Model LPC-3

Line Printer Controller

Technical Manual

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REVISION HISTORY

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1136	9/2/88	Added Appendix A to Manual.	A-1

PREFACE

This manual contains information regarding installation, testing, and operation of the ZETACO Model LPC-3 Line Printer Controller.

The technical contents of this manual have been written based on the assumptions that the reader 1) has a working knowledge of Data General computer hardware (or has access to hardware documentation) and the operating system; 2) has some familiarity with standard installation, power, grounding and peripheral cabling procedures; and 3) has access to technical information about the printer that will be installed with this controller.

The information in this manual is organized into five major sections:

SECTION 1.0 PRODUCT OVERVIEW - Describes the Model LPC-3 Printer Controller's features, capabilities, specifications, power and interface requirements.

SECTION 2.0 INSTALLATION PROCEDURES - Contains procedures for unpacking, configuring and installing the controller.

SECTION 3.0 TROUBLE-SHOOTING, TEST PROGRAMS and CUSTOMER SERVICE - Contains information useful in fault analysis and how to get help.

SECTION 4.0 USAGE GUIDELINES - Contains information explaining the use of the LPC-3 features.

SECTION 5.0 PROGRAMMING NOTES - Contains technical information for those involved in fault analysis or programming

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1.0 PRODUCT OVERVIEW

1.1 GENERAL DESCRIPTION

ZETACO's Model LPC-3 Data Channel Line Printer Controller is designed to interface most popular brands of serial and parallel printers to a Data General Nova, Eclipse or MV minicomputer via the Data Channel (DCH). The LPC-3 Controller supports serial printers using the RS232 interface standard and parallel printers using the Dataproducts/Centronics parallel interface standard.

The LPC-3 Controller is microprocessor based. It supports Dataproducts compatible, down-line loadable VFU's. There is also an on-board VFU for use with printers that do not have a Dataproducts compatible VFU, and horizontal format control.

Upon power-up, the microprocessor executes a Self-test which checks out much of the LPC-3 Controller. Failure of any part of the test is reported via LEDs on the front of the controller.

The LPC-3 Controller also has printout Self-tests which send either a rotating ASCII set or a message to the printer, allowing checkout of the printer, cabling and controller-to-printer interface.

Error reporting (either LPC-3 failure or improper data format) is done both by LEDs and hardcopy via the Printout Self-test feature.

Both FCC and non-FCC compliant cabling are available.

ZETACO's Model LPC-3 Controller and your printer provide a printing subsystem equivalent to the Data General 4215, 4216, 4327, 4328, 4356, 4363, 4364, 4374 and 6192 printer subsystems. With the LPC-3 Controller, changes to existing RDOS, AOS or AOS/VS software are not necessary.

1.2 FEATURES - ADVANTAGES

1. All LPC-3 configurations are done via switches.

2. Allows DG operating systems to work with a Dataproducts VFU.

3. On-board VFU which will work with any printer connected to the LPC-3 Controller.

4. On-board VFU may be configured to perform automatic perforation skipovers.

5. On-board Horizontal Format Control.

6. Can be configured to pass 8 bit data literally as received from the DG computer.

7. Can automatically convert a 96 character ASCII set to a 64 character set.

8. Can mask either Carriage Return or Line Feed codes.

9. Will allow either a serial or a parallel printer to work with DG's Data Channel.

10. Serial printer's baud rate is selectable from 50 to 19,200 baud.

11. +/-12V noise margins on the RS232 interface.

12. Two printout Self-tests: ZETACO message and rotating ASCII.

13. Power-up Self-test of the LPC-3 Controller with error reporting via LEDs.

14. On-line error reporting via a code on four LED indicators.

15. LED which indicates multiple on-line errors have occurred and also distinguishes power-up Self-test codes from on-line error codes.

16. Hardcopy printout of up to 8 on-line errors which have occurred via the LPC-3 printout Self-test.

17. LED indicators to show the following: controller BUSY, printer on-line, and data being transmitted to printer.

18. Selectable device code.

19. Selectable strobe width for parallel printer (0.4 to 3.2 microseconds).

20. Selectable polarities for following signals in the parallel printer interface: on-line, Ready, Demand (Acknowledge), and data.

21. High current drivers (48 ma) on the parallel interface.

1.3 SPECIFICATIONS

1.3.1 FUNCTIONAL CONTROLLER CHARACTERISTICS

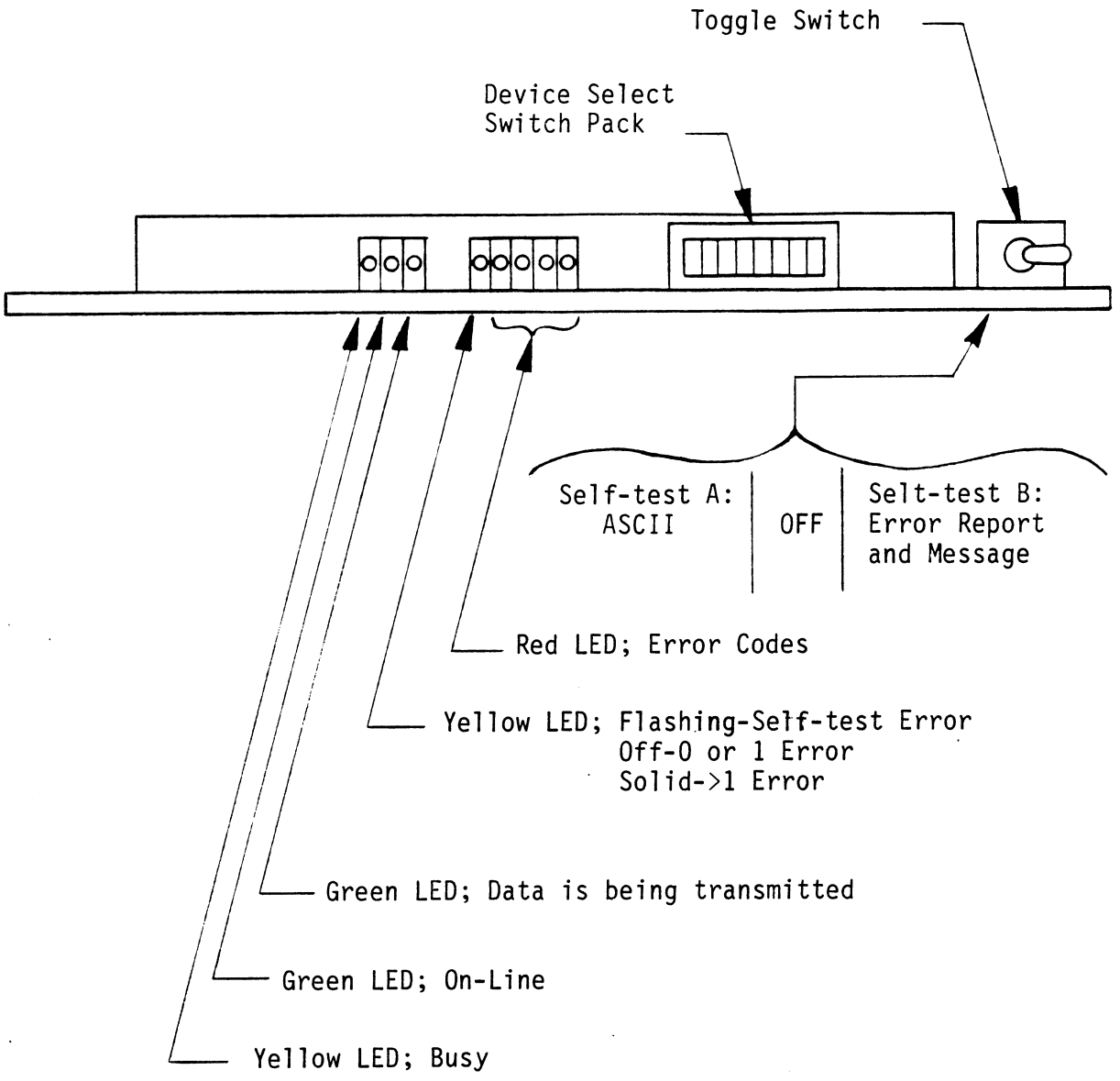
Emulation:	Data General 4215, 4216, 4327, 4328, 4356, 4363, 4364, 4374, and 6192 printer subsystems.
VFU Compatibility:	Conversion of Data General VFU format to Dataproducts VFU format. On-board VFU which can be configured for automatic perforation skipover. Loading and control is done via the Data Channel.
Literal Character Transfer:	In this mode, data is passed in 8 bit format from the Data General computer (using the Paper Instruction (PI) line for the 8th data line) without alteration.
Character Masking:	Either Carriage Returns or Line Feeds can be removed from the data stream.
Horizontal Format Control:	Horizontal tabbing capability is maintained on the LPC-3 Controller for up to 256 columns. Loading and tab commands are done via the Data Channel.

Character Set Conversion:	96 character ASCII set can be converted to 64 character set during data transmission for printers with a reduced character set (essentially means conversion of lower case to upper case).
Indicator LEDs: (See Figure 1.1)	From left to right: A.) LED 1 (YELLOW) indicates the printer controller BUSY flag is set. The BUSY flag is set while activity is occuring between the CPU and the LPC-3 Controller on the Data Channel. B.) LED 2 (GREEN) indicates that the parallel printer is on-line. C.) LED 3 (GREEN) indicates either serial or parallel data is presently being transmitted to the printer. D.) LED 4 (YELLOW) indicates if error code LEDs represent a power-up error (LED 4 is flashing), or if more than 1 error has occurred during on-line operation (LED 4 is solid). See Sections 3.1 and 3.4 for more detail on the error LEDs. E.) Last four LEDs (RED) indicate error codes for the power-up, Self-test, and on-line operation. See Sections 3.1 and 3.4.

1.3.2 COMPUTER INTERFACE

The LPC-3 Controller uses the standard DG I/O (for setting up Data Channel transfers, reading printer status, etc.) and the Data Channel (for data transfer to the printer) buses. It may be inserted into any "I/O" slot. FCC and non-FCC cabling is available for parallel printers, and an FCC internal cable (connects the computer backplane to the rear-mounted backpanel) is available for serial printers.

FIGURE 1.1 Indicator LEDs and Toggle Switch



1.3.3 PRINTER INTERFACE

FUNCTIONAL:	Dataproducts/Centronics interface standard for parallel printers. RS232 standard for serial printers.
ELECTRICAL:	High current (48 ma) drivers (7437s) for the parallel printer interface. +/-12 V noise margin on the serial interface driver.
CABLING:	Non-FCC: Shielded, twisted pair, round cable for parallel printer. FCC: A. Parallel: Flat ribbon internal cable and shielded, twisted pair, round external cable. B. Serial: Internal with 25-pin "D" connector at the CPU bulkhead.

TABLE 1.1 Parallel Printer Interface Signals

SIGNAL	BACKPLANE PIN
PAPER INSTRUCTION (or DATA 8)	B36 AND B51
DATA 7	B49
DATA 6	B31
DATA 5	B27
DATA 4	B25
DATA 3	B23
DATA 2	B19
DATA 1	B15
STROBE	B53
DEMAND (ACKNOWLEDGE)	B38
READY	B54
ON-LINE	B40

TABLE 1.2 Serial Printer Interface Signals

SIGNAL	BACKPLANE PIN
SERIAL DATA OUT	A85
CLEAR TO SEND	A90

1.3.4 PHYSICAL CHARACTERISTICS

DIMENSIONS: 15" X 15" X 0.5" (38.1 X 38.1 X 1.3 cm)

SHIPPING WEIGHT: 10 pounds (4.5 Kg) (includes board,cable, and documentation).

1.3.5 POWER REQUIREMENTS

+5 (+/-5%) VDC @ 1.7 amps typical

-5 (+/-5%) VDC @ 0.1 amps typical

1.3.6 ENVIRONMENTAL CHARACTERISTICS

OPERATING TEMPERATURE: 0° to 55° C

RELATIVE HUMIDITY: 10% to 90% (non-condensing)

2.0 INSTALLATION PROCEDURES

This section contains the procedures necessary for proper installation and configuration of the LPC-3 Printer Controller. Please read it carefully.

2.1 UNPACKING AND INSPECTION

A. If you ordered the LPC-3 for use in DG's Non-FCC-compliant chassis, you will receive:

1) LPC-3 Line Printer Controller with protective cover
2) Technical Manual
3) Single cable for parallel printer with connector as you specified.

B. If you ordered the LPC-3 for us in DG's FCC-compliant chassis, you will receive:

1) LPC-3 Line Printer Controller with protective cover
2) Technical Manual
3) Paddleboard to interface the FCC shielding at the backplane.

If the optional cables were ordered for use in the FCC chassis, you will also receive:

(1) double cable set for parallel printer
OR
(1) internal RS232 cable for serial printer. (Customer supplies the external RS232 cable.)

It is recommended that all packing materials and cartons be saved, in case re-shipping is necessary.

Upon receipt of the Model LPC-3 Controller from the carrier, inspect the shipping carton immediately for any evidence of damage or mishandling in transit.

If the shipping carton is water stained or damaged, contact the carrier and shipper immediately and specify the nature and extent of the damage and request that the carrier's agent be present when the carton is opened.

ZETACO's warranty does not cover shipping damage.

For repair or replacement of any ZETACO product damaged in shipment, call ZETACO or a Zetaco Authorized Distributor to obtain return authorization instructions.

2.2 CHASSIS PREPARATION

2.2.1 SLOT SELECTION

The LPC-3 Controller may be inserted in any "I/O" slot of a DGNova, Eclipse, or MV series minicomputer after the CPU, Memory, and I/O board.

2.2.2 PRIORITY JUMPERS

The controller must receive two priority signals from the minicomputer backplane: Data Channel Priority In (Pin A94) and Interrupt Priority In (Pin A96). If there are any vacant slots between the controller and the processor, priority jumper wires must be installed to obtain priority continuity between controllers. To jumper across unused slots, connect A93 (Data Channel Priority Out) to A94 (Data Channel Priority In) and A95 (Interrupt Out) to A96 (Interrupt Priority In). See Figure 2.1.

2.3 CONTROLLER PREPARATION

For this section, it may be necessary to consult the printer's technical manual in order to properly configure the LPC-3 Controller. The controller is configured entirely with 5 switch packs. The locations that are indicated in Table 2.1 belong to the coordinate scheme which is marked on the LPC-3 printed circuit board silkscreen. However, all switches are accessible either from the front of the controller (the Device Select Switch Pack) or through holes in the board cover (all other switch packs). The switch pack names and brief explanations of the switch setting are silkscreened on the board cover. Therefore the board cover does not need to be removed to alter any of the switch settings.

TABLE 2.1 Switch Pack Names and Locations

	NAME	LOCATION	# SWITCHES/PACK
1.	Device Select	8F	8 (only 6 used)
2.	UART Configuration	4T	8
3.	Strobe Width Select	8R	4
4.	Microprocessor Configuration	7K	8
5.	Hardware Configuration	6E	8 (only 7 used)

2.3.1 DEVICE SELECT SWITCH PACK (LOCATION 8F)

Peripheral controllers are each assigned a unique device code to allow the CPU to distinguish them. The LPC-3 Controller can be set to any device code between 0 and 77 (octal). However, the primary device code is 17 (octal), and the secondary device code is 57 (octal). The primary device code, 17 (octal), has been factory set and should be left as is unless another printer subsystem exists with the same device code.

A switch pack on the handle edge of the controller is used to select the desired device code. Refer to the cover silkscreen to locate this switch pack. Refer to Table 2.2 to determine how to set up arbitrary device codes. The names of the six device select lines are DS0 through DS5. DS0 is the most significant bit. An example of setting up device code 17 follows:

Switch:	S1	S2	S3	S4	S5	S6	S7	S8
Name:			DS0	DS1	DS2	DS3	DS4	DS5
Setting:	X	X	DOWN	DOWN	UP	UP	UP	UP

X = Not Used

FIGURE 2.1 Backpanel Priority Jumpers

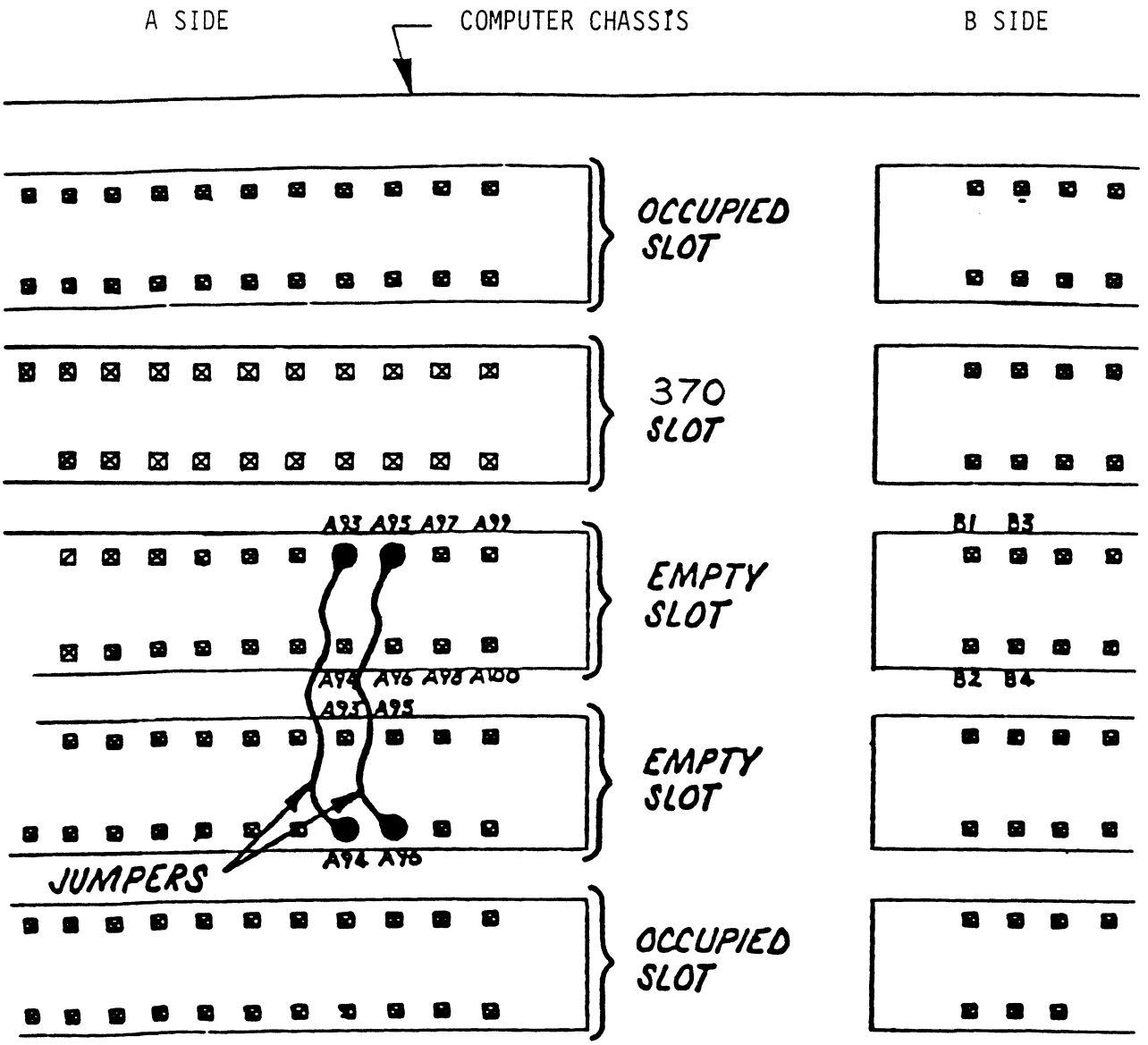
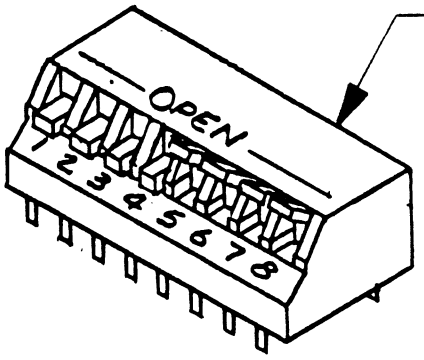


TABLE 2.2 Configuration of Device Code (Location 8F)



Device Select Switch Pack
Device Code 17 (octal) Shown

DEVICE CODE			S3 DS0	S4 DS1	S5 DS2	S6 DS3	S7 DS4	S8 DS5
0X			DOWN	DOWN	DOWN			
1X			DOWN	DOWN	UP			
2X			DOWN	UP	DOWN			
3X			DOWN	UP	UP			
4X			UP	DOWN	DOWN			
5X			UP	DOWN	UP			
6X			UP	UP	DOWN			
7X			UP	UP	UP			
X0						DOWN	DOWN	DOWN
X1						DOWN	DOWN	UP
X2						DOWN	UP	DOWN
X3						DOWN	UP	UP
X4						UP	DOWN	DOWN
X5						UP	DOWN	UP
X6						UP	UP	DOWN
X7						UP	UP	UP

2.3.2 UART CONFIGURATION SWITCH PACK (LOCATION 4T)

This switch pack is used to set the baud rate and various character format options for the serial printer's UART. If a parallel printer is to be used, this switch pack need not be configured. Table 2.3 shows the configuration options.

TABLE 2.3 Configuration of UART

SW4	SW3	SW2	SW1	BAUD RATE
ON	ON	ON	ON	50
ON	ON	ON	OFF	75
ON	ON	OFF	ON	110
ON	ON	OFF	OFF	134.5
ON	OFF	ON	ON	150
ON	OFF	ON	OFF	300
ON	OFF	OFF	ON	600
ON	OFF	OFF	OFF	1200
OFF	ON	ON	ON	1800
OFF	ON	ON	OFF	2000
OFF	ON	OFF	ON	2400
OFF	ON	OFF	OFF	3600
OFF	OFF	ON	ON	4800
OFF	OFF	ON	OFF	7200
OFF	OFF	OFF	ON	9600
OFF	OFF	OFF	OFF	19,200

SW #	SETTING	DESCRIPTION
5	ON	Odd Parity
5	OFF	Even Parity
6	ON	7 bit word length
6	OFF	8 bit word length
7	ON	1 stop bit
7	OFF	2 stop bits
8	ON	Add parity bit
8	OFF	Do not add parity bit

2.3.3 STROBE WIDTH SELECT SWITCH PACK (LOCATION 8R)

The parallel printer strobe width is switch selectable from 0.4 to 3.2 microseconds. To select a strobe width, set the appropriate switch in this switch pack on (see Table 2.4). Note that only one switch should be on at a time or improper operation may result. If a serial printer is used, this switch pack need not be configured.

TABLE 2.4 Configuration of Strobe Width

SW #	STROBE WIDTH
1	3.2 microseconds
2	1.6 microseconds
3	0.8 microseconds
4	0.4 microseconds

For Dataproducts, Centronics, and Printronix printers, the strobe width should be set to 0.8 microseconds (SWITCH 3 ON and the other switches are OFF). Consult the printer's operator manual specifications to determine the strobe width.

2.3.4 MICROPROCESSOR CONFIGURATION SWITCH PACK (LOCATION 7K)

The microprocessor which controls the LPC-3 board can be configured for various types of operation and data manipulation via the microprocessor configuration switch pack. This switch pack is read by the microprocessor only during the Power-up Self-test. The Power-up Self-test occurs either when the board is powered up or when the RESET switch of the computer is pressed. Note however, that an IORESET instruction executed by the CPU will not cause the LPC-3 Controller to go through its Power-up Self-test. Table 2.5 briefly describes each of the configurations. A more detailed explanation follows.

TABLE 2.5 Configuration of Microprocessor (LOCATION 7K)

SW #	SETTING	DESCRIPTION
1	ON	Clear HTAB column pointer for LF or FF
1	OFF	Don't clear HTAB column pointer for LF or FF
2	ON	Pass 96 character ASCII set
2	OFF	Convert 96 character ASCII set to 64 character set
3	ON	Pass LINE FEED
3	OFF	Inhibit LINE FEED
4	ON	Pass CARRIAGE RETURN
4	OFF	Inhibit CARRIAGE RETURN
5	ON	Parallel printer
5	OFF	Serial printer
6	ON	Non-VFU printer
7	ON	
8	ON	
6	ON	DATAPRODUCTS VFU printer
7	ON	
8	OFF	
6	ON	RESERVED
7	OFF	
8	ON	
6	ON	LPC-3 VFU
7	OFF	
8	OFF	
6	OFF	LPC-3 VFU with perforation skipover
7	ON	
8	ON	
6	OFF	Pass 8 bit data literally
7	ON	
8	OFF	
6	OFF	RESERVED
7	OFF	
8	ON	

6	OFF	RESERVED
7	OFF	
8	OFF	

SWITCH 1: HTAB means Horizontal Tab which refers to LPC-3's Horizontal Format Control. Horizontal Format Control is similar to the tabbing feature found in typewriters. A column pointer is used by the controller to keep track of which column of the paper is the one the next character to be sent will be printed on. If SWITCH 1 is on, a LINE FEED or a FORM FEED character in the data stream will clear the column pointer. If switch 1 is off, they won't. If the printer automatically does a carriage return whenever a LINE FEED or a FORM FEED code is received in the data stream, this switch should be on, otherwise it should be off.

SWITCH 2: If the printer uses the 96 character ASCII set, leave this switch on so that none of the printable characters are manipulated by the controller. If the printer only uses the 64 character set (lower case letters along with some other characters are missing), leave this switch off. LPC-3 will then automically convert lower case letters to upper case and ASCII codes 60, 7B, 7C, 7D, 7E (hexidecimal) to ASCII codes 40, 5B, 5C, 5D, 5E (hexidecimal) respectively.

SWITCH 3: If switch 3 is off, LINE FEED (LF) codes are automically removed from the data stream. This switch should only be off if the printer does an automatic line feed whenever a CARRIAGE RETURN (CR) code is received and it is therefore not desirable for LF codes to be sent.

For example, if the operating system issues an LF and CR at the end of each line expecting only one line to be fed, but both LFs and CRs cause the printer to line feed, then it may be desirable to block either LF or CR codes to avoid double line feeding.

SWITCH 4: If switch is off, CARRIAGE RETURN (CR) codes are automically removed from the data stream. This switch should only be off if the printer does an automatic carriage return whenever a LINE FEED (LF) code is received and it is therefore not desirable for CR codes to be sent. See the example for switch 3 above.

SWITCH 5: Set switch 5 on if the LPC-3 Controller is connected to a parallel printer, and off if it is a serial printer.

SWITCHES 6, 7, 8: Switches 6, 7, and 8 work with each other to configure the microprocessor. See Chapter 4 for more information on VFUs. If any settings other than those described below are used, the controller will not operate properly.

A.) If the printer does not have a VFU and it is not desired to use the On Board VFU, set switches 6, 7, 8 all on. The controller will then block VFU loading information, and a FORM FEED code will be issued each time a VFU command is found in the data stream.

B.) If the printer is a Dataproduct model with a VFU, set switches 6, 7, 8 on, on, off respectively. Data General's VFU loading and command codes will then be converted to the proper codes for the Dataproducts printer.

C.) If the On-board VFU is to be used without perforation skipover, set switches 6, 7, 8 on, off, off respectively.

D.) If the on-board VFU is to be used with perforation skipover, set switches 6, 7, 8 off, on, on respectively. Perforation skipover means that when Bottom of Form is encountered in the VFU (channel 12 is set), paper is automatically advanced to Top of Form (channel 1 is set).

E.) If it is desired to pass all 8 bits of data literally as received from the Data General computer, set switches 6, 7, 8 off, on, off respectively. The controller will then not alter any of the data from the CPU. The 8th data bit will be placed on the Paper Instruction (PI) line which is normally used by the VFU of a Dataproducts printer.

2.3.5 HARDWARE CONFIGURATION SWITCH PACK (LOCATION 6E)

Switches 1 through 6 pertain to a parallel printer and switch 7 pertains to a serial printer. Only those switches pertaining to the printer type (parallel or serial) which is to be connected to the LPC-3 Controller need to be configured. Table 2.6 briefly lists the configuration possibilities. A more thorough explanation follows.

TABLE 2.6 Configuration of Hardware (Location 6E)

SW #	SETTING	DESCRIPTION
1	ON	READY polarity = active high
1	OFF	READY polarity = active low
2	ON	No READY in the interface
2	OFF	READY is in the interface
3	ON	ON-LINE polarity = active high
3	OFF	ON-LINE polarity = active low
4	ON	STROBE polarity = active low
4	OFF	STROBE polarity = active high
5	ON	DATA polarity = active low
5	OFF	DATA polarity = active high
6	ON	DEMAND polarity = active high
6	OFF	DEMAND polarity = active low
7	ON	CLEAR TO SEND polarity = active low or no CLEAR TO SEND in the interface
7	OFF	CLEAR TO SEND polarity = active high

SWITCH 1: SWITCH 1 should be on if the READY signal in the parallel printer interface is active high and off if it is active low. Note that often this signal is not supported in ZETACO cabling because conditions for which the printer is "READY" are a subset of the conditions for which it is "ON-LINE". Therefore, use of the ON-LINE signal precludes the need of the READY signal. SWITCH 2 of this switch pack is used to disable this signal. If READY is not in the interface, set SWITCH 1 to the same setting as SWITCH 3.

SWITCH 1; Settings for Common Printers:

DATAPRODUCTS: ON
CENTRONICS: ON
PRINTRONIX: ON

SWITCH 2: SWITCH 2 should be off if there is a READY signal in the parallel printer interface and on if there is not a READY signal. If READY is not in the interface, set SWITCH 1 to the same setting as SWITCH 3.

SWITCH 2; Settings for Common Printers:

DATAPRODUCTS (Amp connector):	OFF
DATAPRODUCTS (Winchester connector):	ON
CENTRONICS:	ON
PRINTRONIX:	ON

SWITCH 3: SWITCH 3 should be on if the ON-LINE signal in the parallel printer interface is active high and off if it is active low.

SWITCH 3; Settings for Common Printers:

DATAPRODUCTS:	ON
CENTRONICS:	ON
PRINTRONIX:	ON

SWITCH 4: SWITCH 4 should be on if the STROBE signal in the parallel printer interface is active low and off if it is active high.

SWITCH 4; Settings for Common Printers:

DATAPRODUCTS:	OFF
CENTRONICS:	ON
PRINTRONIX:	OFF

SWITCH 5: SWITCH 5 should be on if the DATA signals in the parallel printer interface are active low and off if they are active high.

SWITCH 5; Settings for Common Printers:

DATAPRODUCTS:	OFF
CENTRONICS:	OFF
PRINTRONIX:	OFF

SWITCH 6: SWITCH 6 should be on if the DEMAND (sometimes called ACKNOWLEDGE) signal in the parallel printer interface is active high and off if it is active low.

SWITCH 6; Settings for Common Printers:

DATAPRODUCTS:	OFF
CENTRONICS:	OFF
PRINTRONIX:	OFF

SWITCH 7: SWITCH 7 should be off if there is a CLEAR TO SEND (CTS) signal in the RS232 serial printer interface and it is active high (CTS is usually active high). If CTS is active low, or if it is not in the interface, the switch should be on.

2.4 CONTROLLER BOARD INSERTION

After selecting the proper slot (see Section 2.2), insert the controller by fitting the board edges between the slot guides and sliding the board evenly down the guides. Pull out the ejectors on the two outside corners of the front of the board and use them to provide leverage to insert the back of the board into the backpanal connectors. Use equal pressure on both ejectors until the board seats firmly into the connectors.

2.5 CABLE INSTALLATION

If you have purchased a ZETACO cable, you will find that a wirelist has been inserted at the end of this manual for your reference.

The LPC-3 Controller and the printer are interconnected with the supplied interface cable(s). FCC and non-FCC cabling procedures differ. FCC cabling for both parallel and serial printers involves a two-cable set (internal and external cables), and is discussed in Sections 2.5.1 and 2.5.2. If a serial printer is to be used with the controller, the user must supply the external RS232 cable. Non-FCC cabling is available only for parallel printers and is discussed in Section 2.5.3.

2.5.1 INTERNAL CABLES (Required in an FCC Chassis)

Refer to Figure 2.1 for the following cable installation discussion.

PARALLEL PRINTER:

Figure 2.2 illustrates FCC cable installation for a parallel printer. The paddleboard is inserted over the computer backplane pins corresponding to the "B side" of the I/O slot into which the LPC-3 Controller has been placed. The pins on the "B side" of the computer backplane are on the right half of the backplane when viewed from the rear.

Locate the two rows of pins on the "B side" of the backplane corresponding to the slot containing the LPC-3 Controller. Make sure no pins are bent. Position the paddleboard over the pins making sure pin 1 (left-most pin of the upper row) of the proper slot is lined up with the paddleboard socket which is marked "1". Press the paddleboard securely over the pins (make sure all pins insert and do not bend) until it is flush with the backplane.

CAUTION: COMPONENT DAMAGE MAY OCCUR IF PADDLEBOARD IS MIS-ALIGNED. MAKE SURE THE BLOCK IS NOT SHIFTED RIGHT OR LEFT BY CHECKING FOR NON-INSERTED PINS ON BOTH ENDS. DOUBLECHECK THAT THE BLOCK IS POSITIONED OVER THE CORRECT TWO ROWS OF PINS AND NOT BETWEEN SLOTS. IT MAY BE NECESSARY TO COUNT PAIRS OF ROWS TO DETERMINE CORRECT POSITIONING.

After inserting the paddleboard onto the computer backplane pins, insert the internal ribbon cable's connector into the connector on the paddleboard. Make sure the connector is not inserted upside down (pin 1 of each connector is marked with a triangular symbol). Then attach the 50 Pin "D" connector of the internal cable to one of the cut-outs in the connector bulkhead panel of the computer using the supplied hex bolts.

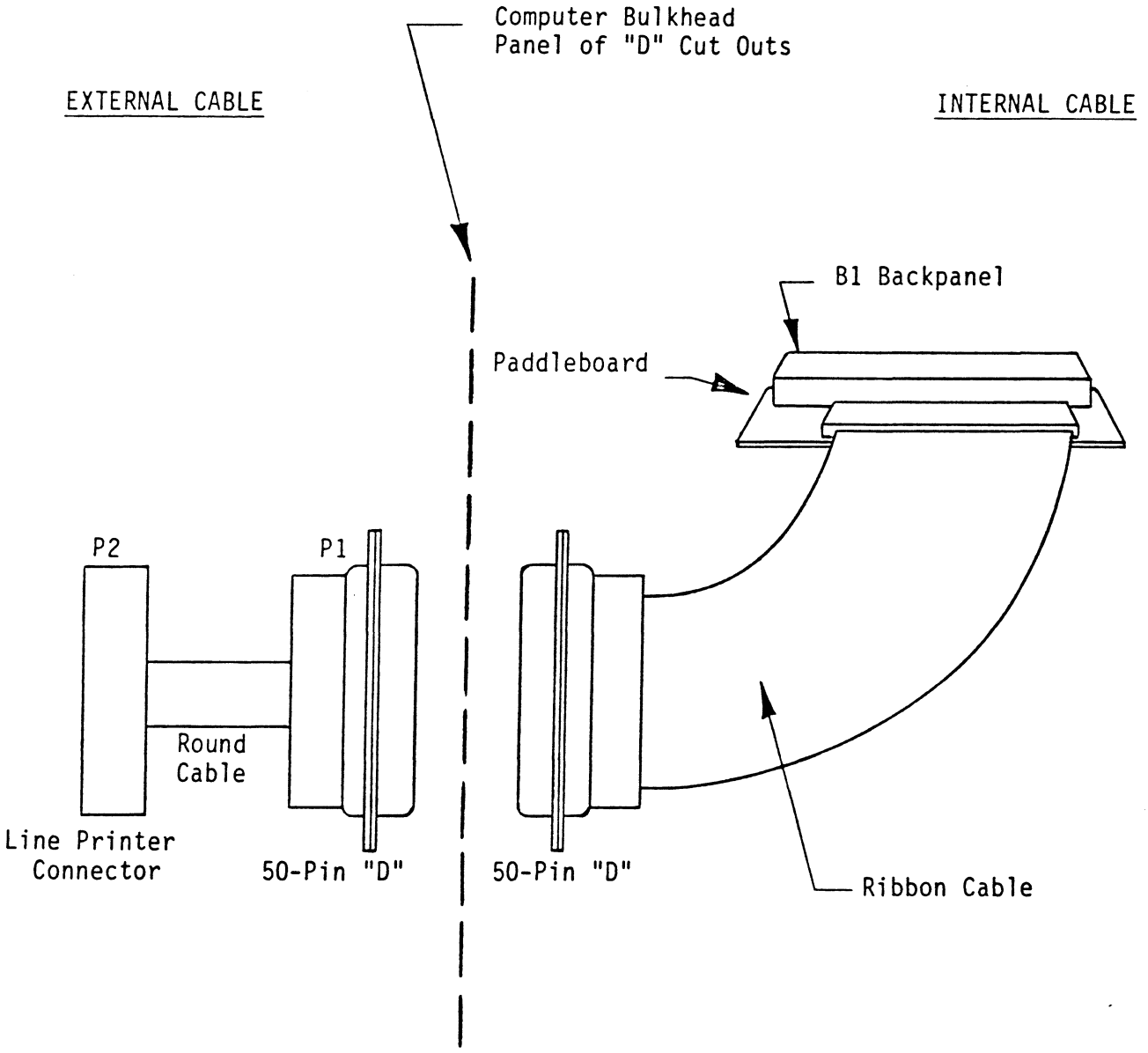
SERIAL PRINTER

Figure 2.3 illustrates FCC cable installation for a serial printer. If a serial printer is used, the connector block end of the internal cable for the serial printer is inserted over the computer backplane pins corresponding the the "A side" of the I/O slot into which the LPC-3 Controller has been placed. The pins on the "A side" are the ones on the left half of the computer backplane when viewed from the rear.

Locate the two rows of pins on the "A side" of the backplane corresponding to the slot containing the LPC-3 Controller. Make sure no pins are bent. Position the connector block over the pins making sure pin 99 (right-most pin of the upper row) of the proper slot is lined up with the connector block socket which is marked "99". Press the connector block securely over the pins (make sure all pins insert and do not bend) until it is flush with the backplane.

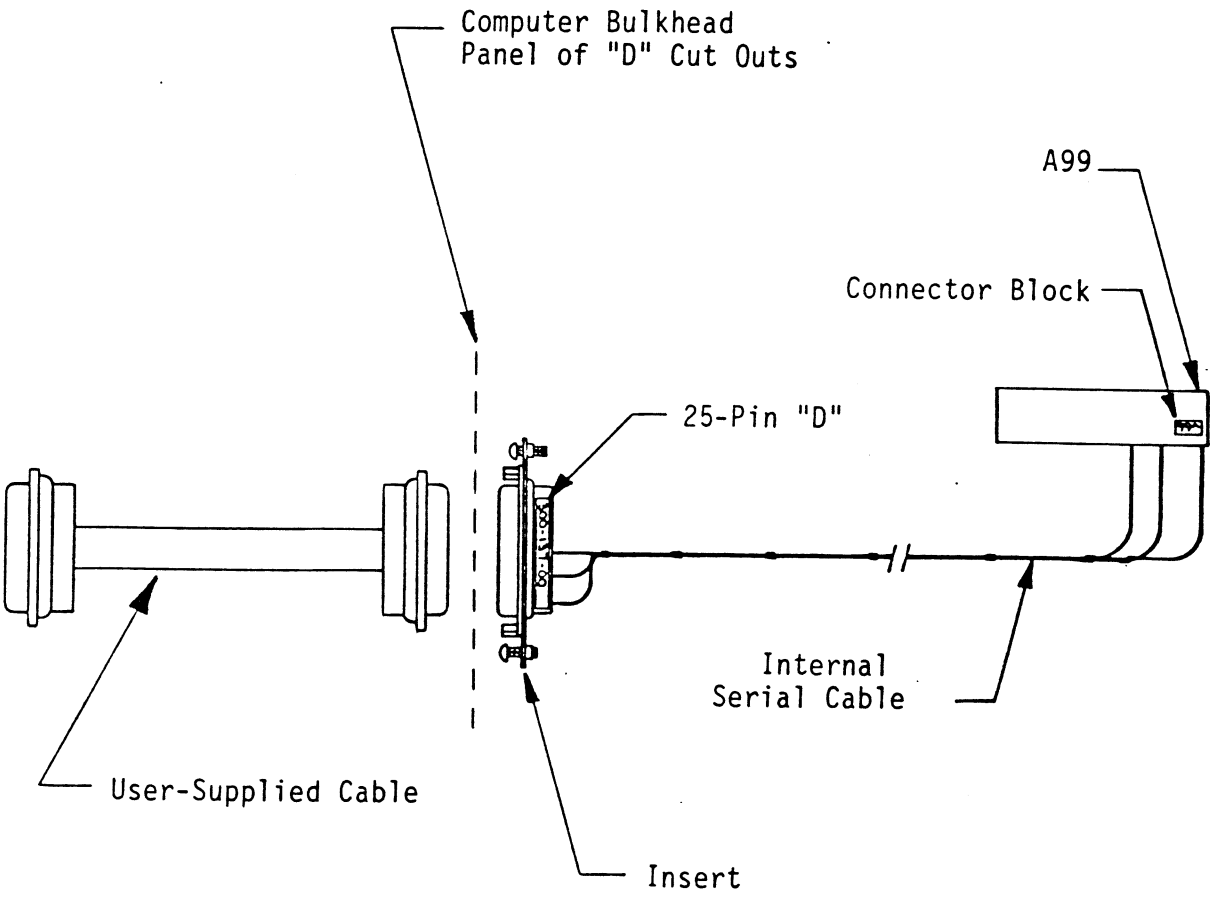
After the connector block has been installed on the CPU backplane, attach the 25 Pin "D" connector on the other end of the internal cable to one of the cut-outs in the connector bulkhead panel of the computer. Use the insert which comes along with the cable to allow the 25 Pin "D" connector to fit in the cut-out which was designed for a 50 Pin "D" connector.

FIGURE 2.2 FCC Cable Installation for a Parallel Printer



NOTE: For the most secure and reliable connection, we recommend using ZETACO cables.

FIGURE 2.3 FCC Cable Installation for a Serial Printer



NOTE: For the most secure and reliable connection, we recommend using ZETACO cables.

2.5.2 EXTERNAL CABLES

PARALLEL PRINTER

Refer to Figure 2.2 for this discussion. Attach the 50 Pin "D" connector of the external, round cable to the 50 Pin "D" connector of the internal cable which is connected to the computer bulkhead. Attach the remaining end of the external cable to the line printer. The connector marked P1 is for the computer bulkhead. The connector marked P2 is for the printer.

SERIAL PRINTER

Refer to Figure 2.3 for this discussion. The user should supply the external RS232 cable for the serial printer. Attach the 25 Pin "D" connector at the controller end of the external cable to the 25 Pin "D" connector of the internal cable which is connected to the computer bulkhead. Attach the remaining end of the external cable to the printer.

2.5.3 NON-FCC CABLING

PARALLEL PRINTER

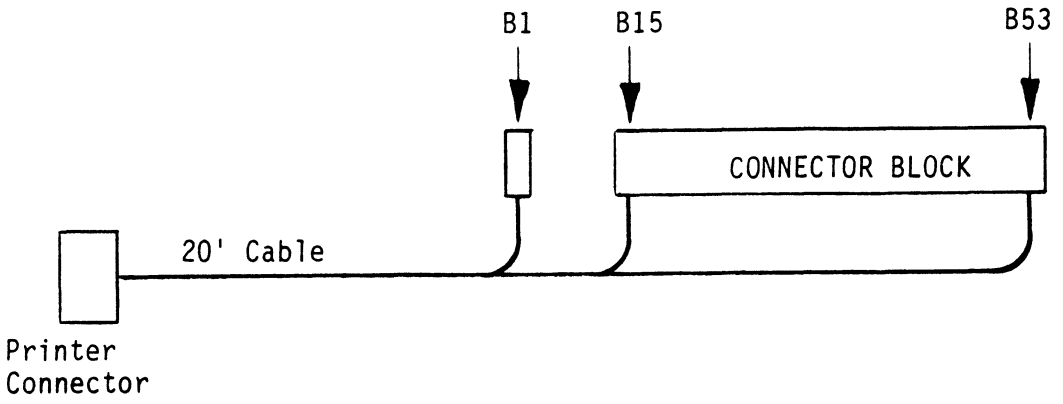
Refer to Figures 2.1 and 2.4 for this discussion. The connector block end of the internal cable for a parallel printer is inserted over the computer backplane pins corresponding to the "B side" of the I/O slot into which the LPC-3 Controller has been placed. The pins on the "B side" of the computer backplane are on the right half of the backplane when viewed from the rear.

Locate the two rows of pins on the "B side" of the backplane corresponding to the slot containing the LPC-3 Controller. Make sure no pins are bent. Position the connector block over the pins making sure pin 15 (8th pin from the left on the upper row of the B side) of the proper slot is lined up with the connector block socket which is marked "15". Press the connector block securely over the pins (make sure all pins insert and do not bend) until it is flush with the backplane. Press the separate, single pin connector over pin B1 of the computer backplane. Attach the other end of the cable to the line printer.

SERIAL PRINTER

Installation of non-FCC cabling for a serial printer is the same as for FCC with the exception that the internal cable does not attach to a computer bulkhead. It is attached directly to the user supplied cable. See Sections 2.5.1 and 2.5.2 for detailed serial printer cable installation intructions.

FIGURE 2.4 Non-FCC Parallel Printer Cable



2.5.4 ZETACO CABLE PART NUMBERS

CABLES FOR PARALLEL PRINTERS	PART #
External FCC Dataproducts (Winchester)	300-004-00
External FCC Dataproducts (Amp)	300-005-00
External FCC Centronics	300-009-00
Internal FCC Cable	300-108-00
Internal FCC Paddleboard	500-412-00
Non-FCC Dataproducts (Winchester)	300-008-00
Non-FCC Dataproducts (Amp)	300-006-00
Non-FCC Centronics	300-010-00

CABLE FOR SERIAL PRINTER	PART #
Internal Serial	300-137-00

2.6 SYSTEM POWER-UP

Place the LPC-3 Printout Self-test toggle switch in its center position (see Figure 1.1). Apply system power. The five LEDs grouped on the right (one yellow LED and four red ones) will flash a pattern during the Power-up Self-test and then go out after approximately 3 seconds, if the Self-test was successful.

If the yellow LED starts continuously blinking, a failure of the Self-test has occurred and red LEDs will show a code indicating which part of the Self-test has failed. Refer to Chapter 3 for more detail on Self-test failure. Once a successful Self-test has occurred, the LPC-3 Controller is ready to accept commands and data from the CPU.

The three LEDs grouped on the left indicate controller and printer status. These LEDs are described in Section 1.3.1.

2.7 SYSGEN PROCEDURE

See Data General's Operating System Manual to select the correct printer subsystem emulation.

3.0 TROUBLE-SHOOTING AND CUSTOMER SERVICE

ZETACO's LPC-3 Controller has the following means of trouble-shooting and customer service support available:

- Microprocessor based Power-up Self-test (see Section 3.1).
- Printout Self-test which checks out the printer interface, cabling and the printer (see Section 3.3).
- Three controller and printer status LEDs (see Section 1.3.1).
- On-Line errors indicated by an LED error code (see Section 3.4).
- Hardcopy of On-Line errors may be obtained via the Printout Self-test (see Section 3.5).
- 48-hour turnaround on most factory repairs or replacement (see Section 3.9).
- Customer Support Hotline manned from 8:00 a.m. to 5:00 p.m. (Central Time) to answer your questions (see Section 3.7). *1-612-890-5135*
- Up to a two year warranty on all controllers in the event of a hardware failure (see Section 3.8).
- Factory-trained personnel in our Authorized Distributor and Authorized Service organizations.

3.1 POWER-UP SELF-TEST ERRORS

The LPC-3 Controller's microprocessor runs on board diagnostics each time the controller is powered up. This test checks the firmware EPROM, scratchpad RAM, and character decoder RAM.

If the Self-test is successful, the five LEDs grouped on the right will flash back and forth twice, count up in binary and then turn off. If the Self-test isn't successful, the yellow LED on the left of the group of five will continuously flash and the four red LEDs will contain a code indicating which part of the Self-test failed.

If neither of the events in the above paragraph occur, then possibly the controller is not receiving the proper power requirements, or the Z80's firmware EPROM has not been programmed properly. Other possibilities are that the Z80 clock circuitry, the Z80, the power fail circuit or the address decoding PALs may be bad.

There are two groups of LEDs on the controller; a group of three LEDs, and a group of five. The Self-test error code is displayed by the four red LEDs that are in the group of five when the yellow LED on the left side of this group is flashing. If the yellow LED is either off or solid, and any of the red LEDs are on, then an On-Line error is indicated and the user should refer to Section 3.4. The rightmost red LED is the least significant bit. The code is given in hexadecimal. Table 3.1 describes the meaning of the Power-up Self-test error codes and possible causes of the failure.

TABLE 3.1 LPC-3 Power-Up Self-test Error Codes

ERROR CODE	TEST	POSSIBLE FAILURE
1	EPROM	If the yellow LED is flashing and only the rightmost red LED is on, then the data in the firmware EPROM did not give the proper sum total for a check-sum test. The EPROM may have been exposed to UV light.
2	SCRATCHPAD RAM	If the yellow LED is flashing and the red LED, which is second from the right, is ON, then data read from the Scratchpad RAM did not compare with data written. The Address Decoding PAL, the Scratchpad RAM, the RAM's address bus, or the RAM's data bus may be bad.
3	CHARACTER DECODER RAM	If the yellow LED is flashing and the rightmost two red LEDs are on, then data read from the Character Decoder RAM did not compare with data written. The Address Decoding PAL, the Character Decoder RAM, the RAM's address bus, or the RAM's data bus may be bad.

If the board fails Self-test, try any or all of the following:

1. Remove the board, clean the gold connector contacts and re-install it.

2. Try the board in a different slot.

3. Remove the board and inspect all socketed ICs for bent pins. If any are found, gently pry the IC out of its socket, straighten the pin and re-insert it, being careful to observe proper orientation.

4. Press firmly on all socketed ICs to ensure good contact.

5. Disconnect the printer cable from the computer backplane.

If the board still fails its Self-test, call the Customer Support Hotline for assistance (see Section 3.7).

3.2 ON-LINE OPERATION FAILURE

If the LPC-3 Controller passes its Power-up Self-test and the printer subsystem is not performing normally under on-line operation, go through the following checkout procedure to ensure proper subsystem setup.

1. Check that the printer is powered up and on line. If the printer uses a parallel interface, the On-Line status can be checked by making sure that the LPC-3 On-Line LED is lit (see Section 1.3.1). Note that the printer must be powered up in order for the On-Line LED to work properly.

2. Check that all cabling connectors are firmly seated.

3. With the computer powered down, check that the cable's connector block or paddleboard is firmly seated over the proper double row of backplane pins which correspond to the slot in which the LPC-3 Controller is installed. Ensure that it is over the proper pins (not shifted to the right or left by one or more pins). Also ensure that it is in the proper half of the computer backplane ("A side" for a serial printer and "B side" for a parallel printer).

4. Make sure that the Data Channel and Interrupt priority jumpers are installed correctly (see Section 2.2.2).

5. Make sure that the LPC-3 device code is set to the one that the operating system is expecting. In general, 17 (octal) is the primary code and 57 (octal) is the secondary code. See Section 2.3.1.

6. Check that the other four configuration switches are all configured properly. Especially check on the Microprocessor Configuration Switch Pack that the proper printer type (parallel or serial) has been selected and that the proper VFU mode has been selected (see Section 2.3.4). In order for a new configuration to be read into the microprocessor from this switch pack, press the RESET switch on the front panel of the computer.

   If a parallel printer is used, make sure that the proper polarities of the interface signals are set up in the Hardware Configuration Switch Pack (see Section 2.3.5). Also make sure that the proper strobe width is selected according to the printer operator manual's specifications, and that only one switch in this switch pack is on (see Section 2.3.3).

   If a serial printer is used, make sure the printer interface signals are properly connected up to the LPC-3 Controller. If the printer uses a CTS (CLEAR TO SEND, perhaps called DATA TERMINAL READY) signal to indicate when data may be sent over the serial interface, make sure the Hardware Configuration Switch Pack is set up properly to accept this signal (see Section 2.3.5). Also make sure the baud rate as well as the other items in the UART Configuration Switch Pack are set up properly (see Section 2.3.2).

If the above checkout does not solve the problem, try to isolate the problem by using the Printout Self-test feature which is described in Section 3.3.

3.3 PRINTOUT SELF-TEST FEATURE

Using the Printout Self-test feature will cause the LPC-3 Controller to send printable code to the printer thus checking out parts of the LPC-3 microprocessor system, the LPC-3 printer interface circuitry, the cabling and the printer.

Printout Self-test "A" is activated when the toggle switch on the controller is placed in the left position (see Figure 1.1). The ASCII character set is printed out on each line and is shifted one position to the left with each new line. Either a 96 or a 64 character set is printed out depending on how switch 2 of the Microprocessor Configuration Switch Pack is set up (see Section 2.3.4).

Printout Self-test "B" is activated when the toggle switch is placed in the right position. First a list of On-Line errors is printed out (see Section 3.5), and then a preprogrammed message is repeatedly printed out.

Placing the toggle switch back in its center position turns off the Printout Self-test feature and returns the LPC-3 Controller back to normal On-Line operation.

3.4 ON-LINE LED ERROR CODES

The five LEDs on the front of the LPC-3 Controller that are grouped together are used to indicate power-up Self-test and on-line operation errors. The four red LEDs indicate the error code and the yellow LED indicates whether the error code refers to a power-up Self-test error, an on-line operation error or whether multiple on-line errors have occurred.

Under normal operation all five of these LEDs will be out after the power-up Self-test is completed. If the yellow LED is flashing then the red LEDs contain an error code for a particular part of the power-up Self-test that failed (see Section 3.1).

If one or more of the red LEDs are on and the yellow LED is out then a single on-line error has occurred. If the yellow LED is on solid then two or more on-line errors have occurred. In either case the four red LEDs contain a hex code which describes the first error to have occurred.

The on-line error codes are described in Section 3.5. Section 3.5 also describes how to obtain a hardcopy of the on-line errors which have occurred (up to 8 errors). Note that most of the error codes involve an improper format of the data which is sent over in the data stream.

An on-line error code is cleared when the RESET switch on the front of the computer is pressed or when Printout Self-test "B" is activated..

3.5 HARDCOPY OF ON-LINE ERRORS

Up to 8 on-line errors which have occurred can be printed out using Printout Self-test "B". Note that some printer subsystem diagnostics programs will deliberately cause some of the errors described below. To get a printout of the errors, turn on Printout Self-test "B" by placing the toggle switch in the right position for a few seconds, then move the toggle switch back to its center position. Operating Printout Self-test "B" will clear the error LEDs and will erase the memory in which the errors were recorded. The red LEDs described in Section 3.4 contain a binary code which indicates the first error to occur. When the controller is viewed from the front, the right red LED is the least significant bit of the four red LEDs. The types of errors are listed and described below along with the various LED codes. "X" means a red LED in a particular location is on and "-" means it's off.

1. LEDS = "---X" (1 in hexadecimal)
   ERROR MESSAGE = 1/"HT LD STT", BUT "LD EN" NOT SET.
   EXPANDED MESSAGE = "Horizontal Tab Load Start code has been sent, but the CPU had not first set the controller's Load Enable flag."

   MEANING: In order for LPC-3's Horizontal Format Control (similar to horizontal tabbing on a typewriter, see Section 4.6) to work, the tab set/clear information must first be sent to the controller. This information is set apart from ordinary data to be sent to the printer by Horizontal Tab Load Start/Stop codes which bracket the tab set/clear information. However, in order for this information to be loaded, the CPU must first set the controller's Load Enable flag via a DOA programmed I/O instruction (see Section 5.3). This error occurred because the Load Enable flag was not set before a Horizontal Tab Load Start code was sent. The information to load the horizontal format control was therefore lost.

2. LEDS = "--X-" (2 in hexadecimal)
ERROR MESSAGE = 2/"VFU LD STT", BUT "LD EN" NOT SET.
EXPANDED MESSAGE = "Vertical Format Unit Load Start code has been sent, but the CPU had not first set the controller's Load Enable flag."

MEANING: VFU loading information to be sent to the printer or loaded into the On Board VFU is bracketed by VFU Load Start/Stop codes (see Section 4.2). However, in order for this information to be allowed to pass, the CPU must first set the controller's Load Enable flag via a DOA programmed I/O instruction (see Section 5.3). This error occurred because the Load Enable flag was not set before a VFU Load Start code was sent. The information to load the VFU as therefore lost.

3. LEDS = "--XX" (3 in hexadecimal)
ERROR MESSAGE = 3/"HT LD STP", BUT "LD EN" NOT SET.
EXPANDED MESSAGE = "Horizontal Tab Load Stop code has been sent, but the CPU had not first set the controller's Load Enable flag."

MEANING: See the meaning of error message 1 above. This error occurred because a DOA programmed I/O instruction was not sent before a Horizontal Tab Load Stop code was sent (see Section 5.3). The information to load the Horizontal Format Control was therefore lost.

4. LEDS = "-X--" (4 in hexadecimal)
ERROR MESSAGE = 4/"VFU LD STP", BUT "LD EN" NOT SET.
EXPANDED MESSAGE = "Vertical Format Unit Load Stop code has been sent, but Data General had not first sent a Load Enable command."

MEANING: See the meaning of error message 2 above. This error occurred because a DOA programmed I/O instruction was not sent before a VFU Stop Load code was sent (see Section 5.3). The information to load the printer's VFU was therefore lost.

5. LEDS = "-X-X" (5 in hexadecimal)
ERROR MESSAGE = 5/"HT LD STP", BUT NO "HT LD STT".
EXPANDED MESSAGE = "Horizontal Tab Load Stop code has been sent, but it wasn't preceded by a Horizontal Tab Load Start code."

MEANING: A Horizontal Tab (HT) Load Start code must precede the tab set/clear information and a Horizontal Tab Load Stop code must follow it. This error occurred because the LPC-3 Controller found a HT Stop Load code in the data stream, but no HT Start Load code preceded it.

6. LEDS = "-XX-" (6 in hexadecimal)
ERROR MESSAGE = 6/"VFU LD STP", BUT NO "VFU LD STT".
EXPANDED MESSAGE = "Vertical Format Unit Load Stop code has been sent, but it wasn't preceded by a Vertical Format Unit Load Start code."

MEANING: A VFU Load Start code must precede the VFU loading information and a VFU Load Stop code must follow it. This error occurred because the LPC-3 Controller found a VFU Stop Load code in the data stream, but no VFU Start Load code preceded it.

7. LEDS = "-XXX" (7 in hexadecimal)
ERROR MESSAGE = 7/CHAR NOT DECODED, LPC-3 ER.
EXPANDED MESSAGE = "The character in the data stream presently being examined by the LPC-3 Controller was not decoded properly."

MEANING: The LPC-3 Controller individually examines each character in the data stream to determine what actions must be taken in order to properly handle it. A Character Decoder RAM is used to rapidly identify the character. This error occurred because of an LPC-3 hardware or firmware error which prevented a proper decoding of the character. Most likely either the character decoder RAM's address bus, the firmware EPROM, or the address decoding PAL is bad.

8. LEDS = "X---" (8 in hexadecimal)
ERROR MESSAGE = 8/HT RNWY.
EXPANDED MESSAGE = "Horizontal Tab runaway."

MEANING: This error occurred because a Horizontal Tab code was sent but no tab stops were found beyond the column pointer. The column pointer is what the LPC-3 Controller uses to identify which column of the printer is to receive the next printable character. When a runaway occurs, LPC-3's DONE flag is set, its BUSY flag is cleared and the error is sent to the Data General status word which can then be read by the CPU via the DIA programmed I/O instruction (see Section 5.3).

9. LEDS = "X--X" (9 in hexadecimal)
ERROR MESSAGE = 9/INVALID MODE.
EXPANDED MESSAGE = "The Microprocessor Configuration Switch Pack was set to an invalid mode of operation."

MEANING: This error occurred because the Microprocessor Configuration Switch Pack was configured to a setting which is meaningless to the LPC-3 firmware program. See Section 2.3.4 to determine the correct setting.

10. LEDS = "X-X-" (A in hexadecimal)
ERROR MESSAGE = A/HT LD OVFL.
EXPANDED MESSAGE = "Horizontal Tab load overflow."

MEANING: During the loading of the Horizontal Format Control on the LPC-3, the CPU attempted to load tab set/clear information for more columns than the maximum allowed. That is, there was tab set/clear information for more than 256 columns between the Start and Stop Load codes.

11. LEDS = "X-XX" (B in hexadecimal)
ERROR MESSAGE = B/VFU LD ERR.
EXPANDED MESSAGE = "Vertical Format Unit load error."

MEANING: The On Board VFU was loaded improperly due to one of three conditions. If this error occurs, the address location FE1C (hex) of the controller's on board microprocessor will have a code in it to indicate which error condition exists. The conditions are:

A.) Less than 1 line (2 bytes) loaded. Address FE1C (hex) contains a 01 (hex).
B.) More than 143 lines (286 bytes) loaded. Address FE1C (hex) contains a 02 (hex).
C.) Odd number of bytes loaded (2 bytes/line required). Address FE1C (hex) contains a 03 (hex).

12. LEDS = "XX--" (C in hexadecimal)
ERROR MESSAGE = C/"VFU CMD", BUT VFU NOT LOADED
EXPANDED MESSAGE = "A Vertical Format Unit command was sent, but the on-board VFU was not loaded."

MEANING: The LPC-3 Controller was in the on-board VFU mode, and a command was sent to advance paper to a particular channel, but the on-board VFU was not loaded.

13. LEDS = "XX-X" (D in hexadecimal)
ERROR MESSAGE = D/ILLEGAL VFU CMD
EXPANDED MESSAGE = "An illegal Vertical Format Unit command was sent."

MEANING: The LPC-3 Controller was in the on-board VFU mode, and a command was sent to advance paper to a non-existent channel, ie: only codes for channels 1-12 can be used.

14. LEDS = "XXX-" (E in hexadecimal)
ERROR MESSAGE = E/NO BIT SET IN CHAN
EXPANDED MESSAGE = "A command was sent to advance paper to a channel in which no bit was set."

MEANING: The LPC-3 Controller was in the on-board VFU mode and a command was sent to advance paper to a particular channel, however, no stop bit was set in that channel.

3.6 DIAGNOSTICS

Diagnostics are not supplied by ZETACO for the Model LPC-3Controller. We suggest you use Data General's DCHPT-TST Diagnostic Test as the diagnostic test program.

Shown below are a couple of short diagnostic routines. These routines can be entered through the computer console switches or a virtual console. Be sure that the LPC-3 Controller device code is set to 17 (octal) (see Section 2.3.1). The routines use a majority of the LPC-3 Controller's logic and will quickly establish whether the controller, cable and printer have been correctly connected and are functioning properly.

TEST A: Shown below is a program which will repeatedly print characters using BUSY/DONE logic. The octal program is entered through the console data switches or virtual console. Start the program at location 100.

MEMORY LOCATION	OCTAL PROGRAM	SYMBOLIC CODE	
100	062677	IORST	
101	062017	DOB,0	LPT
102	067017	DOC,1	LPT
103	060117	NIOS,	LPT
104	063517	SKPBZ	
105	000777	JUMP	.-1
106	000101	JUMP	.-5

Also set the following two memory locations and the following two accumulators.

1	040502	A,B
2	006412	CR,LF

ACC 1	000002
ACC 2	177774

This program prints the letters A and B, does a Carriage Return and a Line Feed, and then repeats itself.

If the program above does not cause printing, check that the LPC-3 BUSY LED is on while the program is running. Also, if a parallel printer is being used, check that the ON-LINE LED is lit (see Section 1.3.1 for more information on the LEDs). If a serial printer is being used, make sure it is on-line.

If the program still does not work, try to get a printout using the LPC-3 Printout Self-test feature. Proper operation of the LPC-3 Printout Self-test feature indicates the problem does not involve the printer. In this case go through the checkout procedure in Section 3.2.

If the Printout Self-test feature does not work properly, check for proper installation of the cabling between the controller and the printer (see Sections 2.5.1 - 2.5.4). If it still does not work, check for proper configuration switch settings on the LPC-3 Controller, and then go through any other items which were missed in the checkout procedure in Section 3.2. Prior to calling ZETACO, run test B below to ensure that the proper printer status bits are being read by the CPU.

TEST B: Program to read printer status bits.

MEMORY LOCATION	OCTAL PROGRAM
110	062677
111	064417
112	063077

Enter the octal program into memory through the console data switches or through a virtual console. Start at location 110. The program reads the printer status word (using a DIA I/O instruction) and then halts. If the printer is powered, selected, and no error conditions exist, bits 14 and 15 of ACC 1 should be on. See Section 5.3 for further explanation of the status word.

3.7 CUSTOMER SUPPORT HOTLINE

ZETACO, Inc. provides a Customer Support Hotline (612-890-5138) to answer technical questions and to assist with installation and trouble-shooting problems. The Hotline is manned by a technical team from 8:00 a.m. to 5:00 p.m. (Central Time) Monday through Friday.

3.8 WARRANTY INFORMATION

All ZETACO controllers and couplers are warranted free from manufacturing and material defects, when used in a normal and proper manner, for a period of up to two years from date of shipment. Except for the express warranties stated above, ZETACO disclaims all warranties including all implied waranties of merchantability and fitness. The stated express warranties are in lieu of all obligations of liabilities on the part of ZETACO for damages, including but not limited to, special, indirect or consequential arising out of or in connection with the use or performance of ZETACO's products.

3.9 PRODUCT RETURN AUTHORIZATION

When controller malfunction has been confirmed using the tests outlined in Sections 3.1 through 3.6, the controller can be returned to ZETACO for warranty repair or for time-and-material repair if the product has been damaged or is out of warranty. A Return Material Authorization (RMA) number is required before shipment and should be referenced on all packaging and correspondence. Call either the ZETACO Authorized Distributor from whom you bought the controller or ZETACO for RMA instructions.

To ensure prompt response, the information outlined in the Material Return Information form on the following page should be gathered before calling your Distributor or the ZETACO Hotline for the RMA number. Please include a completed copy the the Material Return Information form with the product. Each product to be returned requires a separate RMA number and Material Return Information Form.

To safeguard the controller during shipment, please use packaging that is adequate to protect it from damage (the original packing is best). Mark the box "Delicate Instrument" and indicate the RMA number(s) on the shipping label.

MATERIAL RETURN INFORMATION

All possible effort to test a suspected malfunctioning controller should be made before returning the controller to ZETACO for repair. This will: 1) determine if the board is actually defective; 2) increase the speed and accuracy of a product's repair, which is often dependent upon a complete understanding of the user's checkout test results, problem characteristics, and the user system configuration. Test results for the LPC-3 should be obtained by performing the tests below. (Use back of page if more space is needed.)

TEST	RESULT
Power-up Self-test	_____
Print-out Self-test	_____
DG DCHPT-TST	_____

Other tests performed (system operation, errors, etc.)

Please allow our service department to do the best job possible by answering the following questions thoroughly and returning this information with the malfunctioning board.

1. Does the problem appear to be intermittent or heat sensitive? (If yes, explain.)

2. Under which operating system are you running? (RDOS, AOS, AOS/VS) Include revision number.

3. Describe the system configuration (i.e.; peripherals, controllers, model of computer, etc.)

4. Has the controller been returned before? Same problem?

To be filled out by CUSTOMER:

Model # :_____
Serial #:_____
RMA # :_____(Call ZETACO to obtain an RMA number.)

Returned by:

Your name:_____
Firm: _____
Address: _____
_____
Phone: _____

4.0 CONTROLLER USAGE GUIDELINES

4.1 LPC-3 CHARACTER MANIPULATION

Various operating modes of the LPC-3 Controller will cause it to treat characters it receives in the data stream in different manners before passing them from the CPU to the printer; altering some, blocking some, and passing others. This section is intended to give a brief overview of the way the characters are treated for the various modes that are possible. All of the modes refered to below are selected with the Microprocessor Configuration Switch Pack (see Section 2.3.4)

Each 16 bit word the CPU sends to the LPC-3 Controller via the Data Channel contains two 8 bit characters. In general, the printer is only expecting a 7 bit ASCII character, therefore the most significant bit is cleared to 0. Many parallel printers do not use an eighth data line in which case this bit is not even passed.

The full 8 bits can be passed to the printer without any alteration by the LPC-3 Controller if the microprocessor is configured for the literal mode. The eighth bit is placed on the P.I. (Paper Instruction) line which is normally used by Dataproducts printers with VFUs. This line is found on backplane pins B36 and B51.

The types of data manipulation the LPC-3 Controller can perform when it is not in the "Pass 8 Bit Data Literally" mode are as follows (see Section 2.3.4 for more detail).

NOTE: The following list assumes that the controller's Load Enable flag has been set via a DOA programmed I/O instruction (see Section 5.3). If it hasn't, then all Horizontal Tab and VFU load information as well as the Start/Stop load codes for each will be passed from the CPU to the printer literally as received only with the eighth data bit (ie., the P.I. line) cleared to 0.

A. Either Carriage Return (OD hex) or Line Feed (OA hex) codes can be automatically removed from the data stream.

B. Horizontal Tab codes (09 hex) as well as Horizontal Tab Load Start/Stop codes (10/11 hex) and the tab set/clear data that is bracketed by them are always removed from the data stream when not in the "Pass 8 Bit Data Literally" mode (See Section 4.6). Additional ASCII "SPACE" codes may be placed in the data stream in response to Horizontal Tab commands.

C. The 96 character ASCII set is automatically converted to the 64 character set (mainly involves converting lower case letters to upper case ones) when in the 64 character set mode. In this mode, ASCII codes 60 (hex) through 7E (hex) are converted to ASCII codes 40 (hex) through 5E (hex) respectively by subtracting 20 (hex) from each code.

D. When in the "No VFU" mode, VFU Load Start/Stop codes (13/14 hex) and the VFU load information bracketed by them are removed from the data stream. Also, the VFU Byte Next code (12 hex) is removed from the data stream and the VFU command which follows it is converted into a Form Feed code (0C hex).

E. When in the "Dataproducts VFU" mode, VFU Load Start/Stop codes (13/14 hex) are converted to 6E/6F (hex). The Start/Stop codes and the VFU load information bracketed by them are accompanied by an active high signal on the Paper Instruction (P.I.) line. The VFU Byte Next code (12 hex) is removed from the data stream and the VFU command which follows it is sent to the printer unaltered, but it is also accompanied by an active high signal on the P.I. line.

F. When in the "LPC-3 VFU" or "LPC-3 VFU W/PERF SKIP" modes, the VFU Load Start/Stop codes (13/14 hex) and the VFU load information bracketed by them are removed from the data stream. The VFU Byte Next code (12 hex) and the VFU command which follows it are also removed from the data stream. Additional Line Feed and/or Carriage Return codes may be placed in the data stream by the LPC-3 Controller in response to VFU commands or in order to perform perforation skipovers.

G. When in the "Pass 8 Bit Data Literally" mode, all characters are sent to the printer exactly as received from the CPU. The 8th bit is sent over the Paper Instruction line.

4.2 VFU BASICS

The VFU or Vertical Format Unit allows control of paper movement through the set-up of tab stops in a fashion simillar to that of horizontal tabbing. Originally the VFU was implemented with a paper tape loop that ran through a reader on the printer. It had 12 vertical columns called channels. Each horizontal row in the tape carried the 12 channel tab information for a particular line in the form. Therefore the total number of rows in the loop of tape was equal to the total number of lines in a form. Each row of the tape could have tab stops punched in it for any of the 12 channels. A tab command could then be issued on the printer's data lines to either advance to the next tab stop in any one of the 12 channels or to advance a specified number of lines.

VFUs are now implemented with an electronic memory on the printer, but still have the same basic set-up as the old paper tape VFU. The LPC-3 Controller also has its own on-board VFU that can be used with any printer connected to the controller. The VFU is loaded and controlled by the CPU. With an electronic VFU, essentially a matrix is set up in the memory. Each row in the matrix corresponds to a line in the form. The number of rows is equal to the number of lines in the form. Each column in the matrix corresponds to a channel. There are 12 columns for the 12 channels. Tab stops can be arbitrarily set for any channel in any line of the form. There is no limit to the number of channels that can be set in a particular line. Once the VFU is loaded, a command can be issued to tab to a particular channel. The row of the matrix corresponding to the current line to printed on is kept track of. Paper is advanced and the rows in the electronic memory are correspondingly circulated until a tab stop is found in the channel specified. Also, a specified number of lines may be advanced. Therefore there are three modes of VFU operation:

1. Loading the 12 channel memory with tab stop information.
2. Advance paper to the next tab stop in a particular channel.
3. Advance paper a specified number of lines.

The tab stop information is loaded through the printers data lines. First a VFU Load Start code is sent to distinguish the VFU loading information from regular printable data. Then the VFU tab information is loaded in which two bytes of information are sent for each line in the form.

The information is loaded, in order, for the lines in the form; i.e., the first two bytes are for the first line, the second two bytes are for the second line, etc. The odd numbered bytes occurring after the Load Start code (ie., the first of the two bytes loaded for each line) contain the tab stop information for channels 1-6. The even numbered bytes (ie., the second of the two bytes loaded for each line) contain the tab stop information for channels 7-12. These two bytes tell the VFU which of the 12 channels in the line are to receive tab stops. The number of channels that can be set for a particular line is completely arbitrary. The number of double bytes of VFU loading information sent determines the length of the form. After the VFU loading information is sent, a VFU Load Stop code is sent to let the printer know that the VFU loading sequence is finished.

In order to advance paper either to a particular channel or a specified number of lines, the following is done. First a special code is issued in the data stream called a VFU Byte Next code. A single code then immediately follows the VFU Byte Next code in the data stream telling the VFU to advance the paper either a specified number of lines (up to 15) or to advance to a particular channel.

4.3 LPC-3 ON BOARD VFU

The on-board LPC-3 VFU's basic operation is described in Section 4.2. This section goes into further detail on the operation of the LPC-3 VFU.

The LPC-3 VFU can be operated in two modes: with or without Perforation Skipover (see Section 2.3.4 for information on setting up the modes). The loading and control codes sent by the CPU are discussed in Section 4.4. Some restrictions on the loading procedure are as follows:

1. An even number of bytes must be loaded between the Start and Stop Load codes (i.e.; two bytes per line).

2. At least 1 line (2 bytes) must be loaded between the Start and Stop Load codes.

3. No more than 143 lines (286 bytes) can be loaded between the Start and Stop Load codes.

4. Channel 1 is dedicated to Top of Form. Therefore, when a Form Feed code is sent, paper is advanced until a Tab Stop is found in channel 1.

5. If the On Board LPC-3 VFU is used in the Perforation Skipover mode, channel 12 is dedicated to Bottom of Form.

6. Before loading of the On Board VFU can occur, the Load Enable flag on the controller must be set via the DOA programmed I/O instruction (see Section 5.3).

If the LPC-3 VFU is in the Perforation Skipover mode, and a "1" is detected in channel 12 (Bottom of Form), paper is advanced until a "1" is detected in channel 1 (Top of Form).

When in the "LPC-3 VFU" or "LPC-3 VFU W/PERF SKIP" modes, the VFU commands to advance paper to a particular channel require that the VFU first be loaded. However, the VFU commands to advance paper a specified number of lines do not require that it be loaded.

Once loaded, the LPC-3 assumes that the first line loaded corresponds to the present line to be printed on.

4.4 DATA GENERAL VFU SOFTWARE CODES

VFU Load Start Code:	13 (hex)
VFU Load Stop Code:	14 (hex)
VFU Byte Next Code:	12 (hex)

Recall that when loading the VFU, two bytes are needed for each line. If the first byte after the Start Load code is called byte 1 then bytes 1 and 2 are for the first line, bytes 3 and 4 are for the second line, etc. The odd (first byte loaded for each line) and even (second byte loaded for each line) byte formats are shown in Table 4.1. A "1" in a particular channel will set a tab stop for a that channel. "X" means "Don't Care".

TABLE 4.1 VFU Load Code Format

Bit	8	7	6	5	4	3	2	1
Odd Byte	X	1	CH6	CH5	CH4	CH3	CH2	CH1
Even Byte	X	1	CH12	CH11	CH10	CH9	CH8	CH7

X = DON'T CARE

TABLE 4.2 VFU Codes to Advance to a Particular Channel

Bit 8	7	6	5	4	3	2	1	Channel Selected
1	1	X	0	0	0	0	0	1
1	1	X	0	0	0	0	1	2
1	1	X	0	0	0	1	0	3
1	1	X	0	0	0	1	1	4
1	1	X	0	0	1	0	0	5
1	1	X	0	0	1	0	1	6
1	1	X	0	0	1	1	0	7
1	1	X	0	0	1	1	1	8
1	1	X	0	1	0	0	0	9
1	1	X	0	1	0	0	1	10
1	1	X	0	1	0	1	0	11
1	1	X	0	1	0	1	1	12

X = DON'T CARE

TABLE 4.3 VFU Codes to Advance a Particular Number of Lines

BIT	8	7	6	5	4	3	2	1	# Lines Advanced
	X	X	X	1	0	0	0	0	0
	X	X	X	1	0	0	0	1	1
	X	X	X	1	0	0	1	0	2
	X	X	X	1	0	0	1	1	3
	X	X	X	1	0	1	0	0	4
	X	X	X	1	0	1	0	1	5
	X	X	X	1	0	1	1	0	6
	X	X	X	1	0	1	1	1	7
	X	X	X	1	1	0	0	0	8
	X	X	X	1	1	0	0	1	9
	X	X	X	1	1	0	1	0	10
	X	X	X	1	1	0	1	1	11
	X	X	X	1	1	1	0	0	12
	X	X	X	1	1	1	0	1	13
	X	X	X	1	1	1	1	0	14
	X	X	X	1	1	1	1	1	15

X = DON'T CARE

A maximum form length of 143 lines is allowed. Data General's Forms Control Utility uses channel 1 of the VFU for Top of Form and channel 12 for Bottom of Form.

4.5 DATAPRODUCTS 12 CHANNEL VFU

VFU Load Start Code: 6E (hex)
VFU Load Stop Code: 6F (hex)
VFU Byte Next Code: None

Dataproducts printers with VFUs have an extra signal in their interface called the Paper Instruction (PI) signal which is active high and originates from the controller. Whenever VFU loading information (including Load Start and Load Stop codes) or a VFU command is sent, the PI signal is made active.

The LPC-3 Controller will not allow the loading of a Dataproducts printer's VFU until the controller's Load Enable flag has been set via a DOA programmed I/O instruction (see Section 5.3).

The VFU Load Code format (see Table 4.1), the advance to a particular channel commands (see Table 4.2), and the advance a specific number of lines commands (see Table 4.3) are compatible with Data General software and are therefore not altered. Thus VFU data from the CPU is altered in the following ways when the LPC-3 Controller is configured for a Dataproducts printer with a VFU:

A. VFU Load Start Code is converted from 13 to 6E (hex).
B. VFU Load Stop Code is converted from 14 to 6F (hex).
C. The VFU Byte Next code is blocked.
D. The PI signal goes active while all VFU commands and loading information is sent to the printer.

4.6 LPC-3 HORIZONTAL FORMAT CONTROL

Horizontal format control is similar to horizontal tabbing in a typewriter. The tab stops are loaded by first sending an HTAB Load Start code (10 hex) then loading the tab stop and filler code information and finally loading the HTAB Load Stop code (11 hex). When loading the tab information, one byte is loaded for each column starting with the first column. If bit 1 (the least significant bit) of the byte is 0, the tab is cleared for that column. If bit 1 is 1, the tab is set.

The LPC-3 Controller will not allow loading of the Horizontal Format Control until the controller's Load Enable flag has been set via a DOA programmed I/O instruction (see Section 5.3).

Upon power-up, all tab locations are cleared. Tab stops are not automatically cleared at the beginning of each new load. They, can only be set or cleared by loading enough bytes to reach the column in question, and then setting or clearing bit 1 of the byte for that particular column. The format of the tab load bytes is shown below.

Bit	8	7	6	5	4	3	2	1
	X	0	0	0	0	0	0	tab bit (0 = clear) (1 = set)

X = Don't Care

A pointer in the LPC-3 Controller keeps track of which column is the next to be printed on. This pointer is reset to column 0 whenever Carriage Return, VFU command, Line Feed or Form Feed characters are detected in the data stream. Note that Line Feed and Form Feed characters can be prevented from resetting the pointer when configuring the microprocessor (See Section 2.3.4).

Whenever a Horizontal Tab character (09 hex) is detected in the data stream, the pointer is advanced, and ASCII SPACE characters (20 hex) are sent until a tab stop is detected. If no tab stops are set beyond the column which is presently being pointed to, the HTAB RUNAWAY bit in the status word is set (See Section 5.3), and the controller DONE flag is set which causes an interrupt to be sent to the CPU.

5.0 PROGRAMMING NOTES

5.1 INTRODUCTION

The Programming Notes chapter will give a brief description of the following two topics:

A. Interface control between the CPU and the LPC-3 Controller.
B. Programmed I/O instructions which are used to operate the printer subsystem.

Further detail on the LPC-3 Controller behavior which may be helpful in programming can be found in Section 4.0.

The LPC-3 Controller uses Data General's Data Channel bus (DCH) when receiving data to be printed or information for the Vertical Format Unit (VFU) and Horizontal Format Control (HTAB). This is a 16 bit bus (bits are numbered 0-15 where bit 15 is the least significant bit). However, VFU, HTAB, and printable data are always in 8 bit form. Therefore, the LPC-3 Controller splits up each 16 bit word sent over the Data Channel into two bytes for processing by the on board microprocessor.

The DCH is hardware controlled and therefore does not require any CPU software overhead once it has started. However, it does require the CPU to execute some instructions to initially set it up for a transfer. Therefore, the LPC-3 Controller is also connected to the CPU's programmed I/O bus in order to receive the DCH set-up commands. Also, controller status can be sent to the CPU over the I/O bus.

5.2 INTERFACE CONTROL

Each controller in the computer system is given a unique, 6 bit device code which allows the CPU to identify it when sending commands and data or receiving statuses on either the DCH or programmed I/O buses. The primary printer subsystem's device code is 17 (octal). If there are two printer subsystems in a CPU, the secondary subsystem is 57 (octal).

Four flags are used on the LPC-3 Controller for basic control:

1. INTERRUPT REQUEST flag
2. INTERRUPT DISABLE flag
3. DONE flag
4. BUSY flag

When the controller is not using the DCH, it will send an interrupt to the CPU provided the INTERRUPT DISABLE flag has not been set and provided DONE is set. This interrupt indicates to the CPU that the controller is ready to receive more data to be sent to the printer.

There are three possible states for BUSY/DONE:

1. DONE set and BUSY cleared
2. DONE cleared and BUSY set
3. DONE cleared and BUSY cleared

When the controller is not in the process of receiving information on the DCH from the CPU, BUSY is cleared. An interrupt will be sent to the CPU provided INTERRUPT DISABLE is cleared and DONE is set.

When the CPU has data ready to be printed, it sends over two control words via the I/O bus which are needed by the controller for proper DCH operation. One of the control words is sent over using a DOB I/O instruction. This tells the controller the starting memory address of block of data to be transferred. The other control word is sent over using a DOC I/O instruction. It tells the controller the total number of bytes to be transferred. The printable data is stored as two 8 bit bytes which are packed in each 16 bit CPU memory word.

The CPU then sends a START pulse which clears DONE and INTERRUPT REQUEST. The START pulse also starts the DCH transfer. The controller then automatically makes requests to the CPU for data to be printed. Data is simutaneously sent out to the printer and the Byte Count Register is incremented (recall it is a negative, 2's complement number) until it is zero. Once the transfer is complete (up to 32K words per transfer), BUSY is cleared, DONE is set and another interrupt is generated if the INTERRUPT DISABLE flag is cleared.

5.3 PROGRAMMED I/O INSTRUCTIONS

There are 6 programmed I/O instructions that are used by the CPU to send and receive information to and from the printer subsystem. They are DOA, DOB, DOC, DIA, DIB, and DIC. DOA,B,C send out information to the controller in order to set it up for a DCH transfer. DIA,B,C read in status information from the controller. These instructions are discussed in detail later in this section.

Each programmed I/O instruction contains the following information:

A. Which type it is (eg., DIA, DOC etc.).
B. Which of the 4 CPU accumulators the information will be read in to, or sent out from.
C. Which special function, if any, should be executed along with the instruction (discussed below).
D. The device code of the controller the instruction is dealing with.

The source code for the programmed I/O instruction is as follows:

DXXF AC, LPT

DXX means DOA, DOB, DOC, DIA, DIB, or DIC.

F means Function. There are three functions; C, S, and P. Their effects on the controllers BUSY and DONE flags are shown below.

S (START)	Starts a DCH transfer by setting the BUSY flag and clearing the DONE flag.
C (CLEAR)	Ends a DCH transfer and prevents any interrupts by clearing both the BUSY and DONE flags.
P (PULSE)	Not used.
AC	ACCUMULATOR: There are four ACs: 0, 1, 2 and 3.
LPT	DEVICE CODE: PRIMARY = 17 (octal) SECONDARY = 57 (octal) (Others available via Device Select Switch Pack)

BINARY REPRESENTATION OF A PROGRAMMED I/O INSTRUCTION

0	1	2	3 4	5 6 7	8 9	10 11 12 13 14 15
0	1	1	AC	OP CODE	FUNCTION	DEVICE CODE

5.3.1 DOA - LOAD ENABLE (DEVICE CODE = 17 (OCTAL))

0	1	2	3 4	5	6	7	8 9	10	11	12	13	14	15
0	1	1	AC	0	1	0	F	0	0	1	1	1	1

Set the controller's Load Enable flag according to bit 0 of the specified AC. Note: On power-up, the LPC-3 Controller's Load Enable flag is cleared (ie., loading of VFU and HTAB will not be allowed). The controller's BUSY and DONE flags are set according to the function specified by F. The contents of the specified AC remain unchanged. The format of the specified AC is as follows:

0	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
LOAD ENABLE	DON'T CARE

BITS	NAME	CONTENTS
0	Load Enable	If the Load Enable bit is "0", the Load Enable flag will be set and loading of the VFU and HTAB will be allowed. If the Load Enable bit is "1", the Load Enable flag will be cleared and loading of the VFU and HTAB will not be allowed.

5.3.2 DIA - READ STATUS (DEVICE CODE = 17 (OCTAL))

0	1	2	3 4	5	6	7	8 9	10	11	12	13	14	15
0	1	1	AC	0	0	1	F	0	0	1	1	1	1

Place the contents of the controller's status lines in bits 12-15 of the specifies AC. The controller's BUSY and DONE flags are set according to the function specified by F. The format of the specified accumulator is as follows:

0 1 2 3 4 5 6 7 8 9 10 11	12	13	14	15
NOT USED	TAB RUNAWAY	STATUS CHANGE	READY	ON LINE

BITS	NAME	CONTENTS
12	Tab Runaway	A horizontal tab command has been sent but no tab stops were set.
13	Status Change	One of the printer status signals (Ready or On-Line) has changed state.
14	Ready	The printer is not performing a print operation and is ready to receive a command.
15	On-Line	The printer is on line to the processor.

5.3.3 DOB - LOAD MEMORY ADDRESS REGISTER (DEVICE CODE = 17 (OCTAL))

0	1	2	3 4	5	6	7	8 9	10	11	12	13	14	15
0	1	1	AC	1	0	0	F	0	0	1	1	1	1

Load bits 0-14 of the specified AC into the controller's Current Address Register, and bit 15 into the controller's Byte Pointer flip-flop. The controller's BUSY and DONE flags are set according to the function specified by F. The contents of the specified AC remain unchanged. The format of the specified AC is as follows:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	15
STARTING MEMORY ADDRESS	BYTE POINTER

BITS	NAME	CONTENTS
0-14	Memory Address	Location of the first word in memory to be used for the Data Channel transfer.
15	Byte Pointer	Indicator for the first byte to be transferred. If Byte Pointer = 0, then transfer begins with the most significant byte (bits 0-7). If Byte Pointer = 1, then transfer begins with the least significant byte (bits 8-15).

5.3.4 DIB - READ MEMORY ADDRESS REGISTER (DEVICE CODE = 17 (OCTAL))

0	1	2	3 4	5	6	7	8 9	10	11	12	13	14	15
0	1	1	AC	0	1	1	F	0	0	1	1	1	1

Place the contents of the controller's Current Address Register in bits 1-15 and the Current Byte Pointer in bit 0 of the specified AC. The controller's BUSY and DONE flags are set according to the funciton specified by F. The format of the specified AC is as follows:

0	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
BYTE POINTER	CURRENT MEMORY ADDRESS

BITS	NAME	CONTENTS
0	Byte Pointer	Indicator for byte to be printed next. If Byte Pointer = 0, then the most significant byte (bits 0-7). If Byte Pointer = 1, then the least significant byte (bits 8-15).
1-15	Memory Address	Location of the next word in memory to be used for a Data Channel transfer.

5.3.5 DOC - LOAD BYTE COUNT REGISTER (DEVICE CODE = 17 (OCTAL))

0	1	2	3 4	5	6	7	8 9	10	11	12	13	14	15
0	1	1	AC	1	1	0	F	0	0	1	1	1	1

Load bits 0-15 of the specified AC into the controller's Byte Count Register. The controller's BUSY and DONE flags are set according to the function specified by F. The contents of the specified AC remain unchanged. The format of the specified AC is as follows:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BYTE COUNT (2'S COMP)															

BITS	NAME	CONTENTS
0-15	Byte Count	Two's complement of the number of bytes to be transferred.

5.3.6 DIC - READ BYTE COUNT REGISTER (DEVICE CODE = 17 (OCTAL))

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	AC		1	0	1	F		0	0	1	1	1	1

Load the contents of the controller's Byte Count Register in bits 0-15 of the specified AC. The controller's BUSY and DONE flags are set according to the funciton specified by F. The format of the specified AC is as follows:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BYTE COUNT (2'S COMP)															

BITS	NAME	CONTENTS
0-15	Byte Count	Two's complement of the number of bytes left to be transferred.

5.3.7 MEMORY BYTE FORMAT

Printable data must be arranged in memory in the following format:

0	1 2 3 4 5 6 7	8	9 10 11 12 13 14 15
X	CHARACTER N	X	CHARACTER N+1

X = DON'T CARE

NOTE: Formats for Vertical Format Unit (VFU), and Horizontal Format Control (HTAB) loading and command data are described in Chapter 4. The Chapter 4 descriptions of the VFU and HTAB information show the format in length of a single byte. However, the information must be packed in the form of two bytes per word (see the Memory Byte Format above) in the same manner as the printable ASCII data.

APPENDIX A

A.0 INSTALLING LPC-3 UNDER DG/UX

A.1 NOTES

The LPC-3 Line Printer Controller interfaces most popular brands of serial and parallel printers via Data General's Data Channel under the DG/UX operating system.

Changes to existing DG/UX software are not necessary.

For an overview of the high performance features and functions of the LPC-3, read Section 1.0 in this Technical Manual.

A.2 INSTALLATION

Follow Section 2.0 of this Technical Manual for basic installation instructions.

For proper system configuration, review Data General's DG/UX System Administrator Guide.

A.3 TROUBLE-SHOOTING

For LPC-3 error descriptions, diagnostics, and trouble-shooting techniques, refer to Section 3.0 in this Technical Manual.

A.4 USAGE GUIDELINES

Read Section 4.0 of this Manual. Refer to Chapter 4.0 in the DG/UX System Administrator Guide for proper configuration of the line printer system (LP).

Assuming the LPC-3 has been properly generated into the DG/UX operating system, a sample dialogue to configure LP is:

```
# /usr/lib/lpadmin -plpc -v/dev/lp -mdclp
# /usr/lib/lpadmin -dlpc
# /usr/lib/accept lpc
# enable lpc
```

A.5 PROGRAMMING NOTES

Read Section 5.0 in this Technical Manual. For programming features of the DG/UX system, refer to the /UX Family Programmer Reference Manual.