in	2/15 in	4 vertical dots per pixel
1/36 in	1/6 in	5 vertical dots per pixel

*This is the standard vertical grid size (LA34, LA50, LA75 & LA210)

6.3.2.3 Graphic Carriage Return ($) – The graphic carriage return (GCR) control code $ (2/4) returns the carriage to the graphic left margin. The graphic left margin is the active position where the printer enters the Graphic mode.

6.3.2.4 Graphic New Line (-) – The graphic new line (GNL) control code (2/13) sets the active column to the left margin and advances the paper by the current sixel height. This is the logical function of the GNL command.

However, to optimize throughput the physical vertical advance may not be performed immediately. Depending on the current vertical grid size, multiple sixel lines may be stored before printing actually occurs. The printer stores enough data to support all printhead elements before data is printed.

After printing the data and returning to the graphic left margin, the vertical active position is incremented by the number of pixels just printed.

If enough data is not received at the end of the sixel file to cause printing, the (ST) command must be sent to complete printing of sixel file.

6.3.2.5 Numeric Parameters (0 to 9) – Some graphic control codes must be followed by a numeric value. The numeric value is a decimal number that is coded by using the ASCII digits 0 to 9 (3/0 to 3/9). A numeric value is ended by any nondigit, specifically another control code or a graphic printable character. The default value for any numeric parameter is 0.

6.3.2.6 Parameter Separator (;) – The parameter separator, which is a semicolon (;) (3/11), separates a series of numeric parameters. If there is no number before the separator, the preceding parameter value defaults to 0. If a number does not follow the separator, the following parameter value defaults to 0.

6.3.3 Color Introducer (#)

The color introducer begins either a color selection sequence or a color specification sequence. The color specified parameter Pc must always follow the color introducer control code (#). This printer supports up to 256 Pc parameters with values 0 to 255.

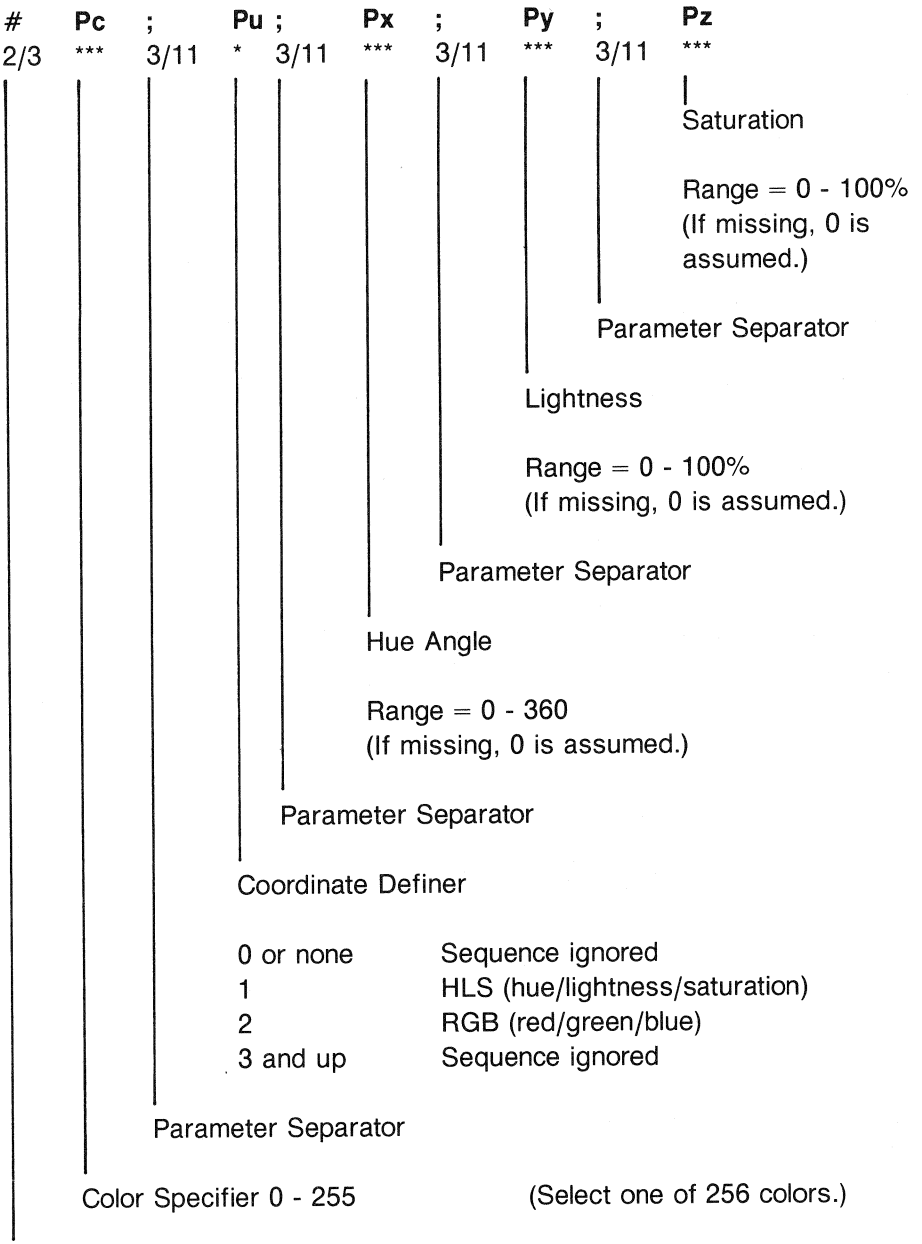
In a color selection sequence, the Pc parameter determines the color to be applied to the following sixel data. On entering sixel mode, all Pc values (0 to 255) are assigned to black. Therefore, application software must first specify the colors of each Pc value it intends to use in one of two coordinate systems: HLS or RGB.

To specify a color for a specific Pc parameter, Pc must be immediately followed by:

; Pu ; Px ; Py ; Pz

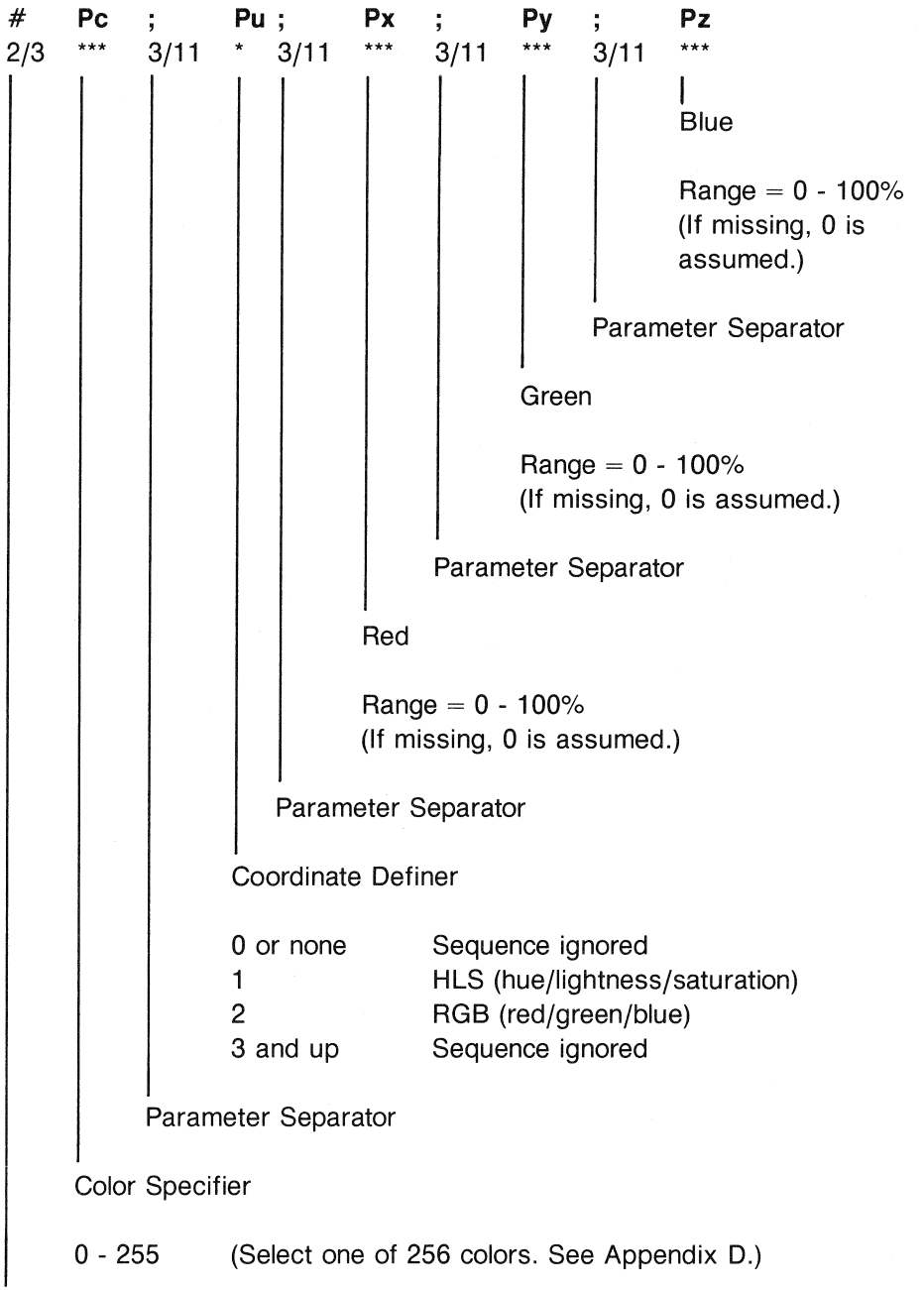
Sections 6.3.3.1 and 6.3.3.2 give details on specifying colors in the HLS and RGB coordinate systems.

6.3.3.1 HLS (Hue/Lightness/Saturation) Sequence –



NOTE: If Pc, Px, Py, or Pz is beyond maximum, sequence is ignored.

6.3.3.2 RGB (Red/Green/Blue) Sequence –



NOTE: If Pc, Px, Py, or Pz is beyond maximum, sequence is ignored.

6.3.4 Graphic C0 Control Characters

In sixel graphic mode, the printer ignores all C0 control characters except CAN, SUB, and ESC. When these control characters are received, the printer performs the following actions.

C0 Control Character	Printer Action
CAN	Terminates sixel graphic mode, enters text mode, then processes CAN.
SUB	Processes SUB as a sixel space (3/15) to limit communication line errors.
ESC	Terminates sixel graphic mode, enters text mode, then processes ESC.

NOTE: When the printer receives any C1 control code in sixel graphic mode, the printer leaves graphic mode and enters text mode. The printer then processes the C1 control codes, if applicable.

6.3.5 Graphic Substitute (SUB) Character

The printer interprets the substitute character SUB (1/10) as being in place of a character or characters received in error. In graphic mode, the printer processes SUB as a sixel space character (3/15).

If the printer is processing a repeat sequence, the sequence is terminated. The printer then prints a number of sixel spaces equal to the repeat number specified in the repeat sequence. The printer remains in graphic mode.

6.3.6 Leaving Sixel Graphic Mode

The following control characters cause the printer to leave graphic mode and perform the following actions.

Control Character	Printer Action
CAN	Enters text mode and processes the CAN character.
ESC	Enters text mode and begins processing another escape sequence.
ST	Enters text mode.

NOTE: The printer prints all stored sixel data before entering text mode.

6.3.7 Printer State After Leaving Graphic Mode

After leaving sixel graphic mode, the printer is in the following state.

- Horizontal position returns to the last active position before entering sixel graphic mode.
- Horizontal pitch returns to the last value used before entering sixel graphic mode.
- Vertical position has been modified by the vertical control characters received in sixel graphic mode. However, the first text mode motion command (for example, LF, VT, or FF) advances the vertical position to the next text line grid before executing the command.
- Vertical pitch returns to the last value used before entering sixel graphic mode.
- All SGR attributes return to the last state before entering sixel graphic mode.

PART 3 COMPANION COLOR PRINTER IN HP PCL MODE

CHAPTER 7
HP PCL FEATURES

7.1 GENERAL

This chapter describes the Companion Color Printer's basic features, control characters, and character sets when operating with Hewlett-Packard's Printer Command Language (PCL) protocol. The LJ250 and LJ252 Companion Color Printers emulate the Hewlett-Packard HP3630™ and Paintjet™ printers.

7.1.1 Protocol

You can set the Companion Color Printer to operate in the PCL mode by using the front panel DEC/PCL switch, the rear panel default switch (LJ250 only), or the DECHPPCL control sequence. The READY indicator on the control panel is NOT lit if the printer is in the PCL mode.

The Companion Color Printer implements Level I of PCL and has some of the features of Level II and Level III, as well as optional features.

7.1.2 Modes of Operation

7.1.2.1 Transparency Mode – Transparency mode is used to maintain the intensity of the colors when printing transparencies. In the transparency mode the printhead makes two passes depositing more than the normal amount of ink. The transparency mode can be entered manually by holding the DEC/PCL switch down while powering on or by sending the printer an escape sequence (Section 7.5.1.9) from the controller.

7.1.2.2 Display Function Mode – The display function mode allows the Companion Color Printer to print a representation of all control and printable characters (Section 7.5.1.2). This feature is a valuable tool when debugging software applications.

NOTE: The DECmode commands ROCS, RIS, and DECSTR are recognized and processed in the PCL mode. See Chapter 5 for a description of these commands.

7.1.3 Specifications

The physical specifications for the printer in HP PCL mode are the same as in DEC mode. The functional specifications, however, are different and are listed here.

Function	Specification
Print Rate	90 characters/second @ 10 cpi
Line spacing	9, 8, or 6 lines/inch 1/2 line up and down
Carriage return rate	30 inches per second
Form feed rate	8 seconds per 11 inch form
Print mode	Unidirectional and bidirectional text printing
Dot size	0.0085 inch diameter
Dot spacing	180 dots per inch

Character sets	Default sets
	Roman8
	PC-8 (IBM-US)
	Supplemental sets
	ECMA-94
	US ASCII
	PC-8 (Danish/Nowegian)
	ISO Norwegian 1
	ISO UK
	ISO French
	ISO German
	ISO Italian
	ISO Swedish Names
	ISO Spanish
	Downloadable character set
Character pitch	10 characters/inch - Courier font 80 characters/line
	12 characters/inch - Courier font 96 characters/line
	18 characters/inch - Gothic font 144 characters/line
Character attributes	Underlining Bolding Color text
Character buffer	2560 plus characters depending on whether downloadable character are in use

Raster color mode	180 × 180 dpi gives 8 colors: Black Yellow Magenta Cyan Red Green Blue White (or background color) 90 × 90 dpi gives 256 colors

7.2 PRINTER INTERFACE AND CONTROL PANEL IN PCL MODE

While in the HP PCL mode the the companion color printer uses the DEC assigned rear panel configuration switch functions (Section 2.4). The control panel also keeps its DEC-assigned functions (Section 2.3) while in the HP PCL mode.

7.3 POWER ON STATUS (DEFAULT FEATURES)

Table 7-1 PCL Intrinsic Features for Level I Compliance

Print pitches	Has 80 columns per line at 10 cpi; allows multiple pitches per line
Character sets	Supports 8-bit character sets, which include extended character sets, in default and compressed pitches
Character cells	Connects character cells horizontally, allowing underlining
Activation/deactivation	Keeps all features active until specifically deactivated
Overstriking	Allows infinite overstrike
Unrecognized commands or codes	Ignores all unrecognized escape sequences or control codes

NOTE: The LJ252 powers up in HP PCL mode.

Table 7-2 Factory-Set Power-On Status for PCL Mode

Parameters	Power-on Status
Perforation skip	OFF
Line spacing	6 lines per inch
Line length	80 column @ 10 char/inch
Horizontal pitch	10 char/inch
Text length	60 lines
Active position	Column 1, line 1
Text color	Black
Underlining	OFF
Bold mode	OFF
Primary symbol set	Normal print
Secondary symbol set	Bold print
Line termination	Line terminated and printing caused by CR and LF codes
Display functions	Display functions off
Directional print	Bidirectional text printing
Resolution	Raster Graphics – 90 dpi
Right margin text mode	Wraps characters beyond 80 columns around to the next line

7.4 PCL CONTROL CODES

A control code is any ASCII character between 0H and 20H. Recognizable control codes cause the printer to perform specified functions. ESC is a recognized control code that instructs the printer to execute a function as specified by the characters following the ESC code.

Table 7-3 PCL Control Code Summary

Abbrv.	Hex	Col/Row	Name
BS	08H	0/8	Backspace
LF	0AH	0/10	Line feed
FF	0CH	0/12	Form feed
CR	0DH	0/13	Carriage return
SO	0EH	0/14	Shift out
SI	0FH	0/15	Shift in
ESC	1BH	1/11	Escape
SP	20H	2/0	Space (Cursor advance)

7.4.1 Backspace (BS)

This control code decreases the active column by one column space at the current horizontal pitch. If the active column is at the left margin, the BS character is ignored.

7.4.2 Line Feed (LF)

This code increases the active line by one line at the current vertical pitch (active column stays the same). The line feed also causes the current line to be printed before the LF is performed.

7.4.3 Form Feed (FF)

The FF code advances the active line to the next top-of-form position (active column stays the same).

7.4.4 Carriage Return (CR)

The CR causes the current line to be printed and then sets the active column to the left margin.

7.4.5 Shift Out (SO)

The SO control code selects the secondary symbol, which remains selected until an SI is received.

7.4.6 Shift In (SI)

The SI control code selects the primary symbol set, which remains selected until an SO is received.

7.4.7 Escape (ESC)

The ESC control code introduces an escape sequence, which provides supplementary control of the printer features (Section 7.5).

7.4.8 Space (SP)

The SP control code advances the current active position forward one character. If the active position is at the right margin + 1, the active position is set at the left margin of the next line before the space is processed.

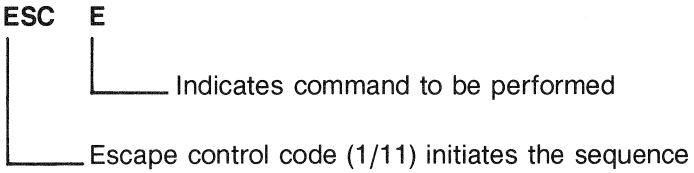
7.5 PCL ESCAPE SEQUENCES

Escape (ESC) is a recognized control code (1/11 or 1BH) that instructs the printer to execute a function as specified by the characters following the ESC code. The printer performs the specified function until another ESC sequence changes the function or the printer is turned off.

The application software that you are using allows you to change the print settings from the default settings. Changing the settings is done with ESC sequences.

Spaces are added to the escape sequences here for clarity.

TWO CHARACTER ESCAPE SEQUENCES:



PARAMETERIZED ESCAPE SEQUENCE FORMAT:

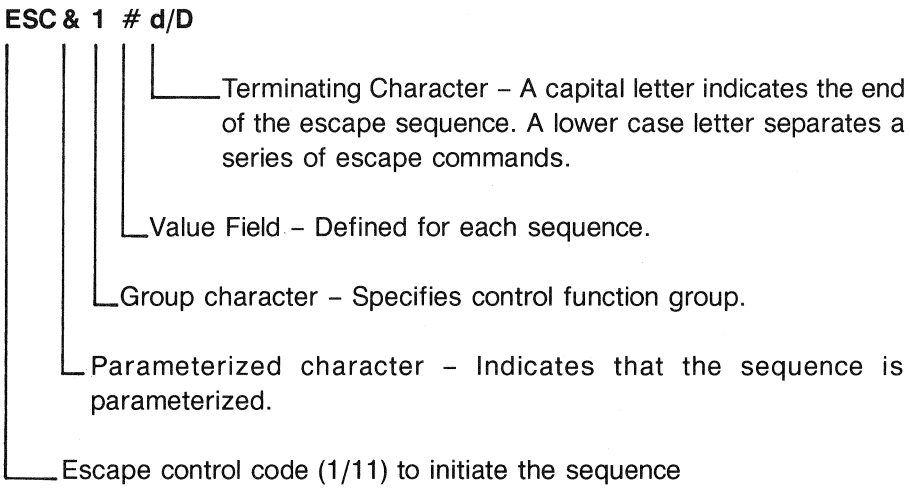


Table 7-4 PCL Escape Sequences Summary

Level	Sequence	Function
Cursor Positioning		
I	ESC =	Advance paper 1/2 line
III	ESC & a # h/H	Horizontal cursor positioning
III	ESC & a # v/V	Vertical cursor positioning
Page Length and Line Spacing		
II	ESC & 1 # d/D	Set line spacing
II	ESC & 1 # f/F	Set text length
I	ESC & 1 # l/L	Perf skip enable/disable
II	ESC & 1 # p/P	Set page length

Table 7-4 PCL Escape Sequences Summary (Cont)

Level	Sequence	Function
Printer Control and Display Functions		
I	ESC E	Hard reset
I	ESC Y	Display mode on
I	ESC Z	Display mode off
I	ESC z	Initiate self-test
I	ESC & d # D	Underline on
I	ESC & d # @	Underline off
Opt	ESC & k # g/G	Line termination
Opt	ESC & k # w/W	Print mode
II	ESC & p # X [data]	Transparent print data
Opt	ESC & v # s/S	Select pen color
Font Designation and Attribute Selection		
III	ESC & k # s/S	Select print pitch
II	ESC (# ID	Designate primary font character set
II	ESC) # ID	Designate secondary font character set
Opt	ESC (0 @	Designate default set as primary
Opt	ESC) 0 @	Designate default set as secondary
Opt	ESC (1 @	Designate primary default set as primary
Opt	ESC) 1 @	Designate primary default set secondary
Opt	ESC (2 @	Designate current primary set as primary

Table 7-4 PCL Escape Sequences Summary (Cont)

Level	Sequence	Function
Opt	ESC) 2 @	Designate current primary set secondary
Opt	ESC (3 @	Designate default font as primary
Opt	ESC) 3 @	Designate default font as secondary
Opt	ESC (# X	Designate downloaded font as primary
Opt	ESC) # X	Designate downloaded font as secondary
I	ESC (s # b/B	Primary set stroke weight
I	ESC) s # b/B	Secondary set stroke weight
Downloaded Font Control		
Opt	ESC (s # W [character data]	Download character
Opt	ESC) s # W [font descriptor]	Create font
Opt	ESC * c # e/E	Character code
Opt	ESC * c # f/F	Font control
Raster Graphics		
Opt	ESC * b # m/M	Transmission mode
Opt	ESC * b # V [data]	Raster data transfer by place
I	ESC * b # W [data]	Raster data transfer by row
Opt	ESC * b # x/X	Temporary horizontal offset
Opt	ESC * b # y/Y	Temporary vertical offset
Opt	ESC * r # a/A	Prepare for raster graphics
I	ESC * r # b/B	Raster graphics complete
Opt	ESC * r # s/S	Pixels per row
Opt	ESC * r # u/U	Data planes per row
Opt	ESC * t # r/R	Graphics resolution
Opt	ESC * v # a/A	Color parameter, red
Opt	ESC * v # b/B	Color parameter, green
Opt	ESC * v # c/C	Color parameter, blue
Opt	ESC * v # i/I	Pen color assignment

7.5.1 PCL Escape Sequences for Print Features

7.5.1.1 Advance Paper One-half Line Feed ESC = – This sequence moves the current active vertical position down one-half line while maintaining the horizontal position. The Companion Color Printer only moves in increments of 4 decipoints and places the active position as close to the true position as it can.

7.5.1.2 Pseudo-Reset (not a hardware reset) ESC E – Pseudo-hard reset includes:

- Printing any partial lines of data in the printer
- Moving paper to top of form
- Setting active position to column 1, line 1
- Returning programmable features to default settings
- Not deleting downloadable set

7.5.1.3 Display Function – Turn On Display Function Mode ESC Y – When in the display function mode, control codes and escape sequences are printed but not executed with the following exceptions:

- (CR) – Printed, then executed as (CR)(LF)
- ESC Z – Printed, then executed

Printing is done in black ink. If the printer was in color text mode when the display function mode was invoked, the printer returns to color text mode when the display function is exited.

Turn off display function mode ESC Z
This sequence turns the display function mode off after printing.

7.5.1.4 Self-test ESC z – The Companion Color Printer prints all data preceding the self-test and moves the paper to the top of form. The self-test is printed and an internal diagnostic is performed. If no error is detected, the printer remains on-line, moves to the top of the next form, and continues processing data. If the printer detects an error, it goes to the off-line state (flashing PROTOCOL/READY indicator).

The input buffer is preserved, but programmable features such as underlining and bolding are returned to default status.

7.5.1.5 Horizontal Cursor Positioning ESC & a # h/H – This sequence moves the current active horizontal position to a new position on the line. The leftmost position is zero and the rightmost position is 5759 decipoints (1 decipoint = 1/720").

Sign preceding value (#):

- The plus sign (+) indicates that the new position is to the right of the current position.
- The minus sign (–) indicates that the new position is to the left of the current position.
- No sign preceding the value indicates an absolute position from the left margin.

If the value indicates a nonexistant position, the cursor position is set at the maximum limit.

NOTE: Since the printer's resolution is 180 dpi, the printer calculates in decipoints and rounds off to the nearest dot position by dividing the decipoint value by four.

7.5.1.6 Vertical Cursor Positioning ESC & a # v/V – This sequence moves the current active vertical position to a new line on the page. The top position is zero and the bottom position is determined by the length of the logical page. (1 inch = 720 decipoints).

Sign preceding value (#):

- The plus sign (+) indicates that the new position is below the current position.
- The minus sign (–) indicates that the new position is relative above the current position.
- No sign preceding the value indicates an absolute position from the top of the page.

If the value indicates a nonexistant position, the cursor position is set at the appropriate limit.

NOTE: Since the printer's resolution is 180 dpi, the printer calculates in decipoints and rounds off to the nearest dot position by dividing the decipoint value by four.

7.5.1.7 Underlining – You can use an escape sequence to control text underlining. All text will be underlined until you send an instruction that turns off underlining, or until you turn the printer off.

ESC & dD Turns on underline mode
ESC & d@ Turns off underline mode

Default = Underlining off

7.5.1.8 Line Termination ESC & k # g/G – This sequence controls the manner in which the printer interprets line termination characters.

Line termination values (#):

0	→	CR = CR;	LF = LF;	FF = FF
1	→	CR = CR,LF;	LF = LF;	FF = FF
2	→	CR = CR;	LF = CR,LF;	FF = CR,FF
3	→	CR = CR,LF;	LF = CR,LF;	FF = CR,FF

Default = CR = CR; LF = LF; FF = FF (or Mode 0)

7.5.1.9 Character Pitch ESC & k # s/S – This sequence defines the horizontal pitch for both primary and secondary character sets.

Pitch Selection values (#):

0 → 10 cpi
1 → Not used
2 → 18 cpi
3 → 10 cpi
4 → 12 cpi
8 → Not used

Default = 10 cpi

7.5.1.10 Print Mode (Motion) ESC & k # w/W – This sequence selects the print mode or printing motion.

Print mode selection values (#):

0 → Unidirectional mode
1 → Bidirectional mode
3 → Transparency (high intensity) mode

Unidirectional mode is recommended for use when the exact alignment between successive lines is critical (that is, when the line-drawing character set is being used.)

Bidirectional mode is used for maximum printing speed. Text is printed bidirectionally; color text and raster graphics are printed unidirectionally.

Transparency mode is always unidirectional with two passes of the printhead. It is used where higher than normal ink volumes, and therefore color intensity, are required.

Default = Bidirectional

7.5.1.11 Line Spacing ESC & 1 # d/D – This sequence sets the vertical pitch to the value specified in the value field (#) in lines per inch. The text and page length are not affect by this setting.

6 → 6 lpi
8 → 8 lpi
9 → 9 lpi

Any value other than 6, 8, or 9 is ignored.

Default = 6 lpi

7.5.1.12 Text Length ESC & 1 # f/F – This sequence sets the number of available text lines for the logical page. If a text length of zero is received the text length is set at 1 inch less than logical page length. If a text length longer than the logical page length is sent, the command is ignored. The maximum form length is 255 lines. If the logical page length equals one inch or less, then the text length is set to logical page length.

Default = 1 inch less than the paper size selected on the rear panel switch (60 or 66 lines)

7.5.1.13 Perforation Skip Enable ESC & 1 # l/L – This sequence is used to enable or disable the automatic perforation skip. The perforation skip area is defined as that area outside the text area, but within the logical page. No text is printed in the perforation area. Raster graphics is unaffected by the perforation skip.

Values (#):

0 → Perforation skip off
1 → Perforation skip on

Default = Perforation skip off

7.5.1.14 Page Length ESC & 1 # p/P – This escape sequence sets the logical page length in lines. The maximum form length is 255 lines. Changing the line spacing does not change the page length.

Value (#) Range:

0 → Printer reset to default setting
Lines totaling 1" or less → page length = forms length
Over 255 lines → command is ignored.

Default = 66 or 72 lines per page depending on the rear panel switch setting

7.5.1.15 Transparent Print Data ESC & p # × [data] – This sequence prepares the printer to receive the number of bytes specified in the value field. Control codes in the data field are not executed. This allows characters that replace normal control codes, as in the PC-8 character set, to print. The feature allows printing of nonstandard downloadable fonts.

7.5.1.16 Text Color ESC & v # s/S – This sequence selects the color for text printing. The text palette is separate from the graphics palette.

Palette Values (#):

0 → Black
1 → Red
2 → Green
3 → Yellow
4 → Blue
5 → Magenta
6 → Cyan
7 → White

Default = Black

7.5.1.17 Bolding – After you send an escape sequence to print in bold text, all text is printed in bold stroke weight.

EXC (s # b/B Designates stroke weight for the primary symbol set

ESC) s # b/B Designates stroke weight for the secondary symbol set

Values (#):

0 → Normal
1 → Bold

Default = Primary set is normal
Secondary set is bold

7.5.2 Character Set Escape Sequences

Figures 7-1, 7-2, 7-3, 7-4 and 7-5 show the character sets available in PCL mode.

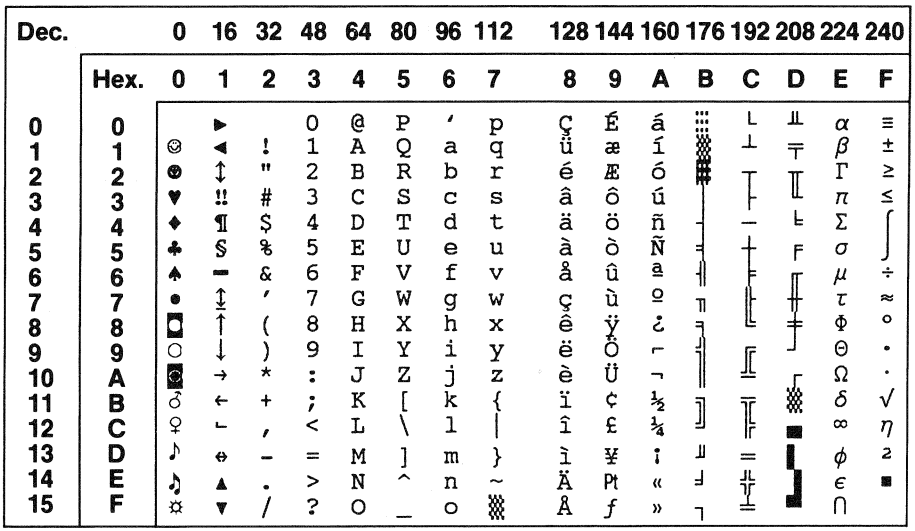


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Figure 7-1 HP PCL Roman8 Character Set

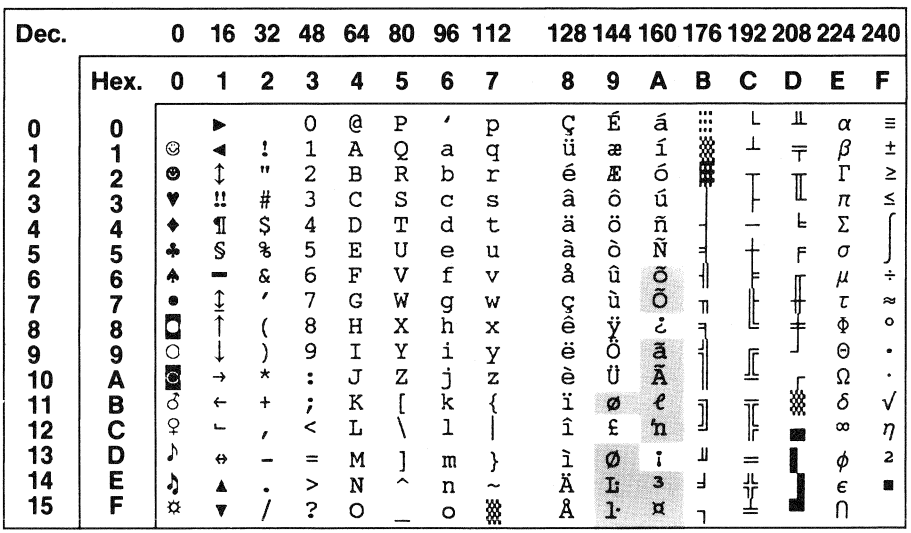

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Figure 7-2 HP PCL PC-8 Character Set

Dec.		32	48	64	80	96	112	160	176	192	208	224	240
	Hex.	2	3	4	5	6	7	A	B	C	D	E	F
0	0		0	@	P	‘	p		—	â	Å	Á	Þ
1	1	!	1	A	Q	a	q	À	Ý	ê	î	Ã	þ
2	2	"	2	B	R	b	r	Â	ý	ô	Ø	ã	·
3	3	#	3	C	S	c	s	È	°	û	Æ	Đ	µ
4	4	$	4	D	T	d	t	Ê	Ç	á	å	ð	¶
5	5	%	5	E	U	e	u	Ë	ç	é	í	Í	¾
6	6	&	6	F	V	f	v	Î	Ñ	ó	ø	Ì	–
7	7	’	7	G	W	g	w	Ï	ñ	ú	æ	Ó	¼
8	8	(	8	H	X	h	x	‘	¡	à	Ä	Ò	½
9	9	)	9	I	Y	i	y	`	¿	è	ì	Õ	ª
10	A	*	:	J	Z	j	z	^	¤	ò	Ö	õ	º
11	B	+	;	K	[	k	{	¨	£	ù	Ü	Š	«
12	C	,	<	L	\	l	|	~	¥	ä	É	š	■
13	D	–	=	M	]	m	}	Ù	§	ë	ï	Ú	»
14	E	.	>	N	^	n	~	Û	ƒ	ö	ß	Ÿ	±
15	F	/	?	O	_	o	▒	£	¢	ü	Ô	ÿ	

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Figure 7-3 HP PCL ECMA-94 Character Set

Dec.		32	48	64	80	96	112	160	176	192	208	224	240
	Hex.	2	3	4	5	6	7	A	B	C	D	E	F
0	0		0	@	P	‘	p		°	À	Ð	à	ð
1	1	!	1	A	Q	a	q	¡	±	Á	Ñ	á	ñ
2	2	"	2	B	R	b	r	¢	²	Â	Ò	â	ò
3	3	#	3	C	S	c	s	£	³	Ã	Ó	ã	ó
4	4	$	4	D	T	d	t	¤	´	Ä	Ô	ä	ô
5	5	%	5	E	U	e	u	¥	µ	Å	Õ	å	õ
6	6	&	6	F	V	f	v	¦	¶	Æ	Ö	æ	ö
7	7	’	7	G	W	g	w	§	·	Ç	×	ç	÷
8	8	(	8	H	X	h	x	¨	¸	È	Ø	è	ø
9	9	)	9	I	Y	i	y	©	¹	É	Ù	é	ù
10	A	*	:	J	Z	j	z	ª	º	Ê	Ú	ê	ú
11	B	+	;	K	[	k	{	«	»	Ë	Û	ë	û
12	C	,	<	L	\	l	|	¬	¼	Ì	Ü	ì	ü
13	D	–	=	M	]	m	}		½	Í	Ý	í	ý
14	E	.	>	N	^	n	~	®	¾	Î	Þ	î	þ
15	F	/	?	O	_	o	▒	¯	¿	Ï	ß	ï	ÿ

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Figure 7-4 HP PCL PC-8 (Danish/Norwegian) Character Set

Dec.	Hex.	US ASCII 6	Roman8	Norwegian 1 60	UK 4	French 69	German 21	Italian 15	Swedish Names 11	Spanish 17
35	23	#	#	#	£	£	#	£	#	£
36	24	$	$	$	$	$	$	$	¤	$
64	40	@	@	@	@	à	§	§	É	§
91	5B	[	[	Æ	[	°	Ä	°	Ä	¡
92	5C	\	\	Ø	\	ç	Ö	ç	Ö	Ñ
93	5D	]	]	Å	]	§	Ü	é	Å	¿
94	5E	^	^	^	^	^	^	^	Ü	^
96	60	‘	‘	`	`	µ	`	ù	é	`
123	7B	{	{	æ	{	é	ä	à	ä	°
124	7C	|	|	ø	|	ù	ö	ò	ö	ñ
125	7D	}	}	å	}	è	ü	è	å	ç
126	7E	~	~	—	—	¨	ß	ì	ü	~

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Figure 7-5 HP PCL International Symbol Sets

7.5.2.1 Designating the Font

ESC (0 @ → Designates printer default set as primary
ESC) 0 @ → Designates printer default set as secondary
ESC (# X → Designates downloaded font as primary
ESC) # X → Designates downloaded font as secondary

Value (#) = Ignored

7.5.2.2 Setting Default Character Set

ESC (1 @ → Designates primary default set as primary
ESC) 1 @ → Designates primary default set as secondary
ESC (2 @ → Designates the current primary set as primary
ESC) 2 @ → Designates the current primary set as secondary
ESC (3 @ → Designates default font as primary
ESC) 3 @ → Designates default font as secondary

7.5.2.3 Selecting Character Sets

ESC (O D → ISO Norwegian 1 as primary
ESC) O D → ISO Norwegian 1 as secondary
ESC (O I → ISO Italian as primary
ESC) O I → ISO Italian as secondary
ESC (O S → ISO Swedish Names as primary
ESC) O S → ISO Swedish Names as secondary
ESC (1 E → ISO UK as primary
ESC) 1 E → ISO UK as secondary
ESC (1 F → ISO French as primary
ESC) 1 F → ISO French as secondary
ESC (1 G → ISO German as primary
ESC) 1 G → ISO German as secondary
ESC (2 S → ISO Spanish as primary
ESC) 2 S → ISO Spanish as secondary
ESC (0 U → ISO US ASCII as primary
ESC) 0 U → ISO US ASCII as secondary
ESC (8 U → ISO Roman8 as primary
ESC) 8 U → ISO Roman8 as secondary
ESC (0 N → ISO ECMA94 as primary
ESC) 0 N → ISO ECMA94 as secondary
ESC (10 U →ISO PC-8 as primary
ESC) 10 U →ISO PC-8 as secondary
ESC (11 U →ISO PC-8 (Danish/Norwegian) as primary
ESC) 11 U →ISO PC-8 (Danish/Norwegian) as secondary

7.5.2.4 Stroke Weights

Primary Set Stroke Weight ESC (s # b/B
This sequence designates the stroke weight of the primary font.

Values (#):

0 or less → Normal stroke weight
1 or more → Bold

Default = Normal weight

Secondary Set Stroke Weight ESC) s # b/B
This seqence designates the stroke weight of the secondary font.

Values (#):

0 or less → Normal stroke weight
1 or more → Bold

Default = Bold

Secondary Set Stroke Weight ESC) s # b/B
This seqence designates the stroke weight of the secondary font.

Values (#):

0 or less → Normal stroke weight
1 or more → Bold

Default = Bold

7.5.2.5 Download Characters and Fonts – In PCL mode the Companion Color Printer has sufficient RAM memory for one downloaded character set. To create a downloaded character set, three escape sequences are sent in the following sequence:

- Create a RAM font – ESC) s # W
- Specify character code – ESC * c # E
- Define download character data – ESC (s # W

The create RAM font sequence is sent only once. However, the character code and download character data sequences are sent for *each* character downloaded to the RAM font. Downloaded characters are assigned to any character codes from 0 to 255, except 32. The characters defined in the downloaded character set are selected as either the primary or secondary set by using the ESC (# X or ESC) # X sequences.

If the available memory is exceeded as characters are downloaded, the entire RAM font is deleted. Memory space is dependent on the amount of data compaction that occurs, and automatic data compaction occurs only when consecutive byte pairs of the downloaded character data are repetitive. If character design does not allow compaction, at least 96 characters can be downloaded before exceeding available memory. RAM memory not used for downloaded characters is used for processing text and graphics. As characters are downloaded to the RAM font, the time during which your computer is tied up may be affected.

A 15 × 30 dot character cell is used to design downloadable characters. Because of the fixed-size character cell, the downloaded characters are fully compatible only with the 12 cpi pitch fonts. When printed, the character cells overlap at 18 cpi pitch, butt together at 12 cpi pitch, and separate at 10 cpi pitch.

Downloaded characters default to the normal stroke weight, whether the RAM font is designated as primary or secondary. The stroke weight is changed with the appropriate stoke weight sequences (see section 7.5.2.5). After the RAM font is designated, the font is subject to all currently invoked printing features.

Creation of Fonts ESC) s # W [Font descriptor]
This sequence creates a RAM (downloadable) font. If a RAM font already exists, it is deleted and a new font defined. The font descriptor block is optional and, if used, it is ignored.

Character Code ESC * c # e/E
This sequence sets the character code state variable. The space character (2/0) may not be downloaded. If the character code is less than 0 or more than 255, the character code is set for 32; thus ignoring all downloaded data for this character code.

Value (#) range: 0 to 31 or 33 to 255

Default = 0

Download Character ESC (s # W [character data]

The character data downloaded by this escape sequence is assigned the code specified by the character code state variable. The downloaded character must be in a format supported by Level I PCL, otherwise the character is discarded. If an out-of-memory condition is encountered while downloading character data, the entire font is deleted.

The value field (#) is the number of bytes following (W), which is the total of the character descriptor block and the actual character data. The value is normally 63.

The [character data] must contain a character descriptor (byte 1) followed by the actual data. Descriptor data is required for the format, but is ignored by the printer. The character data forms a bit map of the character by forming 30 two-byte rows starting from the top. The least significant bit is discarded at the end of the two byte rows.

[Character data] format:

Byte 1	= 6 (Companion Color Printer format number)
Byte 2	= 0 (null)
Byte 3	= 1 (descriptor size)
Byte 4 - 63	= Character data in bit form

Font Control ESC * c # f/F
To define a character set within the font, the user sends the character code sequence followed by the character data until the character set is defined.

Values (#):

0 → Delete RAM font
2 → Delete RAM font

The RAM font is not deleted by a hard reset (ESC E).

7.5.3 Raster Graphics Escape Sequences for PCL

A raster image is a picture created by printing a row/column matrix of pixels (picture element dots). The pixels are printed in rows. Each pixel row can be defined with one to four color planes, depending on the number of pixel colors that are needed.

Each color plane is created by a single escape sequence that defines a binary digit for each column position in a pixel row. Since a maximum of four color planes are allowed, each column position in a pixel row may be defined with up to four bits. The bits specified for each column position define the pixel's color. The bits form a binary number that is interpreted as one of the printer's color palette index numbers.

The printer's color palette contains the colors that the Companion Color Printer can print at any one time. The color palette contains a maximum of sixteen colors. Each color is assigned to an index number from 0 to 15. The pixels in each row can therefore be printed with any of the sixteen colors currently assigned to the color palette's index numbers. The colors in the color palette are defined using the NTSC (National Television Systems Committee) standardized RGB (Red/Green/Blue) coordinate values. The default color palettes are shown in Table 7-5.

The pixel data is printed in dot rows starting at the currently specified left graphics margin. Each dot row (color plane) is sent with a separate escape sequence, which tells the Companion Color Printer how many bytes to interpret as binary data rather than ASCII characters. The first data byte sent defines the dot pattern for the first eight dots from the left graphics margin. The second data byte sent defines the dot pattern for the next eight dots and so on across the page. This process continues until either the specified number of bytes has been received or the right graphics margin is reached. Any dots that would extend beyond the right graphics margin are truncated. If more than the specified number of bytes are received, the excess bytes are printed as ASCII characters.

The Companion Color Printer can print a raster image up to 8 inches (1440 dots) wide. Raster graphics is independent of top and bottom text margins and perforation skip mode. The printer also allows you to move the left graphics margin and to change the picture width. This combination sets the left and right graphic margins and eliminates the need to send pixel data to account for the white space that surrounds centered raster images.

The Companion Color Printer can print raster images at either 180 or 90 dpi (dots per inch) in both the horizontal pixel rows and in the vertical pixel column. At 180 dpi, each bit sent to the printer causes a pixel (column position) to be represented with one dot. At the default 90 dpi, each bit causes a pixel to be represented with four dots. Since the spacing between dots is always the same, changing the resolution changes the size of the printed raster image. The image printed at 90 dpi is twice as wide and twice as tall as the same image printed at 180 dpi.

You may choose colors by using the 256-color palette display (Section 2.3.2.5 and Figure D-1) and the PCL color map (Table 7-6).

7.5.3.1 Transmission Mode ESC * b # m/M – This escape sequence sets the mode for interpreting the data in a raster data transfer by row or by plane. The argument defines the transmission mode. The mode stays in effect until changed or the printer is reset.

Value (#):

0 → Unencoded transmission mode
1 → Run-length encoding mode
Other numbers → Ignored

Mode 0 indicates that the data should be treated as a strict binary transfer, with each bit describing a single pixel. The most significant bit (bit 7) of the first byte corresponds to the first pixel in each plane or row. Bit 6 corresponds to the next pixel and so on.

Mode 1 indicates that data is run-length encoded so that the data consists of byte pairs. The first byte of each byte pair is a repetition count and the second byte is a pattern byte. The repetition byte specifies how many times the following pattern byte should be repeated in the raster graphics being sent.

Repetition counts:

0 →	Pattern not repeated
1 to 255 →	Range

Default = Unencoded transmission mode

7.5.3.2 Raster Data Transfer by Plane ESC * b # V [data] – This sequence prepares the printer to receive the number of data bytes specified by the value field (#). The data bytes form one plane and are interpreted as specified by the transmission mode (Section 7.5.3.1).

Unencoded Transmission Mode – If the unencoded transmission mode (mode 0) is selected, the most significant bit (bit 7) of the first byte of data corresponds to the first pixel within the current plane and the least significant bit corresponds to the eighth pixel. The ninth pixel is bit 7 of the second byte. All bytes are binary data.

Run-Length Encoding – If run-length encoding (mode 1) is selected, the value field (#) must be even or the escape sequence is ignored (Section 7.5.3.1).

The current graphics position is reset to the left graphic margin and the plane position is incremented. The current active row position is unaffected by this command.

If more data planes are sent than assigned to a row, the extra data planes are ignored. The binary block is still read, but has no effect.

If no data exists for a plane, an empty plane must be sent using an ESC * b 0 V, or the row must be ended early by sending a ESC + b 0 V. If a "Raster Graphics Complete" command is received before the row is completed, the missing color planes are assumed to be all zeros.

7.5.3.3 Raster Data Transfer by Row ESC * b # W [data] – This escape sequence prepares the printer to receive the number of data bytes specified by the value field (#). The data bytes form one line of raster graphics data and are interpreted as specified by the transmission mode (Section 7.5.3.1).

Unencoded Transmission Mode – If the unencoded transmission mode (mode 0) is selected, the most significant bit (bit 7) of the first byte of data corresponds to the first pixel within the current plane and the least significant bit corresponds to the eighth pixel. The ninth pixel is bit 7 of the second byte. All bytes are binary data.

Run-Length Encoding – If run-length encoding (mode 1) is selected, the value field (#) must be even or the escape sequence is ignored (Section 7.5.3.1).

On completion of this escape sequence the current active position is set to the beginning of the next raster line at the left graphics margin.

Each pixel of raster data is expanded according to the specified raster resolution. This sequence implies the ability to accept various size raster lines within the same picture. Raster graphics are independent of text margins and perforation skip.

If more than one data plane per row has been selected, any undefined data planes are filled with zeros. When using multiple data planes after completion of the escape sequence, the current active position is the first plane of the next row.

7.5.3.4 Temporary X Offset ESC * b # x/X – The X offset defines a horizontal offset in pixels. This is equivalent to sending leading zeros in the binary data. The offset remains in effect until the row position is incremented and then reset to zero. The offset must land on a binary boundary.

Value (#) Range: 0 to 32767

Default = 0 (no offset)

7.5.3.5 Temporary Y Offset ESC * b # y/Y – The Y offset defines a vertical offset in pixels. This is equivalent to incrementing the row position. The offset is permanent despite its name.

Value (#) Range: 0 to 32767

Default = 0 (no offset)

7.5.3.6 Prepare for Raster Graphics ESC * r # a/A – This sequence informs the printer that a raster graphics dump follows. If a partial line of ASCII data has been received this escape sequence causes the data to be printed. The printer requires a margin setting on an even byte boundary (a multiple of 64 decipoints).

While in raster graphics mode the left graphics margin cannot be changed and the graphics resolution (Section 7.5.3.11) cannot be changed.

Values (#):

0 → Graphics margin set to first printable position
1 → Graphics margin set to current text cursor position
Other values → Treated as a zero

Default = 0 (Hard left graphics margin)

7.5.3.7 Raster Graphics Complete ESC * r # b/B – This sequence informs the printer that all raster data has been transferred. The value field (#) is ignored. This sequence causes any stored raster data to be printed.

Raster graphics mode can be exited only through this sequence. An implicit exit, caused by sending ASCII text while in raster graphics mode, is only temporary. After exiting raster graphics, certain raster attributes can again be changed.

7.5.3.8 Pixels per Row ESC * r # s/S – This sequence defines the number of pixels per row. The pixels per row define the width of the picture. Undefined pixels within the picture are set to zero. If data exceeds the picture width, the excess is ignored.

Value (#) Range: 0 to 32767

Default = 1440 dots (pixels) per row

7.5.3.9 Data Planes per Row ESC * r # u/U – This sequence defines the number of planes per row of a raster dump.

Value (#) range: 1 to 4

Default = 1 (black and white output)

7.5.3.10 Graphics Resolution ESC * t # r/R – This sequence defines the resolution at which graphics data is printed. This sequence can only be sent when the printer is not in raster graphics mode; raster graphics must be exited to change resolution.

Value field (#):

<90 → 90 dots per inch
90 → 90 dots per inch
>90 → 180 dots per inch
180 → 180 dots per inch
>180 → 180 dots per inch

Default = 90 dpi

7.5.3.11 Color Parameters **Red – ESC * v # a/A**
Green – ESC * v # b/B
Blue – ESC * v # c/C

The color parameter is entered as a real value between 1 and 32767. The parameters are initialized to 0 after each color assignment sequence.

Default = n/a

7.5.3.12 Index Number Assignment ESC * v # i/I – The pen number is entered as an integer between 0 and (2**n)-1 (where 'n' is the number of data planes per row). The current color parameters for red, green, and blue are assigned to the specific pen.

Number of Color Planes	Accessable Index Numbers
1	0 to 1
2	0 to 3
3	0 to 7
4	0 to 15

The color parameters are set to zero at the end of each pen color assignment. If one or more of the color parameters are not specified before the next color assignment is received, the missing parameters are assigned values of zero.

7.6 PCL Color Map

Refer to Figure D-1 in Appendix D for assistance in using the color palette display to select colors.

Table 7-5 Default Palettes

Planes/ Row	Pen #	Color	Row/Column	NTSC Standard RGB Red	Green	Blue
1	0	White	25/6	90	88	85
	1	Black	0/1	4	4	6
2	0	Black	0/1	4	4	6
	1	Red	8/7	53	8	14
	2	Green	18/1	3	26	22
	3	White	25/6	90	88	85
3	0	Black	0/1	4	4	6
	1	Red	8/7	53	8	14
	2	Green	18/1	3	26	22
	3	Yellow	12/3	89	83	13
	4	Blue	0/9	4	4	29
	5	Magenta	6/7	53	5	25
	6	Cyan	22/7	2	22	64
	7	White	25/6	90	88	85
4	0	Black	0/1	4	4	6
	1	Red	8/7	53	8	14
	2	Green	18/1	3	26	22
	3	Yellow	12/3	89	83	13
	4	Blue	0/9	4	4	29
	5	Magenta	6/7	53	5	25
	6	Cyan	22/7	2	22	64
	7	Orange	11/8	72	41	13
	8	Purple	2/7	12	6	24
	9	Brown	9/8	12	8	10
	10	Dark gray	25/4	15	16	18
	11	Light gray	25/5	43	43	45
	12	Pink	7/6	52	6	19
	3	Light blue	23/5	3	10	46
	14	Light yellow	12/5	89	87	31
	15	White	25/6	90	88	85

Table 7-6 PCL 256-Color Map

Row/Column	NTSC Standard RGB Red	Green	Blue
0/1	4	4	6
0/2	4	4	12
0/3	6	5	16
0/4	6	6	21
0/5	4	4	19
0/6	6	5	24
0/7	6	6	25
0/8	5	5	31
0/9	4	4	29
0/10	9	8	26
1/1	14	11	27
1/2	25	24	54
1/3	6	6	13
1/4	6	4	18
1/5	8	6	24
1/6	5	5	20
1/7	6	4	28
1/8	6	5	30
1/9	8	6	35
1/10	13	8	38
2/1	12	9	27
2/2	10	10	26
2/3	30	27	56
2/4	6	5	10
2/5	6	4	11
2/6	11	6	19
2/7	12	6	24
2/8	9	5	22
2/9	11	6	22
2/10	10	4	27

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
3/1	9	4	30
3/2	9	5	30
3/3	10	7	36
3/4	11	8	16
3/5	11	7	17
3/6	12	7	16
3/7	12	5	14
3/8	11	5	21
3/9	11	4	17
3/10	21	10	25
4/1	23	11	26
4/2	13	8	14
4/3	10	8	13
4/4	10	7	14
4/5	21	12	25
4/6	20	5	29
4/7	24	5	31
4/8	21	9	38
4/9	26	10	40
4/10	6	5	8
5/1	10	6	14
5/2	12	7	13
5/3	22	8	18
5/4	20	8	18
5/5	20	8	22
5/6	20	6	18
5/7	20	5	21
5/8	20	4	25
5/9	23	6	23
5/10	20	6	22

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
6/1	34	19	31
6/2	22	14	20
6/3	23	12	20
6/4	21	7	16
6/5	26	5	17
6/6	28	7	21
6/7	53	5	25
6/8	58	7	31
6/9	65	19	43
6/10	76	45	62
7/1	12	5	11
7/2	21	9	17
7/3	23	9	17
7/4	21	9	15
7/5	25	6	14
7/6	52	6	19
7/7	57	9	21
7/8	58	12	21
7/9	63	17	26
7/10	64	19	26
8/1	12	5	10
8/2	25	6	12
8/3	28	9	15
8/4	29	11	15
8/5	53	7	16
8/6	53	8	15
8/7	53	8	14
8/8	32	17	18
8/9	32	21	18
8/10	11	6	9

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
9/1	24	6	11
9/2	27	10	12
9/3	57	10	16
9/4	57	12	17
9/5	57	11	14
9/6	56	12	14
9/7	7	5	7
9/8	12	8	10
9/9	13	9	10
9/10	27	11	11
10/1	27	10	11
10/2	57	12	13
10/3	62	18	18
10/4	63	20	15
10/5	64	24	18
10/6	73	40	37
10/7	75	45	38
10/8	13	9	9
10/9	31	18	13
10/10	30	18	13
11/1	30	19	11
11/2	63	22	18
11/3	63	21	15
11/4	62	21	13
11/5	73	41	22
11/6	74	45	22
11/7	73	41	16
11/8	72	41	13
11/9	74	44	16
11/10	15	16	9

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
12/1	38	39	12
12/2	37	39	16
12/3	89	83	13
12/4	89	85	19
12/5	89	87	31
12/6	89	88	54
12/7	7	8	7
12/8	14	14	13
12/9	14	16	11
12/10	15	27	13
13/1	30	53	16
13/2	29	56	20
13/3	34	57	21
13/4	25	27	18
13/5	25	27	16
13/6	40	41	26
13/7	6	12	10
13/8	13	25	17
13/9	13	26	16
13/10	10	38	22
14/1	12	38	18
14/2	29	57	28
14/3	35	58	29
14/4	24	27	18
14/5	27	27	19
14/6	6	7	10
14/7	12	13	14
14/8	11	13	16
14/9	13	13	14
14/10	4	9	11

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
15/1	6	11	12
15/2	9	20	18
15/3	6	19	18
15/4	11	27	23
15/5	6	19	14
15/6	5	31	21
15/7	11	39	21
15/8	25	29	22
15/9	4	6	8
15/10	5	11	11
16/1	6	11	14
16/2	8	19	20
16/3	4	16	16
16/4	5	20	17
16/5	4	30	24
16/6	5	30	23
16/7	9	39	27
16/8	15	41	30
16/9	12	40	28
16/10	28	58	45
17/1	37	58	49
17/2	25	26	22
17/3	28	27	23
17/4	4	9	12
17/5	12	12	18
17/6	5	17	22
17/7	6	16	22
17/8	9	19	24
17/9	6	17	19
17/10	3	15	19

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
18/1	3	26	22
18/2	5	30	29
18/3	4	30	28
18/4	3	26	25
18/5	17	28	24
18/6	6	11	17
18/7	4	10	17
18/8	6	10	16
18/9	13	20	25
18/10	5	16	24
19/1	4	16	23
19/2	5	19	22
19/3	2	25	30
19/4	8	39	42
19/5	9	39	45
19/6	4	6	9
19/7	5	10	16
19/8	5	11	18
19/9	6	11	19
19/10	3	8	16
20/1	6	16	26
20/2	3	15	23
20/3	4	14	25
20/4	7	19	23
20/5	2	24	41
20/6	3	30	41
20/7	5	30	43
20/8	4	6	11
20/9	7	9	19
20/10	4	10	19

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
21/1	4	10	24
21/2	6	14	34
21/3	4	14	32
21/4	5	16	33
21/5	3	14	34
21/6	3	14	33
21/7	5	18	36
21/8	9	17	33
21/9	8	17	31
21/10	16	27	39
22/1	6	7	8
22/2	4	5	13
22/3	4	7	17
22/4	4	8	25
22/5	6	9	26
22/6	4	8	29
22/7	2	22	64
22/8	3	27	68
22/9	12	39	73
22/10	38	58	78
23/1	6	8	28
23/2	5	8	25
23/3	4	7	26
23/4	5	8	27
23/5	3	10	46
23/6	5	11	47
23/7	6	13	49
23/8	10	16	52
23/9	4	4	8
23/10	5	6	13

Table 7-6 PCL 256-Color Map (Cont)

Row/Column	NTSC Standard RGB Red	Green	Blue
24/1	6	7	16
24/2	4	6	22
24/3	6	7	26
24/4	4	7	36
24/5	9	14	50
24/6	6	6	17
24/7	4	5	32
24/8	5	6	36
24/9	6	7	36
24/10	23	14	17
25/1	24	14	17
25/2	22	14	17
25/3	23	14	15
25/4	15	16	18
25/5	43	43	45
25/6	90	88	85

APPENDIX A
CHARACTER SETS

This appendix shows the character sets supported by the Color Companion Printer in DEC mode. Graphic symbols of the ASCII set and the DEC Supplemental set are specified by ISO 6937. The ID code given for each character is a reference to the corresponding ISO 6937 character with the same graphic symbol.

The National Replacement Character (NRC) sets contain 94 characters. Characters in the NRC sets may differ from the ASCII set in only 12 locations.

Table A-1 DEC Mode Character Sets

B7 B6 B5 / BITS B4 B3 B2 B1	ROW	COLUMN 0		COLUMN 1		COLUMN 2		COLUMN 3		COLUMN 4		COLUMN 5		COLUMN 6		COLUMN 7	
0 0 0 0	0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
0 0 0 1	1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
0 0 1 0	2		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
0 0 1 1	3		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
0 1 0 0	4		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
0 1 0 1	5		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
0 1 1 0	6		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
0 1 1 1	7	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
1 0 0 0	8	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
1 0 0 1	9	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
1 0 1 0	10	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
1 0 1 1	1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	[	133 91 5B	k	153 107 6B	{	173 123 7B
1 1 0 0	12	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	\	134 92 5C	l	154 108 6C	|	174 124 7C
1 1 0 1	13	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	]	135 93 5D	m	155 109 6D	}	175 125 7D
1 1 1 0	14	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	~	176 126 7E
1 1 1 1	15	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC / 33 OCTAL / 27 DECIMAL / 1B HEX

MA-7247T

Figure A-1 ASCII/ANSI Character Set

ASCII/ANSI

Octal/Hex Code	ISO 693 ID Code	Description of Character	
041/21H	SP02	!	Exclamation point
042/22H	SP04	"	Quotation marks
043/23H	SM01	#	Number sign
044/24H	SC03	$	Dollar sign
045/25H	SM02	%	Percent sign
046/26H	SM03	&	Ampersand
047/27H	SP05	'	Apostrophe
050/28H	SP06	(	Opening parenthesis
051/29H	SP07	)	Closing parenthesis
052/2AH	SM04	*	Asterisk
053/2BH	SA01	+	Plus
054/2CH	SP08	,	Comma
055/2DH	SP10	-	Hyphen or minus
056/2EH	SP11	.	Period or decimal point
057/2FH	SP12	/	Slash
060/30H	ND01	0	Digit 0 "not slashed"
061/31H	ND02	1	Digit 1
062/32H	ND03	2	Digit 2
063/33H	ND04	3	Digit 3
064/34H	ND05	4	Digit 4
065/35H	ND06	5	Digit 5
066/36H	ND07	6	Digit 6
067/37H	ND08	7	Digit 7
070/38H	ND09	8	Digit 8
071/39H	ND10	9	Digit 9
072/3AH	SP13	:	Colon
073/3BH	SP14	;	Semicolon
074/3CH	SA03	<	Less than
075/3DH	SA04	=	Equals
076/3EH	SA05	>	Greater than
077/3FH	SP15	?	Question mark
100/40H	SM05	@	Commercial at
101/41H	LA02	A	Capital A
102/42H	LB02	B	Capital B
103/43H	LC02	C	Capital C

104/44H	LD02	D	Capital D
105/45H	LE02	E	Capital E
106/46H	LF02	F	Capital F
107/47H	LG02	G	Capital G
110/48H	LH02	H	Capital H
111/49H	LI02	I	Capital I
112/4AH	LJ02	J	Capital J
113/4BH	LK02	K	Capital K
114/4CH	LL02	L	Capital L
115/4DH	LM02	M	Capital M
116/4EH	LN02	N	Capital N
117/4FH	LO02	O	Capital O
120/50H	LP02	P	Capital P
121/51H	LQ02	Q	Capital Q
122/52H	LR02	R	Capital R
123/53H	LS02	S	Capital S
124/54H	LT02	T	Capital T
125/55H	LU02	U	Capital U
126/56H	LV02	V	Capital V
127/57H	LW02	W	Capital W
130/58H	LX02	X	Capital X
131/59H	LY02	Y	Capital Y
132/5AH	LZ02	Z	Capital Z
133/5BH	SM06	[	Opening bracket
134/5CH	SM07	\	Backslash
135/5DH	SM08	]	Closing bracket
136/5EH	SM09	^	Circumflex
137/5FH	SP09	_	Underline
140/60H	SM94	`	Opening single quotation mark, grave accent
141/61H	LA01	a	Small a
142/62H	LB01	b	Small b
143/63H	LC01	c	Small c
144/64H	LD01	d	Small d
145/65H	LE01	e	Small e
146/66H	LF01	f	Small f
147/67H	LG01	g	Small g
150/68H	LH01	h	Small h
151/69H	LI01	i	Small i
152/6AH	LJ01	j	Small j

153/6BH	LK01	k	Small k
154/6CH	LL01	l	Small l
155/6DH	LM01	m	Small m
156/6EH	LN01	n	Small n
157/6FH	LO01	o	Small o
160/70H	LP01	p	Small p
161/71H	LQ01	q	Small q
162/72H	LR01	r	Small r
163/73H	LS01	s	Small s
164/74H	LT01	t	Small t
165/75H	LU01	u	Small u
166/76H	LV01	v	Small v
167/77H	LW01	w	Small w
170/78H	LX01	x	Small x
171/79H	LY01	y	Small y
172/7AH	LZ01	z	Small z
173/7BH	SM11	{	Opening brace
174/7CH	SM13	|	"Solid" vertical line
175/7DH	SM14	}	Closing brace
176/7EH	SD19	~	tilde

ROW	BITS B4 B3 B2 B1	COLUMN 0		1		2		3		4		5		6		7	
		B7 0 B6 0 B5 0		0 0 1		0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	[	133 91 5B	k	153 107 6B	{	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	\	134 92 5C	l	154 108 6C	|	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	]	135 93 5D	m	155 109 6D	}	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	~	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7248C

Figure A-2 British Character Set

British

The British character set differs from the ASCII character set in the following position:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	SC02	Pound sign

ROW	BITS B4 B3 B2 B1	COLUMN 0 (B7 0, B6 0, B5 0)		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	¾	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	ÿ	133 91 5B	k	153 107 6B	¨	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	½	134 92 5C	l	154 108 6C	f	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	|	135 93 5D	m	155 109 6D	¼	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	´	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MKV87-1477

Figure A-3 DEC Dutch Character Set

DEC Dutch

The DEC Dutch character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	SC02	Pound sign
100/40H	@		Fraction three quarter
133/5BH	[		Small y with umlaut
134/5CH	\	NF01	Fraction one half
135/5DH	]	SM13	"Solid" vertical bar
173/7BH	{		Umlaut
174/7CH	|	LF01	Small f (fallback for florin)
175/7DH	}	NF04	Fraction one quarter
176/7EH	μ		Acute accent

ROW	BITS B4 B3 B2 B1	COLUMN 0	1	2	3	4	5	6	7
0	0 0 0 0	NUL 0 0 0	20 16 10	SP 40 32 20	0 60 48 30	@ 100 64 40	P 120 80 50	é 140 96 60	p 160 112 70
1	0 0 0 1	1 1 1	DC1 (XON) 21 17 11	! 41 33 21	1 61 49 31	A 101 65 41	Q 121 81 51	a 141 97 61	q 161 113 71
2	0 0 1 0	2 2 2	22 18 12	" 42 34 22	2 62 50 32	B 102 66 42	R 122 82 52	b 142 98 62	r 162 114 72
3	0 0 1 1	3 3 3	DC3 (XOFF) 23 19 13	# 43 35 23	3 63 51 33	C 103 67 43	S 123 83 53	c 143 99 63	s 163 115 73
4	0 1 0 0	4 4 4	24 20 14	$ 44 36 24	4 64 52 34	D 104 68 44	T 124 84 54	d 144 100 64	t 164 116 74
5	0 1 0 1	5 5 5	25 21 15	% 45 37 25	5 65 53 35	E 105 69 45	U 125 85 55	e 145 101 65	u 165 117 75
6	0 1 1 0	6 6 6	26 22 16	& 46 38 26	6 66 54 36	F 106 70 46	V 126 86 56	f 146 102 66	v 166 118 76
7	0 1 1 1	BEL 7 7 7	27 23 17	' 47 39 27	7 67 55 37	G 107 71 47	W 127 87 57	g 147 103 67	w 167 119 77
8	1 0 0 0	BS 10 8 8	CAN 30 24 18	(50 40 28	8 70 56 38	H 110 72 48	X 130 88 58	h 150 104 68	x 170 120 78
9	1 0 0 1	HT 11 9 9	31 25 19	) 51 41 29	9 71 57 39	I 111 73 49	Y 131 89 59	i 151 105 69	y 171 121 79
10	1 0 1 0	LF 12 10 A	SUB 32 26 1A	* 52 42 2A	: 72 58 3A	J 112 74 4A	Z 132 90 5A	j 152 106 6A	z 172 122 7A
11	1 0 1 1	VT 13 11 B	ESC 33 27 1B	+ 53 43 2B	; 73 59 3B	K 113 75 4B	Ä 133 91 5B	k 153 107 6B	ä 173 123 7B
12	1 1 0 0	FF 14 12 C	34 28 1C	, 54 44 2C	< 74 60 3C	L 114 76 4C	Ö 134 92 5C	l 154 108 6C	ö 174 124 7C
13	1 1 0 1	CR 15 13 D	35 29 1D	- 55 45 2D	= 75 61 3D	M 115 77 4D	Å 135 93 5D	m 155 109 6D	å 175 125 7D
14	1 1 1 0	SO 16 14	36 30 1E	. 56 46 2E	> 76 62 3E	N 116 78 4E	Ü 136 94 5E	n 156 110 6E	ü 176 126 7E
15	1 1 1 1	SI 17 15 F	37 31 1F	/ 57 47 2F	? 77 63 3F	O 117 79 4F	_ 137 95 5F	o 157 111 6F	DEL 177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7420E

Figure A-4 DEC Finnish Character Set

DEC Finnish

The DEC Finnish character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
133/5BH	[	LA18	Capital A with umlaut
134/5CH	\	LO18	Capital O with umlaut
135/5DH	]	LA28	Capital A with ring
136/5EH	^	LE18	Capital U with umlaut
140/60H	°	LE11	Small e with acute accent
173/7BH	{	LA17	Small a with umlaut
174/7CH	|	LO17	Small o with umlaut
175/7DH	}	LA27	Small a with ring
176/7EH	μ	LU17	Small u with umlaut

ROW	BITS B4 B3 B2 B1	COLUMN 0		1		2		3		4		5		6		7	
		B7 0 B6 0 B5 0		0 0 1		0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	à	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 48	°	133 91 5B	k	153 107 6B	é	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	ç	134 92 5C	l	154 108 6C	ù	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	–	55 45 2D	=	75 61 3D	M	115 77 4D	§	135 93 5D	m	155 109 6D	è	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	••	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

NOTE
QUOTATION MARKS (") ARE USED AS AN APPROXIMATION FOR THE DIAERESIS MARK (¨), COLUMN 7/ROW 14.

MA-7425B

Figure A-5 French Character Set

French

The French character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	SC02	Pound sign
100/40H	@	LA13	Small a with grave accent
133/5BH	[	SM19	Degree sign
134/5CH	\	LC41	Small c with cedilla
135/5DH	]	SM24	Section sign
173/7BH	{	LE11	Small e with acute accent
174/7CH	|	LU13	Small u with grave accent
175/7DH	}	LE13	Small e with grave accent
176/7EH	μ		Dieresis, trema

ROW	BITS B4 B3 B2 B1	COLUMN 0 (B7 0, B6 0, B5 0)		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	à	100 64 40	P	120 80 50	ô	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	â	133 91 5B	k	153 107 6B	é	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	ç	134 92 5C	l	154 108 6C	ù	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	ê	135 93 5D	m	155 109 6D	è	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	î	136 94 5E	n	156 110 6E	û	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC / 1/11 (COLUMN/ROW), 33 (OCTAL), 27 (DECIMAL), 1B (HEX)

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7247S

Figure A-6 French-Canadian Character Set

DEC French-Canadian

The DEC French-Canadian character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
100/40H	@	LA13	Small a with grave accent
133/5BH	[	LA15	Small a with circumflex accent
134/5CH	\	LC41	Small c with cedilla
135/5DH	]	LE15	Small e with circumflex accent
136/5EH	^	LI15	Small i with circumflex accent
140/60H	°	LO15	Small o with circumflex accent
173/7BH	{	LE11	Small e with acute accent
174/7CH	|	LU13	Small u with grave accent
175/7DH	}	LE13	Small e with grave accent
176/7EH	μ	LU15	Small u with circumflex accent

ROW	BITS B4 B3 B2 B1	COLUMN 0 (B7 0, B6 0, B5 0)		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	§	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	Ä	133 91 5B	k	153 107 6B	ä	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	Ö	134 92 5C	l	154 108 6C	ö	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	Ü	135 93 5D	m	155 109 6D	ü	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	ß	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 | 33 | 27 | 1B

1/11 COLUMN/ROW
33 OCTAL
27 DECIMAL
1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7423B

Figure A-7 German Character Set

German

The German character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
100/40H	@	SM24	Section sign
133/5BH	[	LA18	Capital A with umlaut
134/5CH	\	LO18	Capital O with umlaut
135/5DH	]	LU18	Capital U with umlaut
173/7BH	{	LA17	Small a with umlaut
174/7CH	|	LO17	Small o with umlaut
175/7DH	}	LU17	Small u with umlaut
176/7EH	μ	LS61	Sharp s

ROW	BITS B4 B3 B2 B1	COLUMN 0 (B7 0, B6 0, B5 0)		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	§	100 64 40	P	120 80 50	ù	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	ò	133 91 5B	k	153 107 6B	à	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	ç	134 92 5C	l	154 108 6C	ò	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	é	135 93 5D	m	155 109 6D	è	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	ì	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7247Q

Figure A-8 ISO Italian Character Set

ISO Italian

The ISO Italian character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	SC02	Pound sign
100/40H	@	SM24	Section sign
133/5BH	[	SM19	Degree sign
134/5CH	\	LC41	Small c with cedilla
135/5DH	]	LE11	Small e with acute accent
140/60H	°	LU13	Small u with grave accent
173/7BH	{	LA13	Small a with grave accent
174/7CH	|	LO13	Small o with grave accent
175/7DH	}	LE13	Small e with grave accent
176/7EH	µ	LI13	Small i with grave accent

ROW	BITS B4 B3 B2 B1	COLUMN 0 B7 0 B6 0 B5 0	1 0 0 1	2 0 1 0	3 0 1 1	4 1 0 0	5 1 0 1	6 1 1 0	7 1 1 1
0	0 0 0 0	NUL 0 0 0	20 16 10	SP 40 32 20	0 60 48 30	@ 100 64 40	P 120 80 50	` 140 96 60	p 160 112 70
1	0 0 0 1	1 1 1	DC1 (XON) 21 17 11	! 41 33 21	1 61 49 31	A 101 65 41	Q 121 81 51	a 141 97 61	q 161 113 71
2	0 0 1 0	2 2 2	22 18 12	" 42 34 22	2 62 50 32	B 102 66 42	R 122 82 52	b 142 98 62	r 162 114 72
3	0 0 1 1	3 3 3	DC3 (XOFF) 23 19 13	# 43 35 23	3 63 51 33	C 103 67 43	S 123 83 53	c 143 99 63	s 163 115 73
4	0 1 0 0	4 4 4	24 20 14	$ 44 36 24	4 64 52 34	D 104 68 44	T 124 84 54	d 144 100 64	t 164 116 74
5	0 1 0 1	5 5 5	25 21 15	% 45 37 25	5 65 53 35	E 105 69 45	U 125 85 55	e 145 101 65	u 165 117 75
6	0 1 1 0	6 6 6	26 22 16	& 46 38 26	6 66 54 36	F 106 70 46	V 126 86 56	f 146 102 66	v 166 118 76
7	0 1 1 1	BEL 7 7 7	27 23 17	' 47 39 27	7 67 55 37	G 107 71 47	W 127 87 57	g 147 103 67	w 167 119 77
8	1 0 0 0	BS 10 8 8	CAN 30 24 18	(50 40 28	8 70 56 38	H 110 72 48	X 130 88 58	h 150 104 68	x 170 120 78
9	1 0 0 1	HT 11 9 9	31 25 19	) 51 41 29	9 71 57 39	I 111 73 49	Y 131 89 59	i 151 105 69	y 171 121 79
10	1 0 1 0	LF 12 10 A	SUB 32 26 1A	* 52 42 2A	: 72 58 3A	J 112 74 4A	Z 132 90 5A	j 152 106 6A	z 172 122 7A
11	1 0 1 1	VT 13 11 B	ESC 33 27 1B	+ 53 43 2B	; 73 59 3B	K 113 75 4B	[133 91 5B	k 153 107 6B	{ 173 123 7B
12	1 1 0 0	FF 14 12 C	34 28 1C	, 54 44 2C	< 74 60 3C	L 114 76 4C	¥ 134 92 5C	l 154 108 6C	| 174 124 7C
13	1 1 0 1	CR 15 13 D	35 29 1D	- 55 45 2D	= 75 61 3D	M 115 77 4D	] 135 93 5D	m 155 109 6D	} 175 125 7D
14	1 1 1 0	SO 16 14 E	36 30 1E	. 56 46 2E	> 76 62 3E	N 116 78 4E	^ 136 94 5E	n 156 110 6E	~ 176 126 7E
15	1 1 1 1	SI 17 15 F	37 31 1F	/ 57 47 2F	? 77 63 3F	O 117 79 4F	_ 137 95 5F	o 157 111 6F	DEL 177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 | 33 | 27 | 1B

1/11 COLUMN/ROW
OCTAL
DECIMAL
HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MKV87-1478

Figure A-9 Japanese (JIS Roman) Character Set

Japanese (JIS Roman)

The JIS Roman character set differs from the ASCII character set in the following position:

Octal/Hex Code	ASCII Symbol	ID	Description
134/5CH	\	SC05	Yen sign
176/7EH	μ		Macron

ROW	BITS B4 B3 B2 B1	COLUMN 0 (B7 0, B6 0, B5 0)		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	Ä	100 64 40	P	120 80 50	ä	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	Æ	133 91 5B	k	153 107 6B	æ	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	Ø	134 92 5C	l	154 108 6C	ø	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	Å	135 93 5D	m	155 109 6D	å	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	Ü	136 94 5E	n	156 110 6E	ü	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7421C

Figure A-10 DEC Norwegian/Danish Character Set

DEC Norwegian/Danish

The DEC Norwegian/Danish character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
100/40H	@	LA18	Capital A with umlaut
133/5BH	[	LA52	Capital AE diphthong
134/5CH	\	LO62	Capital O with slash
135/5DH	]	LA28	Capital A with ring
136/5EH	^	LU18	Capital U with umlaut
140/60H	°	LA17	Small a with umlaut
173/7BH	{	LA51	Small ae diphthong
174/7CH	|	LO61	Small o with slash
175/7DH	}	LA27	Small a with ring
176/7EH	µ	LU17	Small u with umlaut

B7 B6 B5 / BITS B4 B3 B2 B1	ROW	COLUMN 0		COLUMN 1		COLUMN 2		COLUMN 3		COLUMN 4		COLUMN 5		COLUMN 6		COLUMN 7	
0 0 0 0	0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	à	100 64 40	P	120 80 50	ô	140 96 60	p	160 112 70
0 0 0 1	1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
0 0 1 0	2		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
0 0 1 1	3		3 3 3	DC3 (XOFF)	23 19 13	ù	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
0 1 0 0	4		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
0 1 0 1	5		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
0 1 1 0	6		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
0 1 1 1	7	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
1 0 0 0	8	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
1 0 0 1	9	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
1 0 1 0	10	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
1 0 1 1	11	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	é	133 91 5B	k	153 107 6B	ä	173 123 7B
1 1 0 0	12	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	ç	134 92 5C	l	154 108 6C	ö	174 124 7C
1 1 0 1	13	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	ê	135 93 5D	m	155 109 6D	ü	175 125 7D
1 1 1 0	14	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	î	136 94 5E	n	156 110 6E	û	176 126 7E
1 1 1 1	15	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	è	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER

ESC	1/11	COLUMN/ROW
	33	OCTAL
	27	DECIMAL
	1B	HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MKV87-1479

Figure A-11 DEC Swiss Character Set

DEC Swiss

The DEC Swiss character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	LU13	Small u with grave accent
100/40H	@	LA13	Small a with grave accent
133/5BH	[	LE11	Small e with acute accent
134/5CH	\	LC41	Small c with cedilla
135/5DH	]	LE15	Small e with circumflex accent
136/5EH	^	LI15	Small i with circumflex accent
137/5FH	_	LE13	Small e with grave accent
140/60H	°	LO15	Small o with circumflex accent
173/7BH	{	LA17	Small a with umlaut mark
174/7CH	|	LO17	Small o with umlaut mark
175/7DH	}	LU17	Small u with umlaut mark
176/7EH	µ	LU15	Small u with circumflex accent

ROW	BITS B4 B3 B2 B1	COLUMN 0		1		2		3		4		5		6		7	
		B7 0 B6 0 B5 0		0 0 1		0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	'	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	Æ	133 91 5B	k	153 107 6B	æ	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	Ø	134 92 5C	l	154 108 6C	ø	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	Å	135 93 5D	m	155 109 6D	å	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	~	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER | ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7421D

Figure A-12 Norwegian/Danish Character Set

Norwegian/Danish

The Norwegian/Danish character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
133/5BH	[	LA52	Capital AE diphthong
134/5CH	\	LO62	Capital O with slash
135/5DH	]	LA28	Capital A with ring
173/7BH	{	LA51	Small ae diphthong
174/7CH	|	LO61	Small o with slash
175/7DH	}	LA27	Small a with ring

B7 B6 B5 / BITS B4 B3 B2 B1	ROW	COLUMN 0		COLUMN 1		COLUMN 2		COLUMN 3		COLUMN 4		COLUMN 5		COLUMN 6		COLUMN 7	
0 0 0 0	0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
0 0 0 1	1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
0 0 1 0	2		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
0 0 1 1	3		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
0 1 0 0	4		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
0 1 0 1	5		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
0 1 1 0	6		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
0 1 1 1	7	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
1 0 0 0	8	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
1 0 0 1	9	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
1 0 1 0	10	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
1 0 1 1	11	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	Ã	133 91 5B	k	153 107 6B	ã	173 123 7B
1 1 0 0	12	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	Ç	134 92 5C	l	154 108 6C	ç	174 124 7C
1 1 0 1	13	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	Õ	135 93 5D	m	155 109 6D	õ	175 125 7D
1 1 1 0	14	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	~	176 126 7E
1 1 1 1	15	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC / 1/11 / 33 / 27 / 1B

COLUMN/ROW
OCTAL
DECIMAL
HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MKV87-1480

Figure A-13 DEC Portuguese Character Set

DEC Portuguese

The DEC Portuguese character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
133/5BH	[	LA20	Capital A with tilde
134/5CH	\	LC42	Capital C with cedilla
135/5DH	]	LO20	Capital O with tilde
173/7BH	{	LA19	Small a with tilde
174/7CH	|	LC41	Small c with cedilla
175/7DH	}	LO19	Small o with tilde

ROW	BITS B4 B3 B2 B1	COLUMN 0		1		2		3		4		5		6		7	
		B7 0 B6 0 B5 0		0 0 1		0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	`	140 96 60	p	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	a	141 97 61	q	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	b	142 98 62	r	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	c	143 99 63	s	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	d	144 100 64	t	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	e	145 101 65	u	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	f	146 102 66	v	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	g	147 103 67	w	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	h	150 104 68	x	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	i	151 105 69	y	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	j	152 106 6A	z	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	¡	133 91 5B	k	153 107 6B	º	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	Ñ	134 92 5C	l	154 108 6C	ñ	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	¿	135 93 5D	m	155 109 6D	ç	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	n	156 110 6E	~	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	_	137 95 5F	o	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER | ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MKV87-1481

Figure A-14 ISO Spanish Character Set

ISO Spanish

The ISO Spanish character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
043/23H	#	SC02	Pound sign
100/40H	@	SM24	Section sign
133/5BH	[	SP03	Inverted exclamation mark
134/5CH	\	LN20	Capital N with tilde
135/5DH	]	SP16	Inverted question mark
173/7BH	{	SM19	Degree sign
174/7CH	|	LN19	Small n with tilde
175/7DH	}	LC41	Small c with cedilla

ROW	BITS B4 B3 B2 B1	COLUMN 0 B7 0 B6 0 B5 0		1 0 0 1		2 0 1 0		3 0 1 1		4 1 0 0		5 1 0 1		6 1 1 0		7 1 1 1	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	°	60 48 30	À	100 64 40	Ç	120 80 50	à	140 96 60	Ç	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	¡	41 33 21	±	61 49 31	Á	101 65 41	Ñ	121 81 51	á	141 97 61	ñ	161 113 71
2	0 0 1 0		2 2 2		22 18 12	¢	42 34 22	2	62 50 32	Â	102 66 42	Ò	122 82 52	â	142 98 62	ò	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	£	43 35 23	3	63 51 33	Ã	103 67 43	Ó	123 83 53	ã	143 99 63	ó	163 115 73
4	0 1 0 0		4 4 4		24 20 14	Ç	44 36 24	Ç	64 52 34	Ä	104 68 44	Ô	124 84 54	ä	144 100 64	ô	164 116 74
5	0 1 0 1		5 5 5		25 21 15	¥	45 37 25	µ	65 53 35	Å	105 69 45	Õ	125 85 55	å	145 101 65	õ	165 117 75
6	0 1 1 0		6 6 6		26 22 16	Ç	46 38 26	¶	66 54 36	Æ	106 70 46	Ö	126 86 56	æ	146 102 66	ö	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	§	47 39 27	•	67 55 37	Ç	107 71 47	Œ	127 87 57	ç	147 103 67	œ	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	¤	50 40 28	Ç	70 56 38	È	110 72 48	ø	130 88 58	è	150 104 68	ø	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	©	51 41 29	1	71 57 39	É	111 73 49	Ù	131 89 59	é	151 105 69	ù	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	a	52 42 2A	o	72 58 3A	Ê	112 74 4A	Ú	132 90 5A	ê	152 106 6A	ú	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	«	53 43 2B	»	73 59 3B	Ë	113 75 4B	Û	133 91 5B	ë	153 107 6B	û	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	Ç	54 44 2C	¼	74 60 3C	Ì	114 76 4C	Ü	134 92 5C	ì	154 108 6C	ü	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	Ç	55 45 2D	½	75 61 3D	Í	115 77 4D	Ÿ	135 93 5D	í	155 109 6D	ÿ	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	Ç	56 46 2E	Ç	76 62 3E	Î	116 78 4E	Ç	136 94 5E	î	156 110 6E	Ç	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	Ç	57 47 2F	¿	77 63 3F	Ï	117 79 4F	ß	137 95 5F	ï	157 111 6F	DEL	177 127 7F

KEY

ASCII CHARACTER: ESC

1/11 COLUMN/ROW
33 OCTAL
27 DECIMAL
1B HEX

SUPPLEMENTAL GRAPHIC SET

MA-10,087L

Figure A-15 DEC Supplemental Graphic Character Set

DEC Supplemental Graphic

This graphic character set consists of graphic alphabetic symbols not included in ASCII. Character positions identified as "Reserved for future use" print the error character (reverse question mark). In addition to the error character, there are 81 characters defined by this set.

Octal/Hex Code	ISO 6937 ID Code	Description of Character
041/21H	SP03	Inverted exclamation mark
042/22H	SC04	Cent sign
043/23H	SC02	Pound sign
044/24H		(Reserved for future use)
045/25H	SC05	Yen sign
046/26H		(Reserved for future use)
047/27H	SM24	Section sign
050/28H	SC01	General currency sign
051/29H	SM52	Copyright sign
052/2AH	SM21	Feminine ordinal indicator
053/2BH	SP17	Angle quotation mark left
054/2CH		(Reserved for future use)
055/2DH		(Reserved for future use)
056/2EH		(Reserved for future use)
057/2FH		(Reserved for future use)
060/30H	SM19	Degree sign
061/31H	SA02	Plus/minus sign
062/32H	NS02	Superscript 2
063/33H	NS03	Superscript 3
064/34H		(Reserved for future use)
065/35H	SM1	Micro sign
066/36H	SM25	Paragraph sign, pilcrow
067/37H	SM26	Middle dot
070/38H		(Reserved for future use)
071/39H	NS01	Superscript 1
072/3AH	SM20	Masculine ordinal indicator
073/3BH	SP18	Angle quotation mark right
074/3CH	NF04	Fraction one quarter
075/3DH	NF01	Fraction one half
076/3DH		(Reserved for future use)
077/3FH	SP16	Inverted question mark

100/40H	LA14	Capital A with grave accent
101/41H	LA12	Capital A with acute accent
102/42H	LA16	Capital A with circumflex accent
103/43H	LA20	Capital A with tilde
104/44H	LA18	Capital A with diaeresis or umlaut mark
105/45H	LA28	Capital A with ring
106/46H	LA52	Capital AE diphthong
107/47H	LC42	Capital C with cedilla
110/48H	LE14	Capital E with grave accent
111/49H	LE12	Capital E with acute accent
112/4AH	LE16	Capital E with circumflex accent
113/4BH	LE18	Capital E with diaeresis or umlaut mark
114/4CH	LI14	Capital I with grave accent
115/4DH	LI12	Capital I with acute accent
116/4EH	LI16	Capital I with circumflex accent
117/4FH	LI18	Capital I with diaeresis
120/50H		(Reserved for future use)
121/51H	LN20	Capital N with tilde
122/52H	LO14	Capital O with grave accent
123/53H	LO12	Capital O with acute accent
124/54H	LO16	Capital O with circumflex accent
125/55H	LO20	Capital O with tilde
126/56H	LO18	Capital O with diaeresis or umlaut mark
127/57H	LO52	Capital OE ligature
130/58H	LO62	Capital O with slash
131/59H	LU14	Capital U with grave accent
132/5AH	LU12	Capital U with acute accent
133/5BH	LU16	Capital U with circumflex accent
134/5CH	LU18	Capital U with diaeresis or umlaut mark
135/5DH	LY18	Capital Y with diaeresis or umlaut mark
136/5EH		(Reserved for future use)
137/5FH	LS61	German small sharp s
140/60H	LA13	Small a with grave accent
141/61H	LA11	Small a with acute accent
142/62H	LA15	Small a with circumflex accent
143/63H	LA19	Small a with tilde
144/64H	LA17	Small a with diaeresis or umlaut mark
145/65H	LA27	Small a with ring
146/66H	LA51	Small ae diphthong
147/67H	LC41	Small c with cedilla

150/68H	LE13	Small e with grave accent
151/69H	LE11	Small e with acute accent
152/6AH	LE15	Small e with circumflex accent
153/6BH	LE17	Small e with diaeresis or umlaut mark
154/6CH	LI13	Small i with grave accent
155/6DH	LI1	Small i with acute accent
156/6EH	LI15	Small i with circumflex accent
157/6FH	LI17	Small i with diaeresis
160/70H		(Reserved for future use)
161/71H	LN19	Small n with tilde
162/72H	LO13	Small o with grave accent
163/73H	LO11	Small o with acute accent
164/74H	LO15	Small o with circumflex accent
165/75H	LO19	Small o with tilde
166/76H	LO17	Small o with diaeresis or umlaut mark
167/77H	LO51	Small oe ligature
170/78H	LO61	Small o with slash
171/79H	LU13	Small u with grave accent
172/7AH	LU11	Small u with acute accent
173/7BH	LU15	Small u with circumflex accent
174/7CH	LU17	Small u with diaeresis or umlaut mark
175/7DH	LY17	Small y with diaeresis or umlaut mark
176/7EH		(Reserved for future use)

ROW	BITS B4 B3 B2 B1	COLUMN 0 B7 0 B6 0 B5 0	1 (0 0 1)	2 (0 1 0)	3 (0 1 1)	4 (1 0 0)	5 (1 0 1)	6 (1 1 0)	7 (1 1 1)
0	0 0 0 0	NUL 0 0 0	20 16 10	SP 40 32 20	0 60 48 30	É 100 64 40	P 120 80 50	é 140 96 60	p 160 112 70
1	0 0 0 1	1 1 1	DC1 (XON) 21 17 11	! 41 33 21	1 61 49 31	A 101 65 41	Q 121 81 51	a 141 97 61	q 161 113 71
2	0 0 1 0	2 2 2	22 18 12	" 42 34 22	2 62 50 32	B 102 66 42	R 122 82 52	b 142 98 62	r 162 114 72
3	0 0 1 1	3 3 3	DC3 (XOFF) 23 19 13	# 43 35 23	3 63 51 33	C 103 67 43	S 123 83 53	c 143 99 63	s 163 115 73
4	0 1 0 0	4 4 4	24 20 14	$ 44 36 24	4 64 52 34	D 104 68 44	T 124 84 54	d 144 100 64	t 164 116 74
5	0 1 0 1	5 5 5	25 21 15	% 45 37 25	5 65 53 35	E 105 69 45	U 125 85 55	e 145 101 65	u 165 117 75
6	0 1 1 0	6 6 6	26 22 16	& 46 38 26	6 66 54 36	F 106 70 46	V 126 86 56	f 146 102 66	v 166 118 76
7	0 1 1 1	BEL 7 7 7	27 23 17	' 47 39 27	7 67 55 37	G 107 71 47	W 127 87 57	g 147 103 67	w 167 119 77
8	1 0 0 0	BS 10 8 8	CAN 30 24 18	(50 40 28	8 70 56 38	H 110 72 48	X 130 88 58	h 150 104 68	x 170 120 78
9	1 0 0 1	HT 11 9 9	31 25 19	) 51 41 29	9 71 57 39	I 111 73 49	Y 131 89 59	i 151 105 69	y 171 121 79
10	1 0 1 0	LF 12 10 A	SUB 32 26 1A	* 52 42 2A	: 72 58 3A	J 112 74 4A	Z 132 90 5A	j 152 106 6A	z 172 122 7A
11	1 0 1 1	VT 13 11 B	ESC 33 27 1B	+ 53 43 2B	; 73 59 3B	K 113 75 4B	Ä 133 91 5B	k 153 107 6B	ä 173 123 7B
12	1 1 0 0	FF 14 12 C	34 28 1C	, 54 44 2C	< 74 60 3C	L 114 76 4C	Ö 134 92 5C	l 154 108 6C	ö 174 124 7C
13	1 1 0 1	CR 15 13 D	35 29 1D	- 55 45 2D	= 75 61 3D	M 115 77 4D	Å 135 93 5D	m 155 109 6D	å 175 125 7D
14	1 1 1 0	SO 16 14 E	36 30 1E	. 56 46 2E	> 76 62 3E	N 116 78 4E	Ü 136 94 5E	n 156 110 6E	ü 176 126 7E
15	1 1 1 1	SI 17 15 F	37 31 1F	/ 57 47 2F	? 77 63 3F	O 117 79 4F	_ 137 95 5F	o 157 111 6F	DEL 177 127 7F

KEY

ASCII CHARACTER: ESC | 1/11 COLUMN/ROW | 33 OCTAL | 27 DECIMAL | 1B HEX

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7422B

Figure A-16 DEC Swedish Character Set

DEC Swedish

The Swedish character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ID	Description
100/40H	@	LE12	Capital E with acute accent
133/5BH	[	LA18	Capital A with umlaut
134/5CH	\	LO18	Capital O with umlaut
135/5DH	]	LA28	Capital A with ring
136/5EH	^	LE18	Capital U with umlaut
140/60H	°	LE11	Small e with acute accent
173/7BH	{	LA17	Small a with umlaut
174/7CH	|	LO17	Small o with umlaut
175/7DH	}	LA27	Small a with ring
176/7EH	μ	LU17	Small u with umlaut

B8 B7 B6 B5 / BITS		* 0 1 0			* 0 1 1			* 1 0 0			* 1 0 1			* 1 1 0			* 1 1 1		
		GL	GL	GR		GL	GR		GL	GR		GL	GR		GL	GR		GL	GR
B4 B3 B2 B1	COLUMN	2		10		3	11		4	12		5	13		6	14		7	15
0 0 0 0	ROW 0				⊦	60 48 30	260 176 B0	∴	100 64 40	300 192 C0	Π	120 80 50	320 208 D0	¬	140 96 60	340 224 E0	π	160 112 70	360 240 F0
0 0 0 1	1	⌟	41 33 21	241 161 A1	⌜	61 49 31	261 177 B1	∝	101 65 41	301 193 C1	Ψ	121 81 51	321 209 D1	α	141 97 61	341 225 E1	ψ	161 113 71	361 241 F1
0 0 1 0	2	⌐	42 34 22	242 162 A2	∠	62 50 32	262 178 B2	∞	102 66 42	302 194 C2		122 82 52	322 210 D2	β	142 98 62	342 226 E2	ρ	162 114 72	362 242 F2
0 0 1 1	3	⎯	43 35 23	243 163 A3	\	63 51 33	263 179 B3	÷	103 67 43	303 195 C3	Σ	123 83 53	323 211 D3	χ	143 99 63	343 227 E3	σ	163 115 73	363 243 F3
0 1 0 0	4	⌠	44 36 24	244 164 A4	/	64 52 34	264 180 B4	Δ	104 68 44	304 196 C4		124 84 54	324 212 D4	δ	144 100 64	344 228 E4	τ	164 116 74	364 244 F4
0 1 0 1	5	⌡	45 37 25	245 165 A5	¬	65 53 35	265 181 B5	∇	105 69 45	305 197 C5		125 85 55	325 213 D5	ε	145 101 65	345 229 E5	ς	165 117 75	365 245 F5
0 1 1 0	6	⎮	46 38 26	246 166 A6	⌟	66 54 36	266 182 B6	Φ	106 70 46	306 198 C6	√	126 86 56	326 214 D6	φ	146 102 66	346 230 E6	ƒ	166 118 76	366 246 F6
0 1 1 1	7	⌠	47 39 27	247 167 A7	〉	67 55 37	267 183 B7	Γ	107 71 47	307 199 C7	Ω	127 87 57	327 215 D7	γ	147 103 67	347 231 E7	ω	167 119 77	367 247 F7
1 0 0 0	8	⌡	50 40 28	250 168 A8	ς	70 56 38	270 184 B8	~	110 72 48	310 200 C8	Ξ	130 88 58	330 216 D8	η	150 104 68	350 232 E8	ξ	170 120 78	370 248 F8
1 0 0 1	9	⌝	51 41 29	251 169 A9		71 57 39	271 185 B9	≃	111 73 49	311 201 C9	Ψ	131 89 59	331 217 D9	ι	151 105 69	351 233 E9	υ	171 121 79	371 249 F9
1 0 1 0	10	⌡	52 42 2A	252 170 AA		72 58 3A	272 186 BA	Θ	112 74 4A	312 202 CA	⊂	132 90 5A	332 218 DA	θ	152 106 6A	352 234 EA	ζ	172 122 7A	372 250 FA
1 0 1 1	11	⌠	53 43 2B	253 171 AB		73 59 3B	273 187 BB	×	113 75 4B	313 203 CB	⊃	133 91 5B	333 219 DB	κ	153 107 6B	353 235 EB	←	173 123 7B	373 251 FB
1 1 0 0	12	⌠	54 44 2C	254 172 AC	≤	74 60 3C	274 188 BC	Λ	114 76 4C	314 204 CC	∩	134 92 5C	334 220 DC	λ	154 108 6C	354 236 EC	↑	174 124 7C	374 252 FC
1 1 0 1	13	⌡	55 45 2D	255 173 AD	=	75 61 3D	275 189 BD	⇔	115 77 4D	315 205 CD	∪	135 93 5D	335 221 DD		155 109 6D	355 237 ED	→	175 125 7D	375 253 FD
1 1 1 0	14	⌡	56 46 2E	256 174 AE	≥	76 62 3E	276 190 BE	⇒	116 78 4E	316 206 CE	∧	136 94 5E	336 222 DE	ν	156 110 6E	356 238 EE	↓	176 126 7E	376 254 FE
1 1 1 1	15	⌠	57 47 2F	257 175 AF	∫	77 63 3F	277 191 BF	≡	117 79 4F	317 207 CF	∨	137 95 5F	337 223 DF	∂	157 111 6F	357 239 EF			

LEGEND

CHARACTER: A — CODES: 101 (OCTAL), 301 (DECIMAL), 41 (HEX)

* NOTE:
WHEN SET IS MAPPED INTO GR, BIT B8 IS 1 (V2 ONLY).

MA-7602-83

Figure A-17 DEC Technical Character Set

DEC Technical

The DEC Technical character set has 94 characters. It conforms to ANSI X3.41 and ISO 2022 standards for graphic character sets. This set contains Greek letters, mathematical symbols, and logical symbols. In addition, it contains component characters for constructing larger mathematical symbols on character cell devices, such as large integral and summation signs.

Software outputs DEC Technical characters to the terminal by using the ANSI/ISO SINGLE SHIFT 3 (SS3) nonlocking shift control function.

This set does not duplicate any characters in the ASCII or DEC Supplemental sets. It has nine positions reserved for future standardization (not counting the corners 2/0 and 7/15).

This printer conforms to the following:

1. The printer responds to the designating escape sequence for the DEC Technical character set; it does not designate or invoke the DEC Technical character set by default.

2. The printer images the positions in the DEC technical set that are reserved for future standardization as the error character (reverse question mark).

3. The printer images the component characters so that adjacent component characters form connected lines at a vertical pitch of six lines per inch and a horizontal pitch of ten characters per inch.

DEC Technical (Cont)

This specification defines the names and codes for the graphic characters of the DEC Technical character set.

DEC Coding	Name
Uppercase Greek	
SS3 4/4	Capital delta, triangle
SS3 4/6	Capital phi
SS3 4/7	Capital gamma
SS3 4/10	Capital theta
SS3 4/12	Capital lambda
SS3 5/0	Capital pi, product
SS3 5/1	Capital psi
SS3 5/3	Capital sigma, summation
SS3 5/7	Capital omega, Ohm sign
SS3 5/8	Capital xi
SS3 5/9	Capital upsilon
Lowercase Greek	
SS3 6/1	Small alpha
SS3 6/2	Small beta
SS3 6/3	Small chi
SS3 6/4	Small delta
SS3 6/5	Small epsilon
SS3 6/6	Small phi
SS3 6/7	Small gamma
SS3 6/8	Small eta
SS3 6/9	Small iota
SS3 6/10	Small theta
SS3 6/11	Small kappa
SS3 6/12	Small lambda
SS3 6/14	Small nu
SS3 7/0	Small pi
SS3 7/1	Small psi
SS3 7/2	Small rho
SS3 7/3	Small sigma
SS3 7/4	Small tau

SS3 7/7	Small omega
SS3 7/8	Small xi
SS3 7/9	Small upsilon
SS3 7/10	Small zeta

Mathematical

SS3 3/12	Less than or equal
SS3 3/13	Not equal
SS3 3/14	Greater than or equal
SS3 3/15	Integral
SS3 4/1	Variation, proportional to (note 1)
SS3 4/2	Infinity
SS3 4/3	Division, divided by
SS3 4/5	Nabla, del
SS3 4/8	Is approximate to
SS3 4/9	Similar or equal to
SS3 4/11	Times, cross product
SS3 5/6	Radical
SS3 6/15	Partial derivative
SS3 7/6	Function
SS3 7/11	Left arrow
SS3 7/12	Upward arrow
SS3 7/13	Right arrow
SS3 7/14	Downward arrow

Logic

SS3 4/0	Therefore
SS3 4/13	If and only if
SS3 4/14	Implies
SS3 4/15	Identical to
SS3 5/10	Is included in
SS3 5/11	Includes
SS3 5/12	Intersection
SS3 5/13	Union
SS3 5/14	Logical and
SS3 5/15	Logical or
SS3 6/0	Logical not

Component Characters (DEC Technical)
The following characters are designed to connect to adjacent character cells at 10 characters/inch and 6 lines/inch. This design allows formation of technical characters that can occupy several vertically adjacent and/or horizontally adjacent character positions.

DEC Coding	Name
SS3 2/1	Left radical
SS3 2/2	Top left radical
SS3 2/3	Horizontal connector
SS3 2/4	Top integral
SS3 2/5	Bottom integral
SS3 2/6	Vertical connector
SS3 2/7	Top left square bracket
SS3 2/8	Bottom left square bracket
SS3 2/9	Top right square bracket
SS3 2/10	Bottom right square bracket
SS3 2/11	Top left parenthesis
SS3 2/12	Bottom left parenthesis
SS3 2/13	Top right parenthesis
SS3 2/14	Bottom right parenthesis
SS3 2/15	Left middle curly brace
SS3 3/0	Right middle curly brace
SS3 3/1	Top left summation
SS3 3/2	Bottom left summation
SS3 3/3	Top vertical summation connector
SS3 3/4	Bottom vertical summation connector
SS3 3/5	Top right summation
SS3 3/6	Bottom right summation
SS3 3/7	Right middle summation

ROW	BITS B4 B3 B2 B1	COLUMN 0 B7 0 B6 0 B5 0		1 (0 0 1)		2 (0 1 0)		3 (0 1 1)		4 (1 0 0)		5 (1 0 1)		6 (1 1 0)		7 (1 1 1)	
0	0 0 0 0	NUL	0 0 0		20 16 10	SP	40 32 20	0	60 48 30	@	100 64 40	P	120 80 50	◆	140 96 60	SCAN 3	160 112 70
1	0 0 0 1		1 1 1	DC1 (XON)	21 17 11	!	41 33 21	1	61 49 31	A	101 65 41	Q	121 81 51	▒	141 97 61	SCAN 5	161 113 71
2	0 0 1 0		2 2 2		22 18 12	"	42 34 22	2	62 50 32	B	102 66 42	R	122 82 52	␉	142 98 62	SCAN 7	162 114 72
3	0 0 1 1		3 3 3	DC3 (XOFF)	23 19 13	#	43 35 23	3	63 51 33	C	103 67 43	S	123 83 53	␋	143 99 63	SCAN 9	163 115 73
4	0 1 0 0		4 4 4		24 20 14	$	44 36 24	4	64 52 34	D	104 68 44	T	124 84 54	␌	144 100 64	├	164 116 74
5	0 1 0 1		5 5 5		25 21 15	%	45 37 25	5	65 53 35	E	105 69 45	U	125 85 55	␍	145 101 65	┤	165 117 75
6	0 1 1 0		6 6 6		26 22 16	&	46 38 26	6	66 54 36	F	106 70 46	V	126 86 56	␎	146 102 66	┴	166 118 76
7	0 1 1 1	BEL	7 7 7		27 23 17	'	47 39 27	7	67 55 37	G	107 71 47	W	127 87 57	␏	147 103 67	┬	167 119 77
8	1 0 0 0	BS	10 8 8	CAN	30 24 18	(	50 40 28	8	70 56 38	H	110 72 48	X	130 88 58	␐	150 104 68	│	170 120 78
9	1 0 0 1	HT	11 9 9		31 25 19	)	51 41 29	9	71 57 39	I	111 73 49	Y	131 89 59	␑	151 105 69	≤	171 121 79
10	1 0 1 0	LF	12 10 A	SUB	32 26 1A	*	52 42 2A	:	72 58 3A	J	112 74 4A	Z	132 90 5A	␒	152 106 6A	≥	172 122 7A
11	1 0 1 1	VT	13 11 B	ESC	33 27 1B	+	53 43 2B	;	73 59 3B	K	113 75 4B	[	133 91 5B	␓	153 107 6B	π	173 123 7B
12	1 1 0 0	FF	14 12 C		34 28 1C	,	54 44 2C	<	74 60 3C	L	114 76 4C	\	134 92 5C	␔	154 108 6C	≠	174 124 7C
13	1 1 0 1	CR	15 13 D		35 29 1D	-	55 45 2D	=	75 61 3D	M	115 77 4D	]	135 93 5D	␕	155 109 6D	£	175 125 7D
14	1 1 1 0	SO	16 14 E		36 30 1E	.	56 46 2E	>	76 62 3E	N	116 78 4E	^	136 94 5E	␖	156 110 6E	·	176 126 7E
15	1 1 1 1	SI	17 15 F		37 31 1F	/	57 47 2F	?	77 63 3F	O	117 79 4F	(BLANK)	137 95 5F	␗	157 111 6F	DEL	177 127 7F

SCAN 1

KEY

ASCII CHARACTER: ESC / 1/11 / 33 / 27 / 1B (COLUMN/ROW, OCTAL, DECIMAL, HEX)

HIGHLIGHTS DIFFERENCES FROM ASCII

MA-7249C

Figure A-18 VT100 Line Drawing Character Set

VT100 Line Drawing

This graphic character set contains 62 of the ASCII graphic symbols and 32 special graphic symbols. The special graphic symbols of this character set are specified by Table 3-9 of the VT100 User Guide. ISO 6937 ID codes are listed for characters with the same graphic symbol. The line drawing characters of this set span 1/10 inch horizontally and 1/6 inch vertically. Thus these characters connect when printed at the default pitches of 10 characters/inch and 6 lines/inch. These line drawing characters are identified by "*" in the following table.

The VT100 Line Drawing character set differs from the ASCII character set in the following positions:

Octal/Hex Code	ASCII Symbol	ISO 6937 ID Code	Description
137/5FH	_		Blank
140/60H	°		Solid diamond
141/61H*	a		Checkerboard
142/62H	b		"HT"
143/63H	c		"FF"
144/64H	d		"CR"
145/65H	e		"LF"
146/66H	f	SM19 (Note 2)	Degree sign
147/67H	g	SA02 (Note 2)	Plus/minus sign
150/68H	h		"NL"
151/69H	i		"VT"
152/6AH*	j		Lower-right corner
153/6BH*	k		Upper-right corner
154/6CH*	l		Upper-left corner
155/6DH*	m		Lower-left corner
156/6EH*	n		Crossing lines
157/6FH*	o		Horizontal line, scan 1
160/70H*	p		Horizontal line, scan 3
161/71H*	q		Horizontal line, scan 5
162/72H*	r		Horizontal line, scan 7
163/73H*	s		Horizontal line, scan 9

164/74H*	t		Left "T"
165/75H*	u		Right "T"
166/76H*	v		Bottom "T"
167/77H*	w		TOP "T"
170/78H*	x		Vertical bar
171/79H	y	(Note 1)	Less than or equal sign
172/7AH	z	(Note 1)	Greater than or equal sign
173/7BH	{	(Note 1)	Greek letter pi
174/7CH	|	(Note 1)	Not equal sign
175/7DH	}	SC02 (Note 2)	Pound sign
176/7EH	μ	SM26 (Note 2)	Middle dot

Notes: 1 These characters are also found in the DEC Technical character set.

2 These characters are also found in the DEC Supplemental Graphic character set.

BITS B8 B7 B6 B5		* 0 0 0		* 0 0 1		* 0 1 0		* 0 1 1		* 1 0 0		* 1 0 1		* 1 1 0		* 1 1 1	
		GL	GR		GL	GR		GL	GR		GL	GR		GL	GR		GL	GR
B4 B3 B2 B1	COLUMN	2	10		3	11		4	12		5	13		6	14		7	15
	ROW																	
0 0 0 0	0	SP		°	60 48 30	260 176 B0	À	100 64 40	300 192 C0	Ð	120 80 50	320 208 D0	à	140 96 60	340 224 E0	ð	160 112 70	360 240 F0
0 0 0 1	1	¡	41 33 21	241 161 A1	±	61 49 31	261 177 B1	Á	101 65 41	301 193 C1	Ñ	121 81 51	321 209 D1	á	141 97 61	341 225 E1	ñ	161 113 71	361 241 F1
0 0 1 0	2	¢	42 34 22	242 162 A2	2	62 50 32	262 178 B2	Â	102 66 42	302 194 C2	Ò	122 82 52	322 210 D2	â	142 98 62	342 226 E2	ò	162 114 72	362 242 F2
0 0 1 1	3	£	43 35 23	243 163 A3	3	63 51 33	263 179 B3	Ã	103 67 43	303 195 C3	Ó	123 83 53	323 211 D3	ã	143 99 63	343 227 E3	ó	163 115 73	363 243 F3
0 1 0 0	4	¤	44 36 24	244 164 A4	′	64 52 34	264 180 B4	Ä	104 68 44	304 196 C4	Ô	124 84 54	324 212 D4	ä	144 100 64	344 228 E4	ô	164 116 74	364 244 F4
0 1 0 1	5	¥	45 37 25	245 165 A5	µ	65 53 35	265 181 B5	Å	105 69 45	305 197 C5	Õ	125 85 55	325 213 D5	å	145 101 65	345 229 E5	õ	165 117 75	365 245 F5
0 1 1 0	6	¦	46 38 26	246 166 A6	¶	66 54 36	266 182 B6	Æ	106 70 46	306 198 C6	Ö	126 86 56	326 214 D6	æ	146 102 66	346 230 E6	ö	166 118 76	366 246 F6
0 1 1 1	7	§	47 39 27	247 167 A7	•	67 55 37	267 183 B7	Ç	107 71 47	307 199 C7	×	127 87 57	327 215 D7	ç	147 103 67	347 231 E7	÷	167 119 77	367 247 F7
1 0 0 0	8	¨	50 40 28	250 168 A8	¸	70 56 38	270 184 B8	È	110 72 48	310 200 C8	Ø	130 88 58	330 216 D8	è	150 104 68	350 232 E8	ø	170 120 78	370 248 F8
1 0 0 1	9	©	51 41 29	251 169 A9	1	71 57 39	271 185 B9	É	111 73 49	311 201 C9	Ù	131 89 59	331 217 D9	é	151 105 69	351 233 E9	ù	171 121 79	371 249 F9
1 0 1 0	10	a	52 42 2A	252 170 AA	o	72 58 3A	272 186 BA	Ê	112 74 4A	312 202 CA	Ú	132 90 5A	332 218 DA	ê	152 106 6A	352 234 EA	ú	172 122 7A	372 250 FA
1 0 1 1	11	«	53 43 2B	253 171 AB	»	73 59 3B	273 187 BB	Ë	113 75 4B	313 203 CB	Û	133 91 5B	333 219 DB	ë	153 107 6B	353 235 EB	û	173 123 7B	373 251 FB
1 1 0 0	12	≠	54 44 2C	254 172 AC	¼	74 60 3C	274 188 BC	Ì	114 76 4C	314 204 CC	Ü	134 92 5C	334 220 DC	ì	154 108 6C	354 236 EC	ü	174 124 7C	374 252 FC
1 1 0 1	13	–	55 45 2D	255 173 AD	½	75 61 3D	275 189 BD	Í	115 77 4D	315 205 CD	Ý	135 93 5D	335 221 DD	í	155 109 6D	355 237 ED	ý	175 125 7D	375 253 FD
1 1 1 0	14	®	56 46 2E	256 174 AE	¾	76 62 3E	276 190 BE	Î	116 78 4E	316 206 CE	Þ	136 94 5E	336 222 DE	î	156 110 6E	356 238 EE	þ	176 126 7E	376 254 FE
1 1 1 1	15	¯	57 47 2F	257 175 AF	¿	77 63 3F	277 191 BF	Ï	117 79 4F	317 207 CF	ß	137 95 5F	337 223 DF	ï	157 111 6F	357 239 EF	ÿ	177 126 7F	377 255 FF

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Figure A-19 8-Bit ISO Supplemental Character Set

ISO Supplemental (8-Bit)

The majority of the characters used in the 8-Bit ISO Supplemental character set are the same as in the DEC Supplemental character set. This table identifies characters in the ISO 8-bit set that are different or have different table positions than the DEC Supplemental set.

The 8-Bit ISO Supplemental character set consists of 96 characters. This set is intended for use from the GR set. Therefore, table positions range from A0H to FFH. If this set is loaded into GL by SO control code, the code (7FH) is not recognized as DELETE, but prints "small y with diaeresis".

Octal/Hex Code	DEC Supplemental	8-Bit ISO Supplemental	Notes
240/A0H	(Reserved for future use)	No break space	4
244/A4H	(Reserved for future use)	General currency sign	
246/A6H	(Reserved for future use)	Broken vertical bar	1
250/A8H	General currency sign	Diaeresis	1
254/ACH	(Reserved for future use)	Not sign	1
255/ADH	(Reserved for future use)	Soft hyphen	1,2
256/AEH	(Reserved for future use)	Registered trade mark sign	1
257/AFH	(Reserved for future use)	Macron	1
264/B4H	(Reserved for future use)	Acute accent	1
268/B8H	(Reserved for future use)	Cedilla	1
276/BEH	(Reserved for future use)	Vulgar fraction 3/4	1
320/D0H	(Reserved for future use)	Cap. Icelandic letter eth	1
327/D7H	Capital OE ligature	Multiplication sign	1,3
335/DDH	Capital Y with diaeresis	Capital Y with acute accent	1
336/DEH	(Reserved for future use)	Cap. Icelandic letter thorn	1
360/F0H	(Reserved for future use)	Small Icelandic letter eth	1
367/F7H	Small oe ligature	Division sign	1,3
375/FDH	Small y with diaeresis	Small y with acute accent	1
376/FEH	(Reserved for future use)	Small Icelandic letter thorn	1
377/FFH	(Reserved for future use)	Small y with diaeresis	

Notes:

1. This character is not found in the DEC Supplemental character set.

2. This character is distinguishable from the ASCII minus sign (2DH). It is slightly shorter than the minus sign and is centered for use with lower case letters.

3. This character is vertically centered to match the plus sign, minus sign, and numbers 0 - 9. This character does not touch the base line.

4. Image this as a space.

APPENDIX B
PROGRAMMING EXAMPLES

Some generic examples that illustrate LJ250 programming technique follow. Refer to the software/operating instructions of your computer to send the applicable escape sequences.

Example B-1 – Horizontal Pitch

Example B-2 – Using the DEC Technical Character Set

Example B-3 – Form Length Selection

Example B-4 – Text Highlighting

Example B-5 – Using Color

```
10 REM THIS IS A DEMONSTRATION OF HORIZONTAL PITCH PROGRAMMING
20 REM FOR CONVENIENCE,WE'LL ASSIGN THE ESCAPE CODE TO A STRING
30 ESC$=CHR$(27)
40 LPRINT ESC$;"[0w";
50 LPRINT"This line printed at default 10 cpi horizontal pitch. Maximum";
60 LPRINT" column width of 80"
70 LPRINT"characters."
80 LPRINT:LPRINT
90 REM NOW WE'LL SET PRINTER FOR 18 CHARACTERS PER INCH
100 LPRINT ESC$;"[4w";
110 LPRINT"This line is printed at compressed pitch of 18 cpi.  The expanded ";
120 LPRINT"column width allows more data, up to 132 characters, to be";
130 LPRINT" displayed"
140 LPRINT"on a print line."
150 LPRINT ESC$;"[w";
```

```
This line printed at default 10 cpi horizontal pitch. Maximum column width of 80
characters.
```

```
This line is printed at compressed pitch of 18 cpi.  The expanded column width allows more data, up to 132 characters, to be displayed
on a print line.
```

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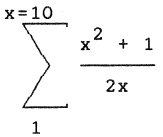
Example B-1 Horizontal Pitch

```
10 REM DEC TECHNICAL SET COMPOSITES
30 REM FOR CONVENIENCE, WE'LL ASSIGN ESCAPE TO A STRING
40 ESC$=CHR$(27)
50 REM LOAD TECHNICAL SET AND CONSTRUCT MATHEMATICAL SIGNS
60 LPRINT"Construction of mathematical signs with DEC technical set"
80 LPRINT       -
90 LPRINT ESC$;"K";
100 LPRINT"  x=10";
110 LPRINT ESC$;"L"
120 LPRINT ESC$;"(>";
130 LPRINT"   1##5"
140 LPRINT"    3";
150 LPRINT ESC$;"(B";
160 LPRINT"   x";ESC$;"L";"2";ESC$;"K";" + 1"
170 LPRINT ESC$;"(>";
180 LPRINT"     7  ######"
190 LPRINT"    4";
200 LPRINT ESC$;"(B";
210 LPRINT"     2x"
220 LPRINT ESC$;"(>";
230 LPRINT"   2##6"
240 LPRINT ESC$;"(B";
250 LPRINT"    1"
260 LPRINT
```

```
Construction of mathematical signs with DEC technical set
```



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Example B-2 Using the DEC Technical Character Set

```
10 REM A DEMONSTRATION OF FORM LENGTH POSITIONING
20 REM ASSIGNING ESCAPE TO A STRING FOR CONVENIENCE
25 ESC$=CHR$(27)
30 REM WE'LL ALSO REASSIGN THE FORMFEED COMMAND TO A STRING
40 FF$=CHR$(12)
50 REM CHANGING FORM LENGTH TO 10 LINES (110/66 IN. AT DEFAULT VERT. PITCH)
60 LPRINT ESC$; "[10t";
70 LPRINT"Form length set to 10 lines: TOP OF FORM - Line 1";
80 FOR X = 1 TO 5
90     LPRINT
100 NEXT X
110 LPRINT"                                                Line 6";
120 LPRINT FF$;
130 LPRINT"                    next page: TOP OF FORM - Line 11";
140 LPRINT


Form length set to 10 lines: TOP OF FORM - Line 1



                                        Line 6



                    next page: TOP OF FORM - Line 11
```

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Example B-3 Form Length Selection

```
10 REM SHADOW BOLD,UNDERLINE,AND DOUBLE UNDERLINE SGR PARAMETERS
20 ESC$=CHR$(27):REM ASSIGNING ESCAPE TO A STRING FOR CONVENIENCE
30 LPRINT ESC$;"[OM"
40 REM SELECTING SHADOW BOLDING
50 LPRINT"For highlighting text, ";
60 LPRINT ESC$;"[1m";
70 LPRINT"shadow bolding ";
80 LPRINT ESC$;"[0m";
90 LPRINT"is available."
100 LPRINT
110 REM SELECTING UNDERLINING AND DOUBLE-UNDERLINING
120 LPRINT ESC$;"[4m";
130 LPRINT"Underlining";
140 LPRINT ESC$;"[0m";
150 LPRINT" and ";
160 LPRINT ESC$;"[21m";
170 LPRINT"double-underlining";
180 LPRINT ESC$;"[0m";
190 LPRINT" provide two means of underscoring."
200 LPRINT
```

For highlighting text, **shadow bolding** is available.

Underlining and double-underlining provide two means of underscoring.

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Example B-4 Text Hightlighting

```
10 LPRINT CHR$(27);"P0;0;1q":REM GRAPHICS MODE & FORMAT INFO
20 REM NEXT WE DEFINE AND ASSIGN COLORS BEING USED
30 LPRINT "#1;1;0;50;100#2;1;50;50;100#3;1;110;50;100"
40 LPRINT "#4;1;170;50;100#5;1;230;50;100#6;1;290;50;100"
50 LPRINT "#7;1;0;0;100"
60 REM FOR CONVENIENCE,WE'LL ASSIGN THE GRAPHICS TO A STRING
70 G$="!770~$--"
80 REM WE USED THE REPEAT INTRODUCER (!) TO PRINT (~) 770 TIMES
90 REM FOLLOWED BY A CARRIAGE RETURN AND TWO GRAPHIC LINEFEEDS
100 REM NOW THE PRINTER IS COLOR PROGRAMMED FOR COLORS #1 TO #7
110 LPRINT "#1";G$
120 LPRINT "#2";G$
130 LPRINT "#3";G$
140 LPRINT "#4";G$
150 LPRINT "#5";G$
160 LPRINT "#6";G$
170 LPRINT "#7";G$
180 REM ALWAYS REMEMBER TO EXIT GRAPHIC MODE WITH ESC/
190 LPRINT CHR$(27);"/"
```

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Example B-5 Using Color

APPENDIX C
TEST PATTERNS AND PRINT SAMPLES

Figure C-1 Printing Self-Test

APPENDIX D
COLOR MAPS

This appendix contains the Companion Color Printer's internal color maps for the HLS and RGB color coordinate systems in DEC mode:

These color maps are accessible only within the in DEC Mode Sixel Protocol. There are three color maps available in each of the HLS and RGB color coordinate systems.

HLS and RGB 256-Color Maps (Tables D-1 and D-2)
These color maps provide for internal composite (dithered) colors using a 2×2 matrix of color dots (1/180 in) to generate a larger (1/90 in) composite color pixel. These maps are automatically selected whenever the following grid sizes are specified within the Sixel Protocol.

HGS	VGS	Aspect/Ratio	
1/90 in	1/90 in	1:1	
1/90 in	1/45 in	2:1	(1:1 A/R pixel above is repeated vertically.)

64-Color Map (Table D-3)

The 64-color map is a subset of the 256-color map. The 64-color map is enabled by DECBCMM. The 64 colors, along with the same HLS and RGB color maps, closely match the VT241 terminal color palette. The VT241 color names are also listed in these tables. As with the 256-color maps, the 64-color maps are available only at the following grid sizes and are enabled only when Business Color Matching Mode (DECBCMM) is set (Section 5.8).

HGS	VGS	Aspect/Ratio	
1/90 in	1/90 in	1:1	
1/90 in	1/45 in	2:1	(1:1 A/R pixel above is repeated vertically.)

8-Color Map (Table D-4)

This color map is used when 2 × 2 composite color generation is not possible. For example, when an HGS of 1/180 inch is selected, the printer honors the selected grid size. This limits the colors to three primaries (yellow/magenta/cyan), three secondaries (red/green/blue), black, and white (no printing). The 8-color map is enabled at the following grid sizes:

HGS	VGS	Aspect/Ratio
1/180 in	1/72 in	2.5:1
1/90 in	1/36 in	2.5:1
1/180 in	1/90 in	2:1
1/144 in	1/72 in	2:1
1/72 in	1/36 in	2:1
1/180 in	1/180 in	1:1
1/72 in	1/72 in	1:1
1/36 in	1/36 in	1:1

To determine the row/column designation for a color:

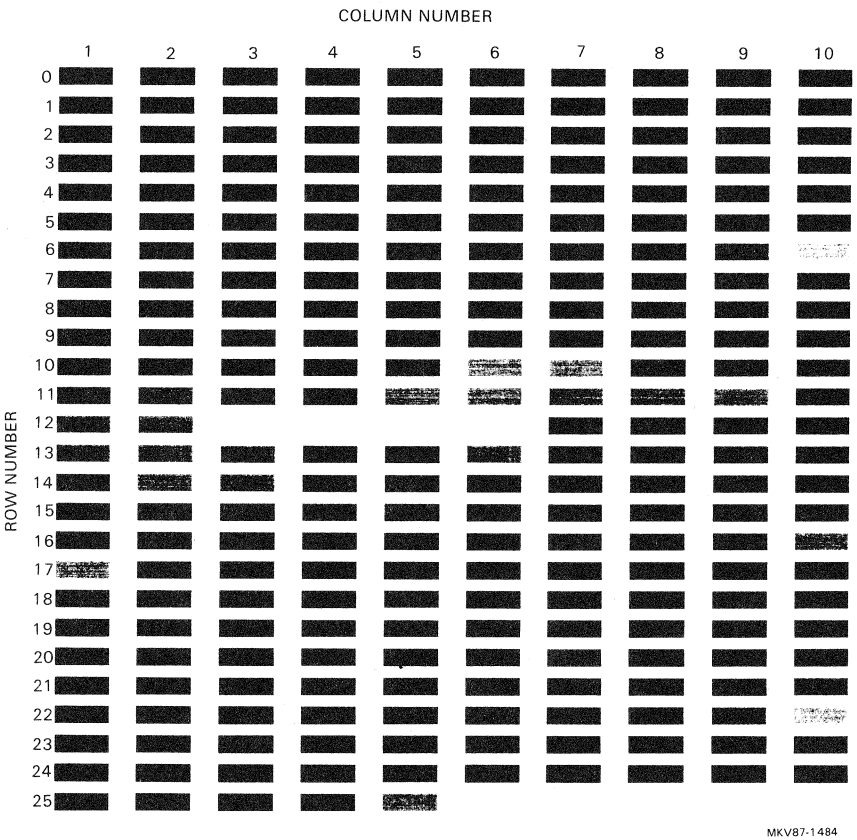

Figure D-1 Using the Color Palette Display

Find the desired color on the color palette display you have printed on your Color Companion Printer. Find the row and column numbers, then find the color on the appropriate color map in this Appendix. Rows are numbered from 0 to 25 down the page. Columns are numbered 1 to 10 from left to right.

Table D-1 HLS 256-Color Map

HLS Range	Row/Column
For Saturation = 0 and Hue = 0 to 359	
L = 0-19	0/1
L = 20-39	22/1
L = 40-59	25/4
L = 60-79	25/5
L = 80-100	25/6
For Saturation = 1 to 100 and Hue = 0 to 359	
L = 0-14	0/1
L = 86-100	25/6
For Lightness 15-28 and Saturation 1 to 49	
H = 330-29	23/9
H = 30-59	2/4
H = 60-89	4/10
H = 90-149	9/7
H = 150-179	14/6
H = 180-209	12/7
H = 210-269	15/9
H = 270-299	20/8
H = 300-329	19/6
For Lightness 15-28 and Saturation 50 to 100	
H = 345-14	0/2
H = 15-29	0/3
H = 30-44	2/5
H = 45-54	2/6
H = 55-64	7/1
H = 65-74	3/7
H = 75-89	5/1
H = 90-104	8/1
H = 105-134	8/10
H = 135-149	4/3

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 150-164	10/8
H = 165-174	17/5
H = 175-184	11/10
H = 185-194	12/8
H = 195-209	16/1
H = 210-224	13/7
H = 225-254	14/10
H = 255-269	18/7
H = 270-284	17/4
H = 285-294	21/1
H = 295-304	19/10
H = 305-314	20/10
H = 315-329	22/3
H = 330-344	22/2
For Lightness 29-42 and Saturation 1-49	
H = 330-344	24/6
H = 345-359	24/1
H = 0-14	23/10
H = 15-29	1/3
H = 30-44	3/5
H = 45-59	3/4
H = 60-74	5/2
H = 75-89	3/6
H = 90-104	4/4
H = 105-119	4/2
H = 120-134	9/8
H = 135-149	9/9
H = 150-164	14/8
H = 165-179	14/7
H = 180-194	12/9
H = 195-209	14/9
H = 210-224	18/8

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 225-239	18/6
H = 240-254	15/10
H = 255-269	15/1
H = 270-284	19/8
H = 285-299	19/9
H = 300-314	19/7
H = 315-329	20/9
For Lightness 29-42 and Saturation 50-100	
H = 350-9	0/5
H = 10-19	0/6
H = 20-29	1/4
H = 30-39	2/8
H = 40-49	3/9
H = 50-59	5/7
H = 60-69	6/5
H = 70-79	5/6
H = 80-89	7/5
H = 90-99	6/4
H = 100-109	8/2
H = 110-129	9/1
H = 130-139	7/4
H = 140-149	9/10
H = 150-159	25/3
H = 160-169	11/1
H = 170-179	13/5
H = 180-189	12/1
H = 190-199	15/2
H = 200-209	12/10
H = 210-219	17/9
H = 220-229	15/5
H = 230-249	16/3
H = 250-259	19/1
H = 260-269	17/10

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 270-279	20/3
H = 280-289	20/2
H = 290-299	21/6
H = 300-309	21/5
H = 310-319	22/6
H = 320-329	22/4
H = 330-339	23/3
H = 340-349	24/2
For Lightness 43-57 and Saturation 1-33	
H = 330-344	0/10
H = 345-359	2/1
H = 0-14	2/2
H = 15-29	1/1
H = 30-44	4/1
H = 45-59	4/5
H = 60-74	6/1
H = 75-89	3/10
H = 90-104	6/3
H = 105-119	6/2
H = 120-134	8/8
H = 135-149	8/9
H = 150-164	17/3
H = 165-179	15/8
H = 180-194	13/6
H = 195-209	17/2
H = 210-224	17/8
H = 225-239	18/9
H = 240-254	15/4
H = 255-269	18/5
H = 270-289	21/9
H = 290-309	21/10
H = 310-329	21/8

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
For Lightness 43-57 and Saturation 34-66	
H = 345-351	0/7
H = 352-359	24/3
H = 0-6	1/6
H = 7-14	0/4
H = 15-21	1/5
H = 22-29	2/7
H = 30-36	3/8
H = 37-44	2/9
H = 45-51	5/9
H = 52-59	5/5
H = 60-66	6/6
H = 67-74	5/10
H = 75-81	5/4
H = 82-89	5/3
H = 90-96	8/3
H = 97-104	8/4
H = 105-111	7/3
H = 112-119	7/2
H = 120-126	9/2
H = 127-134	10/1
H = 135-141	25/2
H = 142-149	25/1
H = 150-156	10/10
H = 157-164	10/9
H = 165-171	14/5
H = 172-179	14/4
H = 180-186	12/2
H = 187-194	13/4
H = 195-201	16/2
H = 202-209	24/10
H = 210-216	13/9
H = 217-224	13/8
H = 225-231	17/7

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 232-239	17/6
H = 240-246	16/4
H = 247-254	15/3
H = 255-261	20/1
H = 262-269	18/10
H = 270-276	19/2
H = 277-284	20/4
H = 285-291	21/3
H = 292-299	21/4
H = 300-306	21/7
H = 307-314	21/2
H = 315-321	23/1
H = 322-329	23/4
H = 330-336	23/2
H = 337-344	22/5
For Lightness 43-57 and Saturation 67-100	
H = 353-7	0/9
H = 8-22	1/7
H = 23-37	2/10
H = 38-52	5/8
H = 53-67	6/7
H = 68-82	7/6
H = 83-97	8/5
H = 98-112	8/6
H = 113-127	8/7
H = 128-142	10/2
H = 143-157	11/4
H = 158-172	11/8
H = 173-187	12/3
H = 188-202	13/1
H = 203-217	14/1
H = 218-232	15/6
H = 233-247	18/1

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 248-262	18/4
H = 263-277	19/3
H = 278-292	20/5
H = 293-307	22/7
H = 308-322	23/5
H = 323-337	24/4
H = 338-352	24/7
For Lightness 58-71 and Saturation 1-49	
H = 300-359	2/3
H = 0-59	1/2
H = 60-119	10/7
H = 120-179	10/6
H = 180-239	17/1
H = 240-299	16/10
For Lightness 58-71 and Saturation 50-100	
H = 350-359	1/8
H = 0-9	0/8
H = 10-19	3/2
H = 20-29	3/1
H = 30-39	4/7
H = 40-49	4/6
H = 50-69	6/8
H = 70-79	7/8
H = 80-89	7/7
H = 90-99	9/4

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
H = 100-109	9/3
H = 110-119	9/6
H = 120-129	9/5
H = 130-139	10/4
H = 140-149	11/3
H = 150-159	11/9
H = 160-169	11/7
H = 170-189	12/4
H = 190-199	13/3
H = 200-209	13/2
H = 210-219	13/10
H = 220-229	15/7
H = 230-239	16/6
H = 240-249	16/5
H = 250-259	18/2
H = 260-269	18/3
H = 270-279	20/7
H = 280-289	20/6
H = 290-309	22/8
H = 310-319	23/7
H = 320-329	23/6
H = 330-339	24/9
H = 340-349	24/8
For Lightness 72-85 and Saturation 1-49	
H = 0-119	6/10
H = 120-239	12/6
H = 240-359	22/10

Table D-1 HLS 256-Color Map (Cont)

HLS Range	Row/Column
For Lightness 72-85 and Saturation 50-100	
H = 345-354	1/10
H = 355-4	1/9
H = 5-14	3/3
H = 15-29	4/9
H = 30-44	4/8
H = 45-74	6/9
H = 75-89	7/10
H = 90-104	7/9
H = 105-114	10/5
H = 115-124	10/3
H = 125-134	11/2
H = 135-149	11/6
H = 150-164	11/5
H = 165-194	12/5
H = 195-209	14/3
H = 210-224	14/2
H = 225-234	16/8
H = 235-244	16/7
H = 245-254	16/9
H = 255-269	19/5
H = 270-284	19/4
H = 285-314	22/9
H = 315-329	23/8
H = 330-344	24/5

Table D-2 RGB 256-Color Map

Row/Column	Red	Green	Blue
0/1	0-19	0-19	0-19
9/7	20-39	0-19	0-19
8/10	40-59	0-19	0-19
9/1	60-79	0-19	0-19
8/7	80-100	0-19	0-19
15/9	0-19	20-39	0-19
12/7	20-39	20-39	0-9
14/6	20-39	20-39	10-19
10/8	40-59	20-39	0-9
4/3	40-59	20-39	10-19
9/10	60-79	20-39	0-9
7/4	60-79	20-39	10-19
10/2	80-100	20-39	0-19
14/10	0-19	40-59	0-19

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
13/7	20-39	40-59	0-9
16/1	20-39	40-59	10-19
11/10	40-59	40-59	0-6
12/8	40-59	40-59	7-13
17/5	40-59	40-59	14-19
11/1	60-79	40-59	0-9
25/3	60-79	40-59	10-19
11/4	80-100	40-59	0-19
16/3	0-19	60-79	0-19
15/5	20-39	60-79	0-9
17/9	20-39	60-79	10-19
12/10	40-59	60-79	0-9
15/2	40-59	60-79	10-19
12/1	60-79	60-79	0-9
13/5	60-79	60-79	10-19
11/8	80-100	60-79	0-19
18/1	0-19	80-100	0-19
15/6	20-39	80-100	0-19
14/1	40-59	80-100	0-19
13/1	60-79	80-100	0-19
12/3	80-100	80-100	0-19
23/9	0-19	0-19	20-39

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
4/10	20-39	0-19	20-29
2/4	20-39	0-19	30-39
8/1	40-59	0-19	20-29
5/1	40-59	0-19	30-39
8/2	60-79	0-19	20-29
6/4	60-79	0-19	30-39
8/6	80-100	0-19	20-39
19/6	0-19	20-39	20-29
20/8	0-19	20-39	30-39
22/1	20-39	20-39	20-39
9/8	40-59	20-39	20-24
9/9	40-59	20-39	25-29
4/4	40-59	20-39	30-34
4/2	40-59	20-39	35-39
9/2	60-79	20-39	20-24
10/1	60-79	20-39	25-29
7/3	60-79	20-39	30-34
7/2	60-79	20-39	35-39
9/5	80-100	20-39	20-29
9/6	80-100	20-39	30-39
17/4	0-19	40-59	20-29
18/7	0-19	40-59	30-39
15/10	20-39	40-59	20-24
15/1	20-39	40-59	25-29
18/8	20-39	40-59	30-34
18/6	20-39	40-59	35-39

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
12/9	40-59	40-59	20-24
14/9	40-59	40-59	25-29
14/8	40-59	40-59	30-34
14/7	40-59	40-59	35-39
10/10	60-79	40-59	20-24
10/9	60-79	40-59	25-29
25/2	60-79	40-59	30-34
25/1	60-79	40-59	35-39
11/3	80-100	40-59	20-29
10/4	80-100	40-59	30-39
17/10	0-19	60-79	20-29
19/1	0-19	60-79	30-39
16/4	20-39	60-79	20-24
15/3	20-39	60-79	25-29
17/7	20-39	60-79	30-34
17/6	20-39	60-79	35-39
13/9	40-59	60-79	20-24
13/8	40-59	60-79	25-29
16/2	40-59	60-79	30-34
24/10	40-59	60-79	35-39
12/2	60-79	60-79	20-24
13/4	60-79	60-79	25-29
14/5	60-79	60-79	30-34
14/4	60-79	60-79	35-39
11/7	80-100	60-79	20-29
11/9	80-100	60-79	30-39

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
18/4	0-19	80-100	20-39
16/5	20-39	80-100	20-29
16/6	20-39	80-100	30-39
15/7	40-59	80-100	20-29
13/10	40-59	80-100	30-39
13/2	60-79	80-100	20-29
13/3	60-79	80-100	30-39
12/4	80-100	80-100	20-39
0/2	0-19	0-19	40-59
2/5	20-39	0-19	40-49
0/3	20-39	0-19	50-59
7/1	40-59	0-19	40-45
3/7	40-59	0-19	46-52
2/6	40-59	0-19	53-59
7/5	60-79	0-19	40-49
5/6	60-79	0-19	50-59
8/5	80-100	0-19	40-59
22/2	0-19	20-39	40-49
22/3	0-19	20-39	50-59
23/10	20-39	20-39	40-44
1/3	20-39	20-39	45-49
24/6	20-39	20-39	50-54
24/1	20-39	20-39	55-59

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
5/2	40-59	20-39	40-44
3/6	40-59	20-39	45-49
3/5	40-59	20-39	50-54
3/4	40-59	20-39	55-59
8/3	60-79	20-39	40-44
8/4	60-79	20-39	45-49
5/4	60-79	20-39	50-54
5/3	60-79	20-39	55-59
9/3	80-100	20-39	40-49
9/4	80-100	20-39	50-59
19/10	0-19	40-59	40-45
20/10	0-19	40-59	46-52
21/1	0-19	40-59	53-59
19/7	20-39	40-59	40-44
20/9	20-39	40-59	45-49
19/8	20-39	40-59	50-54
19/9	20-39	40-59	55-59
25/4	40-59	40-59	40-59
8/8	60-79	40-59	40-44
8/9	60-79	40-59	45-49
6/3	60-79	40-59	50-54
6/2	60-79	40-59	55-59
10/3	80-100	40-59	40-45
11/2	80-100	40-59	46-52
10/5	80-100	40-59	53-59
20/2	0-19	60-79	40-49
20/3	0-19	60-79	50-59

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
19/2	20-39	60-79	40-44
20/4	20-39	60-79	45-49
20/1	20-39	60-79	50-54
18/10	20-39	60-79	55-59
15/4	40-59	60-79	40-44
18/5	40-59	60-79	45-49
17/8	40-59	60-79	50-54
18/9	40-59	60-79	55-59
13/6	60-79	60-79	40-44
17/2	60-79	60-79	45-49
17/3	60-79	60-79	50-54
15/8	60-79	60-79	55-59
11/5	80-100	60-79	40-49
11/6	80-100	60-79	50-59
19/3	0-19	80-100	40-59
18/3	20-39	80-100	40-49
18/2	20-39	80-100	50-59
16/7	40-59	80-100	40-45
16/9	40-59	80-100	46-52
16/8	40-59	80-100	53-59
14/2	60-79	80-100	40-49
14/3	60-79	80-100	50-59
12/5	80-100	80-100	40-59
0/5	0-19	0-19	60-79
1/4	20-39	0-19	60-69
0/6	20-39	0-19	70-79

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
3/9	40-59	0-19	60-69
2/8	40-59	0-19	70-79
6/5	60-79	0-19	60-69
5/7	60-79	0-19	70-79
7/6	80-100	0-19	60-79
24/2	0-19	20-39	60-69
23/3	0-19	20-39	70-79
1/6	20-39	20-39	60-64
0/4	20-39	20-39	65-69
0/7	20-39	20-39	70-74
24/3	20-39	20-39	75-79
3/8	40-59	20-39	60-64
2/9	40-59	20-39	65-69
1/5	40-59	20-39	70-74
2/7	40-59	20-39	75-79
6/6	60-79	20-39	60-64
5/10	60-79	20-39	65-69
5/9	60-79	20-39	70-74
5/5	60-79	20-39	75-79
7/7	80-100	20-39	60-69
7/8	80-100	20-39	70-79
22/4	0-19	40-59	60-69
22/6	0-19	40-59	70-79
23/2	20-39	40-59	60-64
22/5	20-39	40-59	65-69
23/1	20-39	40-59	70-74
23/4	20-39	40-59	75-79

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
2/2	40-59	40-59	60-64
1/1	40-59	40-59	65-69
0/10	40-59	40-59	70-74
2/1	40-59	40-59	75-79
6/1	60-79	40-59	60-64
3/10	60-79	40-59	65-69
4/1	60-79	40-59	70-74
4/5	60-79	40-59	75-79
7/9	80-100	40-59	60-69
7/10	80-100	40-59	70-79
21/5	0-19	60-79	60-69
21/6	0-19	60-79	70-79
21/7	20-39	60-79	60-64
21/2	20-39	60-79	65-69
21/3	20-39	60-79	70-74
21/4	20-39	60-79	75-79
21/10	40-59	60-79	60-65
21/8	40-59	60-79	66-72
21/9	40-59	60-79	73-79
25/5	60-79	60-79	60-79
10/6	80-100	60-79	60-69
10/7	80-100	60-79	70-79
20/5	0-19	80-100	60-79
20/6	20-39	80-100	60-69
20/7	20-39	80-100	70-79

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
19/4	40-59	80-100	60-69
19/5	40-59	80-100	70-79
16/10	60-79	80-100	60-69
17/1	60-79	80-100	70-79
12/6	80-100	80-100	60-79
0/9	0-19	0-19	80-100
1/7	20-39	0-19	80-100
2/10	40-59	0-19	80-100
5/8	60-79	0-19	80-100
6/7	80-100	0-19	80-100
24/7	0-19	20-39	80-100
0/8	20-39	20-39	80-89
1/8	20-39	20-39	90-100
3/1	40-59	20-39	80-89
3/2	40-59	20-39	90-100
4/6	60-79	20-39	80-89
4/7	60-79	20-39	90-100
6/8	80-100	20-39	80-100
24/4	0-19	40-59	80-100
24/8	20-39	40-59	80-89
24/9	20-39	40-59	90-100

Table D-2 RGB 256-Color Map (Cont)

Row/Column	Red	Green	Blue
1/9	40-59	40-59	80-86
3/3	40-59	40-59	87-93
1/10	40-59	40-59	94-100
4/8	60-79	40-59	80-89
4/9	60-79	40-59	90-100
6/9	80-100	40-59	80-100
23/5	0-19	60-79	80-100
23/6	20-39	60-79	80-89
23/7	20-39	60-79	90-100
24/5	40-59	60-79	80-89
23/8	40-59	60-79	90-100
1/2	60-79	60-79	80-89
2/3	60-79	60-79	90-100
6/10	80-100	60-79	80-100
22/7	0-19	80-100	80-100
22/8	20-39	80-100	80-100
22/9	40-59	80-100	80-100
22/10	60-79	80-100	80-100
25/6	80-100	80-100	80-100

Table D-3 64-Color Map

HLS Range	64 Color Map Designation	Row/Column	Red	Green	Blue
For Saturation = 0 and Hue = 0 to 359					
L = 0-24	Black	0/1	0-24	0-24	0-24
L = 25-49	Dim gray	25/4	25-49	25-49	25-49
L = 50-74	Bright gray	25/5	50-74	50-74	50-74
L = 75-100	White	25/6	75-100	75-100	75-100
For Saturation = 1 to 100 and Hue = 0 to 359					
L = 0-14	Black	0/1	0-24	0-24	0-24
L = 86-100	White	25/6	75-100	75-100	75-100
For Lightness 15-28 and Saturation 1-00					
H = 330-29	Medium Blue	0/2	0-24	0-24	25-49
H = 30-89	Violet	7/1	25-49	0-24	25-49
H = 90-149	Indian Red	10/1	25-49	0-24	0-24
H = 150-209	Dark Olive Green	12/8	25-49	25-49	0-24
H = 210-269	Dark Green	16/3	0-24	25-49	0-24
H = 270-329	Dark Slate Gray	19/10	0-24	25-49	25-49
For Lightness 29-42 and Saturation 1-49					
H = 300-59	Cornflower Blue	19/9	25-49	25-49	50-74
H = 60-179	Salmon	8/8	50-74	25-49	25-49
H = 180-299	Medium Sea Green	19/3	25-49	50-74	25-49
For Lightness 29-42 and Saturation 50-100					
H = 340-19	Navy Blue	24/2	0-24	0-24	50-74
H = 20-59	Dark Slate Blue	3/9	25-49	0-24	50-74
H = 60-99	Maroon	6/5	50-74	0-24	25-49
H = 100-139	Firebrick	8/7	50-74	0-24	0-24
H = 140-179	Sienna	11/1	50-74	25-49	0-24
H = 180-219	Med. Forest Green	15/6	25-49	50-74	0-24
H = 220-259	Forest Green	18/4	0-24	50-74	0-24
H = 260-299	Sea Green	18/3	0-24	50-74	25-49
H = 300-339	Steel Blue	19/7	0-24	25-49	50-74

Table D-3 64-Color Map (Cont)

HLS Range	64 Color Map Designation	Row/Column	Red	Green	Blue
For Lightness 43-57 and Saturation 1-33					
H = 360-119	Violet Blue	6/1	50-74	25-49	50-74
H = 120-239	Khaki	14/5	50-74	50-74	25-49
H = 240-359	Cadet blue	20/5	25-49	50-74	50-74
For Lightness 43-57 and Saturation 34-66					
H = 340-19	Medium Blue	21/5	25-49	25-49	75-100
H = 20-59	Dark Orchid	2/8	50-74	0-24	75-100
H = 60-99	Violet Red	7/6	75-100	0-24	50-74
H = 100-139	Orange	10/2	75-100	25-49	25-49
H = 140-179	Gold	11/4	75-100	50-74	0-24
H = 180-219	Yellow Green	13/1	50-74	75-100	0-24
H = 220-259	Lime Green	15/7	25-49	75-100	25-49
H = 260-299	Med. Aquamarine	20/7	0-24	75-100	50-74
H = 300-339	Sky Blue	22/7	0-24	50-74	75-100
For Lightness 43-57 and Saturation 67-100					
H = 345-14	Blue	22/4	0-24	0-24	75-100
H = 15-44	Med. Slate Blue	21/2	25-49	0-24	75-100
H = 45-74	Magenta	5/5	50-74	0-24	50-74
H = 75-104	Orange red	7/7	75-100	0-24	25-49
H = 105-134	Red	8/6	75-100	0-24	0-24
H = 135-164	Coral	11/3	75-100	25-49	0-24
H = 165-194	Yellow	12/3	50-74	50-74	0-24
H = 195-224	Med. Spring Green	13/10	25-49	75-100	0-24
H = 225-254	Green	14/1	0-24	75-100	0-24
H = 255-284	Spring Green	13/2	0-24	75-100	25-49
H = 285-314	Cyan	20/6	0-24	50-74	50-74
H = 315-344	Slate Blue	21/4	0-24	25-49	75-100
For Lightness 58-71 and Saturation 1-49					
H = 300-59	Light Steel Blue	24/5	50-74	50-74	75-100
H = 60-179	Pink	6/9	75-100	50-74	50-74
H = 180-299	Pale Green	14/3	50-74	75-100	50-74

Table D-3 64-Color Map (Cont)

HLS Range	64 Color Map Designation	Row/Column	Red	Green	Blue
For Lightness 58-71 and Saturation 50-100					
H = 360-39	Medium Orchid	4/8	50-74	25-49	75-100
H = 40-79	Orchid	4/7	75-100	0-24	75-100
H = 80-119	Med. Violet Red	6/8	75-100	25-49	50-74
H = 120-159	Tan	10/9	75-100	50-74	25-49
H = 160-199	Goldenrod	11/8	75-100	75-100	0-24
H = 200-239	Green Yellow	13/3	50-74	75-100	25-49
H = 240-279	Aquamarine	16/8	25-49	75-100	50-74
H = 280-319	Medium Turquoise	19/4	0-24	75-100	75-100
H = 320-359	Dark Turquoise	21/3	25-49	50-74	75-100
For Lightness 72-85 and Saturation 1-49					
H = 360-119	Thistle	4/9	75-100	50-74	75-100
H = 120-239	Wheat	12/5	75-100	75-100	50-74
H = 240-259	Light Blue	22/9	50-74	75-100	75-100
For Lightness 72-85 and Saturation 50-100					
H = 360-119	Plum	5/8	75-100	25-49	75-100
H = 120-239	Medium Goldenrod	11/7	75-100	75-100	25-49
H = 240-259	Turquoise	19/5	25-49	75-100	75-100

Table D-4 8-Color Map

HLS Range	8 Color Map Designation	Row/Column	Red	Green	Blue
For Saturation = 0 and Hue = 0 to 359					
L = 0-49	Black	0/1	0-49	0-49	0-49
L = 50-100	White	25/6	50-100	50-100	50-100
For Saturation = 1 to 100 and Hue = 0 to 359					
L = 0-14	Black	0/1	0-24	0-24	0-24
L = 86-100	White	25/6	75-100	75-100	75-100
For Lightness 15-28 and Saturation 1-100					
H = 330-89	Blue	22/4	0-49	0-24	25-49
H = 90-149	Red	8/6	25-49	0-24	0-24
H = 150-269	Green	14/1	0-49	25-49	0-24
H = 270-329	Cyan	20/6	0-24	25-49	25-49
For Lightness 29-42 and Saturation 1-49					
H = 300-59	Blue	22/4	25-49	25-49	50-74
H = 60-179	Magenta	5/5	50-74	25-49	25-49
H = 180-299	Green	14/1	25-49	50-74	25-49
For Lightness 29-42 and Saturation 50-100					
H = 340-19	Cyan	20/6	0-24	0-24	50-74
H = 20-59	Blue	22/4	25-49	0-24	50-74
H = 60-99	Magenta	5/5	50-74	0-24	25-49
H = 100-139	Red	8/6	50-74	0-24	0-24
H = 140-179	Yellow	12/3	50-74	25-49	0-24
H = 180-299	Green	14/1	0-49	50-74	0-49
H = 300-339	Cyan	22/4	0-24	25-49	50-74

Table D-4 8-Color Map (Cont)

HLS Range	8 Color Map Designation	Row/Column	Red	Green	Blue
For Lightness 43-57 and Saturation 1-33					
H = 360-119	Blue	22/4	50-74	25-49	50-74
H = 120-239	Yellow	12/3	50-74	50-74	25-49
H = 240-359	Cyan	20/6	25-49	50-74	50-74
For Lightness 43-57 and Saturation 34-66					
H = 340-19	Cyan	20/6	25-49	25-49	75-100
H = 20-59	Blue	22/4	50-74	0-24	75-100
H = 60-99	Magenta	5/5	75-100	0-24	50-74
H = 100-139	Red	8/6	75-100	25-49	25-49
H = 140-179	Yellow	12/3	75-100	50-74	0-24
H = 180-259	Green	14/1	25-74	75-100	0-49
H = 260-339	Cyan	20/6	0-24	50-100	50-100
For Lightness 43-57 and Saturation 67-100					
H = 345-44	Blue	22/4	0-49	0-24	75-100
H = 45-104	Magenta	5/5	50-100	0-24	25-74
H = 105-164	Red	8/6	75-100	0-49	0-24
H = 165-194	Yellow	12/3	50-74	50-74	0-24
H = 195-284	Green	14/1	0-49	75-100	0-49
H = 285-344	Cyan	20/6	0-24	25-74	50-100

Table D-4 8-Color Map (Cont)

HLS Range	8 Color Map Designation	Row/Column	Red	Green	Blue
For Lightness 58-71 and Saturation 1-49					
H = 300-59	Cyan	20/6	50-74	50-74	75-100
H = 60-179	Magenta	5/5	75-100	50-74	50-74
H = 180-299	Green	14/1	50-74	75-100	50-74
For Lightness 58-71 and Saturation 50-100					
H = 360-39	Blue	22/4	50-74	25-49	75-100
H = 40-119	Magenta	5/5	75-100	0-49	50-100
H = 120-199	Yellow	12/3	75-100	50-100	0-49
H = 200-239	Green	14/1	50-74	75-100	25-49
H = 240-359	Cyan	20/6	0-49	50-100	50-100
For Lightness 72-85 and Saturation 1-49					
H = 360-119	Magenta	5/5	75-100	50-74	75-100
H = 120-239	Yellow	12/3	75-100	75-100	50-74
H = 240-259	Cyan	20/6	50-74	75-100	75-100
For Lightness 72-85 and Saturation 50-100					
H = 360-119	Magenta	5/5	75-100	25-49	75-100
H = 120-239	Yellow	12/3	75-100	75-100	25-49
H = 240-259	Cyan	20/6	25-49	75-100	75-100

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