

Digital Equipment Corporation  
Maynard, Massachusetts

digital

**PDP-8 Family  
Interface Manual**

**LP08  
LINE PRINTER**

**PDP-8 FAMILY  
LP08 LINE PRINTER  
INTERFACE MANUAL**

Copyright © 1970 by Digital Equipment Corporation

The material in this manual is for information purposes and is subject to change without notice.

The following are trademarks of Digital Equipment Corporation, Maynard, Massachusetts:

DEC	PDP
FLIP CHIP	FOCAL
DIGITAL	COMPUTER LAB

## CONTENTS

	Page
<b>CHAPTER 1 GENERAL DESCRIPTION</b>	
1.1 Introduction	1-1
1.2 Specifications	1-1
<b>CHAPTER 2 COMPONENT DESCRIPTION</b>	
2.1 LP08 Line Printer	2-1
2.1.1 Functional Components	2-1
2.1.1.1 Character Drum	2-1
2.1.1.2 Drum Gate	2-2
2.1.1.3 Hammer Bank	2-2
2.1.2 Line Printer Power Supply	2-2
2.1.3 Main Control Panel	2-2
2.2 LP08 Interface	2-2
2.2.1 Interface Logic Modules	2-4
2.2.2 Logic Module Mounting Panel	2-4
2.2.3 Interface Power Supply	2-4
2.2.4 Interface Signals	2-4
<b>CHAPTER 3 INSTALLATION AND CHECKOUT</b>	
3.1 Space Requirements	3-1
3.2 Unpacking the Line Printer and Interface	3-1
3.3 Inspection	3-3
3.4 Interface Installation	3-3
3.5 Checkout Procedure	3-4
3.5.1 Testing	3-4
3.5.2 Accompanying Documents	3-5
3.5.3 Test Equipment	3-6
<b>CHAPTER 4 PROGRAMMING THE LP08</b>	
4.1 Function of Interface	4-1
4.2 IOT Programming Instructions and Commands	4-2
4.3 Line Printer Subroutine	4-3

## CONTENTS (Cont)

		Page
<b>CHAPTER 5 CIRCUIT ANALYSIS</b>		
5.1	General	5-1
5.2	Printer to Interface Signals	5-1
5.3	Processor to Interface	5-1
5.4	Initial Turn-On of Computer Power	5-2
5.5	IOT Commands	5-2
5.6	Memory Buffer Bits	5-2
5.7	Output Data Lines	5-3

## CHAPTER 6 MAINTENANCE

6.1	General	6-1
6.2	Preventive Maintenance	6-2
6.3	Threshold Adjustment	6-2
6.4	Drawings	6-2

## ILLUSTRATIONS

<u>Figure No.</u>	<u>Title</u>	<u>File No.</u>	<u>Page</u>
1-1	LP08 80-Column Line Printer	4916-4	1-1
2-1	LP08 Interface Logic Mounting Frame and Power Supply	08-0607	2-3
3-1	LP08 Line Printer Installation Diagram	08-0608	3-2

## TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
1-1	Equipment Specifications	1-2
2-1	Coded 64-Character Set	2-1
2-2	Controls and Indicators	2-2
2-3	Interface Logic Modules	2-4
2-4	Interface Signals	2-5
3-1	I/O Cable Terminations	3-4
4-1	Printing Speeds	4-1
4-2	IOT Programming Instructions and Commands	4-3

TABLES (Cont)

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
6-1	LP08 Module Schematics	6-2
6-2	LP08 Engineering Drawings	6-3

DRAWINGS

<u>Module Schematic No.</u>	<u>Title</u>	<u>Rev.</u>	<u>Page</u>
B-CS-M101-0-1	Bus Data Interface M101	--	6-4
B-CS-M216-0-1	Six Flip-Flops M216	B	6-4
B-CS-M103-0-1	Device Selector M103	A	6-5
B-CS-M111-0-1	Inverter M111	A	6-5
B-CS-M115-0-1	8 3-Input NAND Gates M115	C	6-6
B-CS-M906-0-1	Cable Terminator M906	B	6-6
C-CS-M100-0-1	Bus Data Interface M100	--	6-7
C-CS-M102-0-1	Device Selector M102	--	6-7

<u>Engineering Drawing No.</u>	<u>Title</u>	<u>Rev.</u>	<u>Page</u>
D-IC-LP08-P-02	I/O Connectors Positive Bus	--	6-9
D-IC-LP08-N-02	I/O Connectors Negative Bus	--	6-11
D-BS-LP08-P-01	Positive Interface Logic	A	6-13
D-BS-LP08-N-01	Negative Interface Logic	C	6-15
D-MU-LP08-P-03	Module Utilization	A	6-17
D-MU-LP08-N-03	Module Utilization	--	6-19

# Foreword

The LP08 Line Printer Interface Manual comprises the following:

- Chapter 1 - presents the purpose of the Interface and its electrical, mechanical, and environmental specifications
- Chapter 2 - presents a description of the electrical and mechanical components making up the Line Printer and its associated Interface
- Chapter 3 - presents the space, unpacking, inspection, and installation requirements and check-out procedures
- Chapter 4 - presents the functional details, programming instructions, commands, and subroutines
- Chapter 5 - presents a detailed operational description of the Interface logic
- Chapter 6 - presents the preventive maintenance procedures necessary to maintain the Line Printer and Interface in an operational condition.

## REFERENCE DOCUMENTS

This manual serves as an auxiliary to the Data Products Corporation Technical Manual DPC-214163A which fully describes the LP08 Line Printer and is referenced throughout to avoid unnecessary duplication of data and drawings. The Data Production Corporation Technical Manual should be consulted for information regarding the installation, operation, principles of operation, maintenance, troubleshooting, associated drawings, and related data concerning the LP08 Line Printer.

Other relevant documents are: the LP08 Test Interface Logic MAINDEC-8/I-D2AA and the LP08 Line Printer MAINDEC-8/I-D2AA programming manuals, and the PDP-8 maintenance manuals.

# Chapter 1

## General Description

### 1.1 INTRODUCTION

The LP08 Line Printer Interface links an 80-column line printer (see Figure 1-1) to one of DEC's family of PDP-8 Processors for impact line printing, with a speed per line ranging from 356 lines per minute (lpm) at 80 columns to 1110 lpm at 20 columns.

Either positive or negative bus computers can be interfaced with the Line Printer by interchanging of the appropriate modules. The wire wrap is common to both positive and negative interfaces.

The Line Printer is available with 80-column, 64- or 96-character sets; models are identified by the following type number:

LP08-x,y

where,

x = F for 80-column, 64-character set

H for 80-column, 96-character set

and,

y = A for Positive bus, 60 Hz operation

B for Positive bus, 50 Hz operation

C for Negative bus, 60 Hz operation

D for Negative bus, 50 Hz operation

### 1.2 SPECIFICATIONS

Electrical, operating, physical, environmental, and ancillary performance specifications are described in Table 1-1.

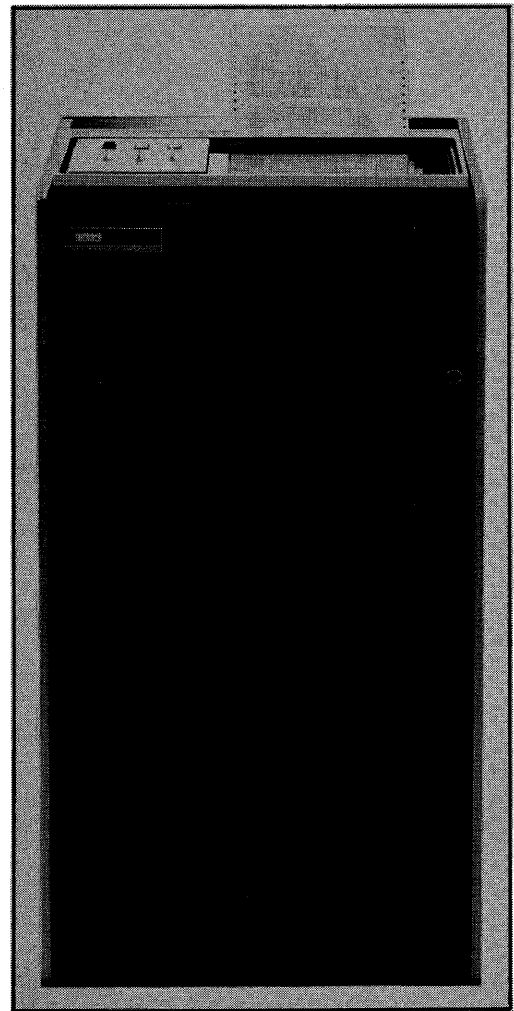


Figure 1-1. LP08 80-Column Line Printer



Table 1-1  
Equipment Specifications

Specification	Equipment	Description
Electrical	Printer	117 Vac $\pm$ 10%, 60 Hz $\pm$ 3 Hz 220 Vac $\pm$ 10%, 50 Hz $\pm$ 3 Hz 250W
	Control	120/240 Vac $\pm$ 10%, 47-63 Hz 60W
	Signal Cable	25 ft maximum length of interconnection signal cable (supplied with system)
Operating Characteristics	Printer	<p>Character set: 64 or 96  Type: Open Gothic print  Size: Typically 0.095 in. high and 0.065 in. wide  Code format: USASCII - 1968  Characters per line: 80  Character drum: 1760 rpm (64-character drum)  Speed: 1170 rpm (96-character drum)</p>
	80-column model, 64-character	<p>Print Speed: 356 lpm, columns 1-80  460 lpm, columns 1-60  650 lpm, columns 1-40  1110 lpm, columns 1-20</p>
	80-column model, 96-character	<p>Print Speed: 253 lpm, columns 1-80  330 lpm, columns 1-60  478 lpm, columns 1-40  843 lpm, columns 1-20</p> <p>Format: Top-of-form control, single line advance.  Paper feed: One pair of pin-feed tractors for 1/2 in. hole center, edge-punched paper. Adjustable for any paper width from 4 in. to 9-7/8 in. on the 80-column model.  Paper slew speed: 13 in. per second  Print area: 8 in. wide, left justified  Character spacing: 0.100 (<math>\pm</math>0.005) in. between centers; maximum possible accumulative error for normal spacing 0.010 in. per 80-character line  Line spacing: 0.167 (<math>\pm</math>0.010) in. (6 lines per in.); each character within <math>\pm</math>0.10 in. from mean line through character</p>

Table 1-1 (Cont)  
Equipment Specifications

Specification	Equipment	Description
Operating Characteristics (Cont)	Printer (Cont)	Line advance time: 20 ms (maximum) Character: Variable reluctance pick-off sense Synchronization: Drum position
Physical Characteristics	Printer, 80-column	Height: 51.5 in. Width: 24-1/4 in. Depth: 34-3/4 in. Weight: 185 lb
	Control, (1 standard DEC logic panel)	Height: 5.25 in. Width: 19.0 in. Depth: 7 in.
Environmental Characteristics	Printer and Control	Operating Temperature: 50°F (10°C) to 110°F (43°C) Humidity: 5% to 90% (non-condensation)
Supplies	Paper	Type: Standard fanfold, edge punched Dimensions: 4 in. to 9-7/8 in. wide (80-column) Weight: Single copy: 15 lb bond (minimum) Multi copy: 12 lb bond with single-sheet carbon for up to six parts
	Ribbon	Type: inked roll Width: 9 in. (80-column) Length: 35 yd Thickness: 0.003 in.

## Chapter 2

### Component Description

#### 2.1 LP08 LINE PRINTER

The LP08 Line Printer is a free-standing unit comprised of functional components, a power supply, and the main control panel. (For further description of the Line Printer, refer to Section I of the Data Products Corporation Technical Manual.)

##### 2.1.1 Functional Components

2.1.1.1 Character Drum - contains 64 different characters: 26 upper-case alphabets, 10 numerals, and 28 special symbols. Table 2-1 shows the character font and sequence of a standard 64-character drum.

Table 2-1  
Coded 64-Character Set

7 6 5	0 0 0	0 1 0	0 1 1	1 0 0	1 0 1
4 3 2 1	Drum Rows	Drum Rows 1-16	Drum Rows 17-32	Drum Rows 33-48	Drum Rows 49-64
0 0 0 0		Space	0	@	P
0 0 0 1		!	1	A	Q
0 0 1 0		"	2	B	R
0 0 1 1		#	3	C	S
0 1 0 0		\$	4	D	T
0 1 0 1		%	5	E	U
0 1 1 0		&	6	F	V
0 1 1 1		'	7	G	W
1 0 0 0		(	8	H	X
1 0 0 1		)	9	I	Y
1 0 1 0	PF	*	:	J	Z
1 0 1 1		+	;	K	[
1 1 0 0	FF	,	<	L	\
1 1 0 1	CR	-	=	M	]
1 1 1 0		.	>	N	^
1 1 1 1		/	?	O	_

2.1.1.2 Drum Gate - is hinged and contains the character drum, drum motor, print ribbon, top ribbon motor, ribbon guide, bottom ribbon motor, ribbon reversal switches, and paper tension bar. The gate swings out 180°, providing easy access to both the print ribbon and paper loading area.

2.1.1.3 Hammer Bank - consists of an upper and lower bank, each containing 40 impact hammers. The upper bank contains the even-numbered hammers, and the bottom bank contains the odd. The hammer bank also contains the backstop screws for time-of-flight adjustment.

### 2.1.2 Line Printer Power Supply

The Line Printer power supply provides ±12, +5, +28, +65 Vdc and 117 Vac for printer operation.

### 2.1.3 Main Control Panel

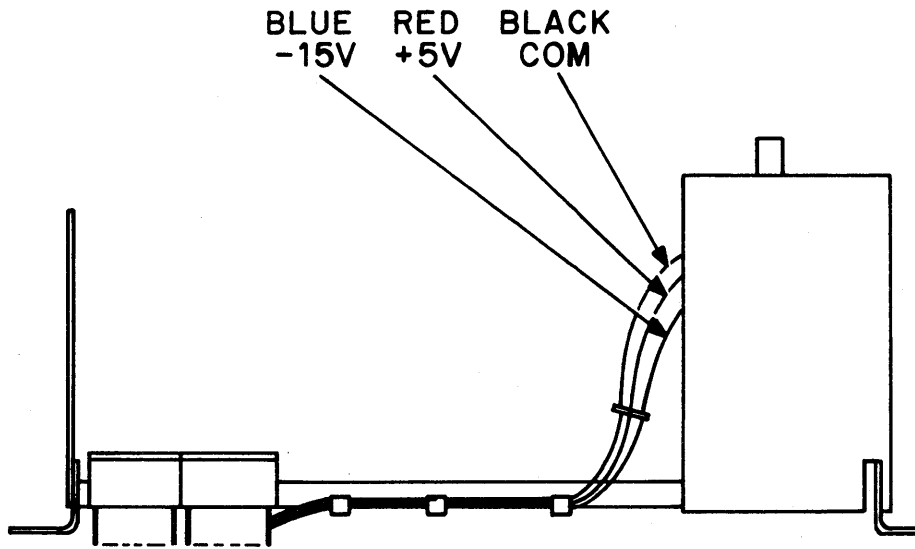
The control panel accommodates the functional indicators and switches. The controls enable the operator to place the Line Printer ON-LINE or OFF-LINE and control paper feed in the OFF-LINE state (see Table 2-2).

Table 2-2  
Controls and Indicators

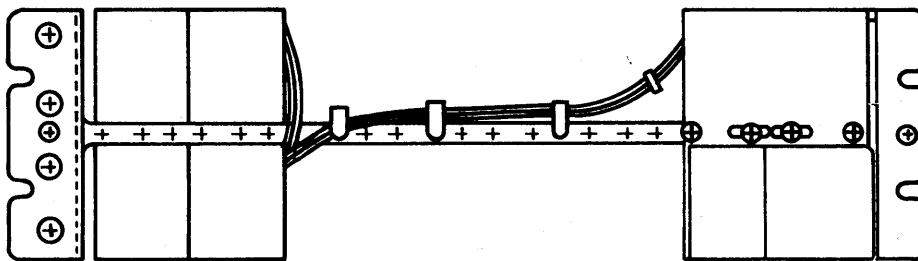
Control and Indicator	Function
POWER indicator	Lights when ac power is applied to the Printer.
READY indicator	Lights when Printer power is up, interlocks are satisfied, paper is loaded, drum is up to speed, and over temperature condition does not exist in the paper drive motor.
ON LINE indicator	Lights when Printer is in ON-LINE mode of operation.
TOP OF FORM switch	Advances tractors to top-of-form position; disabled in ON-LINE mode.
PAPER STEP switch	Advances paper one line; disabled in ON-LINE mode.
ON LINE/OFF LINE switch	Selects mode of operation for Printer.

## 2.2 LP08 INTERFACE

The Line Printer Interface logic, associated module mounting frame, and power supply comprise a one-piece assembly which can be mounted in a 19 in. cabinet. See Figure 2-1.



a. Top View



b. Front View

08-0607

Figure 2-1 LP08 Interface Logic Mounting Frame and Power Supply

### 2.2.1 Interface Logic Modules

Table 2-3 lists the modules utilized in both the positive and negative Interface logic; for location of modules in the mounting frame, see Module Utilization Diagrams D-MU-LP08-P-03 and D-MU-LP08-N-03.

Table 2-3  
Interface Logic Modules

Quantity	Name	Positive Interface	Negative Interface
1	Bus Data Interface	M101	M100
1	Inverter	M111	M111
1	Terminator	M906	M906
1	Device Selector	M103	M102
1	NAND Gate	M115	M115
1	Flip-Flop	M216	M216

### 2.2.2 Logic Module Mounting Panel

This panel contains the logic modules and pluggable cable cards. See Figure 2-1.

### 2.2.3 Interface Power Supply

This power supply furnishes +5 Vdc and -15 Vdc for the Interface logic.

### 2.2.4 Interface Signals

The Interface signals are defined in Table 2-4.

Table 2-4  
Interface Signals

Signal	Signal Source	Definition
READY	Printer	<p>Indicates to the user's system that the Printer is ready to be put ON-LINE by the operator.</p> <p>When READY is true, the following conditions are true:</p> <ul style="list-style-type: none"> <li>a. Power is on,</li> <li>b. the Printer drum gate is closed,</li> <li>c. paper has been loaded,</li> <li>d. an overtemperature condition does not exist in the paper drive motor, and</li> <li>e. drum motor is up to speed.</li> </ul>
DEMAND	Printer	<p>Synchronizes data transmission between the Printer and user's system. The DEMAND signal requests a character from the processor and this signal remains true until the STROBE signal is received. DEMAND is disabled while the character is stored in the printer memory and during the print operation. DEMAND can only come true if READY is true and the operator has placed the Printer ON-LINE.</p>
STROBE	User	<p>Indicates when Printer is to accept the information on data lines. Each time the STROBE signal occurs, the Printer samples the data lines and DEMAND goes false while the character is stored.</p>
DATA	User	<p>Coded information transmitted from the processor to the Printer on seven data lines. Each character of the USASCII-1968 character set is transmitted on the seven parallel data lines.</p>

## Chapter 3

# Installation and Checkout

Although installation and checkout of the LP08 Line Printer and Interface are not a customer function, this chapter contains brief descriptions of the various procedures involved, for informational purposes only.

### CAUTION

The LP08 Line Printer and Interface are installed on-site by DEC Field Service personnel. No attempt should be made by customer personnel to unpack, inspect, install, check out, or service the equipment.

### 3.1 SPACE REQUIREMENTS

In planning the installation facility to accommodate the Printer, sufficient space must be allowed for operating and maintenance personnel.

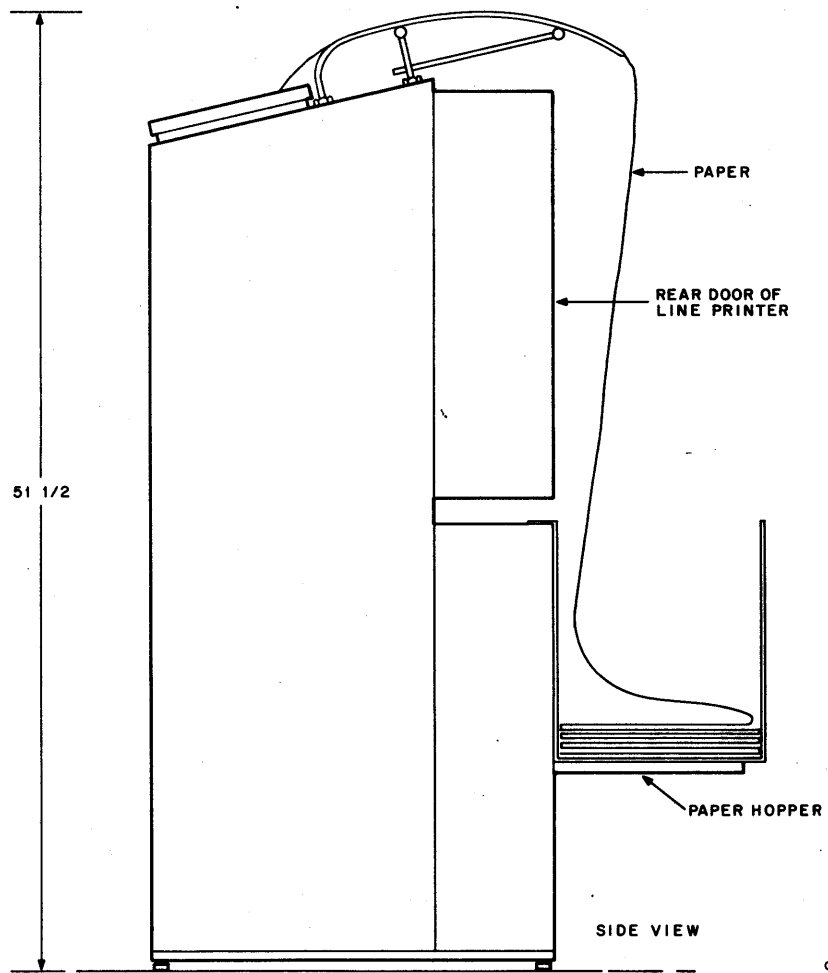
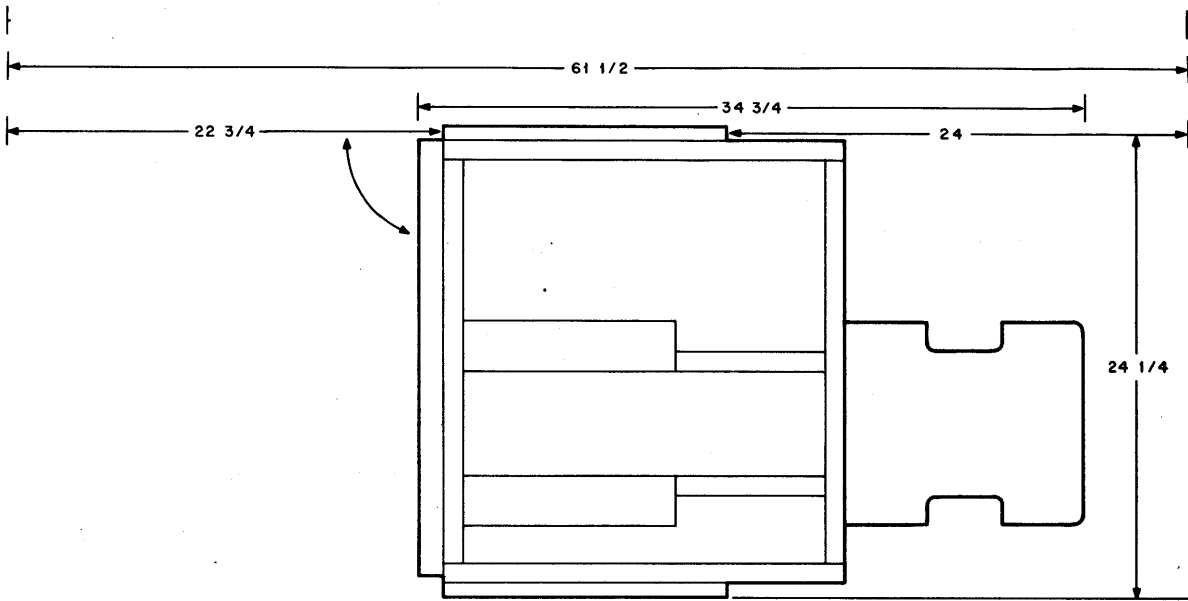
The physical size and shape of the Line Printer and the overall clearances required for opening the associated front and rear doors, drum gate, and cage are shown in Figure 3-1.

### 3.2 UNPACKING THE LINE PRINTER AND INTERFACE

First place the Line Printer/Interface in close proximity to the ac power source, then unpack them as follows:

<u>Step</u>	<u>Procedure</u>
1	Cut the two steel straps that secure the telescoping cap and stitched sleeve to the shipping skid.
2	Remove the Tri-wall clips from all four sides of the stitched sleeve.
3	Remove the four bolts, washers, and nuts securing the Line Printer to the shipping skid, then remove the Printer from the skid and install in the site.
4	Unpack the three Flex-print I/O to Interface cables and the single twisted pair Interface to the Line Printer cable, and install them as indicated in the Interface Installation section of this chapter.





08-0608

Figure 3-1 LP08 Line Printer Installation Diagram

### 3.3 INSPECTION

After removing the Printer and Interface packing material, inspect them and report any damage to the local DEC sales office. Inspection procedures are as follows:

<u>Step</u>	<u>Procedure</u>
1	Inspect external surfaces of the Printer and Interface for surface, bezel, switch, and light damage, etc.
2	Open the rear and front doors of the Printer and inspect it for internal damage to electrical and mechanical components.
3	Inspect the wiring side of the Printer and LP08 logic mounting panels for bent pins, cut wires, loose external components, and foreign material. Also inspect the Interface and computer I/O cables for damage.
4	Inspect the Printer power supply and the LP08 Interface positive and negative logic power supply for proper seating of fuses.
5	Check the equipment received against the packing list to be certain that all equipment has been received.

### 3.4 INTERFACE INSTALLATION

Before the Line Printer and Interface can be made operational, the logic mounting panel and associated LP08-P (for positive bus devices) or the LP08-N (for negative bus devices) logic must be installed in a cabinet rack and interconnected to the LP08 and the user's computer I/O bus.

The cable, with the Flexprint card connector on one end and a conventional connector on the other end, must be connected between the logic mounting panel and the Line Printer. The card connector is inserted in logic mounting panel slot A8, and the other end is inserted in the connector on the rear of the Line Printer. Refer to Module Utilization Diagrams D-MU-LP08-P-03 and D-MU-LP08-N-03.

The I/O Flexprint cables with cable card connectors on both ends must be connected from logic mounting panel slots A1 (BAC bits and BIOP pulses), A2 (BMB bits), and A3 (BAC bits, interrupt bus, and skip bus) to any point on the user's computer I/O bus. See Table 3-1.

It is suggested that the Line Printer ac power cord be plugged into the receptacle on the rear of the LP08-P or LP08-N associated power supply so that both computer power and Line Printer Interface power will be shut down at the same time.

Table 3-1  
I/O Cable Terminations

Interface Logic Mounting Panel Module Slot	Computer Module Slot		
	PDP-8	PDP-8/I	PDP-8L
A1	(1) ME34 (2) MF34	(1) J01 (2) J02	D36
A2	(1) ME35 (2) MF35	(1) J03 (2) J04	D35
A3	(1) PE2 (2) PF2	(1) J05 (2) J06	D34
Note: (1) and (2) indicate the side of the connector block from which the signals originate..			

### 3.5 CHECKOUT PROCEDURE

#### 3.5.1 Testing

After the Line Printer and Interface have been unpacked and installed on-site, the following tests are performed by DEC Service personnel:

<u>Step</u>	<u>Procedure</u>
1	Turn the main power supply maintenance panel ac power circuit breaker switch to OFF.
2	Be certain that the Interface cable is securely connected to the rear of the Line Printer; then install the ribbon in the Printer.
3	Turn the static eliminator on.
4	Insert the one-part Moore Business Form paper in the Printer so that it covers the print hammers and the BOTTOM PAPER OUT switch S5, but not the TOP PAPER OUT switch S4.
5	Turn the main ac power circuit breaker switch ON, and ascertain that the READY light does not illuminate but the PAPER FAULT light does.
6	Turn the power supply maintenance panel circuit breaker switch OFF and place the one-part Moore Business Form paper in the Printer so that it covers the print hammers and the TOP PAPER OUT switch S4, but not the BOTTOM PAPER OUT switch S5.
7	Turn the ac power circuit breaker switch ON and ascertain that the READY light does not illuminate but the PAPER FAULT light does.

<u>Step</u>	<u>Procedure</u>
8	<p>Open the drum gate and remove the paper. Activate the TOP OF FORM switch and place continuous-form paper in the Printer, with the paper perforations lined up to the arrows.</p> <p>If necessary, adjust the right TRACTOR PAPER WIDTH ADJUSTMENT to obtain the correct width and the TRACTOR HORIZONTAL TENSION ADJUSTMENT to obtain the correct tension.</p>
9	<p>Close the drum gate and make certain that the READY light illuminates within 15 seconds. Check the TOP OF FORM and PAPER STEP switches for correct operation.</p>
10	<p>Turn the ON LINE/OFF LINE switch to the ON LINE position and check the TOP OF FORM and PAPER STEP switches to be certain they do not operate.</p>
11	<p>With the ON LINE/OFF LINE switch set in the ON LINE position, activate the power supply maintenance panel MASTER CLEAR switch. Check both the TOP OF FORM and PAPER STEP switches to be certain they operate.</p>
12	<p>Turn the ON LINE/OFF LINE switch to the ON LINE position and start running the MAINDEC-8/I-D2AA diagnostic program, starting at Part one of Step one. While the Program is running, adjust the vertical paper adjustment vernier.</p>
13	<p>Stop the running of the diagnostic program and depress the power supply maintenance panel PRINT INHIBIT switch and set the ON LINE/OFF LINE switch to ON LINE. Restart the diagnostic program from Part one of Test one.</p> <p>The PRINT INHIBIT light should illuminate and the diagnostic program should continue to run as it did in Step 10. Continue running the program for one minute.</p>
14	<p>With the ON LINE/OFF LINE switch in the ON LINE position, set the PRINT INHIBIT switch to OFF. Check the Line Printer for printout errors.</p>
15	<p>Excluding Part one of Test one of the diagnostic program, run all other parts of the program for one hour, using single-part paper. The test should be run with the Printer operating from both a 117 Vac 60-cycle source and a 220 Vac 50-cycle source.</p>
16	<p>Check the right tractor for correct adjustment and make certain that the COPIES CONTROL switch is set to the 1-2 position.</p>
17	<p>Inspect all Printer printouts for errors and compare them to the enclosed factory-printed samples.</p>

### 3.5.2 Accompanying Documents

One LP08 Line Printer print set and one LP08 Line Printer MAINDEC-8/I-D2AA program are supplied with the LP08 equipment.

### 3.5.3 Test Equipment

Any one of the PDP-8 family of computers, one Teletype, Model 33 ASR, and one box of single-part paper (supplied with the Line Printer) comprise the checkout testing equipment.

## Chapter 4

### Programming the LP08

#### 4.1 FUNCTION OF INTERFACE

The LP08 Line Printer/Interface is specifically designed to emulate the Teletype code structure; there is, therefore, a corresponding Line Printer command for each Teletype printer command. In addition, three other commands are available that allow the user to remove the Line Printer from the interrupt bus and detect Line Printer hardware errors. Thus, a user can easily alter a program that is Teleprinter-bound to an output on the Line Printer. The Line Printer does not utilize a conventional vertical format unit to control paper motions, but rather responds to ASCII code in precisely the same manner as a Teleprinter.

The Line Printer print rate varies between 356 and 1110 lpm (PBC), depending upon the printed line length. The Printer prints in segments of 20 characters. If the printed output is left-justified and is between 1 and 20 characters, the print rate will be 1110 lpm; if the printed output is between 60 and 80 characters per line, the print rate will be 356 lpm. Speed ranges are shown in Table 4-1.

Table 4-1  
Printing Speeds

	Number of Characters in line	Print Rate
64-Character Drum	1 - 20	1110
	21 - 40	650
	41 - 60	460
	61 - 80	356
96-Character Drum	1 - 20	843
	21 - 40	478
	41 - 60	330
	61 - 80	253

Each printable character is selected from 64 available characters and 3 format control characters by a 7-bit code which is USASCII-1968. The characters are transferred from the computer processor, through the AC (bits 5 through 11), to the 20-character shift register in the Line Printer control.

After either the shift register is full or one of the three ASCII paper feed characters has been transferred, printing of that 20-character sector occurs. If printing occurs because of a full buffer, the Printer control column counter will increment so that the next characters will print on the same line. After 80 characters have been printed on one line, the column counter will automatically reset to column 1 and overprinting will occur if a paper feed command is not transmitted.

The Interface contains a character FLAG which aids the program transfer of printable characters to the Line Printer. When raised, the character FLAG indicates that the Printer is ready to receive another character. This flag is raised in less than two  $\mu$ s after a load printer buffer command, for all characters except the twentieth, fortieth, sixtieth or eightieth character transfer. At these discrete times, printing will occur and the FLAG will return in approximately 35 ms.

The character FLAG is also delayed in returning after transmitting a carriage return, line feed, or form feed. The raising of the character FLAG causes a program interrupt to indicate a Printer done condition. The character FLAG will remain up until the next LPC or LCF command is issued. If the Printer detects an inoperative condition, i.e., paper out, paper torn, printer power off, or overheating of the Printer's motor, an interrupt will occur.

The Interface also contains software provision to remove or restore the Printer to the interrupt bus. This allows a user with many peripherals to service them as necessary, and not be interrupted by a low priority printer. When the processor is turned on, the Printer is initialized on the interrupt bus.

#### 4.2 IOT PROGRAMMING INSTRUCTIONS AND COMMANDS

The IOT programming instructions and commands which command the Line Printer, are presented in Table 4-2.

Table 4-2  
IOT Programming Instructions and Commands

Octal Code	Mnemonic	Function
6661	LSF	Skip on character FLAG. The content of the character FLAG is sensed; if it contains a binary 1, the content of the PC is incremented by one so that the next sequential instruction is skipped.
6662	LCF	Clear character FLAG. The Line Printer character FLAG is cleared.
6663	LSR	Skip on error. The level of the ready line is sensed, and, if it is at binary 0, indicating an error exists, the content of the PC is incremented by one so that the next sequential instruction is skipped.
6664	LLC	Load Printer buffer. A character is transferred to the Printer buffer from the content of bits 5 through 11 of the AC.
6665	LSP	Set PIE (program interrupt enable). The PIE flag is set to binary 1, allowing the setting of the character FLAG or lack of Printer READY to cause an interrupt.
6666	LPC	Clear character FLAG and load Printer buffer. Microinstruction combination of LCF and LLC.
6667	LCP	Set Program interrupt disable. The PIE flag is set to binary 0, disallowing the character FLAG and Printer READY to cause an interrupt.

### 4.3 LINE PRINTER SUBROUTINE

Any Teletype subroutine presently used can be changed to output on the Printer by changing the device code from 04 to 66. The only exception is a program that depends on the Printer flag not returning in less than 100 ms.

The following represents a typical Teletype subroutine rewritten for the LP08 Printer.

```

PRINT      Ø           /Store return address
           LSF         /Is Printer free
           JMP .-1     /No, inquire again
           LPC         /Yes, output character
           CLA         /Clear character from AC
           JMP I PRINT /Continue main program

```

The above sequence is accessed by a JMS instruction each time a character is to be output. It is assumed that the character code is in the AC.



More efficient routines can be written to output if all the output information is known upon entering the routine. The following subroutine prints a string of 100 characters, starting in location 2000:

PRINT	Ø	/Store return address
	CLA	/Clear AC
	TAD ADDR	/Load in character address
	DCA TEMP1	/Store in auto-index register
	TAD COUNT	/Load character counter
	DCA TEMP2	/Store counter
DOIT	LSF	/Is Printer free
	JMP DOIT	/No, inquire again
	TAD I TEMP1	/Yes, load character
	LPC	/Output character
	ISZ TEMP2	/Is text string complete
	JMP DOIT	/No, continue
	JMP I PRINT	/Yes, continue
ADDR,	1777	/Initial character address
COUNT,	-144	/Character counter = 100 decimal
TEMP 2,	Ø	/Current character address
	TEMP 1 = 100	/Auto-index register definition

# Chapter 5

## Circuit Analysis

### 5.1 GENERAL

The following sections present a detailed descriptive analysis of the LP08 Interface logic. See Engineering Drawings LP08-P-01 and D-BS-LP08-N-01.

### 5.2 PRINTER TO INTERFACE SIGNALS

To identify the operational state of the Line Printer in use, the two signals READY and DEMAND are fed from the Line Printer to the Interface logic. The READY signal indicates that Line Printer ac power is on, the paper interlocks are closed, and the character drum motor is up to speed and is not overheating. When the Line Printer indicates it is able to accept another printable character, DEMAND then goes high. When DEMAND goes low after receipt of STROBE L, it remains in this state, accepting data from the seven input DATA lines, 05 through 11.

Eight input lines originate from the Interface logic and terminate in the Line Printer. Seven are DATA lines and the eighth is the STROBE line. When the STROBE signal goes high, the data on the seven DATA lines is parallel-transferred to the Line Printer, making DEMAND go low until the Printer logic shifts the printable character into its associated memory.

### 5.3 PROCESSOR TO INTERFACE

The Computer processor is interconnected to the Interface by the BAC05 through 11, BMB03 through 11, BIO1, -2, and -4; and the B INIT lines. BAC05 through BAC11 bits are brought into the Interface DATA lines, BMB bits 03 through 08 are brought in as the device selectors, BMB bits 09 through 11 are brought in to decode the three additional commands for the device code, the three IOP pulses are brought in to generate the IOT codes, and the B INIT is brought in as the initialize line.

#### 5.4 INITIAL TURN-ON OF COMPUTER POWER

When computer power is initially turned on, or its associated KEY switch is activated, B INIT H is generated within the computer and fed to the Interface program interrupt enable flip-flop PIE, thus, setting it to the one state placing the Line Printer on the Interrupt bus. The PIE flip-flop can be either direct-cleared to its zero state or direct-set to its one state while under program control.

The character FLAG flip-flop is set to its one state when the DEMAND line from the Line Printer is high. The only way DEMAND can go high is when the Line Printer is ready for operation and has been manually placed ON-LINE. Therefore, the Printer is on the interrupt bus and the character FLAG is raised after it has been turned on and has been placed ON-LINE.

#### 5.5 IOT COMMANDS

When an IOT command is being executed and memory buffer bits 03 through 08 define the 66 device code, the device selector network generates IOT 1, IOT 2, and IOT 4, which are not directly used but gated with memory buffer bits 09 through 11 to generate the P SKF, P CLF, P SKE, P STB, P SIE, and P CIE levels.

#### 5.6 MEMORY BUFFER BITS

If the three low-order memory buffer bits MB09 through 11 form a binary two, P CLF is generated to clear the character FLAG flip-flop. If these bits form a binary three, P SKE is generated and gated with READY from the Line Printer. If READY is not true, it generates a high output pulse, which is connected to the computer skip bus through SKIP.

If the three low-order memory buffer bits form a binary four, P STB is generated and gated with a ground level raising STROBE, which is the Line Printer input strobe signal. STROBE is terminated by DEMAND, which returns to the true condition.

If the three low-order memory buffer bits form a binary five, P SIE is generated, resetting the program interrupt enable PIE flip-flop to its one state, thus, allowing program interrupt requests to be transmitted to the program interrupt bus.

If BMB bit 09 and 10 form a binary six, P SKF is generated and gated with FLAG such that, if FLAG is low, SKIP is generated and returned to the processor, causing the program counter to be incremented.

When the three memory buffer bits form a binary seven, P CIE is generated, direct-clearing the PIE flip-flop to its zero state, thus disallowing program interrupts to be transmitted to the interrupt bus of the processor.

## 5.7 OUTPUT DATA LINES

The output data lines from the M623 module have been terminated in the Printer controller 100 ohms to +5 Vdc to minimize ringing of the signals in the twisted pair 25-ft cable connecting the Interface and the Line Printer.

# Chapter 6

## Maintenance

### 6.1 GENERAL

To ensure maximum life and operating efficiency in the Line Printer and Interface, a regular preventive maintenance schedule must be established. Unnecessary adjustments should not be made to the Printer; such adjustments can alter its performance and cause time-consuming maintenance.

#### NOTE

For comprehensive maintenance information, refer to Section 5 in the Data Products Corporation Technical Manual.

Periodically inspect the Printer for any evidence of component overheating that would discolor resistors and wiring insulation, thereby causing breakage and erroneous operation. Replace any questionable component or module.

Keep the equipment as clean and dry as possible. An air blower or brush with long soft bristles makes an excellent dust remover. A high-pressure air hose is not recommended, as it can cause dust particles to scratch internal surfaces and components.

Before installing replacement parts, check the circuit to determine the cause of failure. When performing tests or alignment procedures on the Printer, the input signal conditions must also be checked, because waveform outputs are dependent on these signals.

The logic modules used in the Line Printer are shown in the following Module Schematics:

C-CS-M100-0-1	B-CS-M101-0-1	B-CS-M111-0-1	B-CS-M906-0-1
C-CS-M102-0-1	B-CS-M103-0-1	B-CS-M115-0-1	B-CS-M216-0-1

For the Interface I/O interconnecting cables for positive and negative logic, see Engineering Drawings D-IC-LP08-P-02 and D-IC-LP08-N-02.

## 6.2 PREVENTIVE MAINTENANCE

The following preventive maintenance data will enable the user to maintain the Line Printer and Interface in peak operating condition and detect problems before they affect their operational characteristics.

At periodic intervals, not to exceed 90 days, the Printer/Interface electrical and mechanical components should be inspected for excessive buildup of dust and dirt, wear of mechanical components (such as the ribbon drive), loose wiring connections and hardware components, burnt contacts, and any other evident irregularities.

The operational characteristics of the Printer should be periodically checked by using the MAINDEC-8/I-D2AA diagnostic programs. Diagnostic programs, combined with pulse checking, is suggested for locating circuit problems. Logic modules and connections should be checked for proper seating in their connectors.

## 6.3 THRESHOLD ADJUSTMENT

The only adjustment which compensates for the inclusion of the Interface circuit is the mounting of Data Products Corporation Receiver Card AK-10 in their associated card location rack, slot 14 (see Figure 5-2, Data Products Corporation Technical Manual).

To maintain proper voltage, perform the following: Connect an oscilloscope probe to the Receiver Card AK-10 test point TP-M (REF VOLTAGE) and adjust the reference voltage generator Q1 control until the threshold level of the seven input data lines is 1/2 of a logical one or is 2.5V. TP-M is the common test point for all seven input data lines. (See Figures 6-13 and 6-19 in the Data Products Corporation Technical Manual.)

## 6.4 DRAWINGS

Module Schematics pertinent to the LP08 Line Printer Interface are listed in Table 6-1; engineering drawings in Table 6-2.

Table 6-1  
LP08 Module Schematics

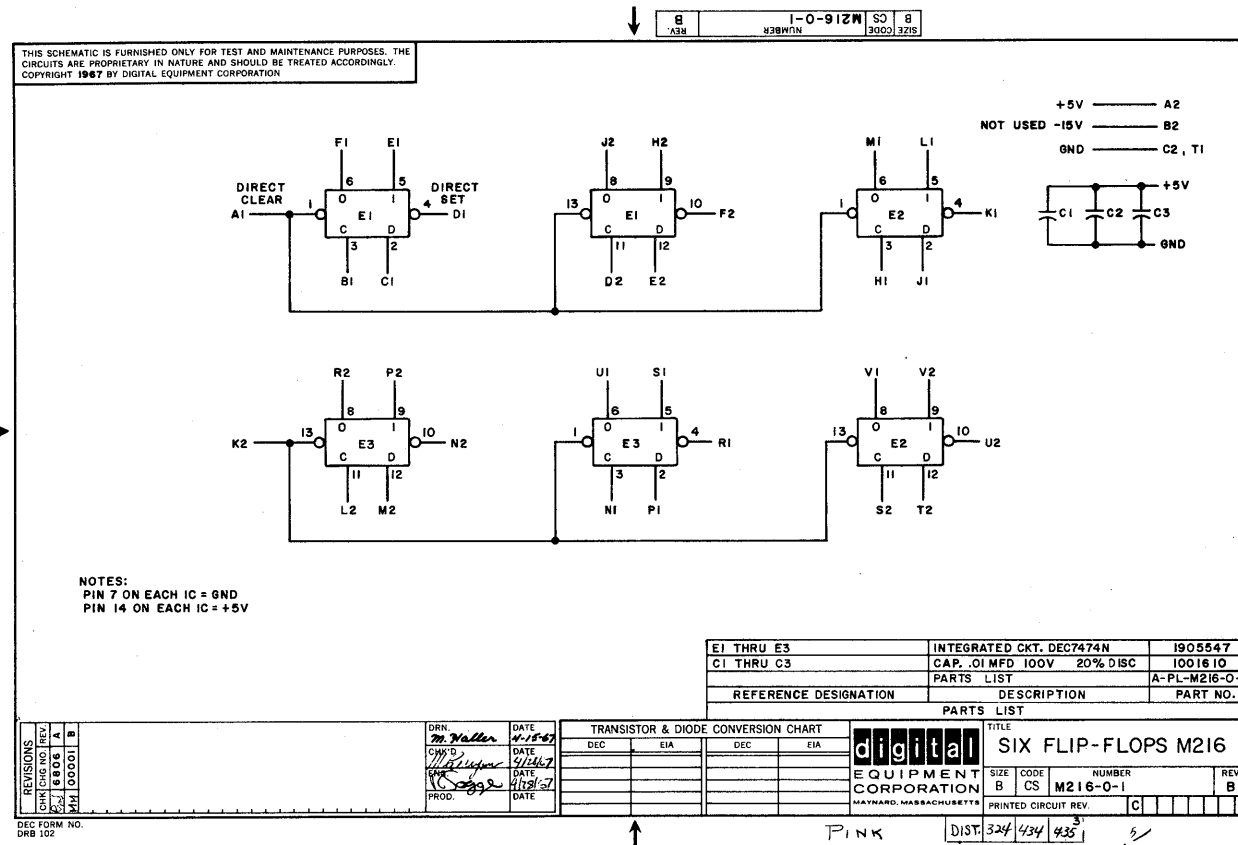
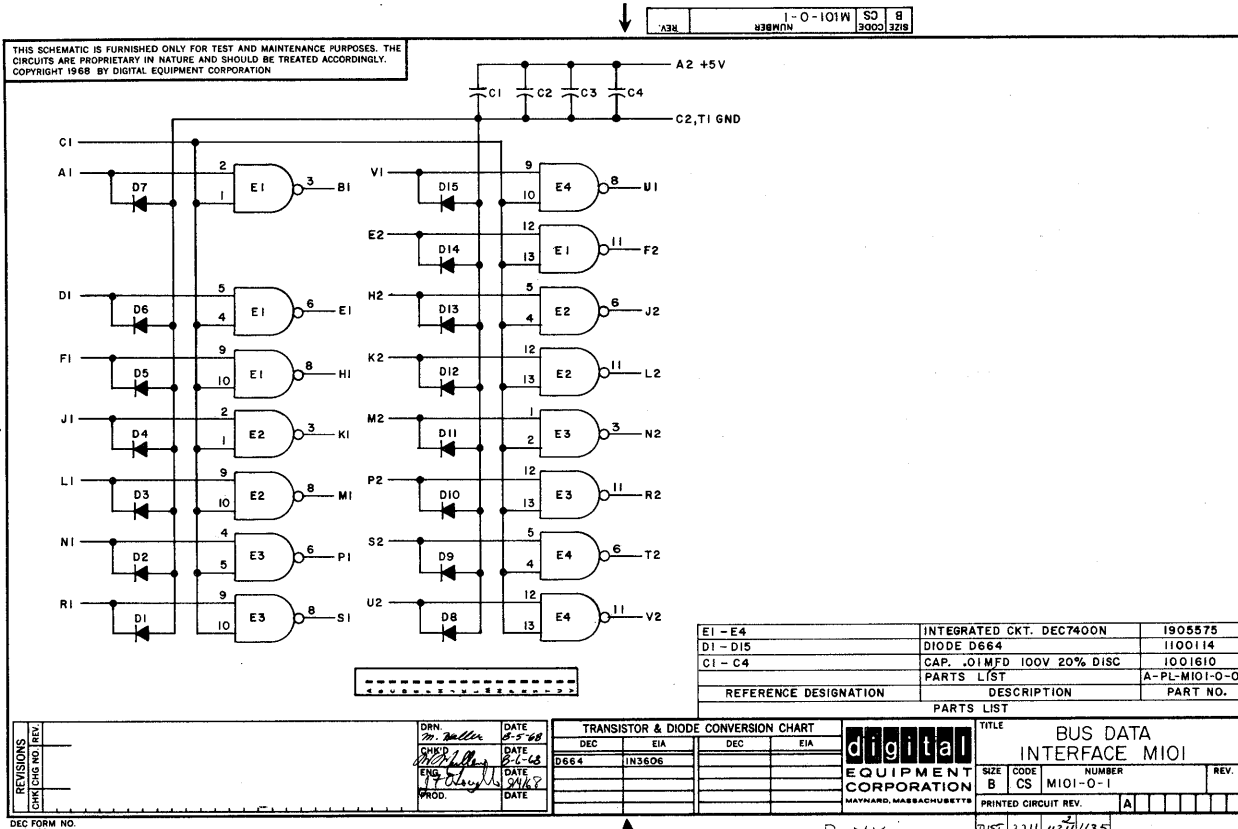
Module Schematic No.	Title	Rev.	Page
B-CS-M101-0-1	Bus Data Interface M101	--	6-4
B-CS-M216-0-1	Six Flip-Flops M216	B	6-4
B-CS-M103-0-1	Device Selector M103	A	6-5

Table 6-1 (Cont)  
LP08 Module Schematics

Module Schematic No.	Title	Rev.	Page
B-CS-M111-0-1	Inverter M111	A	6-5
B-CS-M115-0-1	8 3-Input NAND Gates M115	C	6-6
B-CS-M906-0-1	Cable Terminator M906	B	6-6
C-CS-M100-0-1	Bus Data Interface M100	--	6-7
C-CS-M102-0-1	Device Selector M102	--	6-8

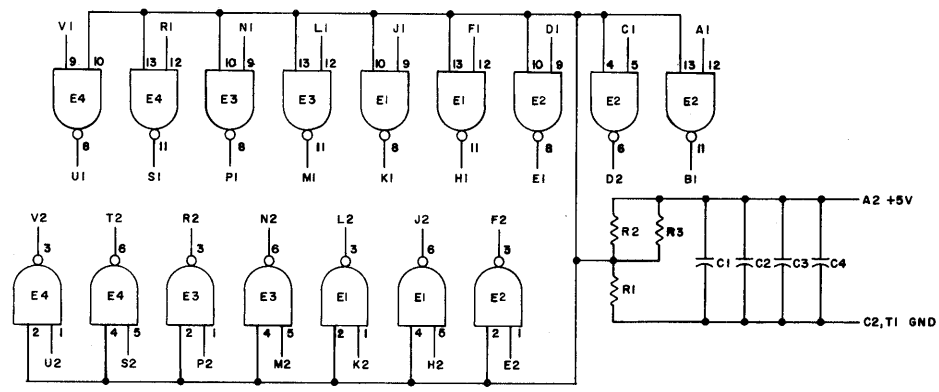
Table 6-2  
LP08 Engineering Drawings

Engineering Drawing No.	Title	Rev.	Page
D-IC-LP08-P-02	I/O Connectors Positive Bus	--	6-9
D-IC-LP08-N-02	I/O Connectors Negative Bus	--	6-11
D-BS-LP08-P-01	Positive Interface Logic	A	6-13
D-BS-LP08-N-01	Negative Interface Logic	C	6-15
D-MU-LP08-P-03	Module Utilization	A	6-17
D-MU-LP08-N-03	Module Utilization	--	6-19





THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1968 BY DIGITAL EQUIPMENT CORPORATION



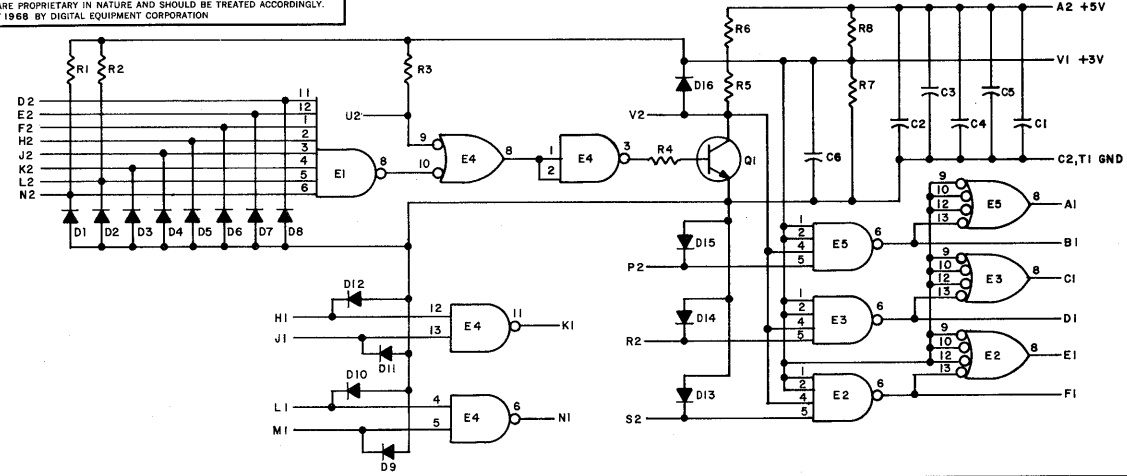
NOTES:  
 PIN 7 ON EACH IC = GND  
 PIN 14 ON EACH IC = +5V

E1-E4	INTEGRATED CKT. DEC7400N	1905575
R1-R3	RES. 750 1/4W 5% CC	1301401
C1-C4	CAP. .01MFD 100V 20% DISC	1001810
	PARTS LIST	A-PL-M111-0-0
REFERENCE DESIGNATION	DESCRIPTION	PART NO.

REVISIONS CHKD. NO. REV. A 00001	DRN. <i>M. Waller</i> DATE 5-21-68	TRANSISTOR & DIODE CONVERSION CHART		digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	TITLE INVERTER M111	
	CHK'D. <i>[Signature]</i> DATE 5/21/68	DEC	EIA		SIZE B	CODE CS
DEC FORM NO. DRB 102	PROD. <i>[Signature]</i> DATE	DEC	EIA	PRINTED CIRCUIT REV. C	REV. A	

DIST. 434 435 324 PINK

THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1968 BY DIGITAL EQUIPMENT CORPORATION

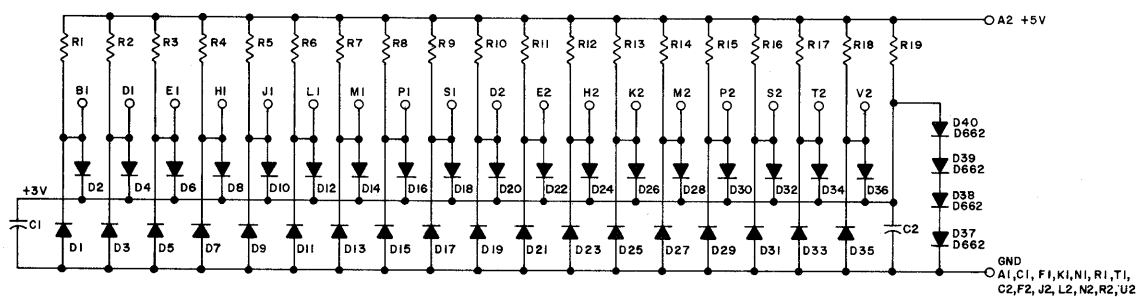


Q1	TRANSISTOR DEC3009B-S	1503100
E4	INTEGRATED CKT. DEC7400N	1905575
E2, E3, E5	INTEGRATED CKT. DEC74H40N	1905586
E1	INTEGRATED CKT. DEC7430N	1905578
R8	RES. 330 1/4W 5% CC	1300295
R4-R7	RES. 750 1/4W 5% CC	1301401
R1, R2, R3	RES. 8.2K 1/4W 5% CC	1303179
D1-D16	DIODE D664	1001114
C1-C6	CAP. .01MFD 100V 20% DISC	1001810
	PARTS LIST	A-PL-M103-0-0
REFERENCE DESIGNATION	DESCRIPTION	PART NO.

REVISIONS CHKD. NO. REV. A 00001	DRN. <i>M. Waller</i> DATE 10-4-68	TRANSISTOR & DIODE CONVERSION CHART		digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	TITLE DEVICE SELECTOR M103	
	CHK'D. <i>[Signature]</i> DATE 2-12-69	DEC	EIA		SIZE B	CODE CS
DEC FORM NO. DRB 102	PROD. <i>[Signature]</i> DATE 11-17-68	DEC	EIA	PRINTED CIRCUIT REV. B	REV. A	

DIST. 324 434 435 PINK

THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1968 BY DIGITAL EQUIPMENT CORPORATION

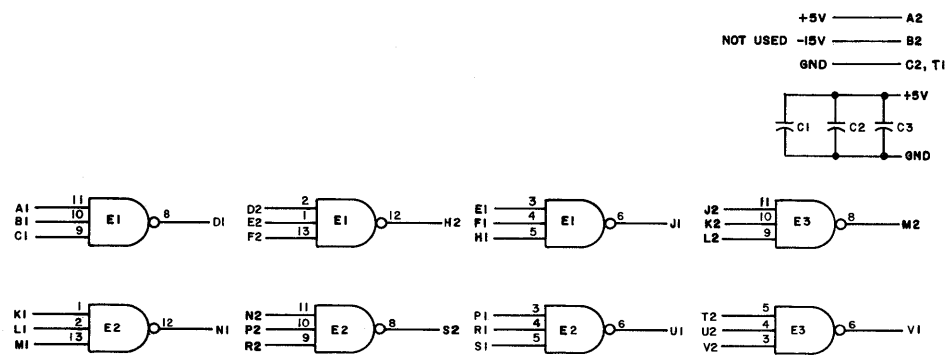


UNLESS OTHERWISE INDICATED:  
RESISTORS ARE 220, 1/4W, 5%  
DIODES ARE D664  
CAPACITORS ARE .01 MFD, 100V, 20%

REVISIONS CHK'D GND REV. REV. & REOR. 00001 B	DRN. M. HALLER	DATE 8-2-68	TRANSISTOR & DIODE CONVERSION CHART				digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	TITLE CABLE TERMINATOR M906			
	CHK'D W. MULLEN	DATE 8-2-68	DEC	EIA	DEC	EIA		SIZE B	CODE CS	NUMBER M906-0-1	REV. B
	ENG. D.A. WHITE	DATE 10-16-68	D662	1N645							
	PROD.	DATE	D664	1N3606							
DEC FORM NO. DRB 102										PRINTED CIRCUIT REV. A B	

DIST. 224,434,435 PINK

THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1967 BY DIGITAL EQUIPMENT CORPORATION

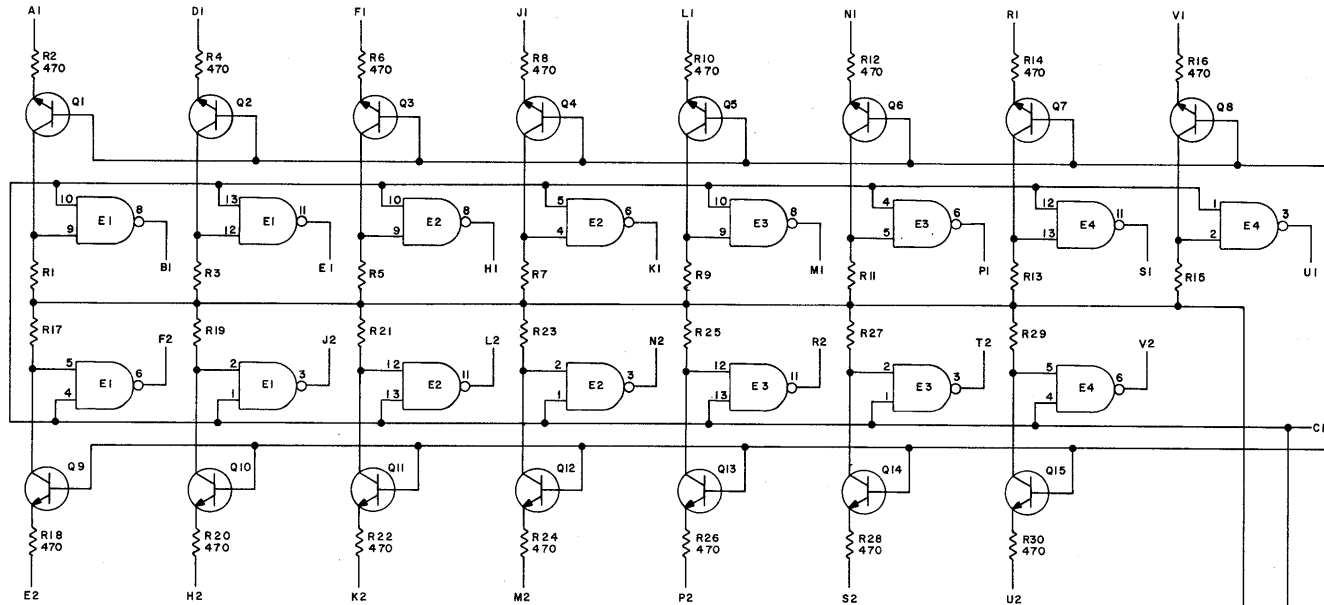


NOTES:  
PIN 7 ON EACH IC = GND  
PIN 14 ON EACH IC = +5V

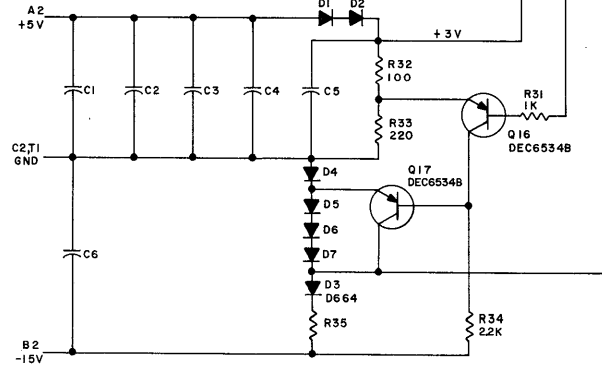
REVISIONS CHK'D GND REV. REV. & REOR. 00001 B	DRN. M. HALLER	DATE 8-20-67	TRANSISTOR & DIODE CONVERSION CHART				digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	TITLE 8-3 INPUT NAND GATES M115			
	CHK'D W. MULLEN	DATE 4-21-69	DEC	EIA	DEC	EIA		SIZE B	CODE CS	NUMBER M115-0-1	REV. C
	ENG. D.A. WHITE	DATE 4/21/67									
	PROD.	DATE									
DEC FORM NO. DRB 102										PRINTED CIRCUIT REV. D	

DIST. 224,434,435 PINK

THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1969 BY DIGITAL EQUIPMENT CORPORATION



UNLESS OTHERWISE INDICATED:  
 PIN 7 ON EACH IC = GND  
 PIN 14 ON EACH IC = +5V  
 IC'S ARE DEC 7400N  
 CAPACITORS ARE .01MFD  
 DIODES ARE D662  
 RESISTORS ARE 1/4W 5%  
 RESISTORS ARE 4.7K  
 TRANSISTORS ARE DEC3009B



6-7

REVISIONS  
 CHK CHG NO. REV.

DRN. DATE 3-27-69  
 CHG'D M. M... DATE 3/28/69  
 ENG. DATE 7-14/69  
 PROD. DATE

TRANSISTOR & DIODE CONVERSION CHART			
DEC	EIA	DEC	EIA
D662	1N645		
D664	1N3806		
DEC3009B	2N3009		
DEC6534B	MPS6534		

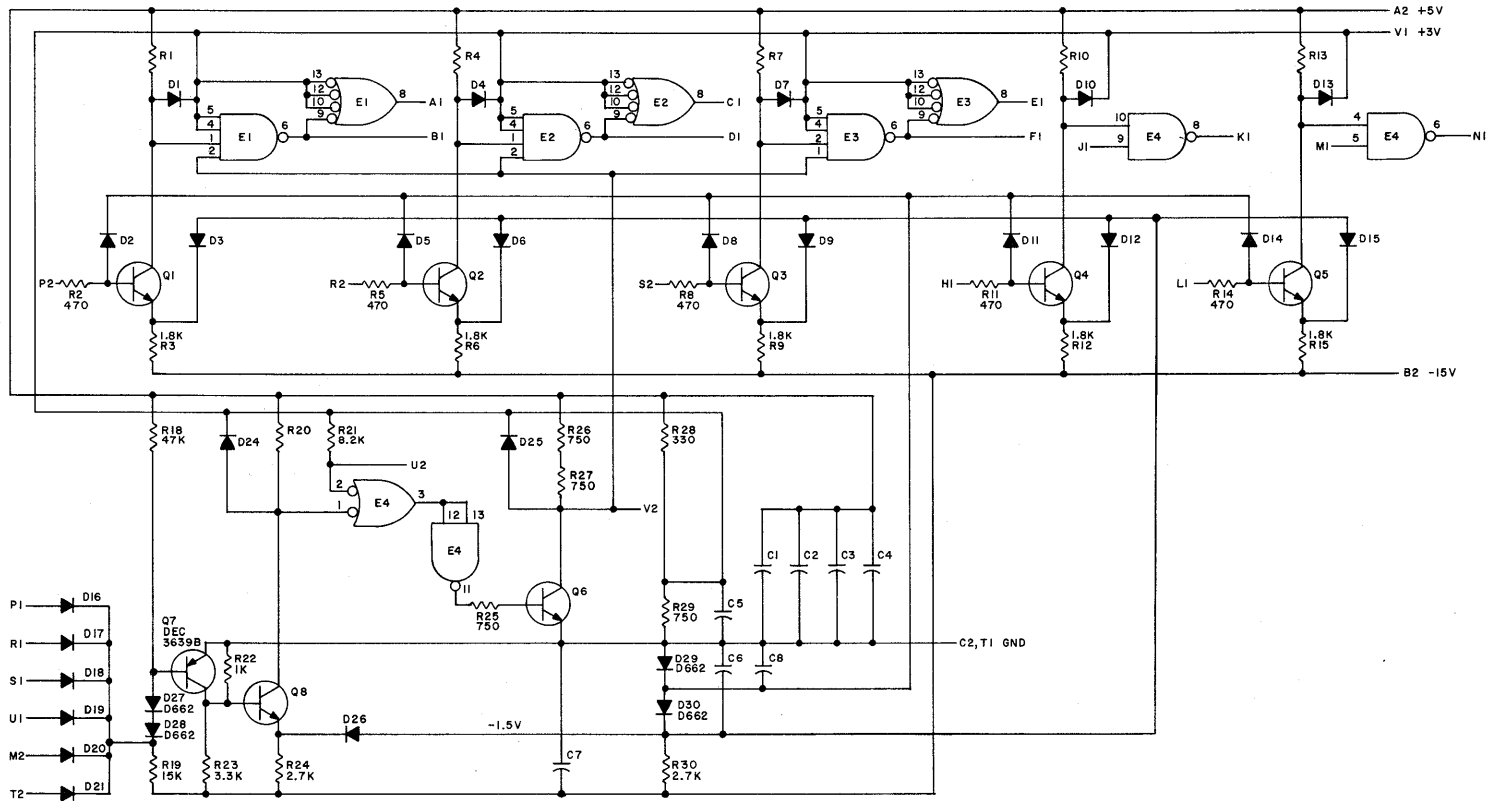
**digital**  
 EQUIPMENT CORPORATION  
 MAYNARD, MASSACHUSETTS

TITLE BUS DATA INTERFACE  
 M100  
 SIZE CODE NUMBER  
 C CS M100-0-1  
 PRINTED CIRCUIT REV. A

REV. NUMBER  
 C. L. LIS. M100-0-1

DEC 69 100  
 DEC 100

THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY. COPYRIGHT 1969, BY DIGITAL EQUIPMENT CORPORATION.



UNLESS OTHERWISE INDICATED:  
 DIODES ARE D664  
 RESISTORS ARE 1.5K, 1/4W, 5%  
 CAPACITORS ARE .01 MFD 100V 20%  
 TRANSISTORS ARE DEC3009B  
 E1, E2, E3 ARE DEC74H40N  
 E4 IS DEC7400N  
 PIN 7 ON EACH IC = GND  
 PIN 14 ON EACH IC = +5V

8-9

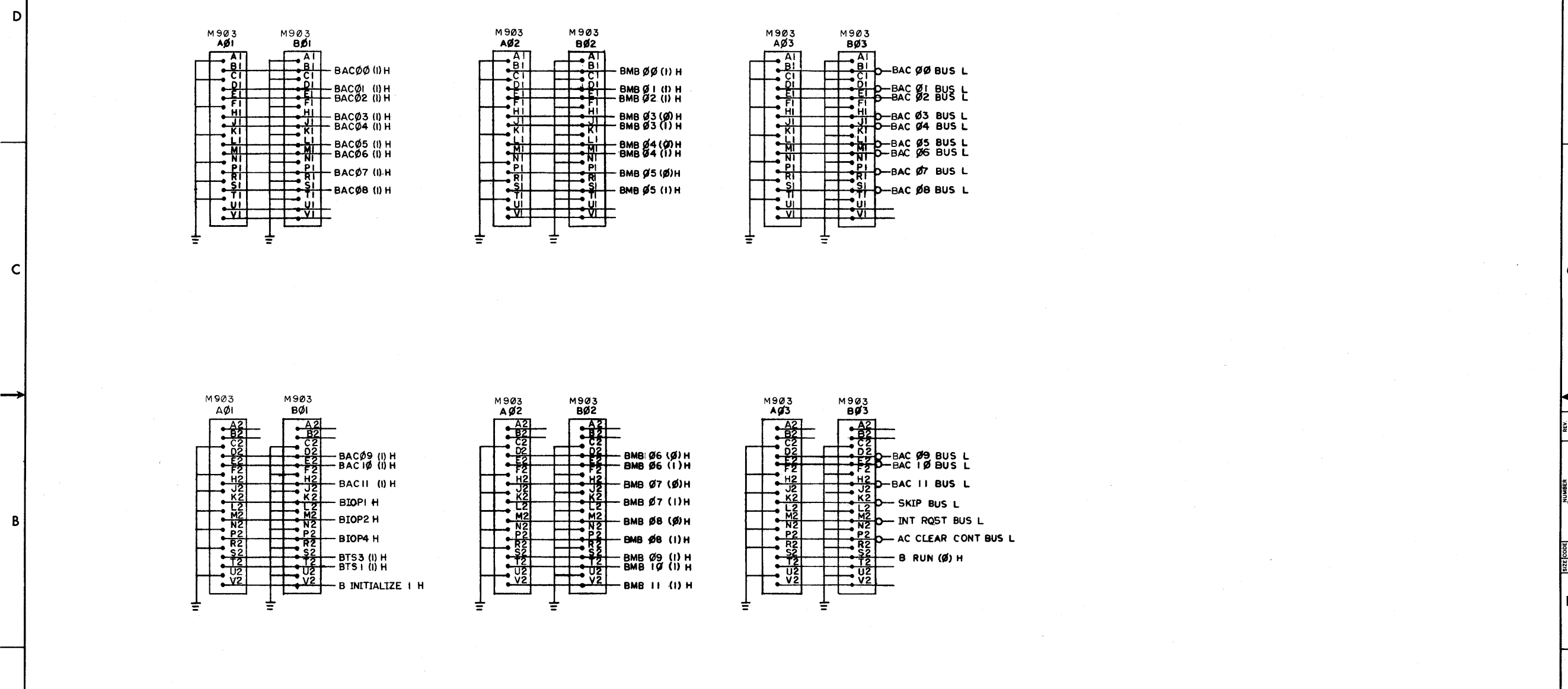
REV. NUMBER  
 CS M102-0-1

REVISIONS CHG. NO. DATE BY	DRN. <i>Dr. Miller</i> DATE <i>4-2-69</i>	TRANSISTOR & DIODE CONVERSION CHART				TITLE <b>digital</b> DEVICE SELECTOR M102 EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS PRINTED CIRCUIT REV. <i>A</i>
	CHWD. DATE <i>8-1-69</i>	DEC D662 IAN45	DEC	EIA	NUMBER CS M102-0-1	
	ENG. DATE <i>5/6/69</i>	D664 IAN508	DEC	EIA	REV.	
	PROD. DATE <i>5/6/69</i>	DEC3009B 2N3009 DEC3639B 2N3639	DEC	EIA	REV.	

DEC FORM NO. DRC 102

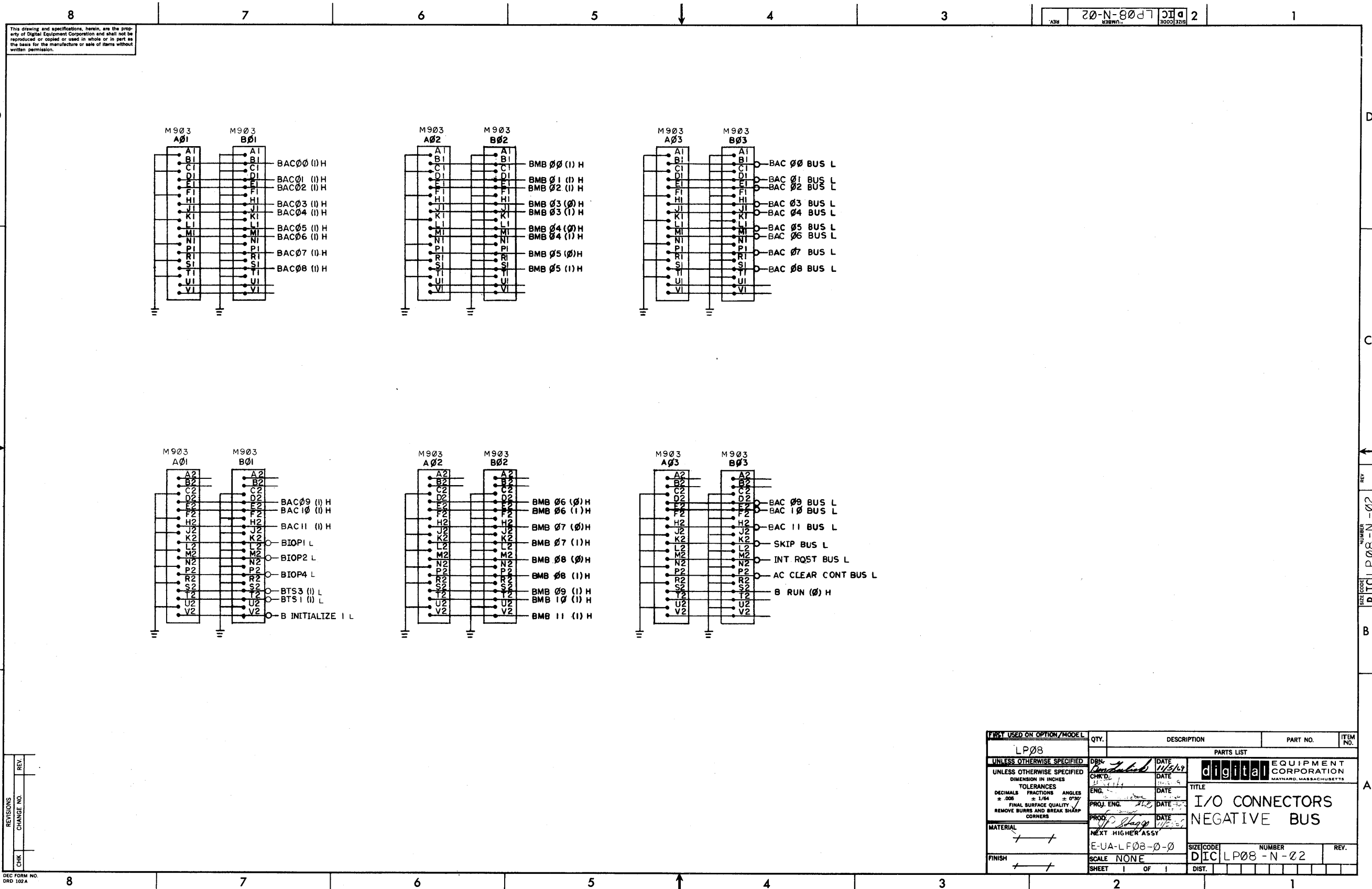
5 DIST. 324, 434, 435 PINK

This drawing and specifications, herein, are the property of Digital Equipment Corporation and shall not be reproduced or copied or used in whole or in part as the basis for the manufacture or sale of items without written permission.

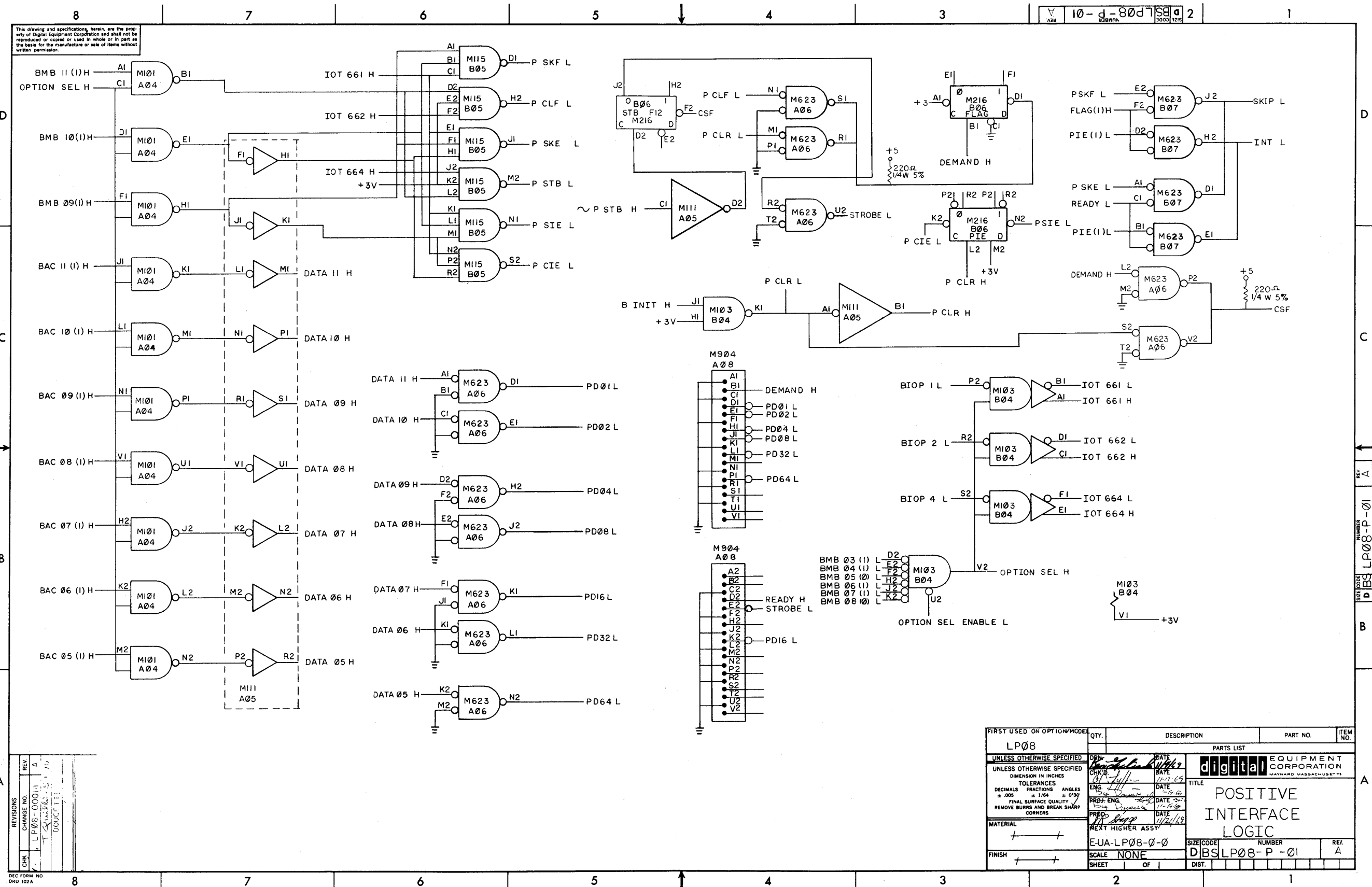


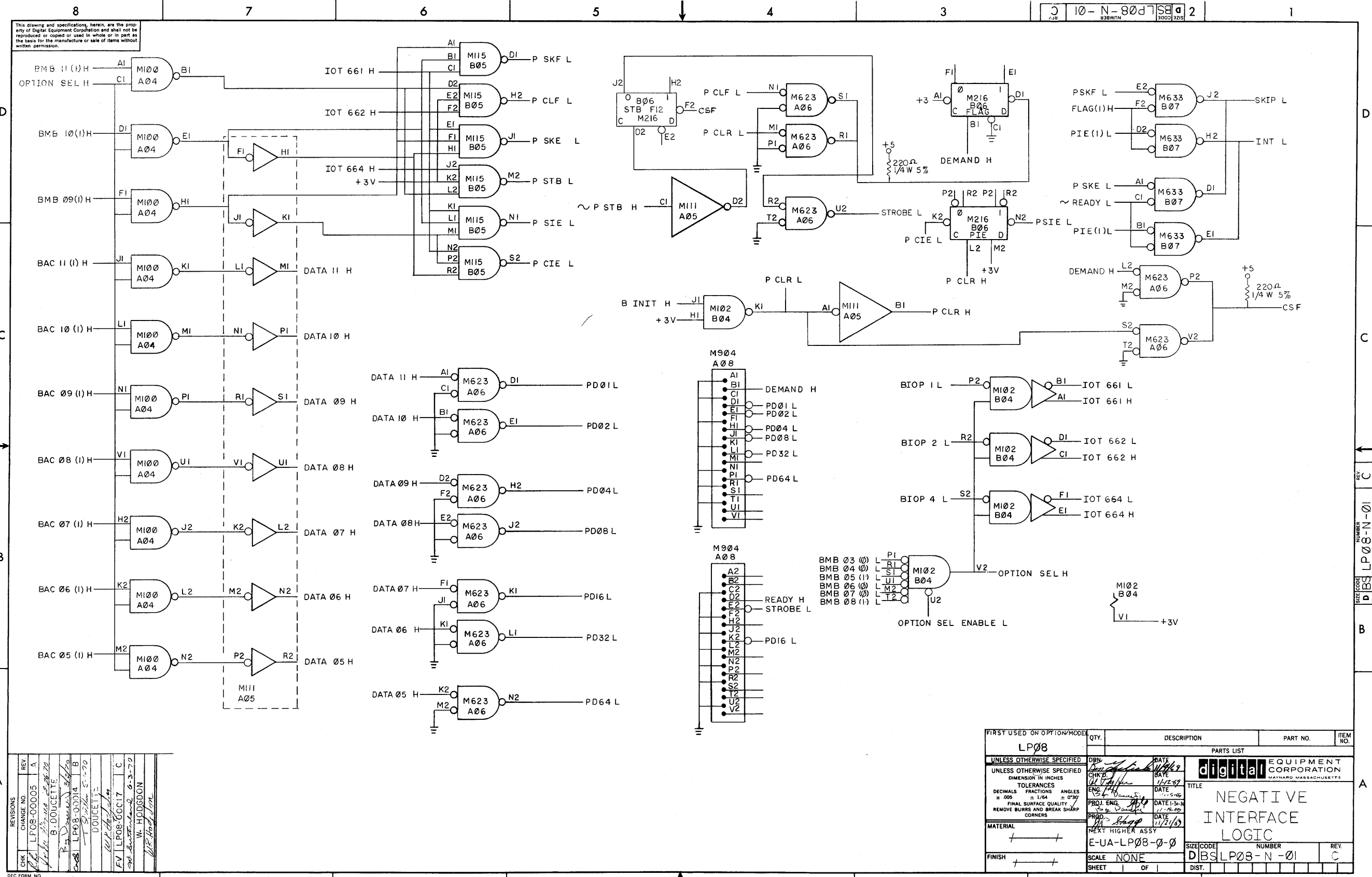
REV.	
REVISIONS	
CHANGE NO.	
CHK	

FIRST USED ON OPTION/MODEL	QTY.	DESCRIPTION	PART NO.	ITEM NO.
LP08				
PARTS LIST				
UNLESS OTHERWISE SPECIFIED	DRN	DATE	digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	
DIMENSION IN INCHES	CHK'D	DATE	TITLE	
TOLERANCES	ENG	DATE	I/O CONNECTORS	
DECIMALS FRACTIONS ANGLES	PROJ. ENG.	DATE	POSITIVE BUS	
±.008 ± 1/64 ± 0°30'	PROD.	DATE	SIZE CODE	NUMBER
FINAL SURFACE QUALITY	DATE	11/2/69	DIC	LP08-P-02
REMOVE BURRS AND BREAK SHARP CORNERS	DATE		SCALE	NONE
MATERIAL	DATE		SHEET	OF 1
FINISH	DATE		DIST.	



PART USED ON OPTION/MODEL	QTY.	DESCRIPTION	PART NO.	ITEM NO.
LP08				
PARTS LIST				
UNLESS OTHERWISE SPECIFIED	DRN. <i>Handwritten</i>	DATE <i>11/2/69</i>	<b>digital</b> EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	
DIMENSION IN INCHES	CHK'D. <i>Handwritten</i>	DATE <i>11/2/69</i>		
TOLERANCES	ENG. <i>Handwritten</i>	DATE <i>11/2/69</i>	TITLE <b>I/O CONNECTORS NEGATIVE BUS</b>	
DECIMALS FRACTIONS ANGLES	PROJ. ENG. <i>Handwritten</i>	DATE <i>11/2/69</i>		
± .006 ± 1/64 ± 0°30'	PROD. <i>Handwritten</i>	DATE <i>11/2/69</i>	SIZE/CODE NUMBER REV. <b>DIC LP08-N-02</b>	
FINAL SURFACE QUALITY REMOVE BURRS AND BREAK SHARP CORNERS	NEXT HIGHER ASSY E-UA-LF08-0-0			
MATERIAL	SCALE NONE		SHEET 1 OF 1	
FINISH	DIST.			





REVISIONS

CHK	CHANGE NO.	REV	DATE
	LP08-0005	A	
		B	
		C	

DEC FORM NO. DFD 102A

FIRST USED ON OPTION/MODEL	QTY.	DESCRIPTION	PART NO.	ITEM NO.
LP08				
UNLESS OTHERWISE SPECIFIED				
DIMENSION IN INCHES		DATE 11/2/69		
TOLERANCES		DATE 11/2/69		
DECIMALS	FRACTIONS	ANGLES	DATE 11/2/69	
± .005	± 1/64	± 0°30'	DATE 11/2/69	
FINAL SURFACE QUALITY				
REMOVE BURRS AND BREAK SHARP CORNERS				
MATERIAL				
NEXT HIGHER ASSY				
E-UA-LP08-0-0				
SCALE NONE				
FINISH				
SHEET OF				
TITLE			SIZE CODE	NUMBER
NEGATIVE INTERFACE LOGIC			D	BS LP08-N-01
REV.			C	







**Digital Equipment Corporation  
Maynard, Massachusetts**

**digital**