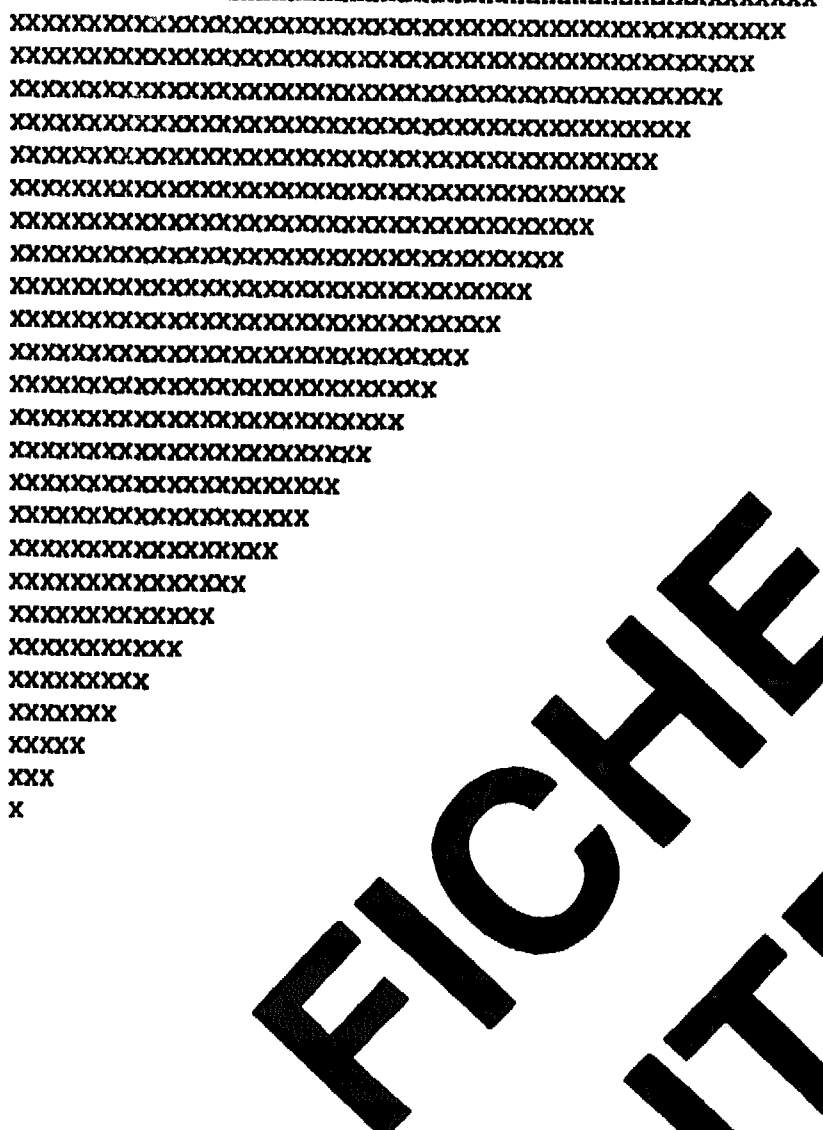
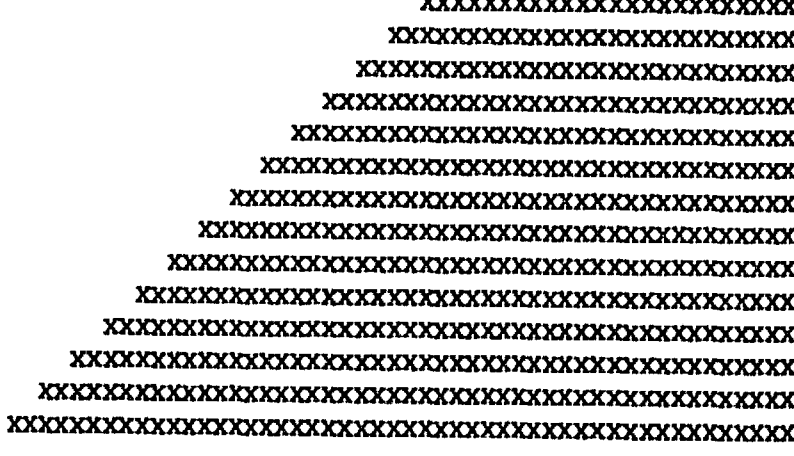


FICHE CONTENTS

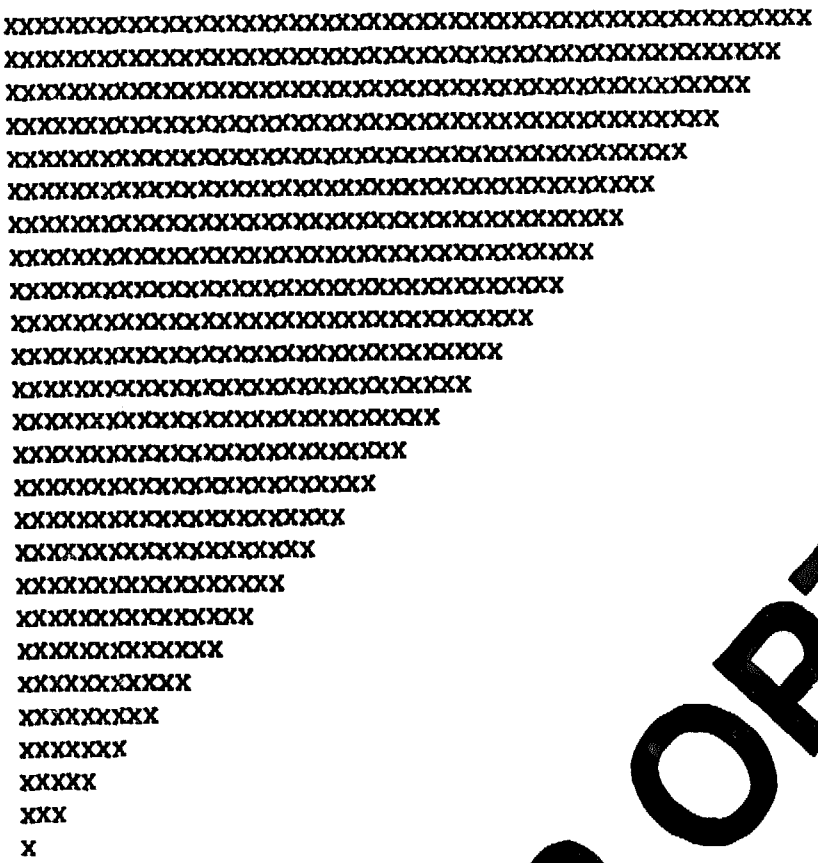


EK-LN03S-UP-001

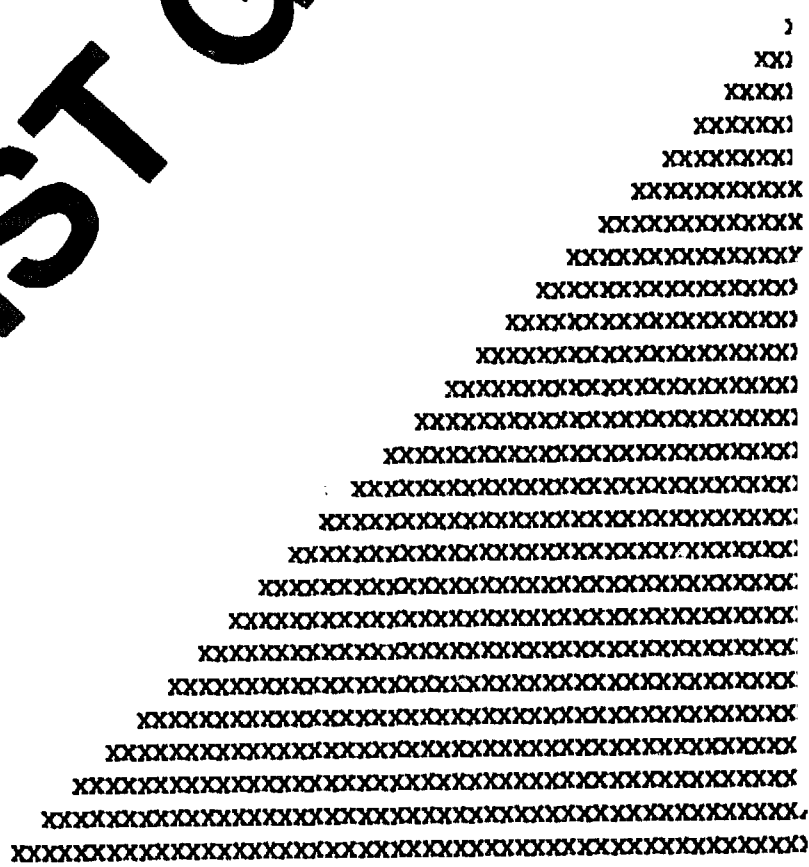
LN03 PLUS User Documentation Package

This package contains one copy of the following documents.

LN03 PLUS User Guide	EK-LN03S-UG-001
LN03 PLUS Programmer Reference Manual	EK-LN03S-RM-001
LN03 PLUS Bitmap Option Installation Guide	EK-LN03S-IG-001



BITMAP OPTION INST GUIDE



LN03S
Bitmap Option

Installation Guide

Prepared by Educational Services
of Digital Equipment Corporation

1st Edition. May 1986

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This equipment generates and uses radio frequency energy. 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 radio and television interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, the user is encouraged to try to correct the interference.

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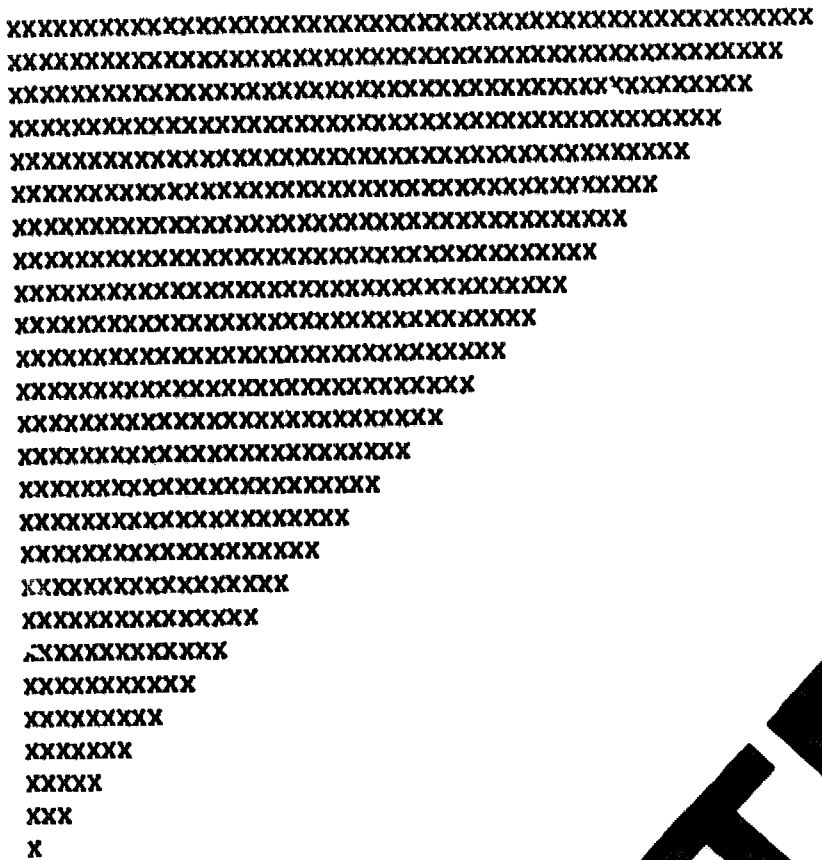
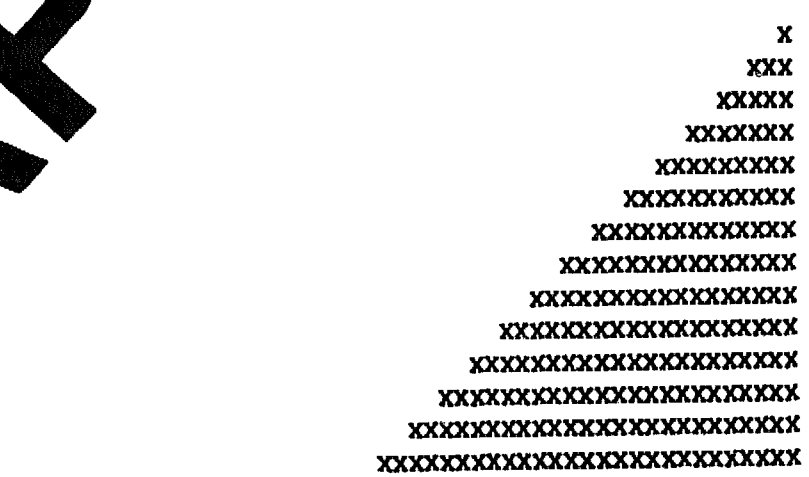
DECdirect	DECwriter	Rainbow	VMS
DECmate	DIBOL	RSTS	VT
DECnet	PDP	RSX	Work Processor

CONTENTS



CHAPTER 1



INTRODUCTION 1

GENERAL

The LN03S bitmap option is used to upgrade the base LN03 printer to the LN03 PLUS graphics configuration.

The LN03S-UA upgrade kit consists of the LN03S bitmap option board (part number 54-16943-01), V4.4 microcode, LN03 PLUS manuals, and LN03 PLUS labels.

USING THIS GUIDE

This guide describes how to install the LN03S bitmap option in the base LN03 printer and how to check the printer after you complete the installation.

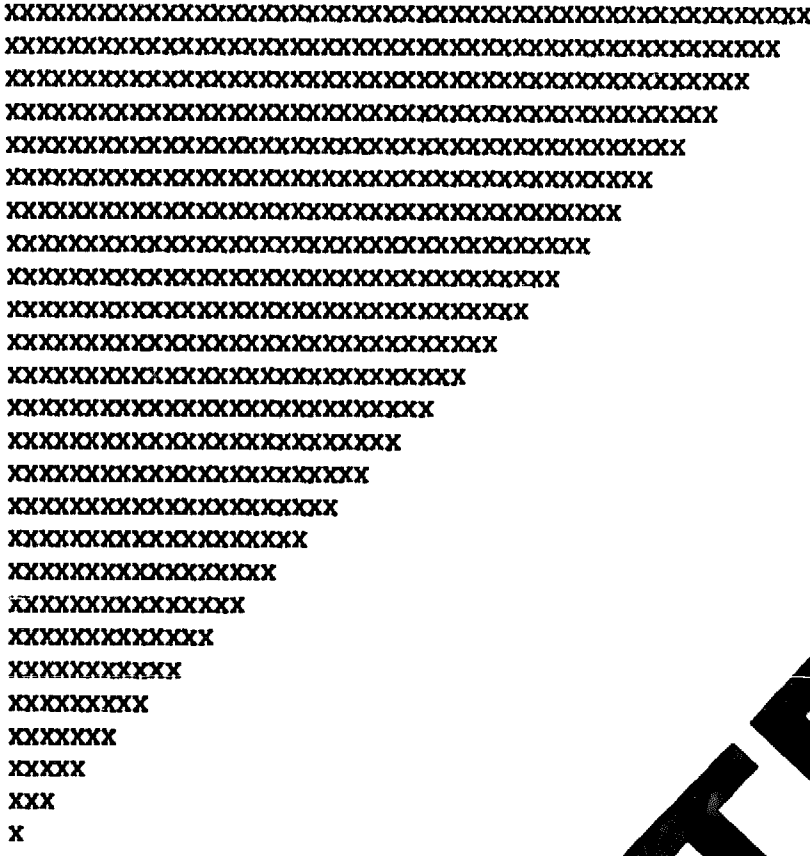
This guide is designed to be used by Digital Field Service personnel to install the LN03S bitmap option at the customer site.

WARNING: The LN03S bitmap option is not intended for customer installation. Digital written or implied warranties may be voided if the option is installed by an unauthorized person.

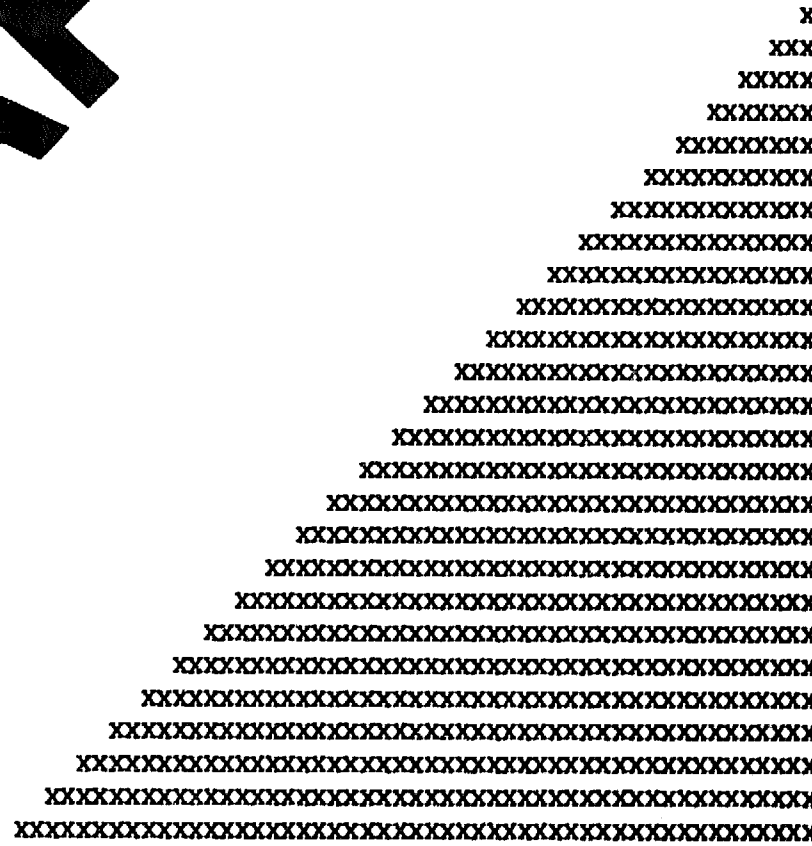
IMPORTANT CUSTOMER NOTICE

LN03S installation must be performed by Digital Field Service or other trained service personnel. Call Digital at one of these telephone numbers for information on installation service.

U.S.A.	(800)554-3333
Australia	(02)4125555
Austria	(222)6776410
Belgium	(02)2425095
Canada	(800)267-5251
Denmark	(2)889666
Finland	(0)423511
France	(6)0778292
Holland	(30)640293
Ireland	(1)308433
Italy	(02)617961
Japan	(03)9897161
Norway	(2)160290
Portugal	(1)725402
Spain	(1)7331900
Sweden	(8)7338000
Switzerland	(01)8169111
United Kingdom	(734)868711
West Germany	(089)95910



CHAPTER 2



CHECKING THE MICROCODE 2

GENERAL

Before you start to install the LN03S option, check the firmware microcode currently installed in your LN03 printer. To do this, print the summary sheet by pressing the Test (T) button on the rear panel of the printer.

Figure 1 shows an example of an LN03 summary sheet. Check the firmware code revision number in the upper right corner of the summary sheet. If the summary sheet shows a DEC 4.4 revision level for the LN03, continue with LN03S option installation.

If the revision number is lower, you must install the V4.4 microcode in the printer using the EPROM chips supplied in the kit. The EPROMs are installed on the printer's controller board. To access the board, continue with LN03S installation and refer to step 9.

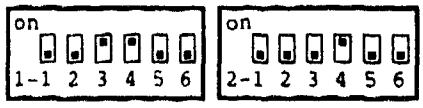
```
S U M M A R Y   S H E E T                          Revision Level DECXXX.X

 SWITCH #      SETTING      MEANING

   1-1         OFF          SERIAL INPUT
     2         OFF
     3         ON           4800 BAUD
     4         ON
     5         OFF          8 DATA BITS
     6         OFF          PARITY DISABLED
   2-1         OFF
     2         OFF          LN03 DEVICE ID
     3         OFF
     4         ON           AUTO WRAP ON
     5         OFF          XON/XOFF ENABLED
     6         OFF

Paper Size:8.5 by 11       Cartridge 1:empty       Cartridge 2:empty

Memory available for fonts:   27Kb
```




```
Test Pattern Printed by the DEC LN03 Printer

Job Status: No Errors

RCOURIR RCOURIR101VK00GG0001CZZZZ02F000 <
D000000 D000000101VK00GG0001CZZZZ02F000 <
RELITE0 RELITE0L02SK00GG0001CZZZZ02F000 A
D000000 D000000L02SK00GG0001CZZZZ02F000 A
RCOURIR RCOURIR202SK00GG0001CZZZZ02F000 A
RCOURIR RCOURIRJ02SK00GG0001CZZZZ02F000 A
D000000 D000000202SK00GG0001CZZZZ02F000 A
D000000 D000000J02SK00GG0001CZZZZ02F000 A
RCOURIR RCOURIR101VK00GG0001QZZZZ02F000
D000000 D000000101VK00GG0001QZZZZ02F000
RELITE0 RELITE0L02SK00GG0001QZZZZ02F000
D000000 D000000L02SK00GG0001QZZZZ02F000
RCOURIR RCOURIR202SK00GG0001QZZZZ02F000
RCOURIR RCOURIRJ02SK00GG0001QZZZZ02F000
D000000 D000000202SK00GG0001QZZZZ02F000
D000000 D000000J02SK00GG0001QZZZZ02F000
RCOURIR RCOURIR101VK00GG0001OZZZZ02F000
DBULTN1 DBULTN1101VK00GG0001OZZZZ02F000
RELITE0 RELITE0L02SK00GG0001OZZZZ02F000
DBULTN1 DBULTN1L02SK00GG0001OZZZZ02F000
RCOURIR RCOURIR202SK00GG0001OZZZZ02F000
DBULTN1 DBULTN1202SK00GG0001OZZZZ02F000
RCOURIR RCOURIRJ02SK00GG0001OZZZZ02F000
DBULTN1 DBULTN1J02SK00GG0001OZZZZ02F000
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DBULTN1 DBULTN1101VK00GG0001UZZZZ02F000 <
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DBULTN1 DBULTN1L02SK00GG0001UZZZZ02F000 AaFfGgIiJjLlMmOoSs1234567890
RCOURIR RCOURIR202SK00GG0001UZZZZ02F000 AaFfGgIiJjLlMmOoSs1234567890
DBULTN1 DBULTN1202SK00GG0001UZZZZ02F000 AaFfGgIiJjLlMmOoSs1234567890
RCOURIR RCOURIRJ02SK00GG0001UZZZZ02F000 AaFfGgIiJjLlMmOoSs1234567890
DBULTN1 DBULTN1J02SK00GG0001UZZZZ02F000 AaFfGgIiJjLlMmOoSs1234567890
```
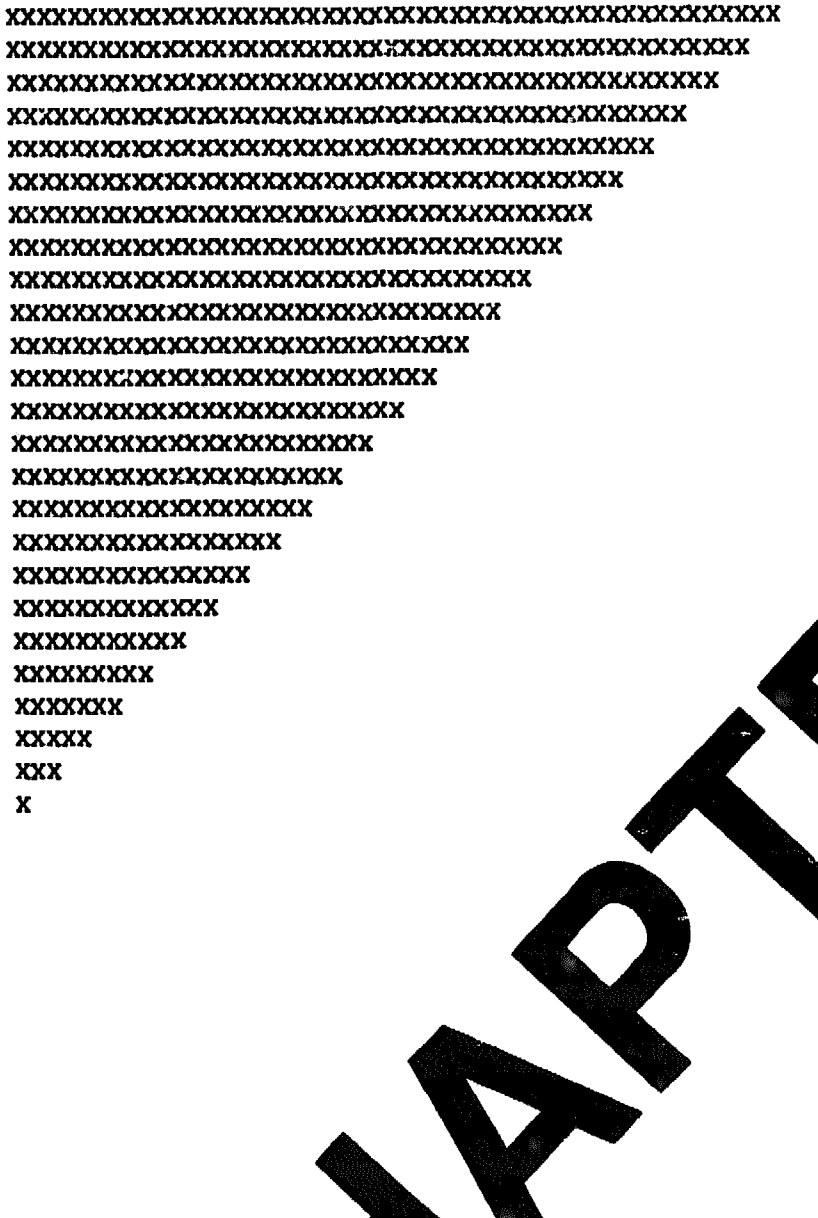
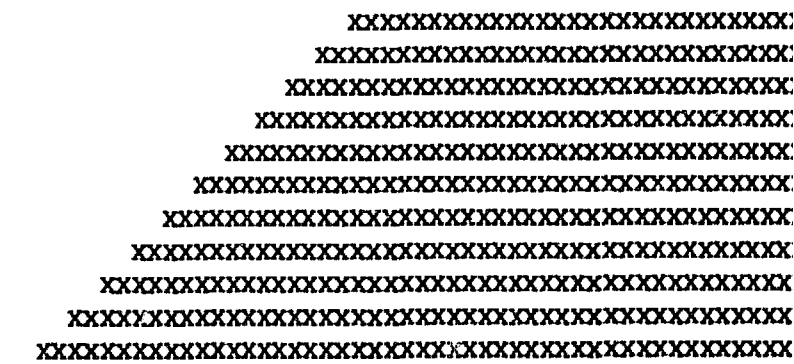

MA-1392-84

Figure 1 Base LN03 Summary Sheet



CHAPTER 3



INSTALLATION 3

GENERAL

This chapter describes how to install the LN03S board in the base LN03 printer.

WARNING: Before you start, make sure that the printer is powered off. Then unplug the power cord from the wall socket.

DO NOT plug in the power cord until you are instructed to do so.

1. Place the LN03 printer so that you have access to its rear panel.

   WARNING: The printer weighs 30 kg (66 lb). If necessary, ask another person to help you.

2. Detach the host interface cable from the rear panel of the printer (Figure 2).
3. Remove six screws from the rear cover.
4. Detach the internal interface cable connector from the rear cover.
5. Disconnect the exhaust fan connector.
6. Disconnect the white CN1 and CN2 connectors from the controller board.

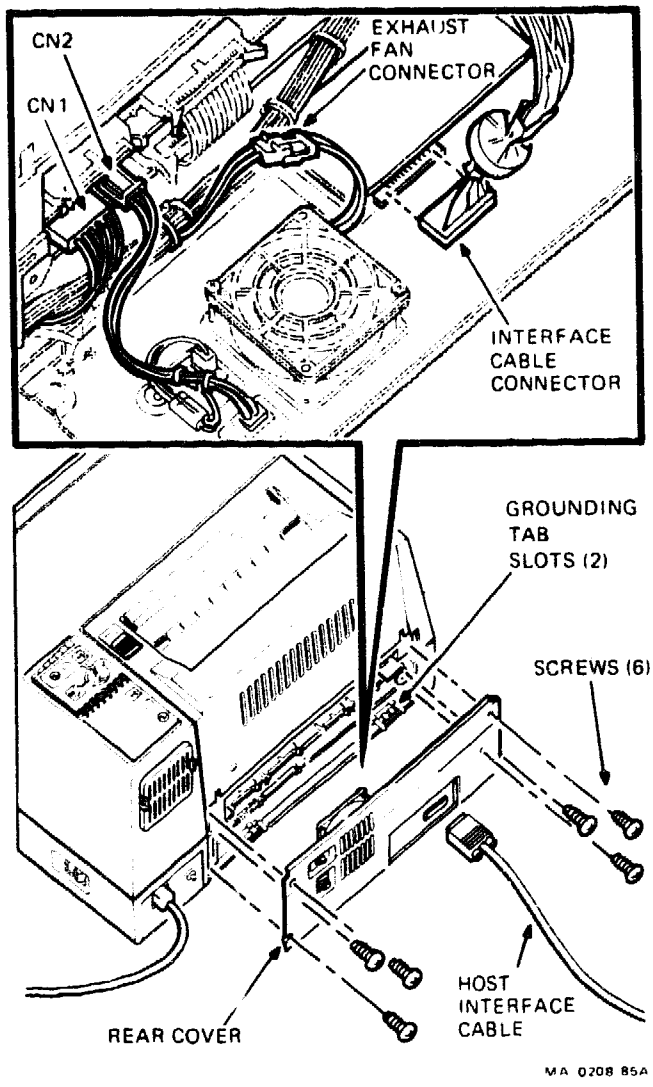


Figure 2 Rear Panel and Interface Cables

7. Remove two screws and star washers that secure ground straps A and B to the rear cover. then remove the rear cover (Figure 3).

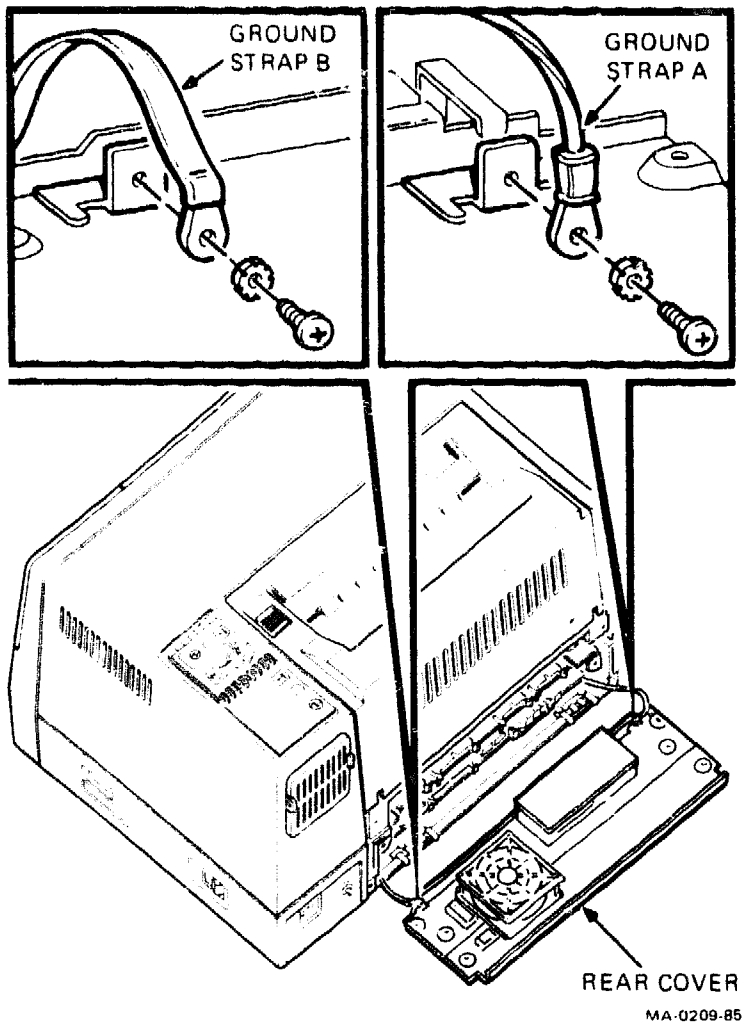


Figure 3 Removing the Ground Straps

8. Remove the printed circuit board separator (Figure 4).

9. If you need to install the firmware EPROMs on the controller board, refer to the *LN03 Pocket Service Guide*, Paragraph 2.35. Also follow the instructions provided with the chips.

   After the EPROMs are installed, continue with the option installation.

10. Lift the wiring harness and insert the LN03S board into the bottom slot of the card cage (below the controller board).

11. Push the board into the slot and plug it into the backplane connector.

12. Locate the power cable with the 6-pin connector on the wiring harness. Plug this connector into the power connector on the option board.

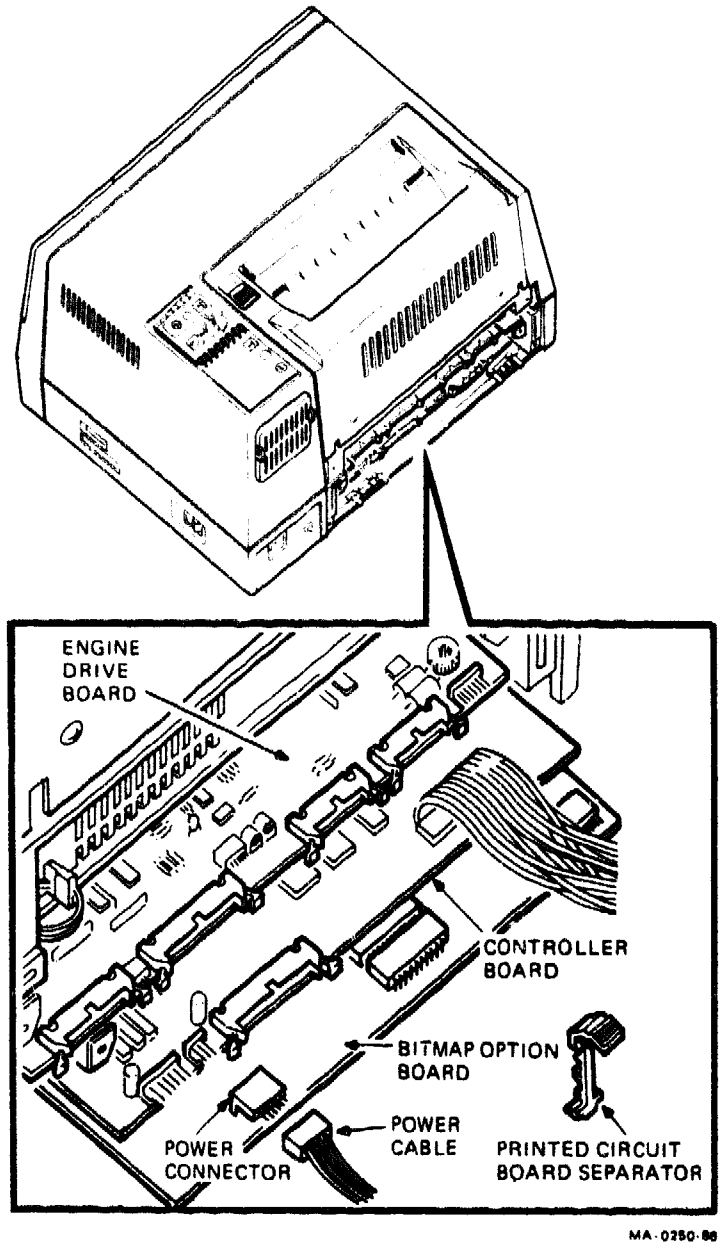


Figure 4 Installing the Bitmap Option Board

13. Reconnect the following.

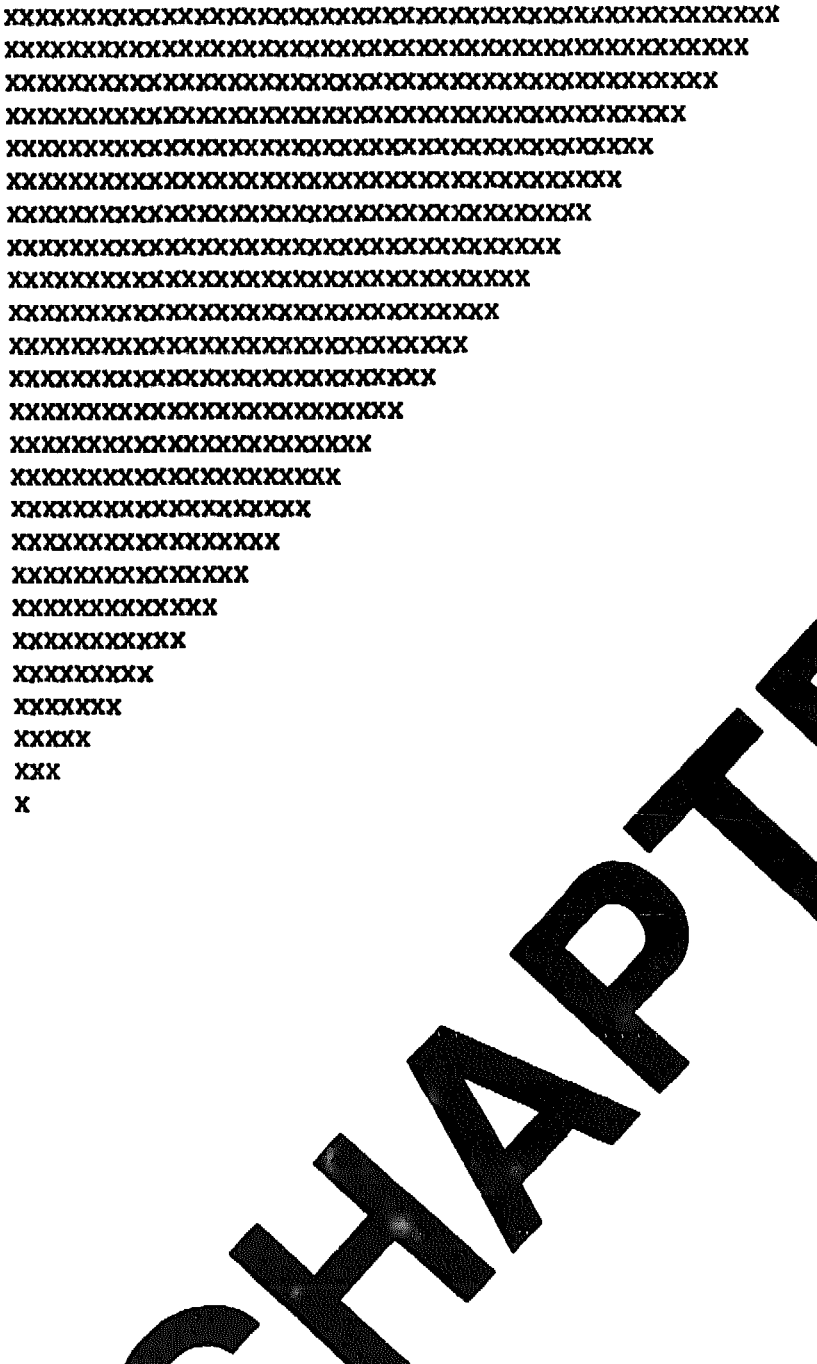
    - Ground straps A and B to the rear cover
    - CN1 and CN2 connectors to the controller board
    - Exhaust fan cable to the fan
    - Internal interface cable to the rear panel connector

14. Replace the rear cover.

    CAUTION: Make sure the cover sits in the grounding tab slots correctly and the wiring harness is not pinched at any location. The harness should wrap below the exhaust fan and above the DIP switches.

15. Connect the host interface cable at the back of the printer.

16. Plug the power cord into the wall outlet.



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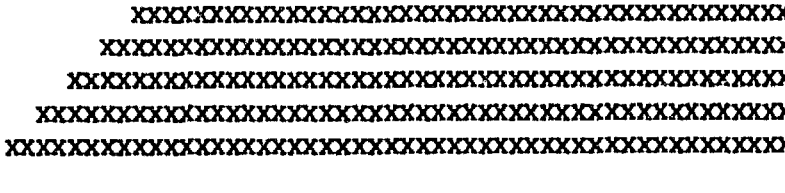

CHECKOUT 4

GENERAL

Follow these instructions to check for correct LN03S option board installation in the LN03 printer.

POWER-UP CHECK

1. Press the power switch on (1) to power up the printer.
2. Check the indicator panel for any error messages. The indicator panel symbols and error codes are described in *Installing and Using the LN03.*

   If the printer does not power up or if error codes light on the indicator panel (except for a bitmap option error), refer to Chapter 1 in the *LN03 Pocket Service Guide* for further instructions.

   If a bitmap option error code (62, 63, or 64) appears on the indicator panel, the LN03S board is bad. Replace it.

NOTE: To reset the printer after a malfunction, use the DECSTR (ESC [! p) sequence. Do not use the RIS (ESC c) sequence. Refer to the LN03 PLUS Programmer Reference Manual (Chapter 3) if you need more information on how to reset the LN03 PLUS printer.

SUMMARY SHEET TEST

To complete the checkout, print a summary sheet by pressing the Test (T) button at the rear of the printer.

The printer should print a summary sheet similar to the one shown in Figure 5. Note the base firmware code (DEC 4.4) and the PLUS firmware code (DEC 1.0 or higher) in the upper right corner of the page. Also note in the middle of the page the memory space allocated for the bitmap (1024 Kbytes). Check for any errors in the job status section of the sheet. There should be no errors.

- If the test fails (the summary sheet does not print) or if errors are listed, take the corrective action described in the *LN03 Pocket Service Guide*. Refer to the *LN03 PLUS Programmer Reference Manual* for all LN03 PLUS error codes.
- If the summary sheet prints with no indication that the LN03S board is installed (no PLUS firmware code revision), the board failed the test and you must replace it.

NOTE: At power-up, you can print single or multiple (continuous) summary sheets. To print multiple summary sheets, press the Test button and keep it depressed until the first sheet of paper starts to feed from the input paper tray. To stop printing, press the Test button again for at least five seconds. During operation, you can print single summary sheets only.

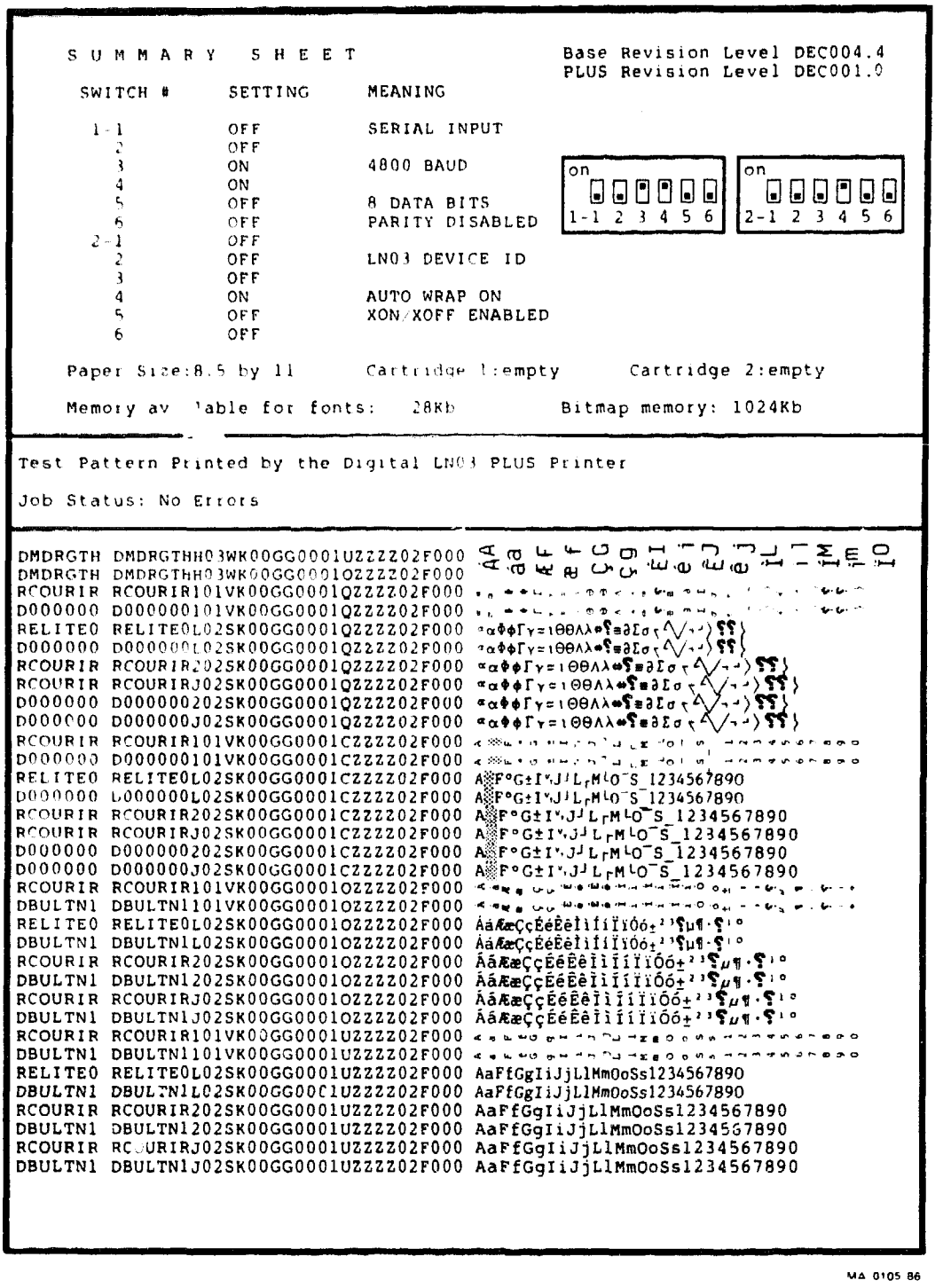

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Figure 5 LN03 PLUS Summary Sheet


USER
GUIDE

EK-LN03S-UG-001

LN03 PLUS

User Guide

Addendum to Installing
and Using the LN03

Prepared by Educational Services
of Digital Equipment Corporation

1st Edition, May 1986

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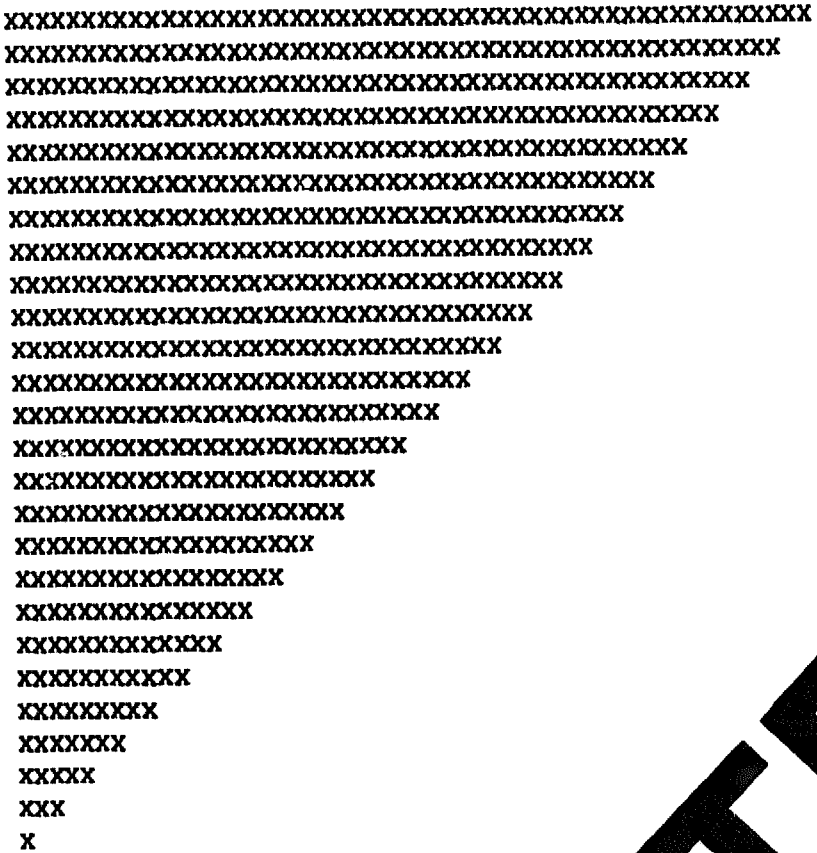
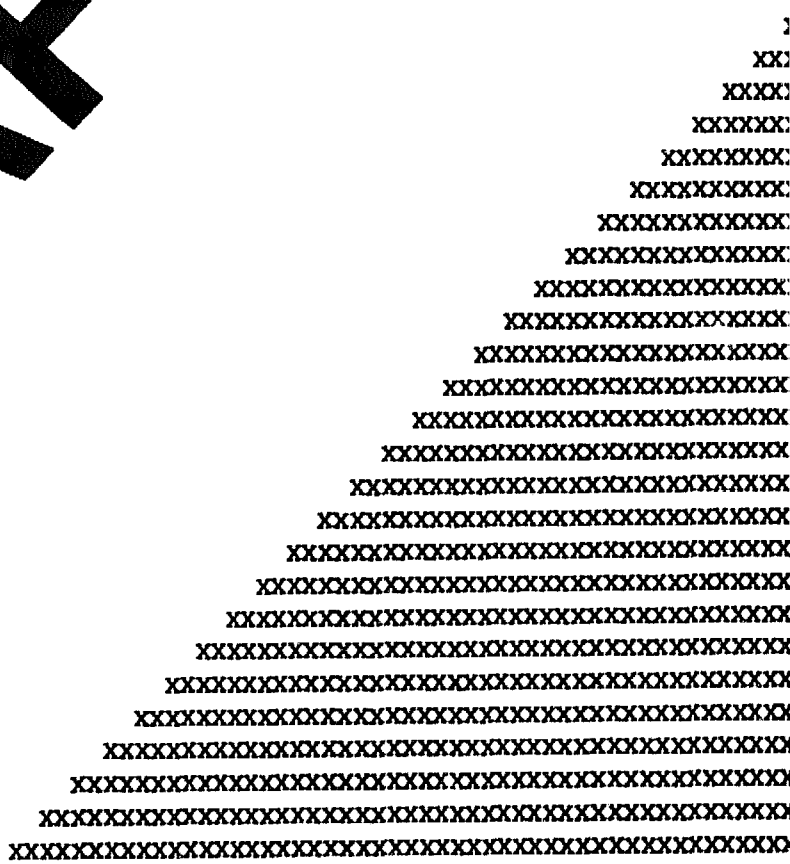


CHAPTER 1



1 INTRODUCTION

GENERAL

This guide describes the operation of the LN03 PLUS laser printer. Because the LN03 PLUS is an expanded version of the base LN03 printer, this guide only provides the operating and troubleshooting features that relate specifically to the LN03 PLUS configuration.

To operate and maintain the LN03 PLUS, you have to know how to operate the base LN03 laser printer. Use the LN03 manuals that come with your printer for information on operating requirements, general operation, programming, and maintenance of the printer.

If you need programming information specifically for the LN03 PLUS, refer to the *LN03 PLUS Programmer Reference Manual* (EK-LN03S-RM).

LN03 PLUS DESCRIPTION

The LN03 PLUS is the upgrade configuration of the LN03 laser printer. The LN03 PLUS system consists of an LN03 laser printer and an LN03S bitmap option board installed in the printer.

The LN03 PLUS comes in two variations.

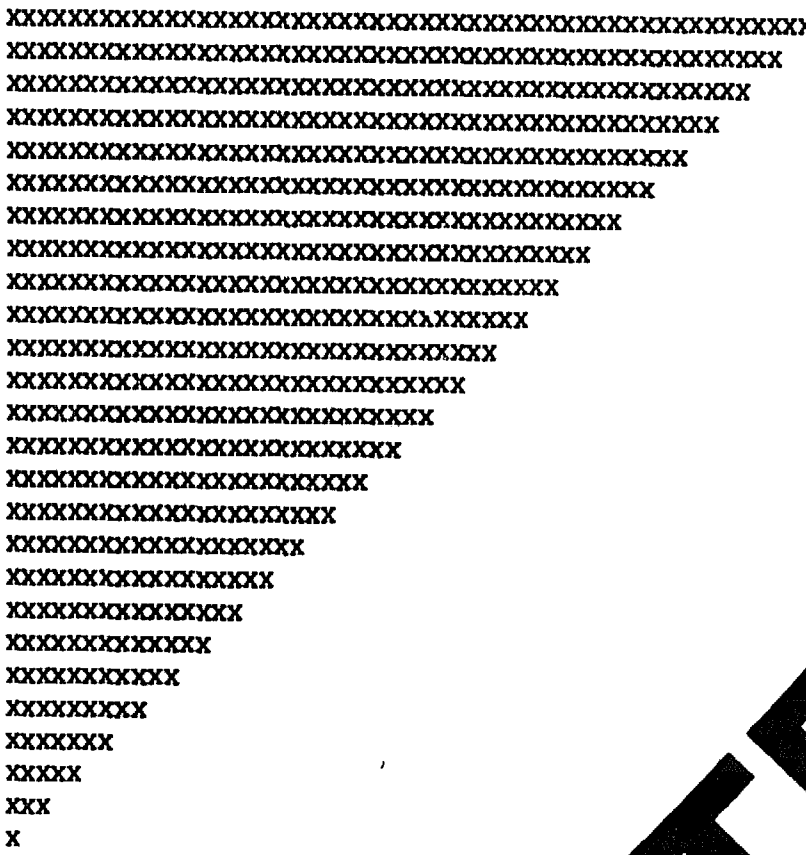
LN03S-AA	110/120 volts, 50/60 Hz
LN03S-A3	200/240 volts, 50 Hz

The LN03 PLUS enhances the ability of the base LN03 printer to print high quality documents composed of text and graphics.

SAFETY

The LN03 PLUS complies with laser product performance standards set by the FCC as a Class 1 Laser Product. It does not emit hazardous light, because the beam is completely enclosed during all modes of customer operation and maintenance.

All LN03 cautions and warnings apply to the LN03 PLUS.



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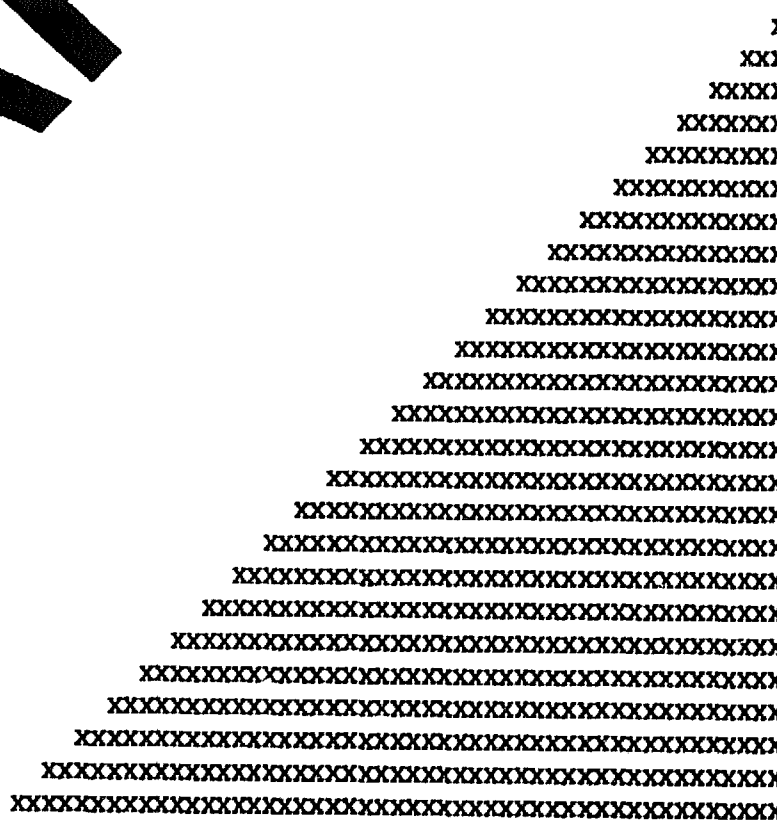


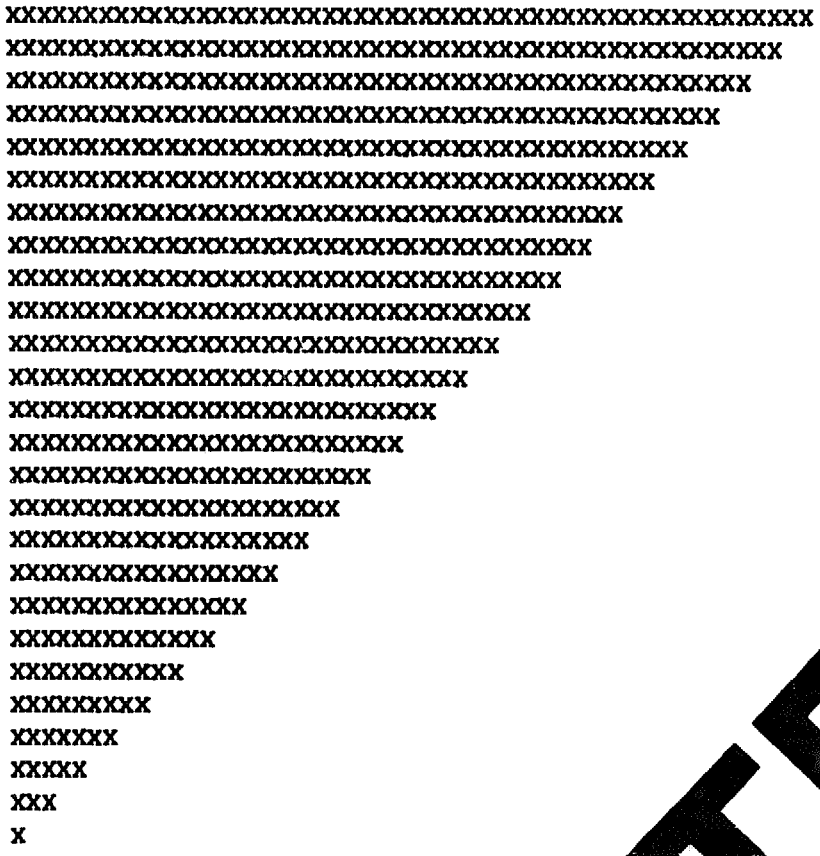
OPERATION 2

GENERAL

Installing and Using the LN03 describes the printer controls and indicators. This manual also tells how to perform printer operations such as loading paper and replacing the toner cartridge.

The only difference between LN03 and LN03 PLUS operation is that the LN03 PLUS has variable printing throughput. The LN03 PLUS has a maximum print speed of eight pages per minute. The speed may be lower depending on the complexity of the graphics and text.

Do not be alarmed if the print speed slows down. Complex, high resolution graphic images require much more time to build than normal text or simple graphics.



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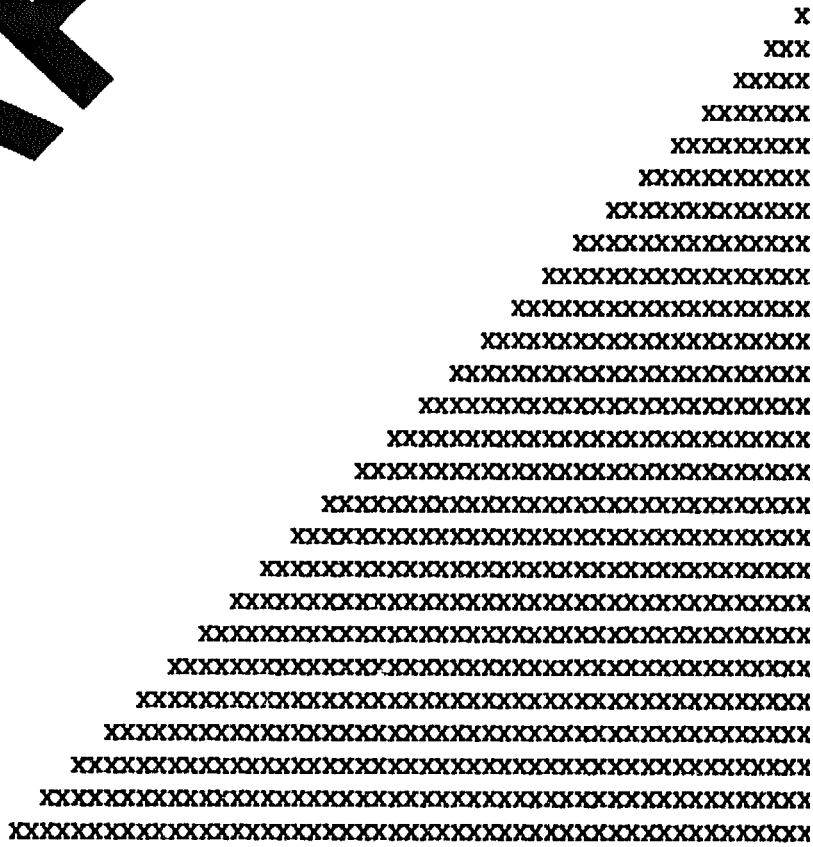

3 TROUBLESHOOTING

GENERAL

Installing and Using the LN03 describes the operating problems and error codes common to both the LN03 and LN03 PLUS. The following information relates only to LN03 PLUS problem solving.

CONTROLLER OPERATIONAL ERRORS

The *LN03 PLUS Programmer Reference Manual* lists all the operational errors that can occur. The operational error codes are shown on the indicator panel together with the ↳ symbol.

NOTE: When the indicator panel has a flashing 6 and the ↳ symbol, the printer is busy (down-line loading fonts or printing). This is NOT an error condition.

BITMAP ERROR CODES

In addition to controller and print engine error codes, the LN03 PLUS printer has error codes 62, 63, and 64 that light on the indicator panel (together with the 🯅 symbol). These error codes light at power-up only. Error codes 62, 63 and 64 indicate failure of the bitmap option board. If one of these failures occurs, call Digital Field Service.

SUMMARY SHEET TEST

The summary sheet provides information about the current status of the printer, including the interface, the available fonts, and a listing of any errors.

To start this test, press the Test (T) button at the rear of the printer.

NOTE: At power-up, you can print multiple (continuous) summary sheets. Press the Test button and then turn the power switch on. Keep the Test button depressed until the first summary sheet is printed. To stop printing, press the Test button again for at least five seconds. During operation, you can get only one summary sheet when you press the Test button.

The printer should print a summary sheet similar to the one shown in Figure 1. Note the base firmware code (DEC 4.4) and PLUS firmware code (DEC 1.0 or higher) in the upper right corner that indicate an LN03 PLUS configuration. The summary sheet also shows the bitmap memory space (1024 Kb).

Check for any errors that may be printed in the job status section of the summary sheet. If errors are listed, refer to Chapter 4 of the *LN03 PLUS Programmer Reference Manual.*

If the summary sheet does not print or if it prints with no indication that the printer is an LN03 PLUS (no PLUS firmware code revision), call Digital Field Service. (Refer to Chapter 4.)

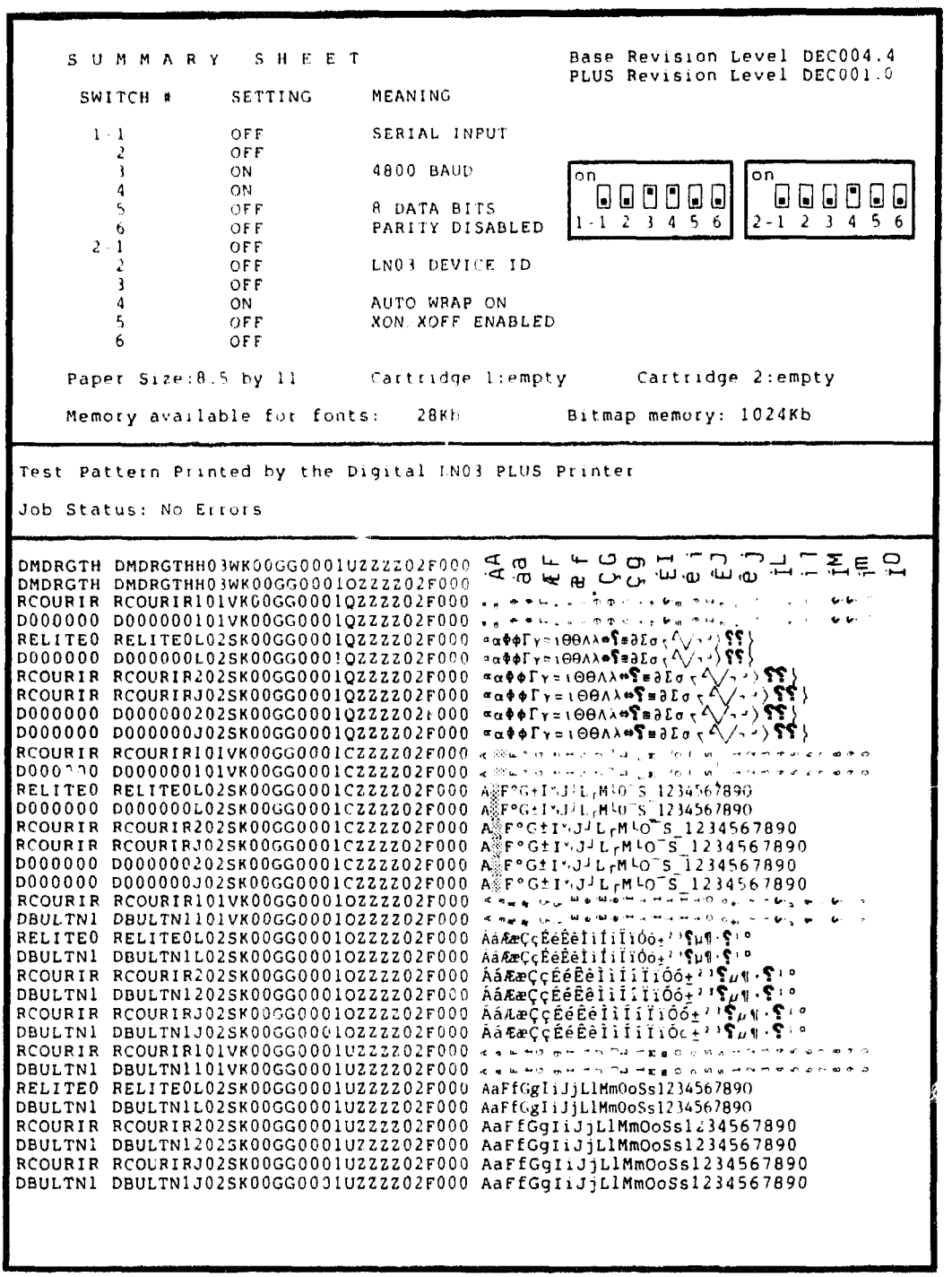

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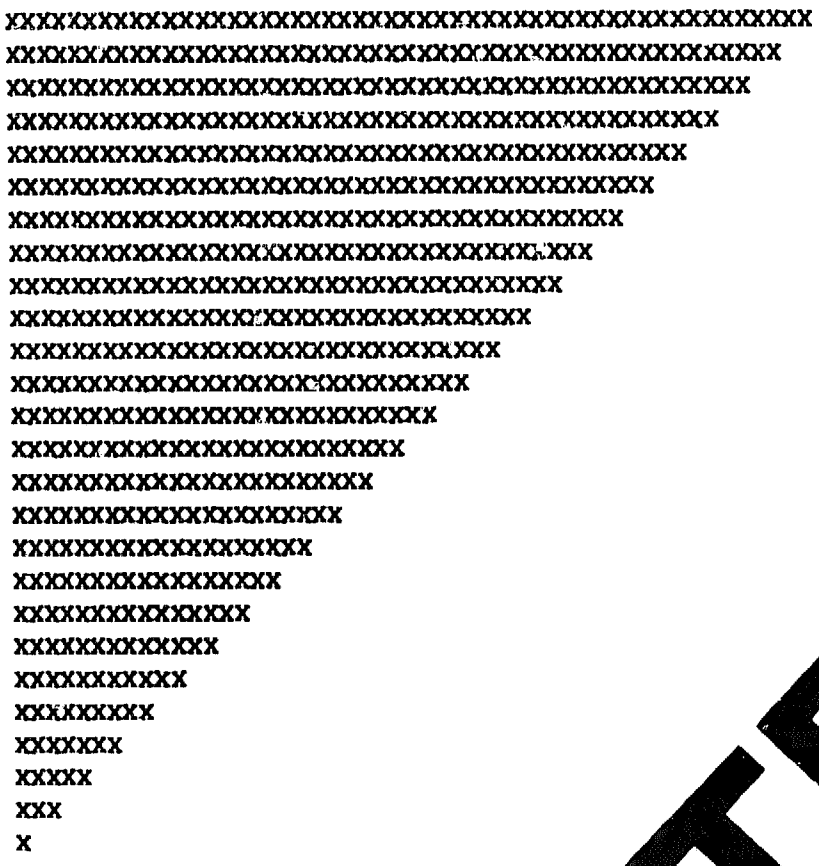
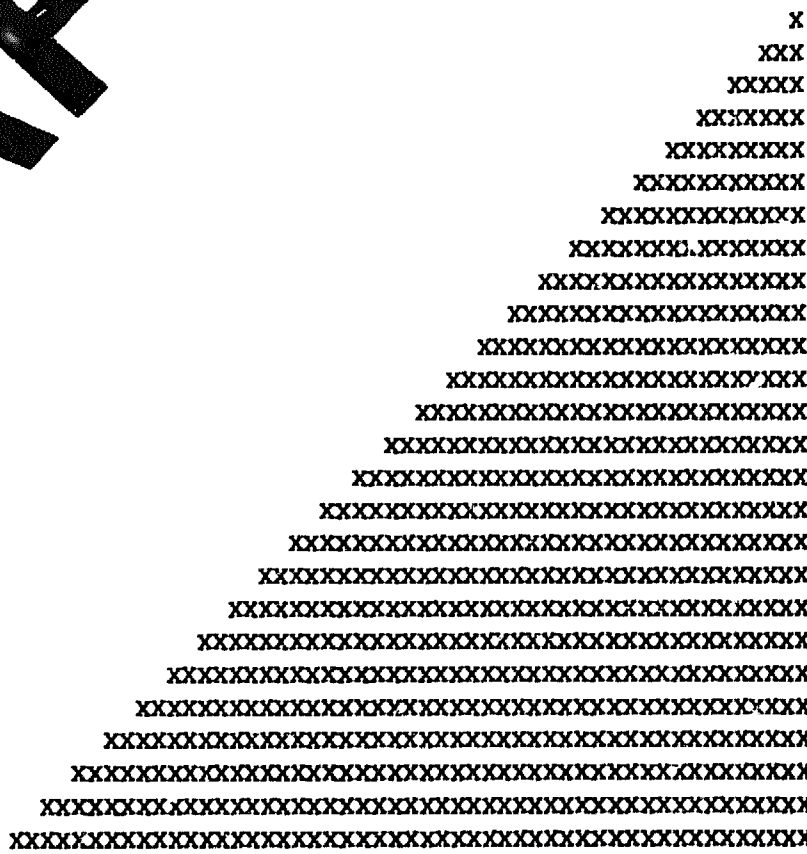
Figure 1 LN03 PLUS Summary Sheet



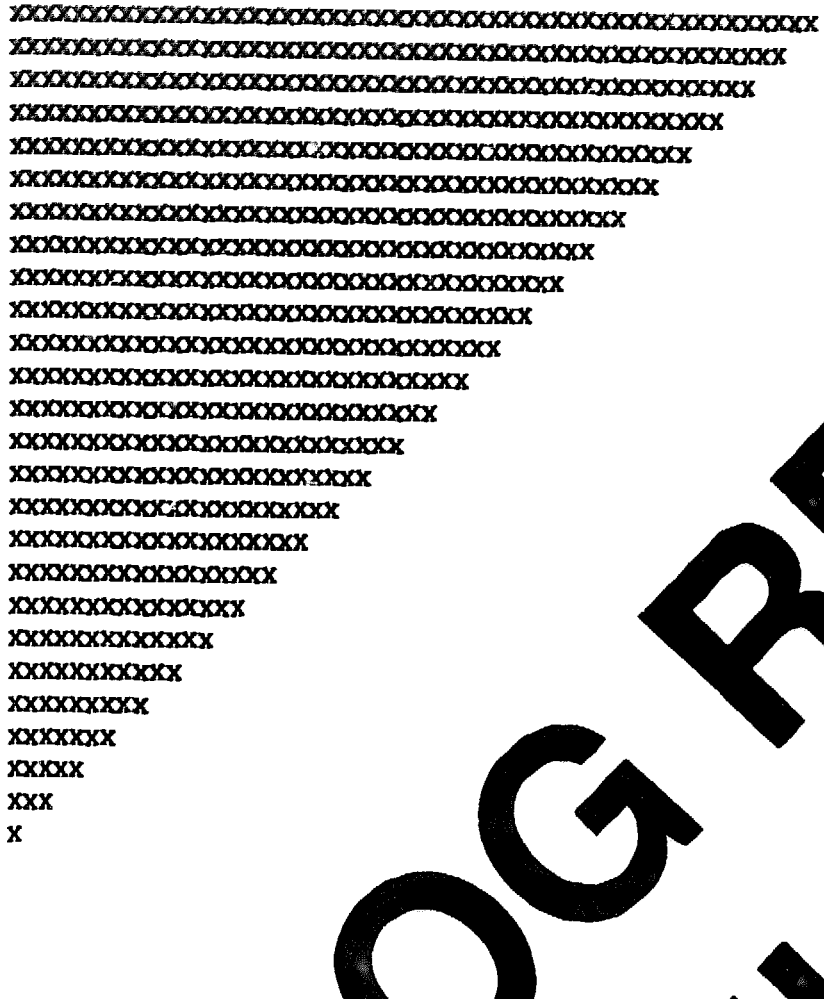
CHAPTER 4



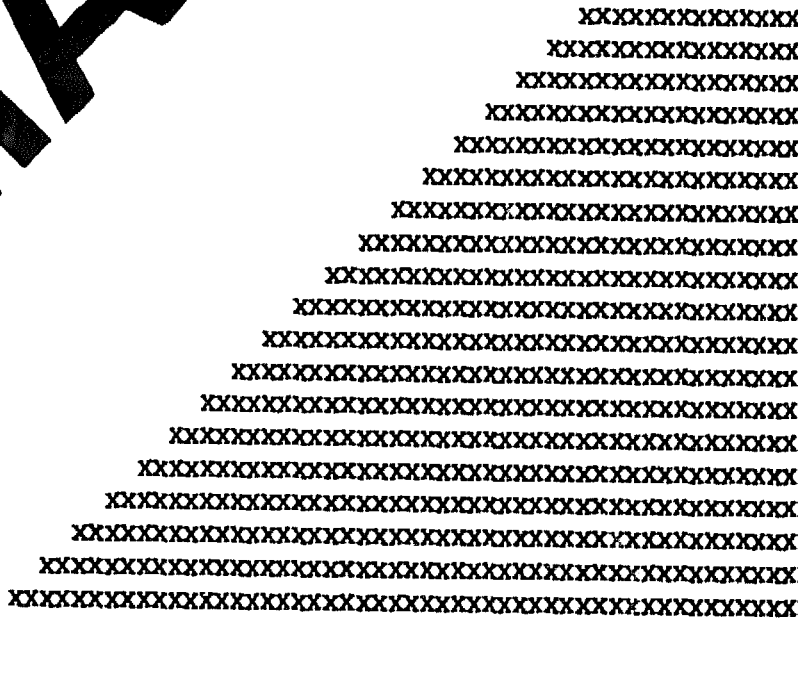
SERVICE 4

GENERAL

Installing and Using the LN03 (Chapter 6) provides complete information on what to do and where to call if you need help from Digital Field Service.



PROG REF MANUAL



EK-LN03S-RM-001

LN03 PLUS

Programmer Reference Manual

Addendum to the
LN03 Programmer Reference Manual

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INTRO

INTRODUCTION

This manual describes how to use the LN03 PLUS printer with a host computer. It is an addendum to the *LN03 Programmer Reference Manual* and provides information on functional differences between the base LN03 and LN03 PLUS printers, add-on features (bitmapping and Tektronix emulation), and sixel graphic protocol.

HOW TO USE THIS MANUAL

The following paragraphs provide a brief overview of the manual.

Chapter 1 — Provides a general overview of the LN03 PLUS.

Chapter 2 — Describes the differences between the base LN03 and LN03 PLUS printers. It also provides an overview of Tektronix protocol and emulation mode.

Chapter 3 — Describes how you can communicate with a host computer and print Tektronix-generated data using escape and control sequences.

Chapter 4 — Describes how you can print sixel graphics in DEC mode.

Chapter 5 — Provides troubleshooting and product identification information.

Appendix A — Lists the ASCII codes that you can use in Tektronix emulation mode.

Glossary — Describes some terms that are used in this manual.

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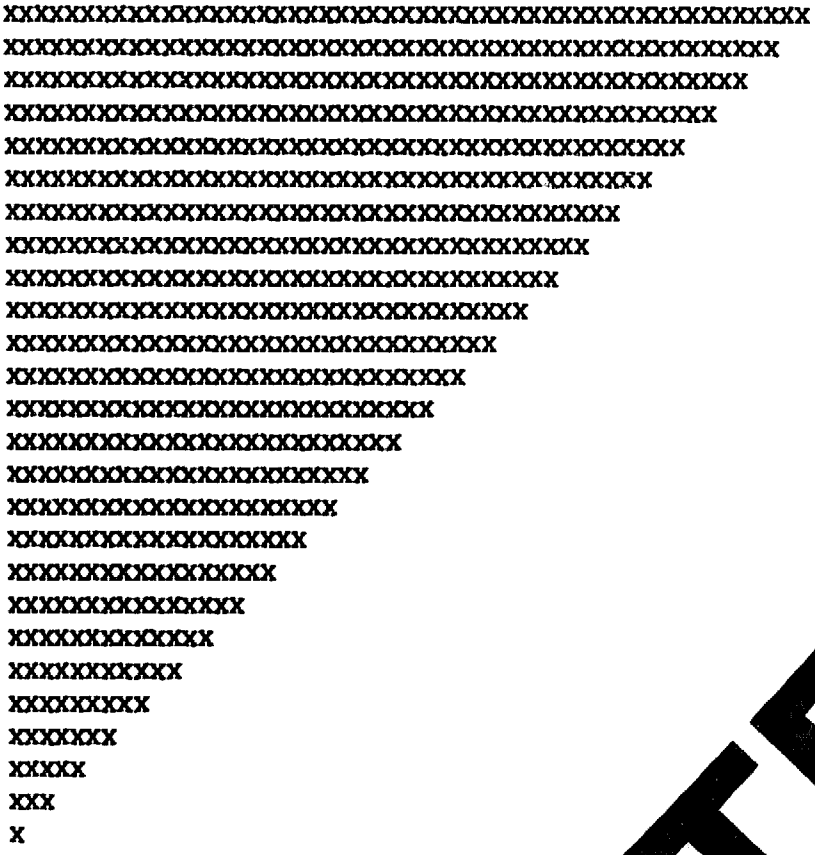
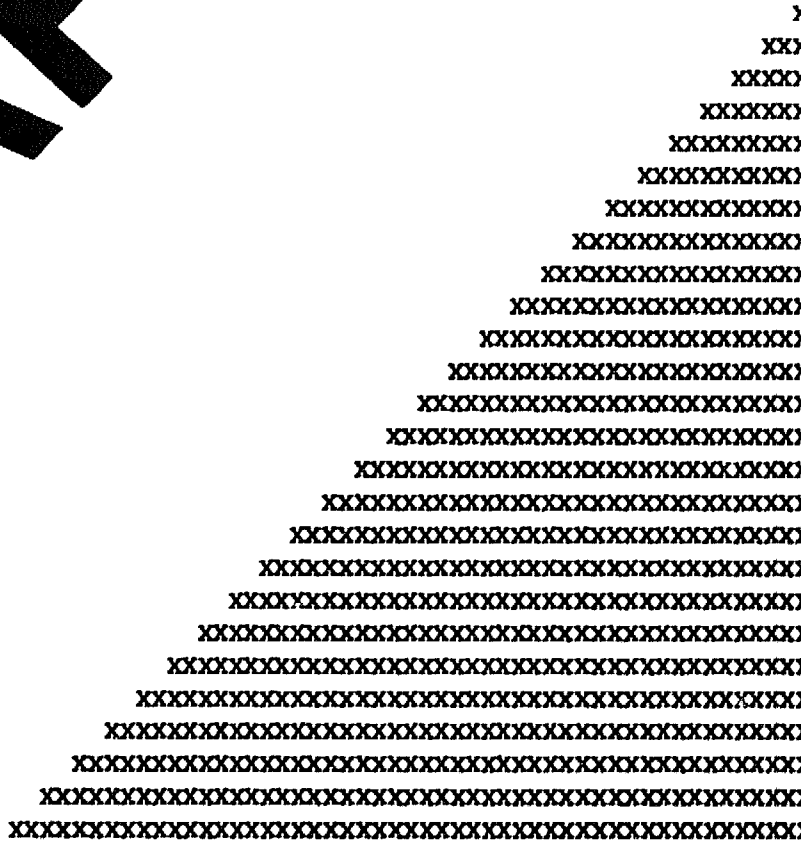


CHAPTER 1



GENERAL DESCRIPTION 1

This manual describes the operating and programming features for the LN03 PLUS laser printer. Because the LN03 PLUS is an expanded version of the base LN03 printer, this manual only provides the programming and functional features that relate specifically to the LN03 PLUS.

You can use the LN03 PLUS in DEC mode (described in the *LN03 Programmer Reference Manual*) and in Tektronix emulation mode (described in this manual).

To operate and program the LN03 PLUS, you have to know how to use the base LN03 laser printer. If you want to use Tektronix emulation, you should also understand Tektronix 4010/4014 protocol and terminals.

1.1 OVERVIEW

The LN03 PLUS is the upgrade configuration of the LN03 laser printer. The LN03 PLUS system consists of a base LN03 laser printer and an LN03S bit-map option board. The LN03 PLUS requires the firmware microcode V4.4 installed in the base LN03 printer.

1.2 SYSTEM DESCRIPTION

The LN03 PLUS enhances the ability of the LN03 printer to print documents composed of text and graphics. The LN03 PLUS lets you process ANSI and Tektronix data files with any ratio of text to graphics. You will find no limits on image complexity.

The LN03S bitmap option is a single printed-circuit board designed for use in existing LN03 printers. The LN03S board is inserted into the available option slot of the LN03 printer and obtains power through the reserved internal power cable. All data transfers are passed to and from the printer's controller module through the 50-pin interconnect bus of the LN03.

The key feature of the LN03S bitmap option is the on-board memory capacity of one Mbyte of dynamic random access memory (RAM) used as the bitmap storage. The LN03S also has up to 128 Kbytes of read only memory (ROM) used for program and font storage.

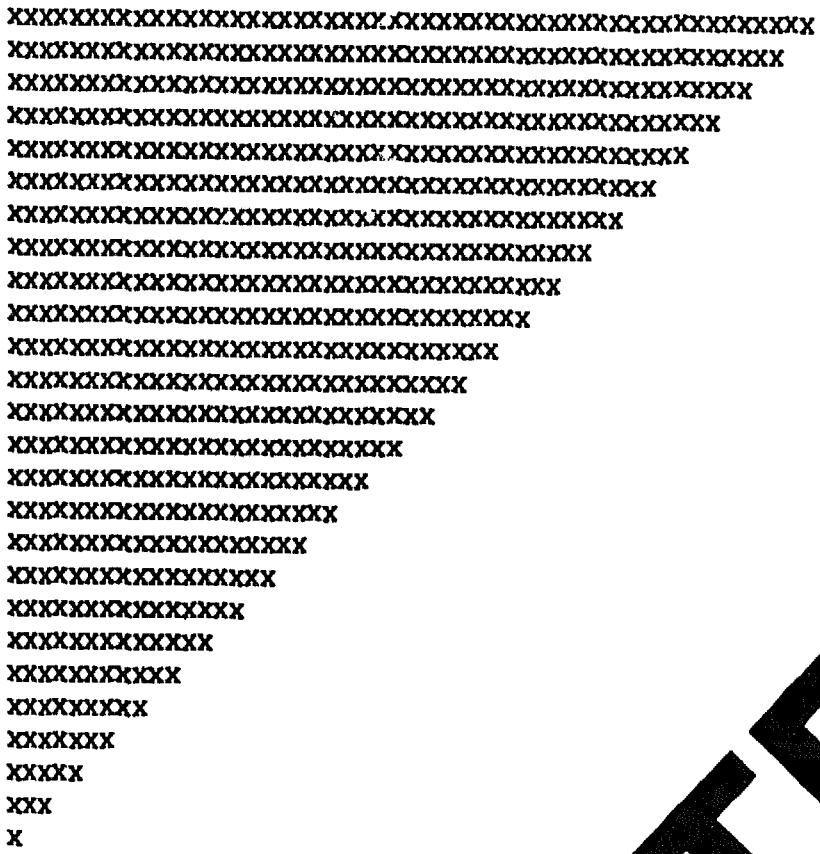
The host and printer communicate through the standard RS232-C serial interface.

All setup features in the LN03 PLUS are the same as in the base LN03 and are controlled through the default setting of configuration switches or under program control. (See the *LN03 Programmer Reference Manual* for more information on printer setup.)

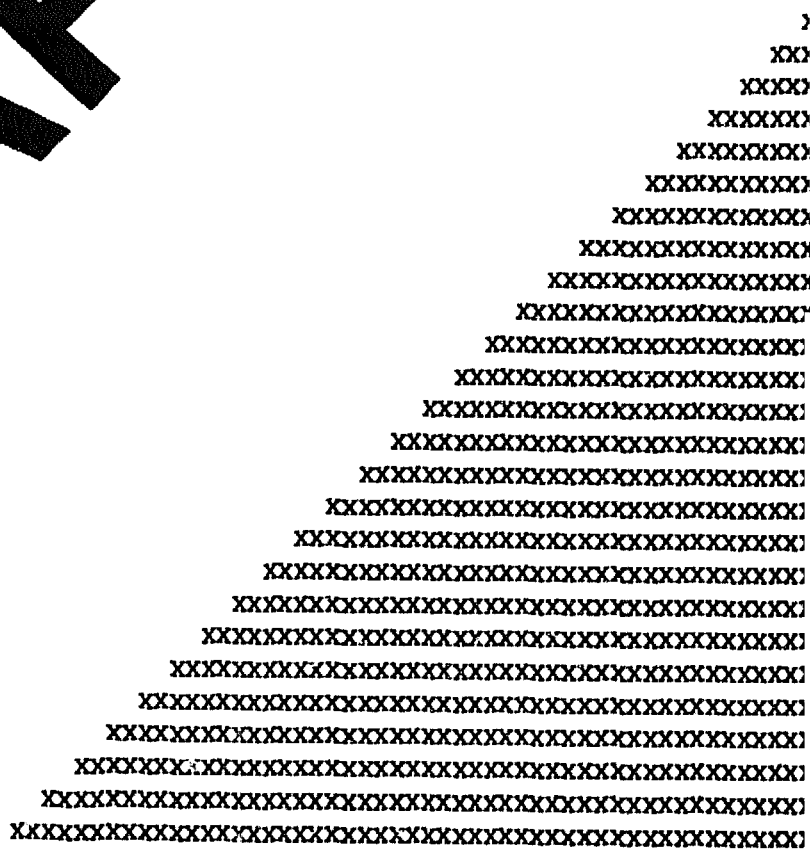
1.3 REFERENCES

You should use the *LN03 PLUS Programmer Reference Manual* with the following documents.

LN03 Programmer Reference Manual (EK-OLN03-RM)
Installing and Using the LN03 (EK-OLN03-UG)
LN03S Bitmap Option Installation Guide (EK-LN03S-IG)
LN03 PLUS User Guide (EK-LN03S-UG)



CHAPTER 2



LN03 PLUS FUNCTIONAL OVERVIEW 2

This chapter describes the bitmap upgrade and the differences between the LN03 and the LN03 PLUS printers. It also gives an overview of Tektronix emulation protocol.

2.1 LN03 AND LN03 PLUS DIFFERENCES

The LN03 PLUS (LN03S) option upgrades your base LN03 in two important ways.

- It adds one full Mbyte of bitmap memory.
- It supplies Tektronix 4010/4014 emulation mode.

The advantages that these two enhancements provide are as follows.

- "Band too complex" and "page too complex" errors no longer occur. because the printer automatically begins to use the bitmap as required.
- The printer does not automatically eject the pages when it processes very complex images or receives font delete commands.
- The quality of sixel graphics is improved. The printer can draw one-pixel wide lines. LN03 PLUS sixel graphics differ slightly from base LN03 sixel graphics. Chapter 4 describes LN03 PLUS sixel graphics.

- The printer has two new font files that are built into the LN03 PLUS option. The fonts come as ASCII and DEC Supplemental character sets. They are encoded into regular font files, so that they can be used from the text (DEC) mode as well as from Tektronix emulation mode. The fonts are as follows.

  DMDRGTHH03WK00GG0001UZZZZ02F000

  This is 14 point, 8 pitch Modern Gothic ASCII set in landscape orientation. It is assigned to select graphic rendition (SGR) 19 by the font family.

  DMDRGTHH03WK00GG0001OZZZZ02F000

  This is 14 point, 8 pitch Modern Gothic DEC Supplemental set in landscape orientation. It is assigned to SGR 19 by the font family.

- The LN03 PLUS supports the DECTEK (Tektronix mode) escape sequence.

Building complex images on the LN03 PLUS may slow down printing throughput. The slowdown is most noticeable when the LN03 PLUS prints many complex pages in a row especially if these images cover most of the page area. The data transmission time that the host needs to send complex images also affects LN03 PLUS throughput.

2.2 TEKTRONIX EMULATION

The LN03 PLUS printer emulates the Tektronix 4010/4014 terminal series with some restrictions caused by the differences in operation of a hardcopy output device. Digital's VAXstations and VT240 terminals are compatible with the Tektronix 4010/4014 series. The LN03 PLUS uses 4010/4014 mode to provide hardcopy output of files developed on these terminals using industry-standard Tektronix software packages.

The Tektronix feature in the LN03 PLUS operates in five modes. You can control these modes by means of escape sequences consisting of ESC followed by one character, control characters from the ASCII C0 control set, and certain ASCII printable characters. Some control characters and sequences may perform different functions depending on the current mode of operation.

2.2.1 Implementation

The 4010/4014 mode supports the following operating modes and special functions (described in detail in Chapter 3).

Operating Modes

- Alpha — Processes text characters.
- Graph — Interprets characters as vector endpoints and draws the vectors accordingly.
- Point plot — Like Graph mode, except that only the endpoints of the vectors are plotted.
- Incremental plot — Vectors are plotted relative to the current position.
- Bypass — The printer does not display or process alpha (text) characters.

Special Functions

- Control characters — ASCII characters that cause the printer to take some action.
- Escape sequences — Sequences starting with ESC that control or define 4010/4014 functions available on the LN03 PLUS.

NOTE: Graphics input (GIN) mode is not available on the LN03 PLUS. The command to enter GIN mode is ignored, and the Tektronix emulator passes directly into Alpha mode without activating Bypass mode.

2.2.2 Page Mapping

The LN03 PLUS prints Tektronix images on a fixed page area within the physical page. This fixed area is known as the Tekpage and is equal to 19.3 × 25.64 cm (7.68 × 10.24 inches). The home position of the cursor is at the top left corner of the Tekpage. The coordinate origin is at the bottom left corner of the Tekpage. Characters printed in Alpha mode may extend above, to the right of, or below the Tekpage area, as long as the reference point of the character is within this area. Figure 2-1 shows page mapping on standard 8-1/2 × 11 inch paper, and Figure 2-2 shows page mapping on A4 paper.

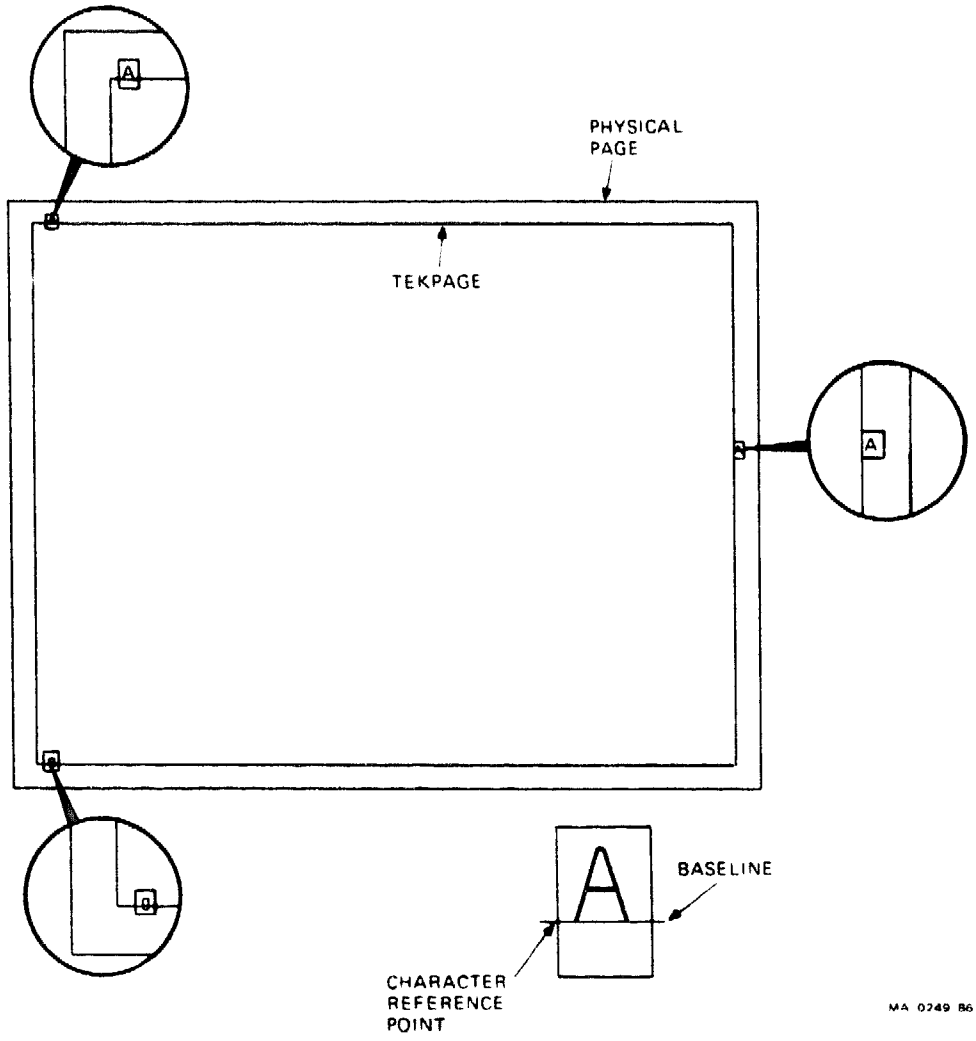


Figure 2-1 Page Mapping on 8-1/2 × 11 Inch Paper

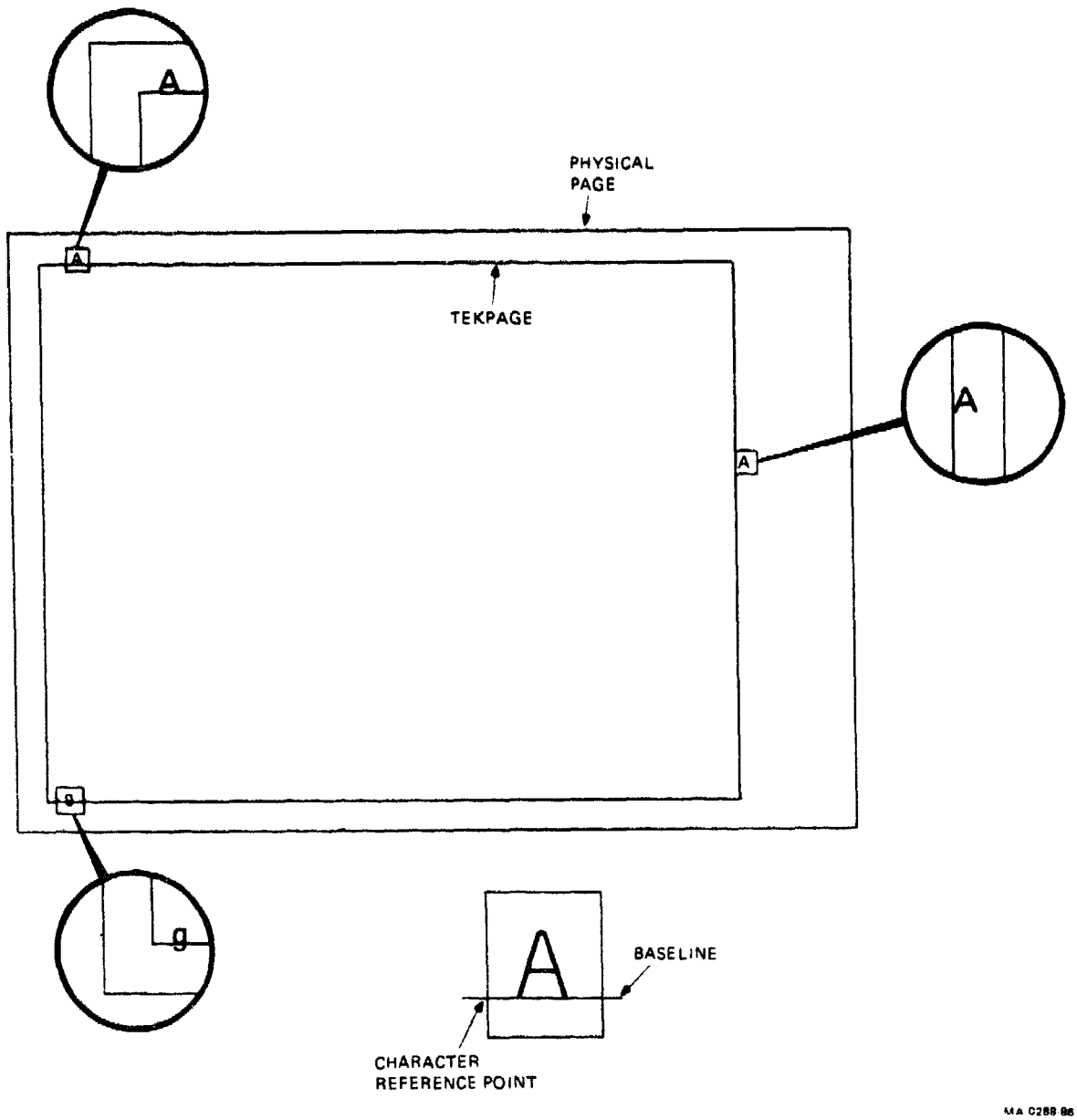


Figure 2-2 Page Mapping on A4 Paper

The LN03 PLUS prints within the same size Tekpage whether it is using 8-1/2 × 11 inch or A4 paper. If you use A4 paper, you may notice some white space on the right side of the page. When using the larger character size, A4 paper has fewer lines per page.

2.2.3 Screen/Page Addressing

While the LN03 PLUS is in Tektronix emulation mode, the unit of screen addressing is the Tekpoint. By default, there are 1024 Tekpoints horizontally and 768 Tekpoints vertically within the Tekpage. Each default-sized Tekpoint equals three pixels. To address a default-sized Tekpoint in Graph mode, you need 10 address bits.

However, you can achieve much higher resolution if you activate the enhanced graphics module (EGM) feature (see the Glossary) by sending an extra address byte. The number of Tekpoints increases to 4096 horizontally and 3072 vertically. The size of each Tekpoint goes down to 0.75 pixel, with increased positioning resolution. You need 12 bits to address the printer in EGM mode.

Paragraph 3.5.2 describes coordinate addressing technique in more detail.

2.2.4 Communication and Character Processing

In Tektonix emulation mode, the LN03 PLUS communicates with the host computer using 7-bit ASCII codes. Figure 2-3 is an ASCII chart that shows the 7-bit ASCII codes used for communication.

NOTE: Any eighth bit is always removed from received characters.

The function of a received character depends on the operating mode the printer is in when the character is received and whether or not the character is part of an escape sequence.

Tables 3-1 and 3-2 describe valid ASCII characters and sequences. Table A-1 (Appendix A) lists all ASCII codes and briefly describes the effects these codes may have in different modes or when used as part of an escape sequence.

Unlike the Tektronix 4010/4014, the LN03 PLUS in Tektronix mode does not have any specific setup capability. Therefore, the LN03 PLUS implements the default Tektronix switch settings.

Following are the differences in character processing from the Tektronix 4014.

- CR (carriage return) is always interpreted as CR, never as CR/LF.
- LF (line feed) is always interpreted as LF, never as LF/CR.
- The ESC ? sequence is always interpreted as a Lo Y coordinate component equal to 11111. It is never ignored.
- The ESC ETB (dump screen to printer) sequence is ignored.
- The ESC FF (clear screen and home cursor) sequence ejects the page as well as clearing the screen.
- The ESC ENQ (send crossbar cursor position) sequence is ignored.
- The ESC FS sequence sets the printer to normal Point Plot mode, never to Special Point Plot mode.

ROW	BITS B4 B3 B2 B1	COLUMN 0 B7 0 B6 0 B5 0	1	2	3	4	5	6	7
0	0 0 0 0	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	ENQ 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	ETB 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	FS 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	GS 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	RS 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	US 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

CHARACTER **ESC** 33 OCTAL, 27 DECIMAL, 1B HEX

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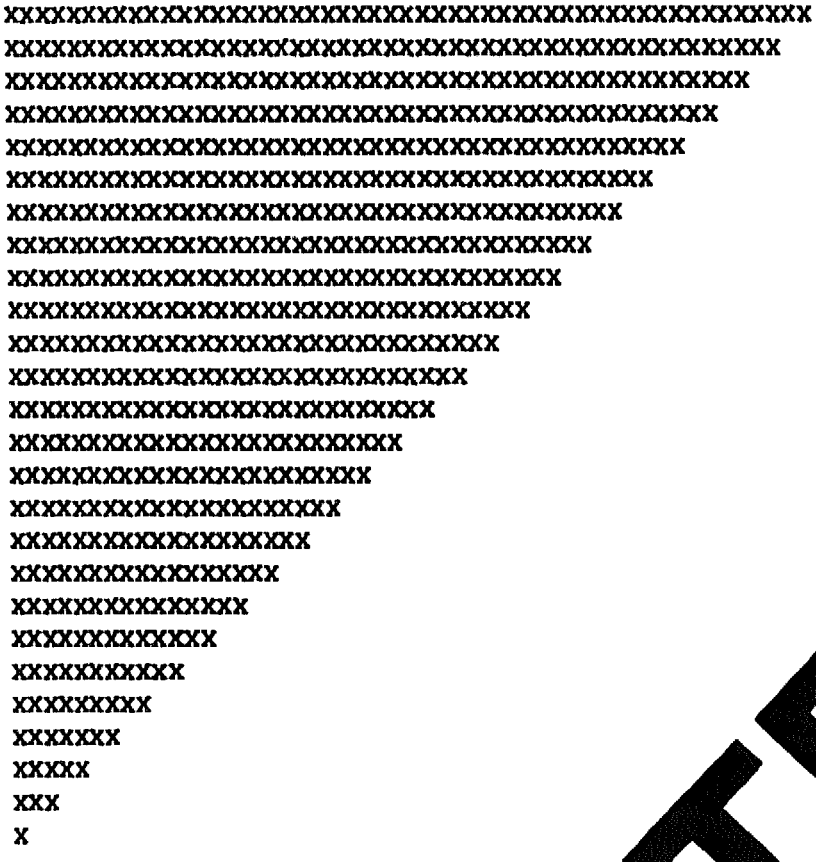
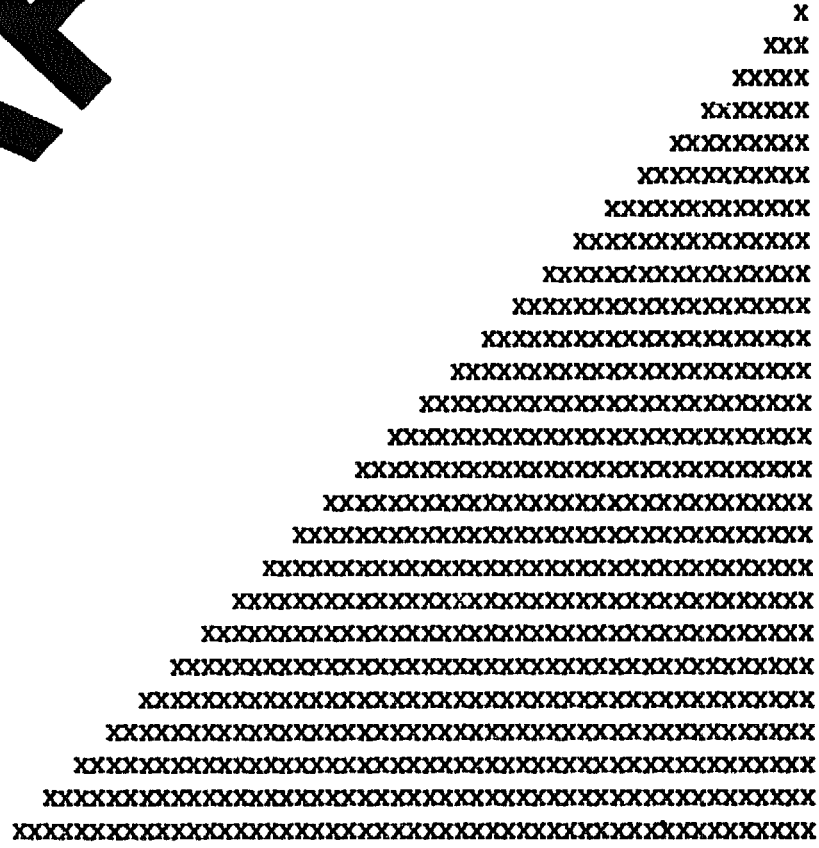
Figure 2-3 7-Bit ASCII Chart



CHAPTER 3



TEKTRONIX OPERATING MODES AND ESCAPE/CONTROL SEQUENCES 3

This chapter describes the five operating modes and the escape and control sequences you can use to control Tektronix 4010/4014 emulation.

3.1 ENTERING AND EXITING 4010/4014 EMULATION MODE

You can set or reset 4010/4014 mode using the ANSI escape sequences.

3.1.1 Entering Emulation Mode

To enter 4010/4014 mode, use the following DECTEK sequence.

ESC	**[**	**?**	**3**	**8**	**h**
1/11	5/11	3/15	3/3	3/8	6/8

When the LN03 PLUS receives the the DECTEK entry sequence, it prepares for 4010/4014 mode as follows.

1. If there is printable data in the current page buffer, the printer generates a form feed. That brings the cursor to the page home (top) line with the same horizontal position on the line.

   Selecting Tektronix emulation does not affect the state of the ANSI parser. Any ANSI modes (such as autowrap, font selection, or spacing) will still be in effect when the printer returns to ANSI (DEC) mode.

2. The 4010/4014 mode's cursor is set at the home position (top left corner).

3. The printer automatically selects the landscape paper orientation and Tektronix fonts. (See Paragraph 3.4.1.) All previous Tektronix modes are reset.

4. Any additional parameters received in the DECTEK sequence are applied for later use in regular ANSI mode.

3.1.2 Exiting Emulation Mode

To exit 4010/4014 mode, enter one of the following sequences.

ESC	**[**	**?**	**3**	**8**	**l**	DECTEK exit sequence
1/11	5/11	3/15	3/3	3/8	6/12	

or

ESC	**[**	**!**	**p**	DECSTR (soft
1/11	5/11	2/1	7/0	terminal reset)

Enter either sequence exactly as specified. Any extra or different parameters may be wrongly interpreted, and the sequence may be ignored or processed as a Tektronix command.

NOTE: Never use CSI (9 11) instead of ESC [, because the eighth bit is ignored.

These two escape sequences perform the same task of exiting 4010/4014 emulation mode. However, the DECSTR command also resets all ANSI variables to their initial values and ejects the current page if it contains printable data.

NOTE: Do not use the reset to initial state (RIS) sequence to reset the LN03 PLUS printer. The LN03 PLUS accepts the ESC c (1 11 6 3) sequence as a valid Tektronix command.

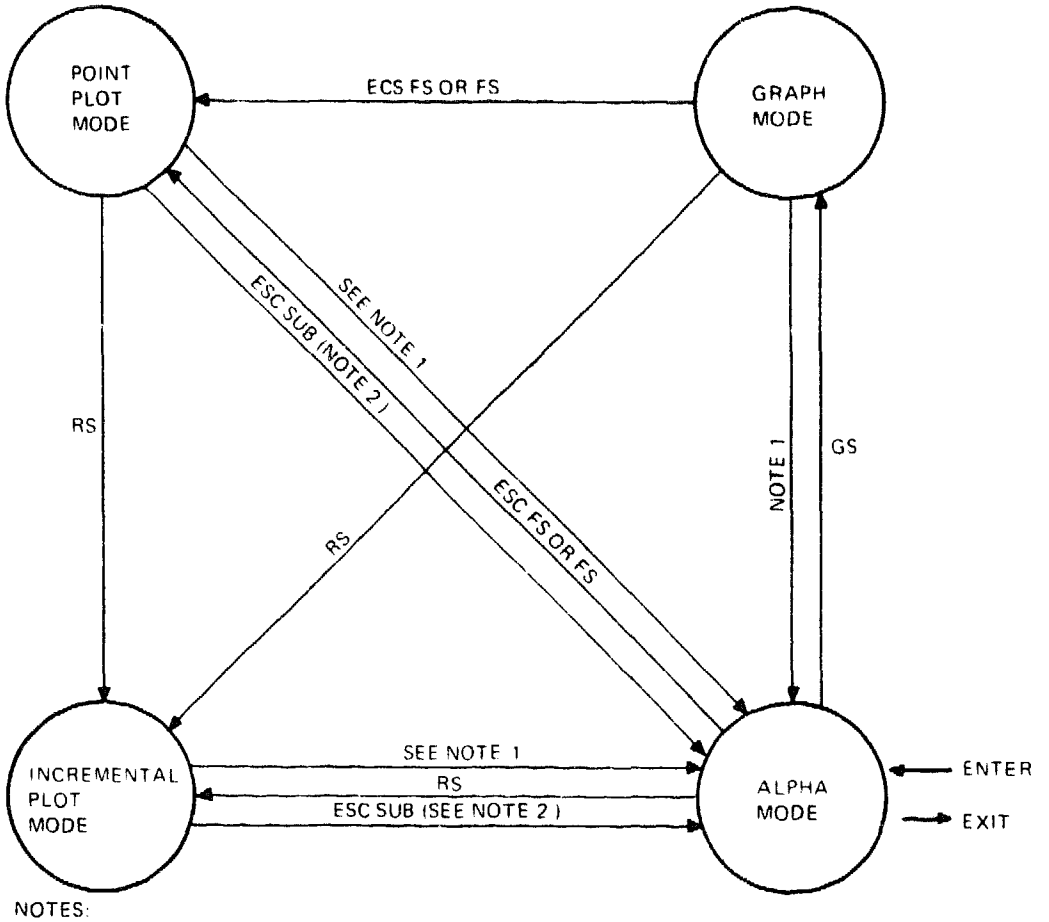
The DECTEK exit sequence does not automatically eject the page. This lets you mix Tektronix or ANSI data on one page, if the Tektronix data comes first.

NOTE: The ability to mix Tektronix and ANSI data is provided for compatibility with LN01 printers and may not be supported in future products.

3.2 CHANGING OPERATING MODES

Figure 3-1 shows the operating modes available when the LN03 PLUS printer is in 4010/4014 mode. (Bypass mode cannot be graphically represented in this diagram.) Transitions between these modes are represented by arrows. The ASCII control characters or escape sequence that you can use to cause the mode transition are shown with each arrow. These control characters and escape sequences are described in Paragraphs 3.3.1 and 3.3.3.

You enter and exit 4010/4014 emulation mode through Alpha mode, which is the default operating mode.



NOTES:
1. US, CR, ESC US, OR ESC FF

2. GIN MODE IS NOT SUPPORTED IN THE LN03 PLUS. ANY ATTEMPT TO ENTER GIN MODE INSTEAD ACTIVATES ALPHA MODE AND DOES NOT SET THE BYPASS CONDITION

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Figure 3-1 Operating Modes Chart

3.3 USING ESCAPE SEQENCES AND CONTROL CHARACTERS

The LN03 PLUS accepts C0 control characters, printable characters, and escape sequences as part of the Tektronix protocol.

In the LN03 PLUS, a control character is a single character in the range from 0/0 to 1/15 in the ASCII chart (Figure 2-3). A printable character is a single character in the range from 2/1 through 7/14 in the ASCII chart. An escape sequence consists of a single control or printable character preceded by an escape character.

DECTEK and DECSTR are the only multiple-character escape sequences used in Tektronix emulation mode.

The printer ignores any command that is not a valid Tektronix command or printable character. If a command is a valid Tektronix command but is not implemented in the LN03 PLUS, it is either ignored or implemented using an appropriate fallback presentation.

Table 3-1 lists the valid ASCII control characters (not preceded by ESC) that you can use when the LN03 PLUS is in Tektronix emulation mode.

Table 3-1 C0 Control Characters

Mnemonic	Code	Name	Action
BEL	0/7	Bell	Clears a bypass condition. (See Paragraph 3.8.)
BS	0/8	Backspace	Moves the active position one space to the left. If the active position is already in column 1, BS has no effect. If the active position is moved onto an existing Alpha character, the next character overstrikes the existing one.
HT	0/9	Horizontal tab	Moves the active position one space to the right. If the active position is already at the end of the line, HT causes an automatic line feed and a carriage return.

Table 3-1 C0 Control Characters (Cont)

Mnemonic	Code	Name	Action
LF	0/10	Line feed	Moves the active position down one line. If the active position is already at the bottom, LF causes it to move to the top of the Tekpage and to switch margins. (See Paragraph 3.4.3.) LF also clears a bypass condition.
VT	0/11	Vertical tab	Moves the active position down one line. If the active position is already at the bottom of the Tekpage, VT has no effect.
CR	0/13	Carriage return	Moves the active position to the current left margin without advancing the line. Resets the printer from Graph mode to Alpha mode. Clears a bypass condition.
ESC	1/11	Escape	Introduces an escape sequence. If an escape sequence is already in progress, it is aborted and a new one is initiated.
FS	1/12	File separator	Sets the printer to Point Plot mode. FS also resets the active vector pattern to solid.
GS	1/13	Group separator	Sets the printer to Graph mode.
RS	1/14	Record separator	Sets the printer to Incremental Plot mode.
US	1/15	Unit separator	Resets the printer from Graph mode to Alpha mode, clears a bypass condition, and sets the vector pattern to solid.

Table 3-2 lists the valid escape sequences that you can use when the LN03 PLUS is in Tektronix emulation mode.

Table 3-2 Control Characters Preceded by the Escape Code

Code		Function
ESC	BEL	Same as BEL (bell).
1/11	0/7	
ESC	BS	Same as BS (backspace).
1/11	0/8	
ESC	HT	Same as HT (horizontal tab).
1/11	0/9	
ESC	LF	Same as ESC CR.
1/11	0/10	
ESC	VT	Same as VT (vertical tab).
1/11	0/11	
ESC	FF	Sets Alpha mode, erases the Tekpage, moves the
1/11	0/12	active position to the home position (top left corner), clears EGM mode, makes margin 1 active, ejects the page, and clears a bypass condition.
ESC	CR	Some computer configurations require periodic line
1/11	0/13	terminators to work properly. Use ESC CR followed by some no-op control code to imbed CRs in the Tektronix file. For example, the entire sequence ESC CR ACK is ignored by the printer.
ESC	CAN	Sets a bypass condition in order to inhibit the
1/11	1/8	printer response to data echoed by the host.
ESC	SUB	Bypasses GIN mode and sets Alpha mode. Does not set
1/11	1/10	Bypass mode.
ESC	FS	Sets the printer to Point Plot mode and selects the
1/11	1/12	solid vector pattern.
ESC	GS	Same as GS (sets Graph mode).
1/11	1/13	
ESC	RS	Same as RS (sets Incremental Plot mode).
1/11	1/14	
ESC	US	Same as US (resets Alpha mode).
1/11	1/15	

NOTE: The LN03 PLUS ignores the ESC ETB and ESC ENQ sequences.

3.3.1 Escape Followed by Printable Characters

You can use ESC followed by printable characters to enter and exit 4010/4014 mode, select the alpha (text) character size, or select the vector type. These escape sequences are described in the following paragraphs.

3.4 ALPHA MODE

In Alpha mode, text (noncontrol) characters are printed in the currently selected size. You can choose from four character sizes using an escape sequence (Paragraph 3.4.2). The text display is also affected by the choice of margin, as explained in Paragraph 3.4.3.

To enter Alpha mode, use the following escape sequence.

ESC	FF
1/11	0/12

In addition to selecting Alpha mode, this sequence also performs the following.

Erases the Tekpage
Moves the cursor position to the top left corner
Clears the high resolution (extra byte) condition
Makes left margin 1 active
Ejects the page
Clears the bypass condition

You can also set Alpha mode using the following commands.

CR (0/13)	From Graph mode (also moves the cursor to left margin 1). This command is ignored if an ESC CR sequence was previously received.
US and **ESC US** (1/15) (1/11 1/15)	From Graph mode

NOTE: Because the LN03 PLUS does not support GIN mode, attempting to display the crosshair cursor on a terminal puts the printer in Alpha mode. Bypass mode is NOT selected as a result of this transition. The ESC ENQ sequence is ignored in every mode.

Application software should not use this as a method to enter Alpha mode, because it may not be implemented in future products.

3.4.1 Fonts

While in Tektronix emulation mode, the LN03 PLUS can use two built-in fonts. The 14 point Modern Gothic font (DMDRNGTH) (see Paragraph 2.1) is used for the two large character cell sizes. The 6.7 point Courier font (DCOURIR) is used for the two small character cell sizes. (See Paragraph 3.4.2.)

3.4.2 Character Sizes

There are four character cell sizes available for Tektronix text printing. You can select them using an escape sequence consisting of ESC followed by a printable character as shown in the following list. Table 3-3 lists the character size characteristics.

ESC 8 1/11 3/8	Select largest character size (default)
ESC 9 1/11 3/9	Select medium large character size
ESC : 1/11 3/11	Select medium small character size
ESC ; 1/11 3/11	Select smallest character size

Table 3-3 Character Size Characteristics

Size Char	Chars/ Line	Lines/ Page	Chars/ Inch	Lines/ Inch
8	74	35	7.14	4.55
9	81	38	7.89	4.92
:	123	58	12.00	7.69
;	134	64	13.04	8.33

If you created a user-defined font that you want to down-line load, you have to use the DECLFF command. (See the *LN03 Programmer Reference Manual.*) Use the full font file ID name given in Paragraph 2.1.

The summary sheet (Figure 5-1) shows the built-in default fonts available with the LN03 PLUS.

3.4.3 Margin Processing

This function provides two-column text writing. When the LN03 PLUS is in Alpha mode and receives printable characters without intervening control characters, the characters are printed using two different left margins, but the same right margin.

Left margin 1 is an imaginary vertical line running down the left edge of the Tekpage. Left margin 2 is an imaginary vertical line running down the middle of the Tekpage.

When margin 1 is active, rows of characters are written from the left edge of the Tekpage to the right edge. When margin 2 is active, rows of characters are written from the middle of the display area to the right edge.

To "switch margins" is to activate the currently inactive left margin, that is, to begin writing characters at the other margin. The only way you can switch margins is by performing a line feed when the active position is on the last line of the page.

In this case, the characters are printed as follows.

1. The first row of characters is printed from the top of margin 1 to the top right corner of the Tekpage.
2. When the right edge is reached, wraparound occurs to the next character row down on margin 1.
3. Rows of characters continue until the bottom row has been written.
4. The first character that does not fit in the bottom row wraps to the top middle of the Tekpage, activating margin 2.
5. A row of characters is written from the top of margin 2 to the top right corner (overstriking any characters already written there).
6. When the right edge is reached, wraparound occurs to the next character row down on margin 2.
7. Rows of characters are written left-justified at margin 2 until the bottom row has been written.
8. The first character that does not fit in the bottom row wraps to the top left corner of the Tekpage, activating margin 1, and the process begins again.

Figure 3-2 shows an example of margin use.

EXAMPLE:
TYPE THE FOLLOWING CHARACTERS:
1 <CR> <LF> 2<CR> <LF> 3<CR> <LF>.....40 <CR>
THE LN03 PLUS WILL PRINT IN TWO MARGINS

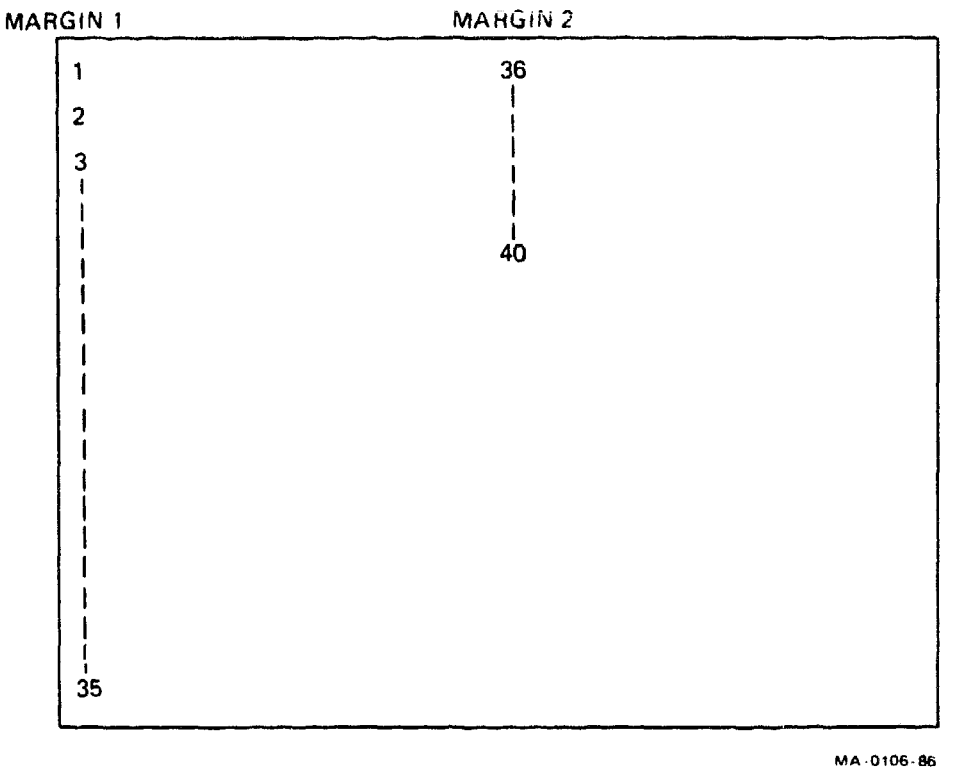


Figure 3-2 Left Margins 1 and 2

You can use this function together with carefully inserted carriage returns (CRs) and other formatting commands (like LF) to allow text writing in either one column (full width) or two columns (half width).

If you need one-column writing, enter ESC FF at the bottom of the page before the wraparound to margin 2 occurs. If you need two-column writing, insert CR and LF in each row before the text reaches margin 2, so that the wraparound does not overstrike any characters.

NOTE: Alpha mode text can be transparent if you select a transparent vector in a preceding Graph mode. (See Paragraph 3.5.3.) This means that the writing position is updated, but active characters are not printed.

3.5 GRAPH MODE

In Graph mode, the LN03 PLUS interprets characters as absolute addresses for the endpoints of vectors. Vectors are drawn between these specified absolute coordinates. Vectors may be drawn in any of five line patterns and two thicknesses. Normal vector thickness is three pixels wide, and bold thickness is five pixels wide.

To enter Graph mode, use the following commands.

GS	or	**ESC GS**
1/13		1/11 1/13

You can exit Graph mode to the other operating modes using the following commands. (See Figure 3-1, Table 3-1, and Table 3-2 for detailed mode interactions and additional command functions.)

To Alpha mode — **US**, **CR**, **ESC US**, and **ESC FF**
To Point Plot mode — **FS**
To Incremental Plot mode — **RS**

NOTE: Using the US command in Graph mode sets the printer to Alpha mode with the cursor in the same position as it was in Graph mode. Using the CR command in Graph mode sets the printer to Alpha mode with the cursor set at the left margin 1.

In Graph mode, the ESC ? (1/11 3/15) sequence is equivalent to the DEL character, which is the encoding of a Lo Y coordinate value of 11111.

3.5.1 Position Setting and Vector Drawing

The control character you use to invoke Graph mode is GS. The graph cursor position is kept from the alpha cursor position. The first coordinate after GS is interpreted as the position to which the first vector should be drawn. Usually the first vector is transparent (invisible) to establish the starting point.

You can select a vector type (pattern) in any operating mode. Vector patterns are described in Paragraph 3.5.3.

Vector Drawing Examples

1. If the drawing position is at point A when GS is received, the following commands both draw three vectors, from point A to point B, from point B to point C, and from point C to point D (Figure 3-3, A).

   GS A B C D
   GS BEL B C D

2. The following command draws vectors from A to B and from C to D (Figure 3-3, B).

   GS A B GS C D

If the endpoints of a vector both describe the same point, that point is "turned on." You can use this as a point plotting method.

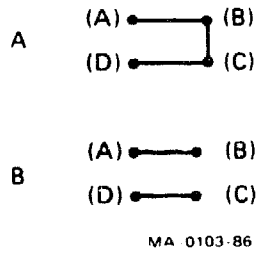


Figure 3-3 Drawing the Vectors

3.5.2 Encoding of Coordinates and High/Low Resolution

Graph mode coordinates are encoded into four bytes (in 10-bit addressing mode) or five bytes (in 12-bit addressing mode). The standard 10-bit addressing provides low resolution images with the 1024 × 768 Tekpoint matrix. The EGM (12-bit) mode provides high resolution with the 4096 × 3072 Tekpoint matrix. The extra fifth byte contains two low order bits of the X and Y coordinate address (Figure 3-4).

In EGM mode, the positioning resolution changes to 0.75 pixels per Tekpoint. You can build sharper images using the high resolution method.

Table 3-4 shows the transmission order and format of these bytes.

On receiving the extra byte needed in 12-bit addressing, the printer logically changes the addressable grid size to one-fourth the default grid size and repositions the bits of the received address coordinates.

Figure 3-4 shows examples of 10-bit and 12-bit screen/page addressing.

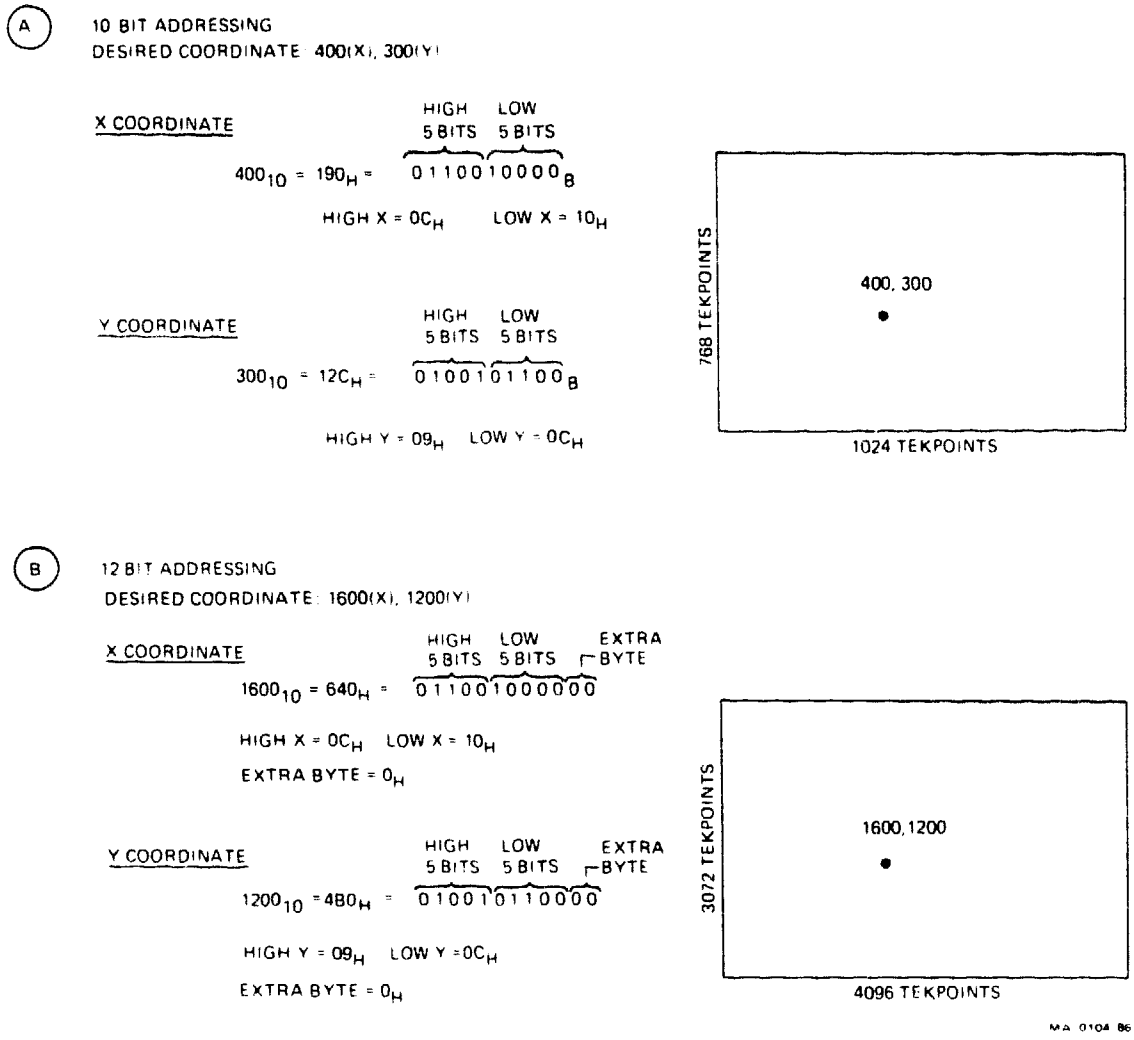


Figure 3-4 Screen/Page Addressing

Table 3-4 Coordinate Encoding Byte Values

	7-Bit ASCII Character						
	Tag Bits		Address Bits				
Byte Name	7	6	5	4	3	2	1
High order Y (Hi Y)	0	1	5 MSB of Y address				
Extra byte	1	1	*	Y2	Y1	X2	X1
Low order Y (Lo Y)	1	1	5 intermediate bits of Y address				
High order X (Hi X)	0	1	5 MSB of X address				
Low order X (Lo X)	1	0	5 intermediate bits of X address				

*Setting this bit makes margin 1 active.

NOTE: MSB is the most significant (leftmost) bit in a byte.

If you send an extra byte of 0 (null), the shrinkage of the grid size and the shifting of the address cancel each other, and the vector appears the same size as it would have without the extra byte.

If the extra byte is nonzero, one to three high resolution Tekpoints are added to the desired address. This has a significant effect on the length of a vector image only if you plot many small vectors chained together.

The ESC FF and CR commands reset the last received extra byte to 0 (null). This returns the printer to the default, low resolution printing.

Tektronix emulation mode also supports shortened address transmission in either 10-bit or 12-bit addressing. That is, when only parts of the address change, only certain bytes need to be sent. Table 3-5 describes the shortened address transmission rules.

Table 3-5 Shortened Address Transmission Rules

Bytes That Change	Bytes That Must Be Sent				
	Hi Y	Lo Y	Hi X	Lo X	Extra
Hi Y	Yes			Yes	
Lo Y		Yes		Yes	
Hi X		Yes	Yes	Yes	
Lo X				Yes	
Extra byte					Yes

3.5.3 Vector Patterns

The LN03 PLUS supports five line patterns — solid, short-dashed, long-dashed, dotted, and dot-dashed. Any of these patterns can be printed in normal thickness or bold. Bold vectors are significantly thicker than the normal vectors (five versus three pixels wide). You can also specify write-through (see the Glossary) on any of the five patterns. On the LN03 PLUS, write-through is interpreted as transparent (invisible) drawing. That is, the drawing position is updated as though the vector was done without putting down the pen.

All patterned vectors begin with the longest part of the pattern. For example, the dot-dashed vector starts with a dash.

Table 3-6 describes the vector patterns that you can select and the escape sequences needed for each selection. Figure 3-5 shows the vector patterns.

Table 3-6 Vector Pattern Selections

Escape Sequence	Vector Pattern
ESC '	Normal (solid) vector pattern, normal intensity
ESC a	Dotted vector pattern, normal intensity
ESC b	Dot-dashed vector pattern, normal intensity
ESC c	Short-dashed vector pattern, normal intensity
ESC d	Long-dashed vector pattern, normal intensity
ESC e	Normal (solid) vector pattern, normal intensity
ESC f	Normal (solid) vector pattern, normal intensity
ESC g	Normal (solid) vector pattern, normal intensity
ESC h	Normal (solid) vector pattern, bold intensity
ESC i	Dotted vector pattern, bold intensity
ESC j	Dot-dashed vector pattern, bold intensity
ESC k	Short-dashed vector pattern, bold intensity
ESC l	Long-dashed vector pattern, bold intensity
ESC m	Normal (solid) vector pattern, bold intensity
ESC n	Normal (solid) vector pattern, bold intensity
ESC o	Normal (solid) vector pattern, bold intensity
ESC p	Normal (solid) vector pattern, transparent
ESC q	Dotted vector pattern, transparent
ESC r	Dot-dashed vector pattern, transparent
ESC s	Short-dashed vector pattern, transparent
ESC t	Long-dashed vector pattern, transparent
ESC u	Normal (solid) vector pattern, transparent
ESC v	Normal (solid) vector pattern, transparent
ESC w	Normal (solid) vector pattern, transparent

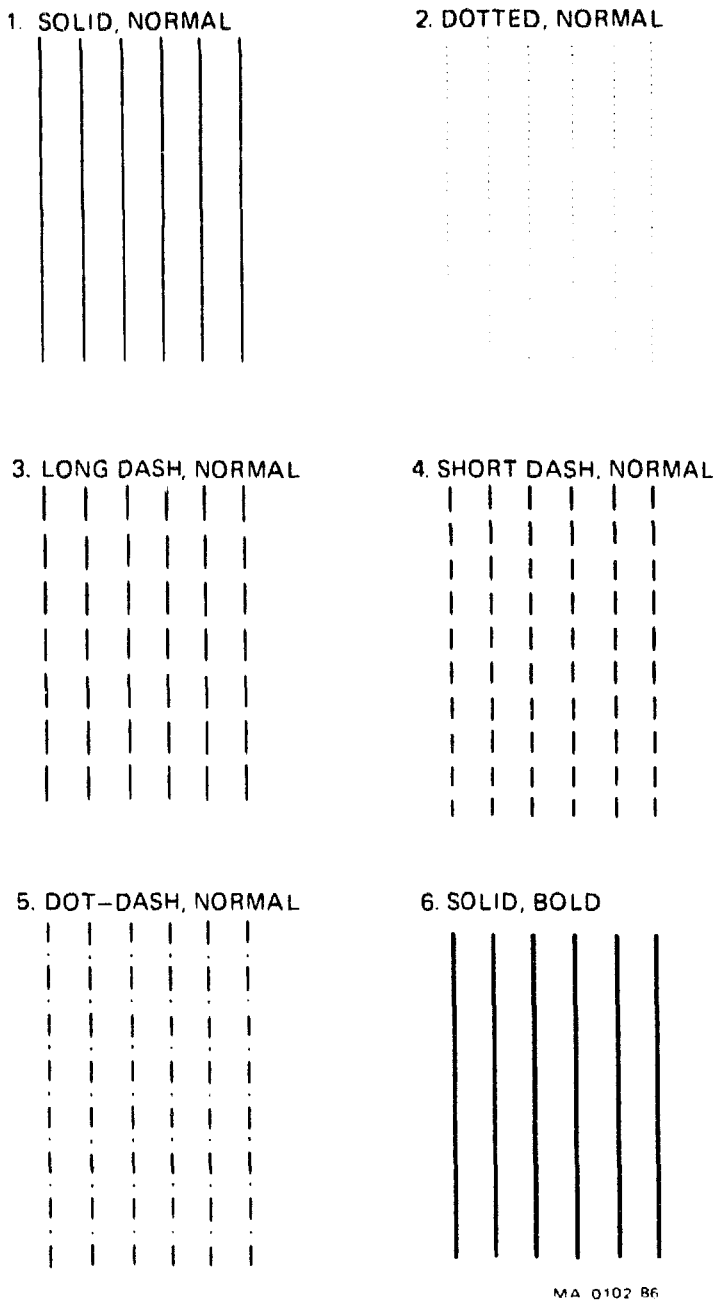


Figure 3-5 Vector Patterns

3.6 POINT PLOT MODE

Point Plot mode is similar to Graph mode except that only the endpoints are plotted, not the vectors.

NOTE: The Tektronix 4014 Special Point Plot mode is not supported in the LN03 PLUS. When you request Special Point Plot mode, the printer enters regular Point Plot mode.

Software should always use the ESC command when regular Point Plot mode is desired, because this fallback may not be implemented in future products.

Point plot coordinate values are transmitted in the same way as the coordinate values in Graph mode that support 10-bit and 12-bit addressing.

You can enter Point Plot mode from Alpha or Graph modes by using the following commands.

FS	or	**ESC**	**FS**	(fallback)
1/12		1/11	1/12	

Once in Point Plot mode, you do not need to send the FS character again. The second endpoint of each vector (including the first vector after FS) is always plotted.

Cursor positioning is the same as in Graph mode.

3.7 INCREMENTAL PLOT MODE

In Incremental Plot mode, points are plotted relative to the current position using the special characters listed below. Plotting is done with a logical "pen" that must be "lowered" to the paper to make plotting visible.

You can enter Incremental Plot mode from any other mode using the following commands.

RS	or	**ESC**	**RS**
1/14		1/11	1/14

This is high resolution mode with the Tekpoint as small as 0.75 pixel. Because the increment is so small, you may sometimes need to enter a command character twice in order to move the drawing point far enough to turn on a new physical pixel. (The visible matrix is 4096 × 3072 in this mode.)

While in Incremental Plot mode, you can plot the points using the following command characters.

space (SP, 2/0)	Pen up
P	Pen down
D	Up (north)
E	Up right (northeast)
A	Right (east)
I	Down right (southeast)
H	Down (south)
J	Down left (southwest)
B	Left (west)
F	Up left (northwest)

NOTE: All these characters must be uppercase.

The space (SP) and P characters act as the pen up/pen down commands in an imaginary plotter, allowing you to stop drawing at one point and continue at another point on a page. However, these commands themselves do not change the active position. The space (SP)only turns the pen off. You then have to enter the correct directional letters to move to the new active position, where P turns the pen back on.

NOTE: The pen position is reset to "up" when the printer first receives the RS command. The pen must be "lowered" to draw.

3.8 BYPASS MODE

In Bypass mode, the LN03 PLUS printer ignores any alpha (text) data received from the host computer. Text data is not displayed, and the cursor position is not updated.

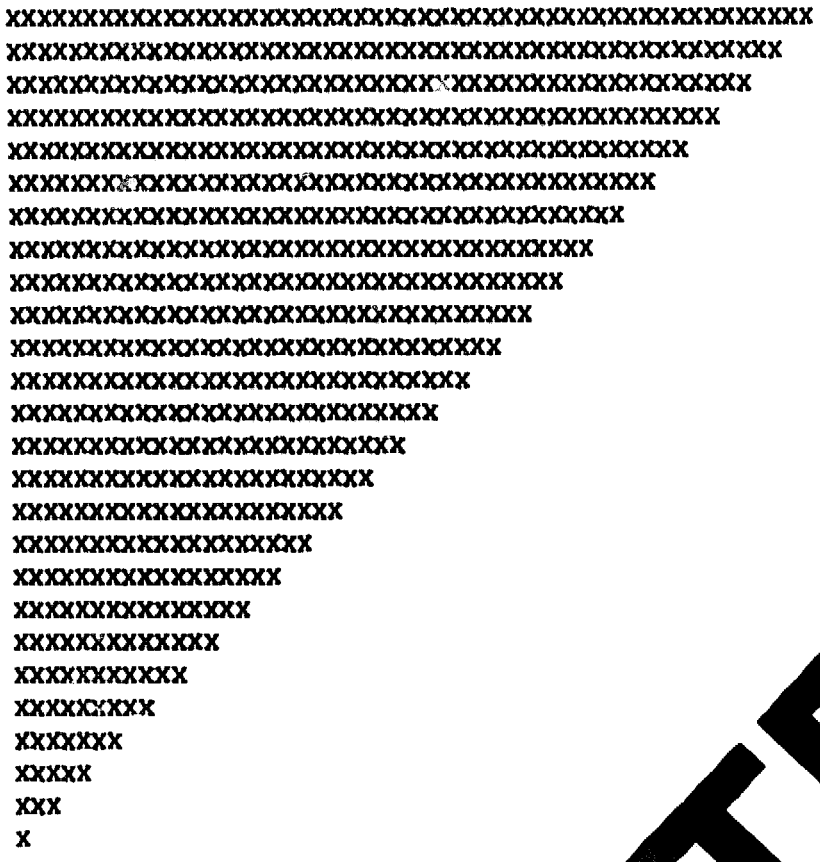
Bypass mode is only supported when you invoke it from the host computer. This is an overall mode that you can enter or reset while the printer is in any other operating mode.

You can enable Bypass mode by using the following sequence.

ESC	CAN
1/11	1/8

Bypass mode is cleared by any of the following control commands. (Tables 3-1 and 3-2 describe these commands.)

ESC CR
ESC LF
ESC FF
ESC US
ESC BEL
CR
LF
US
BEL
Executing a bold or normal vector in Graph mode.
Plotting a point in Point Plot mode.



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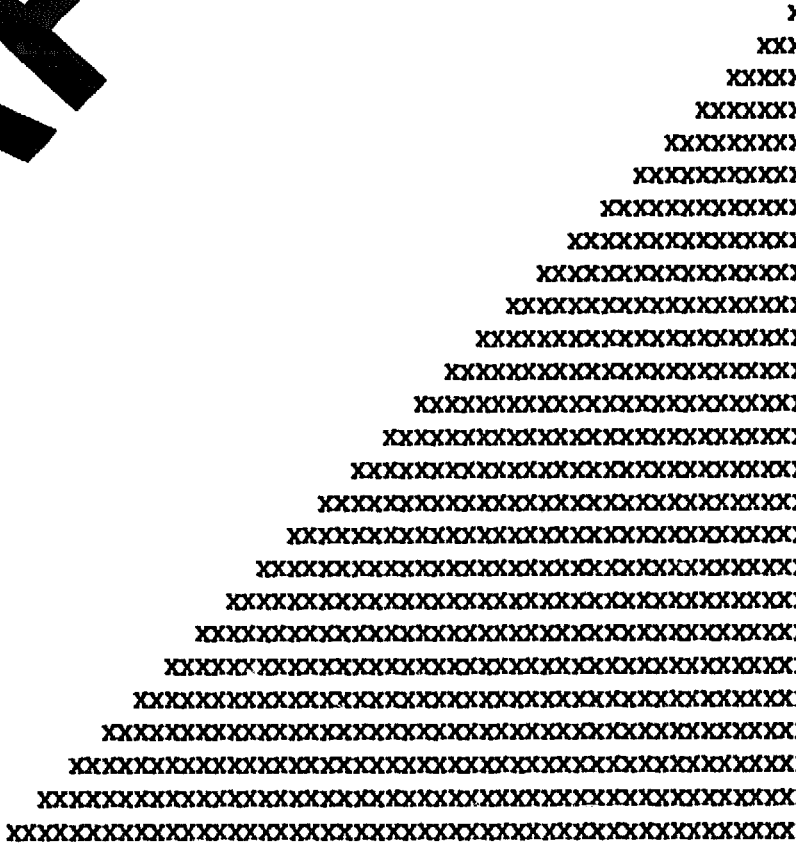


SIXEL GRAPHICS 4

4.1 INTRODUCTION

This chapter describes how to select DEC sixel mode. In sixel mode, you can print graphs and other drawings. The chapter also describes how you should send sixels if you want compatibility with other printers or if you want the best quality graphics to be printed on the LN03 PLUS. In addition, there are examples of sixel strings at the end of the chapter.

LN03 PLUS sixel graphics differ from base LN03 sixels. These differences are mentioned in this chapter.

A sixel is a column of six vertical pixels that represent bitmap data for a graphic image. In text mode, a pixel is considered 1/300 inch. In sixel mode, a pixel can vary in size and may consist of one or more dots, depending on the sixel string received and the capabilities of the printer. The LN03 PLUS can print 300 dots per inch and so the LN03 PLUS can be programmed to print up to 300 pixels per inch.

A dot represents the individual ink dots on a printed page (Figure 4-1). A pixel represents one or many dots (arranged in a square or rectangle) that are printed as a group. A sixel defines six pixels arranged as a vertical column. A graphics picture consists of sixels printed, sequentially, across the page in sixel lines. A picture with large pixels requires fewer sixels to define the picture, but it is coarser in resolution than a picture with small pixels.

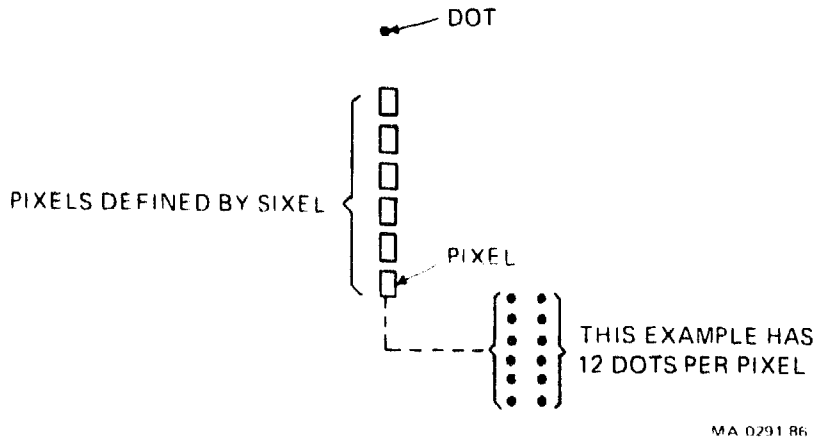


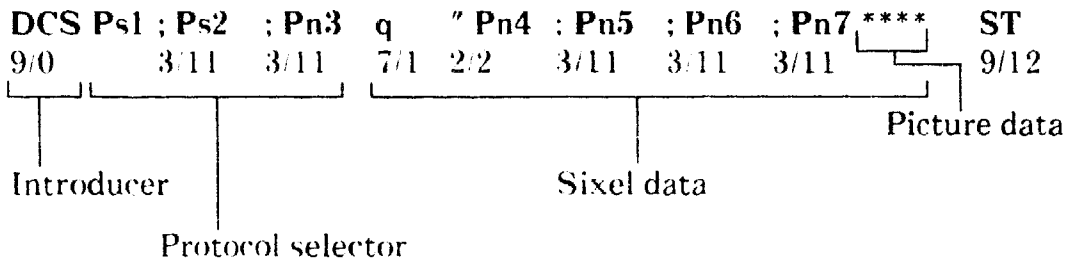
Figure 4-1 Sixel Representation

Figure 4-1 Sixel Representation

Sixels are coded as 8-bit bytes. Each byte is an ASCII character code. Paragraphs 6.3 and 6.4 of the *LN03 Programmer Reference Manual* describe the coding and decoding processes. When you select sixel mode, the printer interprets the ASCII character codes as sixel data. The printer processes sixel data as bits of information. A bit value of 1 means print the pixel. A bit value of 0 means do not print the pixel (leave a space).

4.2 SELECTING SIXEL MODE

You select sixel mode by sending the following device control string (DCS), which includes the sixel data. (Refer to the *LN03 Programmer Reference Manual* for the use of other device control strings, such as Load Font File.) This section describes the elements of the string and how you use it to print graphics.



Two types of software are typically used on the host computer to create text and graphic data. The first is the creation software, used to draw the picture. The second is the page composition software, used to integrate the picture with the text into a formatted page.

The picture data (everything after the q in the string) is determined by the creation software. The protocol selector parameters are determined by the page composition software.

4.2.1 DCS Introducer and Protocol Selector

The DCS introducer and the protocol selector place the printer in sixel mode. The protocol does not have an initial state. The printer interprets the parameters in the protocol selector as follows.

NOTE: You can use the 8-bit DCS control code or the 7-bit ESC P escape sequence for the the string introducer. You can use ST or ESC \ for the string terminator.

4.2.1.1 Ps1 Parameter (Macro Parameter) - Ps1 has fixed values that are decoded by the printer to provide a known horizontal grid size, vertical grid size, and pixel aspect ratio. Table 4-1 lists the LN03 PLUS Ps1 values available along with the assigned grids and ratio. The horizontal grid size (the horizontal distance between each sixel) specifies how wide (in dots) each pixel will be. The vertical grid size (the vertical distance between the tops of each pixel) specifies how high (in dots) each pixel will be. The aspect ratio specifies the relationship between the vertical and horizontal grids.

Table 4-1 LN03 PLUS Fixed Grid Sizes

Ps1	HGS Inches	Inches	Aspect Ratio Vertical:Horizontal	VGS Inches	Inches
0	.0067	1/150	200:100	.0133	1/75
1	.0067	1/150	200:100	.0133	1/75
2	.0030	1/337.5	450:100	.0133	1/75
3	.0044	1/225	300:100	.0133	1/75
4	.0053	1/187.5	250:100	.0133	1/75
5	.0067	1/150	200:100	.0133	1/75
6	.0089	1/112.5	150:100	.0133	1/75
7	.0103	1/97.5	130:100	.0133	1/75
8	.0119	1/84	112:100	.0133	1/75
9	.0133	1/75	100:100	.0133	1/75

HGS = Horizontal Grid Size
VGS = Vertical Grid Size

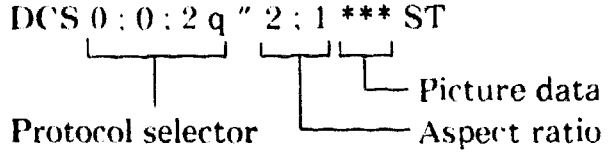
4.2.1.2 Ps2 Parameter - Ps2 selects a background color. The printer ignores this parameter. However, if you are creating sixel data that could be used on a device that has background color capability, you should include a value for Ps2.

4.2.1.3 Pn3 Parameter - Pn3 lets you select any horizontal grid size. Any Pn3 value other than 0 overrides the Ps1 value for horizontal grid size only. The aspect ratio selected by Ps1 remains in effect. To select a new aspect ratio, you must enter a raster attribute control character (") followed by Pn4 and Pn5 values immediately after the letter q. The control character " and the Pn4 and Pn5 values are the first characters in the sixel data stream.

NOTE: The Pn3 parameter overrides the Ps1 parameter for horizontal grid size, which means the vertical grid size changes accordingly.

The Pn3 measurement units can be in decipoints (1/720 inch) or pixels (1/300 inch), selected by the select size unit (SSU) sequence. (The default setting for SSU is decipoints.) If SSU is in pixels, the horizontal grid size is arrived at based on the 300 dots per inch resolution of the LN03 PLUS. In other words, the printer can print 300 dots of ink in one inch. So when you make a Pn3 selection, you are selecting the number of ink dots to print horizontally in a pixel. If the SSU sequence is set for decipoints, the printer does a conversion to 1/300 inch before printing, positioning the sixels so that any positioning error does not accumulate. This positioning may result in unwanted patterns in certain gray-scaled or cross-hatching patterns. (See Paragraph 4.3.2.)

The Pn3 value and the pixel aspect ratio define the grid size (including the vertical grid size). For example, if the SSU sequence is set for pixel units, the following DCS will result in a horizontal grid of .0067 inch (horizontal distance between each pixel) and a vertical grid of .0133 inch (vertical distance between the tops of each pixel). This will result in a pixel size of two dots wide by four dots high. The horizontal resolution will be 150 pixels per inch. The vertical resolution will be 75 pixels per inch.



(Ps1 = 0, Ps2 = 0, Pn3 = 2)

To get a horizontal resolution of 300 pixels per inch, you would send the following string.

DCS 0 ; 0 ; 1 q " 100 ; 100 **** ST

NOTE: For picture consistency, it is recommended that you use lines that are at least two dots thick.

4.2.2 q Character

The q (7/1) character indicates the selected protocol is sixels and signifies the start of the sixel data stream.

4.2.3 Sixel Data

You can embed control characters and printable characters in the sixel data stream. The printer responds to the control characters listed in Tables 4-2 and 4-3. The printer responds to printable sixel codes in the 3/15 to 7/14 range. Graphic right (GR) codes in the range 10/0 through 15/15 are stripped of the eighth bit and should not be used. (Paragraph 6.4 of the *LN03 Programmer Reference Manual* describes how the printer interprets printable codes.)

After entering the sixel mode, the printer determines the current sixel horizontal position from the text position. This position becomes the graphic left margin. The top pixel starts 70 decipoints above the baseline of the last character printed in text mode. If the position is at the top margin, the uppermost pixel prints just below the top margin. This establishes the sixel baseline. The portrait or landscape orientation in effect when sixel mode was entered remains in effect.

NOTE: If the last character printed in text mode was a small (less than 7 point) character on the first line of a page, then the top of the first sixel line to be printed will be partially clipped.

As each sixel is printed, the active position advances to the next horizontal grid position. The distance moved is equal to the horizontal grid selected by Ps1 or Pn3. Sixels do not print beyond the margins. Any sixel that exceeds the right margin is clipped. Any sixel that exceeds the bottom margin causes a page to eject.

Positioning is always relative to the active position. You cannot move backward, except by using the graphic carriage return and the graphic new line control characters (Table 4-3). A graphic carriage return returns the active position to the graphic left margin on the same sixel line. This causes sixels to overprint. A graphic new line advances the active position to the graphic left margin and down one sixel line. The top pixel of the new line is printed just below the last pixel of the previous sixel line.

Table 4-2 ANSI Graphic Control Characters

Name	Mnemonic	Column/ Row	Function
Cancel	CAN	1/8	Causes the printer to abort sixel mode (error condition).
Substitute	SUB	1/10	Is processed as a blank sixel (3/15).
Escape	ESC	1/11	Causes the printer to leave sixel mode and process ESC as the start of a new escape sequence.
All C1 control codes		8/0 through 9/15	Any C1 code causes the printer to abort sixel mode and process that C1 code (error condition).

NOTE: The printer treats other control codes in the 0/0 through 1/15 range as errors and ignores them.

Table 4-3 Private Control Characters

Name	Mnemonic	Code	Function
Graphics repeat introducer	DECGRI	! 2/1	DECGRI starts a repeat sequence. This is followed by a decimal integer that indicates how many times to repeat the next sixel code. If you omit the integer or use a value of 0, the printer uses 1. The maximum DECGRI value is 32767.
Raster attributes	DECGRA	" 2/2	DECGRA signifies the pixel aspect ratio follows. (See Paragraph 4.2.3.1.)
Graphic carriage return	DECGCR	$ 2/4	DECGCR returns the horizontal active position to the graphic left margin (the point where sixels were entered). This can be used to overprint a line of sixels.
Graphic new line	DECGNL	- 2/13	DECGNL returns the active position to the graphic left margin and down for the next line of sixels.

NOTE: The following codes are reserved for future use.

(space)	2/0	.	2/12
%	2/5	.	2/14
&	2/6	/	2/15
'	2/7	:	3/10
(	2/8	<	3/12
)	2/9	=	3/13
*	2/10	>	3/14
+	2/11		

These codes will abort any DECGRI or DECGRA sequence in progress. Software should not use these codes.

4.2.3.1 Raster Attribute Character (") - The raster attribute character " (2/2) shown in the DCS string is optional. However, when used in the LN03 PLUS, it must be the first charcter in the sixel data stream. If " is not the first character in the sixel data stream, it is ignored. This character signifies the next two parameters Pn4 and Pn5 will be the aspect ratio numerator and denominator, respectively.

4.2.3.2 Pn4 and Pn5 Parameters - Pn4 and Pn5 parameters define the aspect ratio (shape of the pixel). Pn4 can be any decimal integer, and it is the numerator of the ratio. Pn5 can be any decimal integer, and it is the denominator of the ratio.

$$\text{Aspect ratio} = \frac{\text{Vertical}}{\text{Horizontal}} = \frac{\text{Pn4}}{\text{Pn5}}$$

The values for Pn4 and Pn5 are separated in the DCS string by a semicolon (;). (Anything other than a decimal integer (3/0 to 3/9) terminates the ratio value.) Using the ratio and the horizontal grid size, you can define the vertical grid size.

The ratio defines the shape of the pixel. For example, if the pixel is to be twice as high as wide, the ratio will be 2:1 or 200:100. The vertical grid will be twice the size of the horizontal grid size. Because the horizontal grid size is fixed by Ps1 or Pn3, the aspect ratio defined by Pn4 and Pn5 affects only the vertical grid size.

4.2.3.3 Pn6 and Pn7 Parameters - Pn6 and Pn7 parameters are optional and are ignored by the LN03 PLUS. These parameters specify the vertical (height) and horizontal (width) size, respectively, of the intended image defined by the picture data. The unit for both the vertical and horizontal size is one grid size. You should use these parameters if the picture could ever be used on a device with gray scale or color capabilities, so that the graphic will have the right sized rectangle in some background color. This data is also useful for the page composition software on the host computer.

4.2.3.4 * Picture Data** - The picture data defines the graphic and may include acceptable control characters as indicated in Tables 4-2 and 4-3.

4.2.4 ST (String Terminator)

ST (9/12) causes the printer to leave sixel mode. On exiting sixel mode, the active horizontal position will be where you entered sixel mode. The active vertical position will be 70 decipoints below the top of the current sixel line.

4.3 COMPATIBILITY OR BEST QUALITY PRINTING

The Digital sixel graphics protocol is used on many printers. Previous printers, especially the impact dot matrix printers, provide only some of the functions available with the LN03 PLUS.

Different printers, regardless of their technology, tend to have different resolution capabilities (for example, 330 dpi, 300 dpi, or 72 dpi). So it is impossible for any two printers of different resolutions to print exactly the same picture in exactly the same way.

The LN03 PLUS sixel implementation is flexible enough to allow you to approximate the output of other Digital printers. However, because of the functionality and resolution restrictions among printers, this compatibility may be accompanied by some loss in quality of the LN03 PLUS output.

The following paragraphs describe how you can program the LN03 PLUS to:

- achieve compatibility with other printers, or
- produce the best quality printout.

4.3.1 Compatibility

The Ps1 parameter is designed to permit compatibility between printers with different grid sizes. This compatibility allows you to prepare a graphic on an impact dot matrix printer and have the final copy of the graphic output on the laser printer. Ps1 values listed in Tables 4-1 and 4-4 have been assigned to the LN03 PLUS and the base LN03, respectively.

Looking at Tables 4-1 and 4-4, you see that the LN03 PLUS vertical grid size (.0133 inch) is the same for each Ps1 value, while the base LN03 vertical grid size varies for each Ps1 value. So the LN03 PLUS graphic output will match dot matrix printers more closely than the base LN03, if Ps1 is used alone.

Table 4-4 Base LN03 Fixed Grid Sizes

Psl	HGS	Aspect Ratio Vertical:Horizontal		VGS
0	.0067	200:100	2:1	.0133
1	.0067	200:100	2:1	.0133
2	.0033	400:100	4:1	.0133
3	.0033	300:100	3:1	.0100
4	.0067	250:100	5:2	.0166
5	.0067	200:100	2:1	.0133
6	.0100	150:100	3:2	.0149
7	.0100	125:100	5:4	.0125
8	.0133	112:100	9:8	.0150
9	.0133	100:100	1:1	.0133

HGS = Horizontal grid size
VGS = Vertical grid size

Table 4-5 lists the Digital Standard grids and aspect ratios. Most Digital printers approximate these values within the restrictions of the device. When this data is compared to Tables 4-1 and 4-4, you will see that the LN03 PLUS numbers match very well except the LN03 PLUS will print a slightly smaller (4 percent) graphic.

NOTE: Only the horizontal grid size and aspect ratio are defined. The vertical grid size is determined by the restrictions of the printer.

Table 4-5 Digital Standard Grid Sizes

Ps1	HGS	Aspect Ratio Vertical:Horizontal	
0	.0075	200:100	2:1
1	.0075	200:100	2:1
2	.0030	450:100	9:2
3	.0045	300:100	3:1
4	.0060	250:100	5:2
5	.0075	200:100	2:1
6	.0090	150:100	3:2
7	.0105	130:100	5:4
8	.0120	112:100	9:8
9	.0135	100:100	1:1

HGS = Horizontal grid size
VGS = Vertical grid size

If you plan on having a graphic output on more than one printer (for example, a dot matrix printer as well as the LN03 PLUS), you should select the Ps1 value that is most compatible between the printers and the device being used to develop the sixel graphic.

Because the LA100/LA210 and other dot matrix printers in this class ignore all the parameters except Ps1, it is possible to gain some degree of device independence by specifying the Ps1 parameter (for the dot matrix printer) and then redefining the aspect ratio and grid sizes using Pn3, Pn4, and Pn5 (for the LN03 PLUS).

Table 4-6 shows the Ps1, Pn3, Pn4, and Pn5 values to include in a sixel file that will force each device to print as close as possible to the Digital Standard.

Table 4-6 LA100/LA210 Versus Base LN03/LN03 PLUS

File Parameters				LA100/LA210 Result			LN03/LN03 PLUS Result		
Ps1	Pn3	Pn4	Pn5	HGS	VGS	Ratio	HGS	VGS	Ratio
0	2	200	100	.0076	.0138	183:100	.0067	.0133	200:100
1	2	200	100	.0076	.0138	183:100	.0067	.0133	200:100
2*	2	450	100	.0030	.0138	465:100	.0028	.0125	450:100
3*	3	300	100	.0045	.0138	305:100	.0042	.0126	300:100
4*	4	250	100	.0060	.0138	230:100	.0056	.0145	250:100
5	2	200	100	.0076	.0138	183:100	.0067	.0133	200:100
6*	6-	150	100	.0090	.0138	150:100	.0083	.0125	150:100
7	3	130	100	.0106	.0138	130:100	.0100	.0130	130:100
8*	8-	112	100	.0121	.0138	115:100	.0111	.0124	112:100
9	4	100	100	.0136	.0138	100:100	.0133	.0133	100:100

* Printer must be in Decipoint mode (SSU 2).

\- Using one decipoint more than this will give an LN03 result that is closer to the Digital Standard but will result in exceeding the Digital Standard.

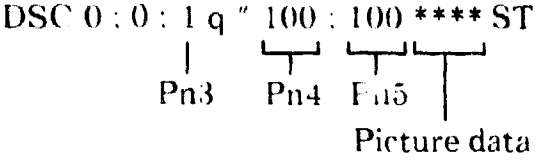
HGS = Horizontal grid size
VGS = Vertical grid size

Table 4-6 provides a result as close as possible to the Digital Standard for sixel printing (to the nearest decipoint grid size) without exceeding the grid size. If the goal in developing the sixel file is LA100/LA210 compatibility, you should use slightly different aspect ratios (Pn4 and Pn5). However, most video devices use the Digital Standard, because it gives a better match for video aspect ratios.

4.3.2 Quality

Each printer, whether it is a laser printer or an impact printer, has some print matrix (natural grid size) associated with it. Any horizontal or vertical grid size that is not an integral number of pixels can result in undesirable secondary patterns, which are especially noticeable in gray scales or cross-hatching. In other words, quality cannot be portable across matrices, although it is portable between devices using the same matrix.

Software packages that want quality over compatibility should override the macro parameter Ps1 and should use pixels for the size unit (SSU). To get 300 pixels per inch graphics on the LN03 PLUS, set SSU to pixels and use the following sixel string.



Using a 2 for Pn3 results in 150 pixels per inch graphics (at 1:1 aspect ratio). Using a 3 for Pn3 results in 100 pixels per inch, and so on.

NOTES:
Very thin lines vary in width, depending on the orientation of the line. To lessen the visual effect this has on pictures, use lines that are at least two dots in thickness wherever possible.

To do gray scale printing, use solid lines or use a dot pattern that is random in nature or has a coarse resolution. Using horizontal lines with the sixel repeat introducer (!) will reduce the transmission time for the image.

4.4 EXAMPLES

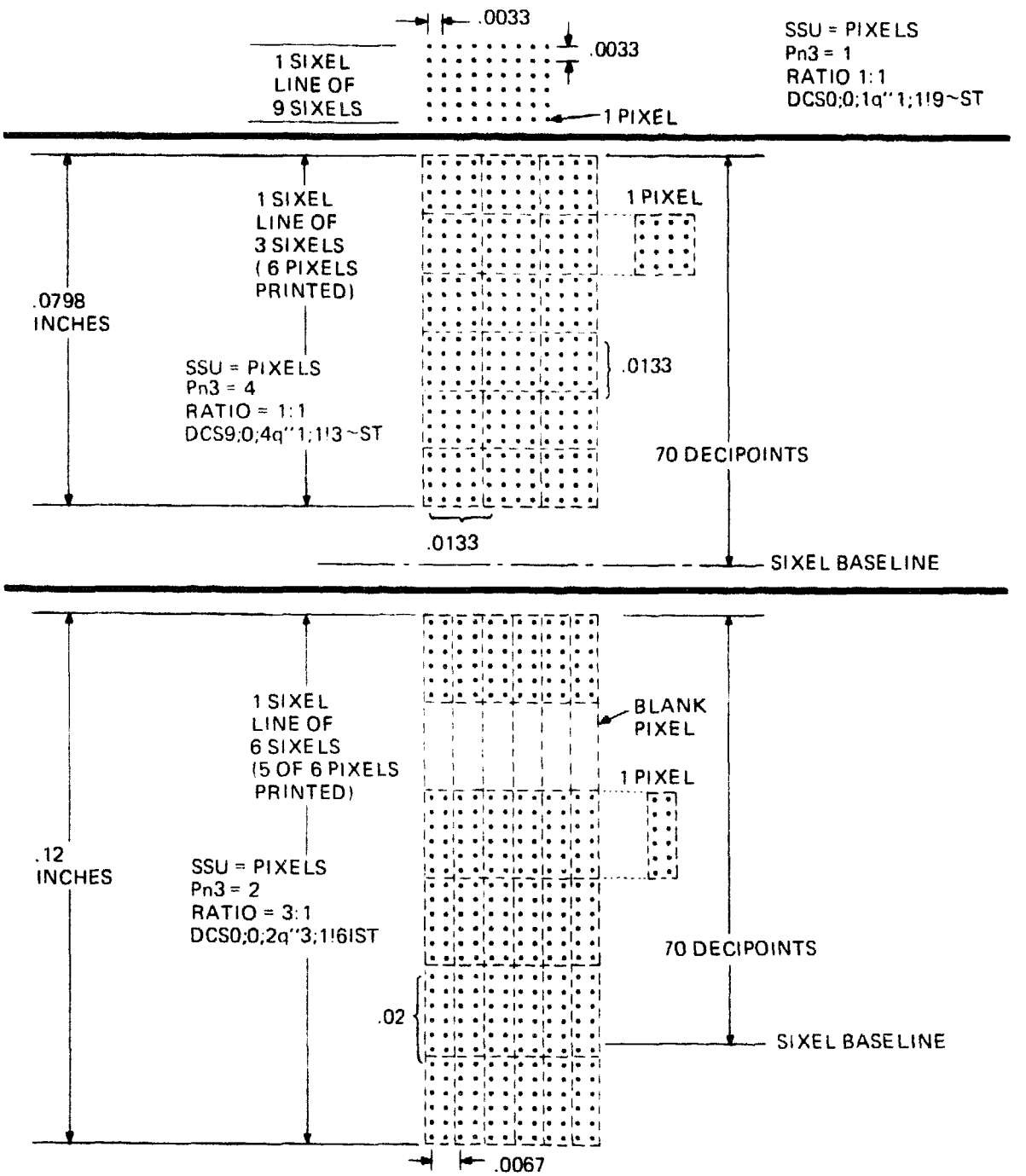
The following examples show you how to use the various parameters in the sixel string to print sixels. In each example, you can see that for a wider pixel (more dots) fewer sixels are required to achieve the same line length.

Example 1

This example is an exaggerated representation of three sixel lines with different Pn3 values and aspect ratios. The example shows the horizontal and vertical grid sizes for the parameters selected. The example also shows the number of dots for each pixel and the DSC string that would give you the sixel line.

To understand the actual size of the examples, think of a sixel as being a character with a height of 7 points, 10 points, 14 points, and so on. Since a point is 0.0137 inches high, the sixel lines of the example will be as follows.

1st sixel line — slightly taller than 1 point
2nd sixel line — slightly shorter than 6 point
3rd sixel line — slightly shorter than 9 point



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Example 2

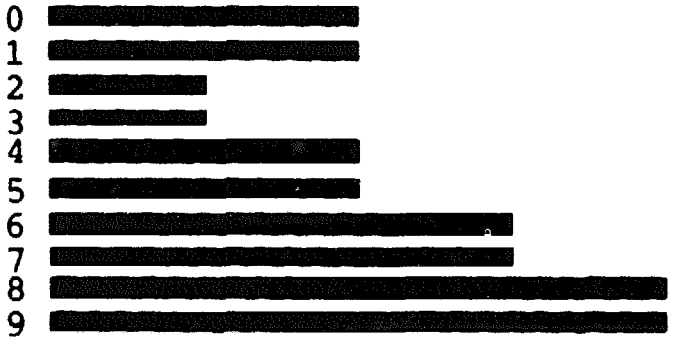
This example illustrates DCS strings (the 7-bit ESC P is the string introducer) that use the Ps1 values listed in Table 4-1 (LN03 PLUS Fixed Grid Sizes) and the graphic that results from each string. Each string has the Ps1 parameter (0, 1, 2, and so on), a repeat control character (!), the number of times to repeat (200), and the ~ character.

```
0 <ESC>P0q!200~<ESC>\
1 <ESC>P1q!200~<ESC>\
2 <ESC>P2q!200~<ESC>\
3 <ESC>P3q!200~<ESC>\
4 <ESC>P4q!200~<ESC>\
5 <ESC>P5q!200~<ESC>\
6 <ESC>P6q!200~<ESC>\
7 <ESC>P7q!200~<ESC>\
8 <ESC>P8q!200~<ESC>\
9 <ESC>P9q!200~<ESC>\
```

Example 3

This example illustrates DCS strings that use the Ps1 values listed in Table 4-4 (Base LN03 Fixed Grid Sizes) and the graphic that results from each string. Each string has the Ps1 parameter (0, 1, 2, and so on), a repeat control character (!), the number of times to repeat (200), and the ~ character.

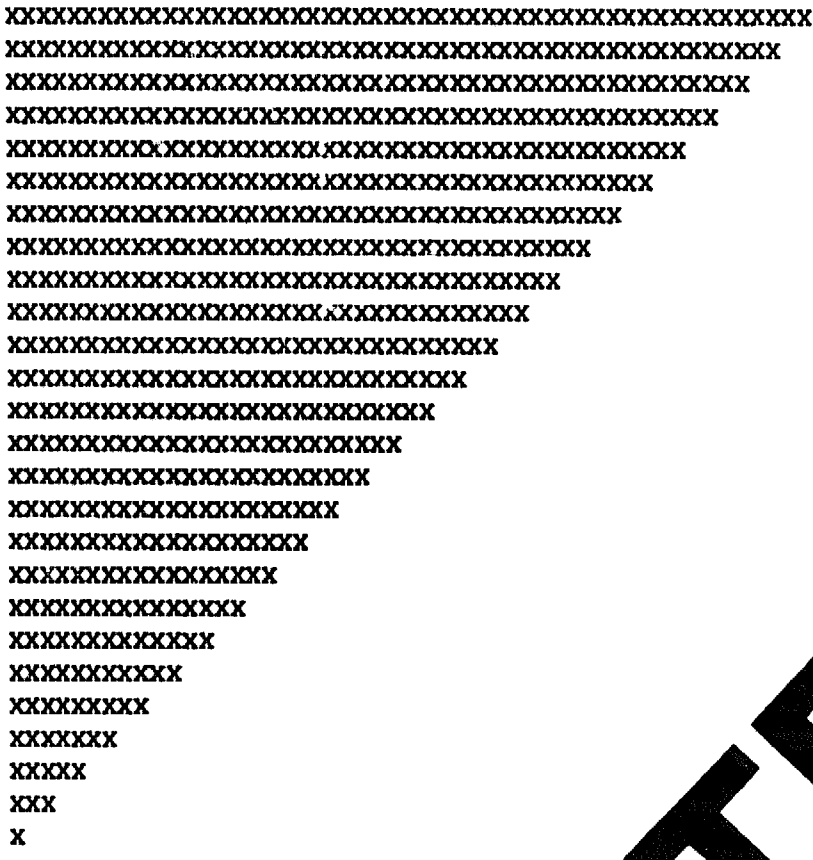
```
0 <ESC>P0q!200~<ESC>\
1 <ESC>P1q!200~<ESC>\
2 <ESC>P2q!200~<ESC>\
3 <ESC>P3q!200~<ESC>\
4 <ESC>P4q!200~<ESC>\
5 <ESC>P5q!200~<ESC>\
6 <ESC>P6q!200~<ESC>\
7 <ESC>P7q!200~<ESC>\
8 <ESC>P8q!200~<ESC>\
9 <ESC>P9q!200~<ESC>\
```



Example 4

This example illustrates DCS strings that use the parameter values listed in Table 4-6 and the graphic that results from each string. An SSU sequence, which sets the printer for decipoints or pixels, precedes each DCS string. Each DCS string has the Ps1, Ps2, and Pn3 parameters, the raster attribute character ("), the Pn4, Pn5, Pn6, and Pn7 parameters, a repeat control chracter (!), the number of times to repeat (200), and the ~ character.

```
<ESC>[7 I0 <ESC>P0;0;2q"200;100;6;200!200~<ESC>\
<ESC>[7 I1 <ESC>P1;0;2q"200;100;6;200!200~<ESC>\
<ESC>[2 I2 <ESC>P2;0;2q"450;100;6;200!200~<ESC>\
<ESC>[2 I3 <ESC>P3;0;3q"300;100;6;200!200~<ESC>\
<ESC>[2 I4 <ESC>P4;0;4q"250;100;6;200!200~<ESC>\
<ESC>[7 I5 <ESC>P5;0;2q"200;100;6;200!200~<ESC>\
<ESC>[2 I6 <ESC>P6;0;6q"150;100;6;200!200~<ESC>\
<ESC>[7 I7 <ESC>P7;0;3q"130;100;6;200!200~<ESC>\
<ESC>[2 I8 <ESC>P8;0;8q"112;100;6;200!200~<ESC>\
<ESC>[7 I9 <ESC>P9;0;4q"100;100;6;200!200~<ESC>\
```



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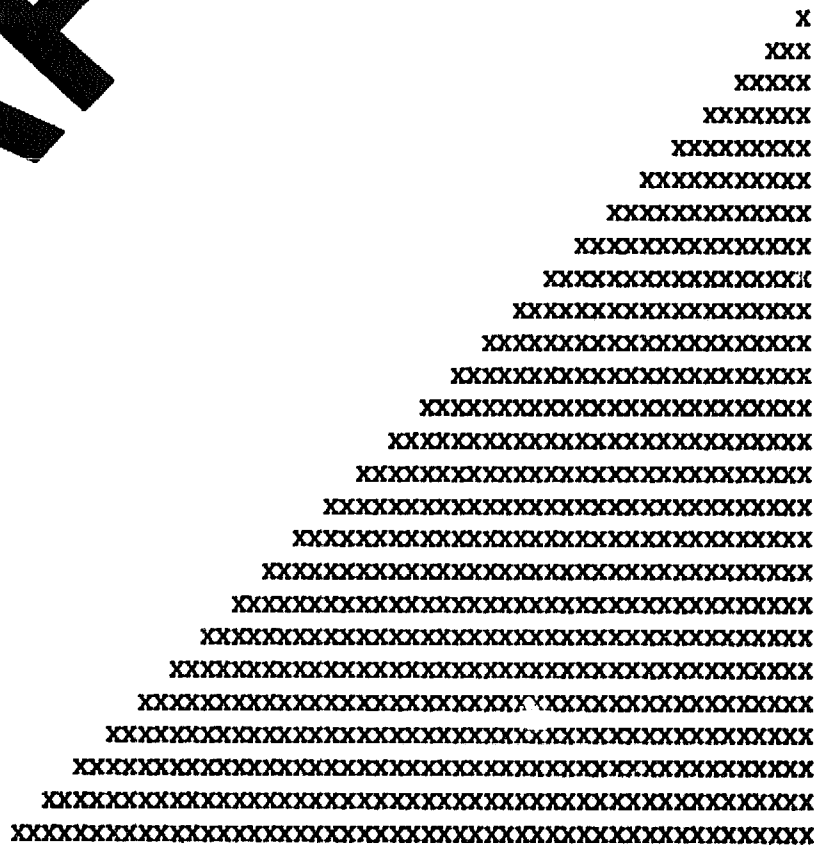


TROUBLESHOOTING AND STATUS REPORTS 5

This chapter provides troubleshooting and printer ID information for the LN03 PLUS upgrade configuration of the LN03 printer.

This chapter describes LN03 PLUS indications and error codes only. For the base LN03 information, see Appendix E of the *LN03 Programmer Reference Manual*.

5.1 INDICATOR PANEL AND TROUBLESHOOTING

The LN03 PLUS indicator panel is the same as for the base LN03 configuration, except that it also provides information related to LN03 PLUS testing.

5.1.1 Bitmap Option Error Codes

LN03 PLUS has three bitmap error codes — 62, 63, and 64. These are fatal errors that may be displayed (together with the symbol) at power-up. Call Digital Field Service if any of these errors appear on the indicator panel.

5.1.2 Flashing 6 Condition

The number 6 and flashing together does NOT indicate an error condition. The printer may be loading fonts or printing data at this time.

5.1.3 Operational Error Codes

Table 5-1 lists the operational error codes and diagnostic error codes (fatal and nonfatal) that can appear on the summary sheet (Paragraph 5.2). See Appendix E of the *LN03 Programmer Reference Manual* for corrective actions (except for bitmap error codes). Fatal errors appear on the indicator panel character display only.

Table 5-1 Diagnostic Error Codes

Operational Error Codes and Conditions

Error Code	Error Condition
1	Justify buffer overflow.*
2	Lost characters or part of ruling.
3	Font memory exceeded — only complete fonts loaded.†
4	Excess fonts not loaded in font memory.†
12	Illegal codes in down-line loaded fonts
13	30 or more errors were detected on this page.
16	Invalid parameter
24	Character not defined in selected font.
25	Test button pressed during font load.
31	Communication error on received character.
32	Communication error — input buffer overflow.
34	Font cartridge removed while printing.
35	RAM cartridge removed while printing.

Self-Test Diagnostic Error Codes (Nonfatal)

Error Code	Error Condition
43	Controller font ROM CRC failure (font name)
51	Cartridge font ROM CRC failure
52	Cartridge RAM failure
53	Loopback test failure — control bits
54	Loopback test failure — transmit/receive test
55	Loopback test failure — restraint failure

* To correct this condition, use shorter lines.

† If you did many font deletes using the DECDTFF command, you should "clean up" the LN03's font memory by using the DECLFF command with Ps3 = 0 (delete all fonts) before the next font is down-line loaded. It is usually easiest to do this between documents, when you send the reset command (DECSTR). Refer to the *LN03 Programmer Reference Manual* for information on these commands.

Table 5-1 Diagnostic Error Codes (Cont)

Self-Test Diagnostic Error Codes (Fatal)

Error Code	Error Condition
47	I/O device failure at power-up
57	Baud rate error
62	Bitmap module font ROM failure
63	Bitmap module controller ROM failure
64	Bitmap module RAM failure
71	Program ROM failure
72	Controller RAM failure
73	No fonts in system
75	Font firmware failure

NOTE: Fatal errors are reported on the indicator panel only.

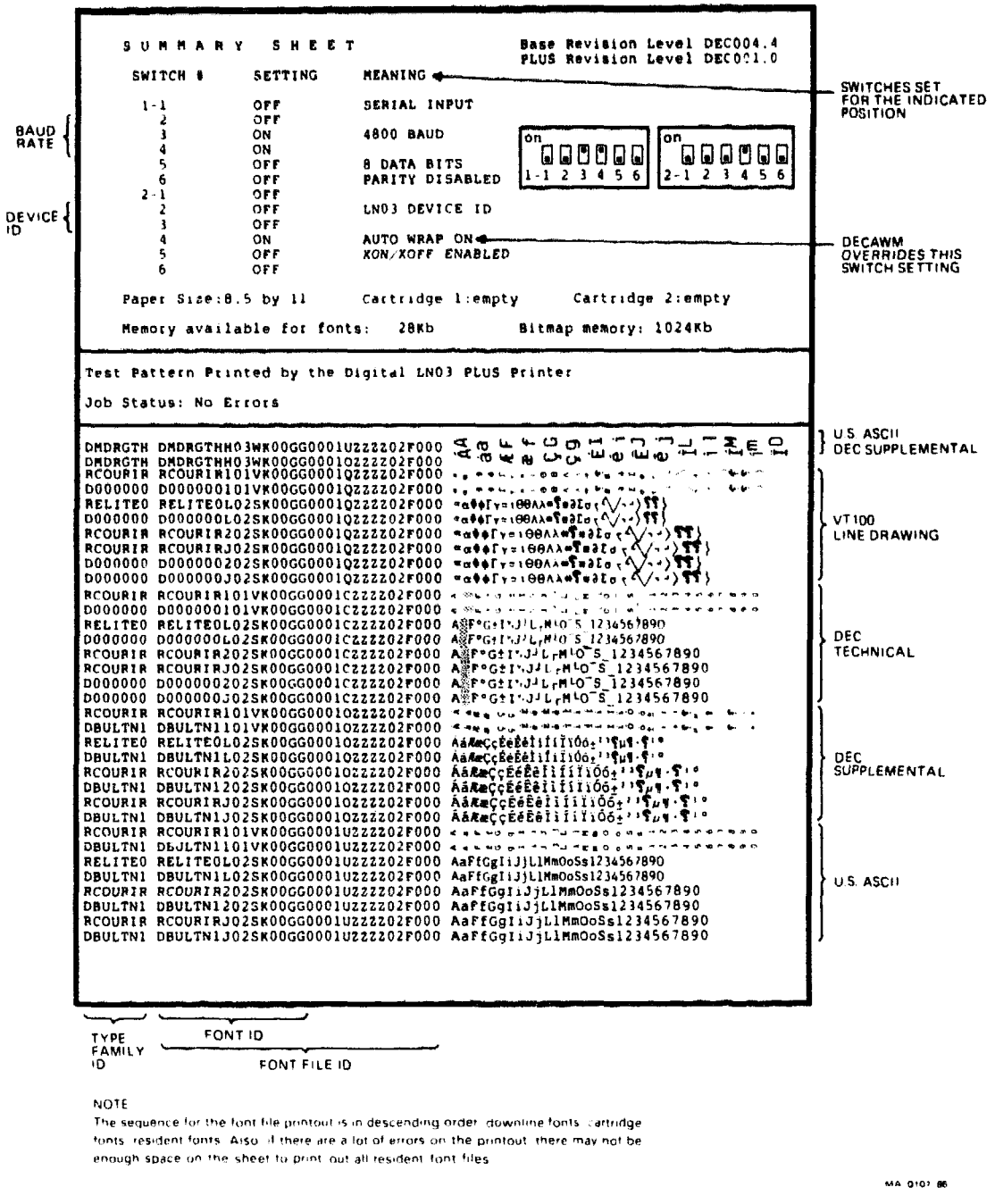
5.2 SUMMARY SHEET

Figure 5-1 is a sample summary sheet of the LN03 PLUS printer.

The summary sheet is a printout of the current status of the printer. It identifies printer software/hardware characteristics, the currently available built-in fonts, and error codes. The sheet prints when you request it by the load font file sequence (see Paragraph 4.4.1 of the *LN03 Programmer Reference Manual* or when you place the printer off-line and press the Test (T) button on the rear panel.

Note the firmware revision level for the base LN03 (DEC 4.4) and LN03 PLUS (DEC 1.0) in the top right corner of the summary sheet. Also note the memory allocated for the fonts and bitmap (1024 Kbytes).

Table 5-1 lists the error codes that may be printed on the summary sheet (up to 30 error codes may be on the summary sheet).



NOTE
The sequence for the font file printout is in descending order: downline fonts, cartridge fonts, resident fonts. Also, if there are a lot of errors on the printout, there may not be enough space on the sheet to print out all resident font files.

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Figure 5-1 Summary Sheet

If the LN03 PLUS does not print the summary sheet or there is no indication that the LN03S module is installed (no DEC 1.0 firmware), the test failed. If this happens, call Digital Field Service.

NOTE: You can print multiple (continuous) summary sheets at power-up. Press the Test button and power on the printer. Keep the Test button depressed until the first sheet of paper starts to feed from the input paper tray. The printer will continue printing summary sheets until you press the Test button again and hold it down for at least five seconds. During operation you can print a single summary sheet only.

5.3 PRODUCT IDENTIFICATION

The LN03 PLUS has the same product identification as the base LN03 printer. On receiving a device attribute (DA) sequence from the host computer, the printer sends out its product identification based on the setting of the device ID switches. (See Paragraph 2.4 of the *LN03 Programmer Reference Manual.*)

The DA request sequences are as follows.

CSI	**c**	or	**CSI**	**0**	**c**
9/11	6/3		9/11	3/0	6/3

In response to the DA sequence the LN03 PLUS identifies itself (depending on the setting of configuration switches SP2-2 and SP2-3 as described in Paragraph 2.4.2 of the *LN03 Programmer Reference Manual*) as:

CSI	**?**	**2**	**6**	**;**	**2**	**c**	when the switches are set
9/11	6/3	3/2	3/6	3/11	3/2	6/3	for the LN03/LN03 PLUS response.
CSI	**?**	**1**	**3**	**c**			when the switches are set
9/11	6/3	3/1	3/3	6/3			for the LQP02 response.
CSI	**?**	**1**	**0**	**c**			when the switches are set
9/11	6/3	3/1	3/0	6/3			for the LA100 response.

5.4 PRINTER STATUS

If you want information about the printer's status, including errors, you can request a device status report. The host can request two types of status reports, brief and extended.

NOTE: For information on font status reports, see Paragraph 4.6 of the LN03 Programmer Reference Manual.

5.4.1 Device Status Request (DSR)

The host uses the following sequences to request printer status reports, request a cursor position report, and enable or disable unsolicited printer reports.

Request Sequence				Request
CSI	**n**			Send extended status report.
9/11	6/14			
CSI	**0**	**n**		Send extended status report.
9/11	3/0	6/14		
CSI	**6**	**n**		Send a cursor position report (active column and active line).
9/11	3/6	6/14		
CSI	**?**	**1**	**n**	Disable unsolicited status reports from printer.
9/11	3/15	3/1	6/14	
CSI	**?**	**2**	**n**	Enable unsolicited brief status reports and send extended status report.
9/11	3/15	3/2	6/14	
CSI	**?**	**3**	**n**	Enable unsolicited extended status reports and send extended status report.
9/11	3/15	3/3	6/14	

NOTE: Unsolicited status reports are sent only when an error occurs. The printer does not report most of the errors that occur until you enable unsolicited reports.

5.4.2 Device Status Report (DSR)

The printer can send brief and extended status reports (solicited or unsolicited) as well as a cursor position report. If enabled, unsolicited reports are sent when a change occurs in any reportable status condition. Unsolicited status reports are initially disabled.

NOTE: Unsolicited reports are always sent after the current page. When errors occur on a page, the unsolicited report lists each type of error only once — even if an error occurred several times on that page.

It would be time consuming and redundant to send reports throughout a page, for each occurrence of an error. Also, it is easier for applications to handle reports in one place — after a page is printed.

5.4.2.1 Device Status Report (Brief) - The format for the brief printer status report is as follows.

CSI	**0**	**n**	No malfunction detected.
9/11	3/0	6/14	
CSI	**3**	**n**	Malfunction detected.
9/11	3/3	6/14	

5.4.2.2 Device Status Report (Extended) - For extended status reports, the printer sends two sequences — a brief sequence, followed by a longer sequence. The formats for the longer sequence are as follows:

CSI	**?**	**2**	**0**	**n**			No malfunction detected.
9/11	3/15	3/2	3/0	6/14			
CSI	**?**	**Pn**	**;**	...	**Pn**	**n**	Malfunction detected.
9/11	3/15	***	3/11	...	***	6/14	

where the values of Pn (up to three digits each) are defined as indicated in Table 5-3. The codes for malfunctions (errors) are reported in pairs. The generic code is first, followed by a specific code.

NOTE: The (3 15) occurs only once in each DSR sequence.

Table 5-3 Printer Status Error Codes

Generic Codes

Pn	Failure
20	No failure detected.
21	Hardware failure.
22	Communication I/O failure.
23	Input buffer overflow.
24	Printer off-line.
26	Cover open.
27	Paper out.
33	Toner low.
34	Call field service.
35	Perform user maintenance.
36	Paper error (paper jam).
40	Character not available.
41	Line content exceeded. (Not used on LN03 PLUS.)
42	Font file format error.
44	Font memory exceeded.
46	Collection bottle full.
47	Too many errors.

Specific Codes

Pn	Failure
101	Justify buffer overflow.
102	Lost characters or part of ruling.
103	Font memory exceeded — only complete fonts loaded.
104	Excess fonts not loaded in font memory.
105	Page data has exceeded available page memory. Data will be printed on the next page. (Not used on LN03 PLUS.)
112	Illegal codes in down-line loaded fonts.
113	30 or more errors were detected on this page.
116	Invalid parameter.
124	Character not defined in selected font.
125	Printer is off-line or the Test button was pressed during font down-line load.
131	Communication error on received character.
132	Communication error — input buffer overflow.
134	Font cartridge removed while printing.
135	RAM cartridge removed while printing.

Table 5-3 Printer Status Error Codes (Cont)

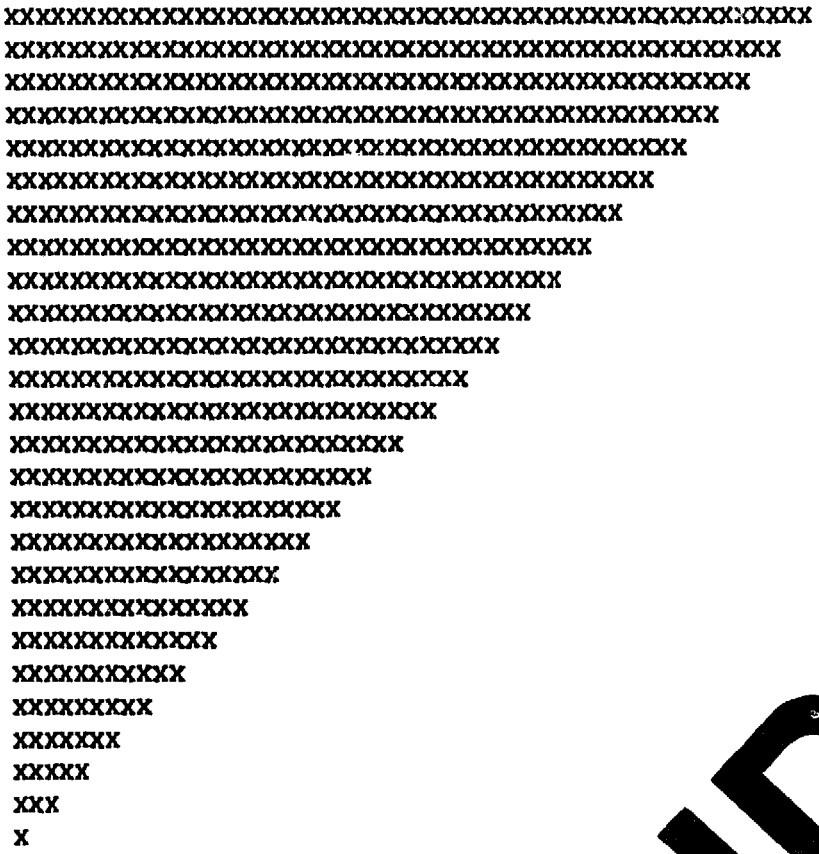
Print Engine Error Codes

Pn	Failure
201	Fuser error.
202	Optical system error.
203	Toner is low.
204	Optical synchronization error.
205	Replace OPC belt.
206	Paper tray is empty.
207	Collection bottle overflow.
208	Main motor error.
210	Engine memory error.
212	Open cover.
213	Printer is off-line.
214	Transport or eject paper jam.
215	Paper misfeed error.

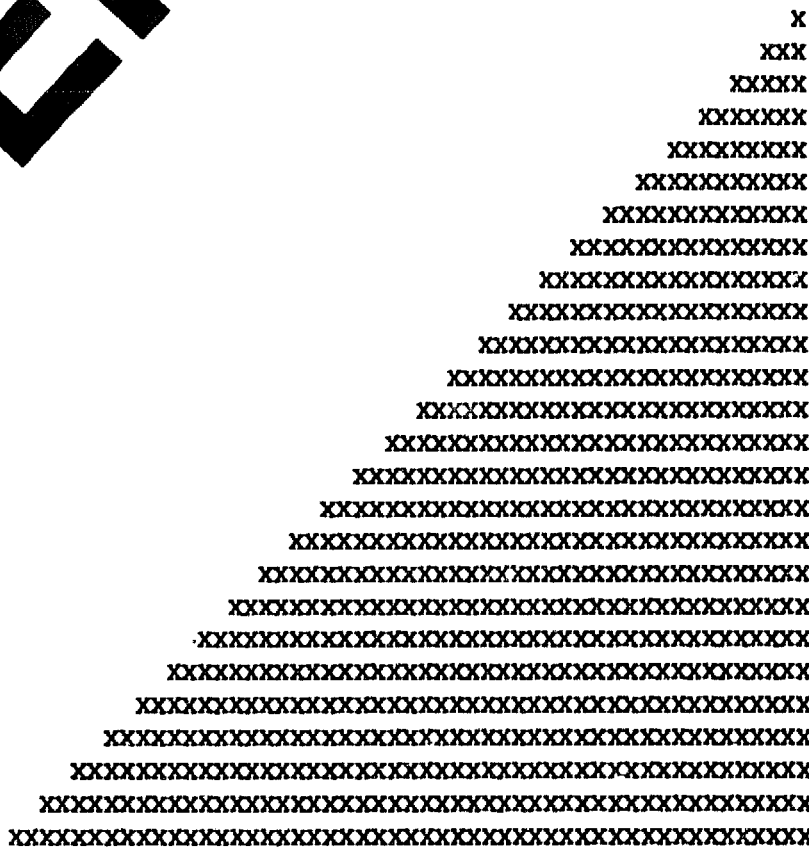
5.4.2.3 Cursor Position Report - The format for the cursor position report is as follows:

CSI	Pn1	;	Pn2	R
9/11	***	3/11	***	5/2

where Pn1 is the active line and Pn2 is the active column. The unit of measurement can be a character cell, decipoint, or pixel. You select the unit by using the position unit mode (PUM) and select size unit (SSU) sequences. (See Paragraphs 5.2.7 and 5.3 of the *LN03 Programmer Reference Manual*)



APPENDIX A



TEKTRONIX COMMAND SUMMARY A

Table A-1 lists the ASCII characters (codes) you can use to control LN03 PLUS printer operation in the Tektronix 4010/4014 operating modes.

NOTES:

1. *If a character action is not listed under a particular mode, the printer does no action on receiving that character.*
2. *Last character escape (LCE) tells how the printer interprets the character when it is preceded by an escape character.*

Table A-1 Tektronix Emulator Controls

Character	Operating Mode	Action
BEL (0/7)		Bell does not ring, but bypass mode is cleared.
	Graph:	Start vector from current drawing position.
	LCE:	Same as BEL.
BS (0/8)	Alpha:	Move one space left.
	LCE:	Move one space left.
HT (0/9)	Alpha:	Move one space right
	LCE:	Move one space right
LF (0/10)	Alpha:	Move one line down.
	Bypass:	Move one line down. Same as ESC CR.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
VT (0/11)	Alpha:	Move one line up
	LCE:	Move one line up
FF (0/12)	LCE:	Set Alpha mode, erase Tekpage, move cursor to home position, clear EGM, move to margin 1, page eject, and clear bypass condition.
CR (0/13)	Alpha:	Move to left margin.
	Graph:	Set Alpha mode and move to left margin.
	Bypass:	Set Alpha mode and move to left margin
	LCE:	This CR is ignored. LCE is still active.
SO	LCE:	Use GR (not used in Tektronix mode).
SI	LCE:	Use GL (not used in Tektronix mode).
ETB (1/7)	Bypass:	Clear Bypass mode.
CAN (1/8)	LCE:	Set Bypass mode.
SUB (1/10)	LCE:	Set Alpha mode. Ignore GIN mode.
ESC (1/11)		Set LCE condition.
FS (1/12)	Alpha:	Set Point Plot mode.
	Graph:	Set Point Plot mode.
	Bypass:	Set Point Plot mode.
	LCE:	Set Point Plot mode.
GS (1/13)	Alpha:	Set Graph mode and expect one invisible vector.
	Graph:	Expect one invisible vector.
	Bypass:	Set Graph mode and expect one invisible vector.
	LCE:	Set Graph mode and expect one invisible vector.
RS (1/14)	Alpha:	Set Incremental Plot mode.
	Graph:	Set Incremental Plot mode.
	Bypass:	Set Incremental Plot mode.
	LCE:	Set Incremental Plot mode.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
US (1/11)	Graph:	Set Alpha mode.
	Bypass:	Set Alpha mode.
	LCE:	Set Alpha mode.
SP (2/0)	Alpha:	Move one space right.
	Graph:	High X or high Y.
! (2/1)	Alpha:	Print character.
	Graph:	High X or high Y.
" (2/2)	Alpha:	Print character.
	Graph:	High X or high Y.
# (2/3)	Alpha:	Print character.
	Graph:	High X or high Y.
$ (2/4)	Alpha:	Print character.
	Graph:	High X or high Y.
% (2/5)	Alpha:	Print character.
	Graph:	High X or high Y.
& (2/6)	Alpha:	Print Character
	Graph:	High X or high Y
' (2/7)	Alpha:	Print character.
	Graph:	High X or high Y.
((2/8)	Alpha:	Print character.
	Graph:	High X or high Y.
) (2/9)	Alpha:	Print character.
	Graph:	High X or high Y.
* (2/10)	Alpha:	Print character.
	Graph:	High X or high Y.
+ (2/11)	Alpha:	Print character.
	Graph:	High X or high Y.
, (2/12)	Alpha:	Print character.
	Graph:	High X or high Y.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
- (2/13)	Alpha:	Print character.
	Graph:	High X or high Y.
. (2/14)	Alpha:	Print character.
	Graph:	High X or high Y.
/ (2/15)	Alpha:	Print character.
	Graph:	High X or high Y.
0 (3/01)	Alpha:	Print character.
	Graph:	High X or high Y.
1 (3/1)	Alpha:	Print character.
	Graph:	High X or high Y.
2 (3/2)	Alpha:	Print character.
	Graph:	High X or high Y.
3 (3/3)	Alpha:	Print character.
	Graph:	High X or high Y.
4 (3/4)	Alpha:	Print character.
	Graph:	High X or high Y.
5 (3/5)	Alpha:	Print character.
	Graph:	High X or high Y.
6 (3/6)	Alpha:	Print character.
	Graph:	High X or high Y.
7 (3/7)	Alpha:	Print character.
	Graph:	High X or high Y.
8 (3/8)	Alpha:	Print character.
	Graph:	High X or high Y.
	LCE:	Largest characters
9 (3/9)	Alpha:	Print character.
	Graph:	High X or high Y.
	LCE:	Medium large characters.
: (3/10)	Alpha:	Print character.
	Graph:	High X or high Y.
	LCE:	Medium small characters.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
: (3/11)	Alpha:	Print character.
	Graph:	High X or high Y.
	LCE:	Smallest characters.
< (3/12)	Alpha:	Print character.
	Graph:	High X or high Y.
= (3/13)	Alpha:	Print character.
	Graph:	High X or high Y.
> (3/14)	Alpha:	Print character.
	Graph:	High X or high Y.
? (3/15)	Alpha:	Print character.
	Graph:	High X or high Y.
	LCE:	Low Y for graph.
		In case you cannot use DEL.
@ (4/0)	Alpha:	Print character.
	Graph:	Low X.
A (4/1)	Alpha:	Print character.
	Graph:	Low X.
B (4/2)	Alpha:	Print character.
	Graph:	Low X.
C (4/3)	Alpha:	Print character.
	Graph:	Low X.
D (4/4)	Alpha:	Print character.
	Graph:	Low X.
E (4/5)	Alpha:	Print character.
	Graph:	Low X.
F (4/6)	Alpha:	Print character.
	Graph:	Low X.
G (4/7)	Alpha:	Print character.
	Graph:	Low X.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
H (4/8)	Alpha: Graph:	Print character. Low X.
I (4/9)	Alpha: Graph:	Print character. Low X.
J (4/10)	Alpha: Graph:	Print character. Low X.
K (4/11)	Alpha: Graph:	Print character. Low X.
L (4/12)	Alpha: Graph:	Print character. Low X.
M (4/13)	Alpha: Graph:	Print character. Low X.
N (4/14)	Alpha: Graph:	Print character. Low X.
O (4/15)	Alpha: Graph:	Print character. Low X.
P (5/0)	Alpha: Graph:	Print character. Low X.
Q (5/1)	Alpha: Graph:	Print character. Low X.
R (5/2)	Alpha: Graph:	Print character. Low X.
S (5/3)	Alpha: Graph:	Print character. Low X.
T (5/4)	Alpha: Graph:	Print character. Low X.
U (5/5)	Alpha: Graph:	Print character. Low X.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
V (5/6)	Alpha: Graph:	Print character. Low X.
W (5/7)	Alpha: Graph:	Print character. Low X.
X (5/8)	Alpha: Graph:	Print character. Low X.
Y (5/9)	Alpha: Graph:	Print character. Low X.
Z (5/10)	Alpha: Graph:	Print character. Low X.
[(5/11)	Alpha: Graph:	Print character. Low X.
\ (5/12)	Alpha: Graph:	Print character. Low X.
] (5/13)	Alpha: Graph:	Print character. Low X.
^ (5/14)	Alpha: Graph:	Print character. Low X
_ (5/15)	Alpha: Graph:	Print character. Low X.
` (6/0)	Alpha: Graph: LCE:	Print character. Low Y. Normal. solid vector.
a (6/1)	Alpha: Graph: LCE:	Print character. Low Y. Normal. dotted vector.
b (6/2)	Alpha: Graph: LCE:	Print character. Low Y. Normal. dot-dashed vector.

Table A-1 Tektronix Emulator Controls (Cont)

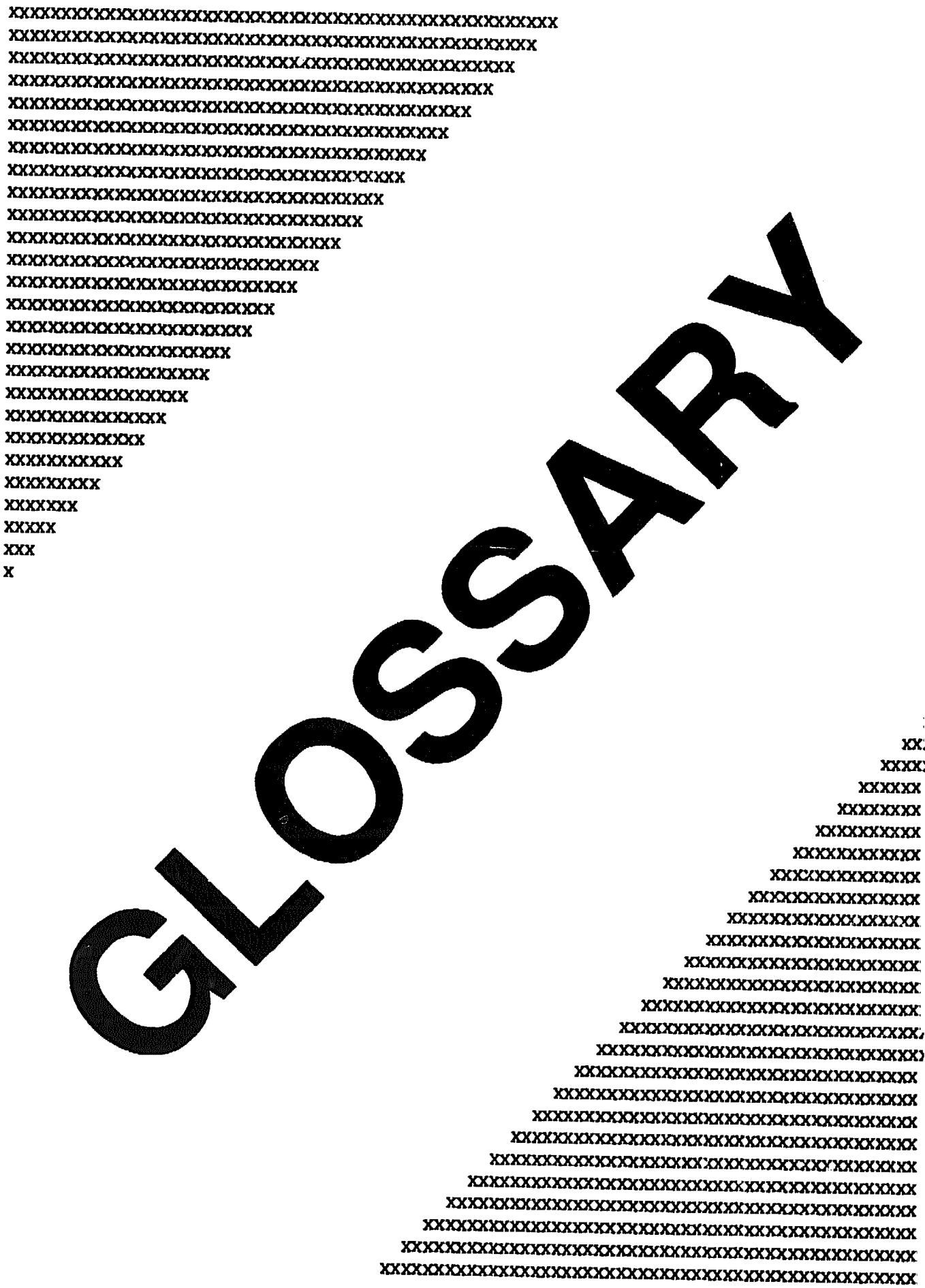
Character	Operating Mode	Action
c (6/3)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Normal, short-dashed vector.
d (6/4)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Normal, long-dashed vector.
e (6/5)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Normal, solid vector.
f (6/6)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Normal, solid vector.
g (6/7)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Normal, solid vector.
h (6/8)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, solid vector.
i (6/9)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold dotted vector.
j (6/10)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, dot-dashed vector.
k (6/11)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, short-dashed vector.
l (6/12)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, long-dashed vector.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
m (6/13)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, solid vector.
n (6/14)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, solid vector.
o (6/15)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Bold, solid vector.
p (7/0)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
q (7/1)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
r (7/2)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
s (7/3)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
t (7/4)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
u (7/5)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.
v (7/6)	Alpha:	Print character.
	Graph:	Low Y.
	LCE:	Transparent vector.

Table A-1 Tektronix Emulator Controls (Cont)

Character	Operating Mode	Action
w (7/7)	Alpha: Graph: LCE:	Print character. Low Y. Transparent vector.
x (7/8)	Alpha: Graph:	Print character. Low Y.
y (7/9)	Alpha: Graph:	Print character. Low Y.
z (7/10)	Alpha: Graph:	Print character. Low Y.
{ (7/11)	Alpha: Graph:	Print character. Low Y.
| (7/12)	Alpha: Graph:	Print character. Low Y.
} (7/13)	Alpha: Graph:	Print character. Low Y.
~ (7/14)	Alpha: Graph:	Print character. Low Y.
DEL (7/15)	Graph:	Low Y (never ignored).


GLOSSARY

GLOSSARY

Enhanced graphics module (EGM)

An option offered by Tektronix for the 4014 series. It adds a number of features to that product, some of which are available in the LN03 PLUS. The most important of these is a capability for higher resolution, which requires 12 bits for addressing rather than the usual 10.

Extra byte

One addressing byte (sent in Graph mode) that contains two low order bits for both X and Y coordinate directions. When this byte is non-zero, the Tekpoint size is reduced to 0.75 pixels.

Graphics Input (GIN) mode

A mode on a terminal in which you use a crosshair cursor to input data. In GIN mode, the host computer uses <ESC> ENQ to request a report of the current alpha, graph, or crosshair cursor position.

The LN03 PLUS does not support GIN mode.

High resolution

In this manual, refers to the mode the printer enters after receiving the extra byte. At high resolution, the Tekpoint size is 0.75 pixel rather than the default three pixels. CR or ESC FF cancels high resolution.

Horizontal grid size (HGS)

Horizontal distance between each sixel.

Last character escape (LCE)

The LCE flag is set whenever an ESC character is received. It is set again if any character that is received after the ESC is to be ignored.

Low resolution

In this manual, refers to the default addressing mode when the Tekpoint size is three pixels. The printer goes into low resolution on receiving CR or ESC FF.

Pattern register

A logical register that tracks the drawing of a patterned vector and keeps the dots and dashes where they should be.

Pixel

In text or Tektronix mode, pixel is the 1/300 inch square dot of ink. In sixel mode, pixel is one or more dots (arranged in a square or rectangle) that are printed as a group.

Sixel

A column of six vertical pixels.

Special Point Plot mode

A 4014 mode that is the same as Point Plot mode except that you can specify the intensity of the dots. Not supported in the LN03 PLUS.

Tekpage

The area within the printable area of the page that can be addressed in Tektronix emulation mode. Some characters may extend over the boundaries of the Tekpage. See Paragraph 2.2.2, "Page Mapping," for details.

Tekpoint

The unit of addressing in Tektronix emulation mode. It is equal in size (linearly) to three pixels or 3/4 of a pixel depending on the addressing mode used.

Vector

A line drawn on the Tekpage. The line may be normal thickness or bold thickness. In transparent mode, the drawing position is updated without drawing a vector.

Vertical grid size (VGS)

Vertical distance between the tops of each pixel.

Write-through

In write-through mode, images are drawn on the storage tube but not retained. In the LN03 PLUS, these images are transparent (not actually drawn), although the drawing or character position is updated. Write-through may be used for Alpha mode characters as well as for graphics.