DISTRIBUTED LOGIC CORPORATION

MODEL DQ616

DISK CONTROLLER FOR ST506/ST412 WINCHESTER DISK DRIVES

INSTALLATION AND OPERATION MANUAL

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REVISION R

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SECTION 1

DESCRIPTION

This manual describes the installation and operation of Distributed Logic Corporation (DILOG) Model DQ616 Disk Controller. The dual-height controller interfaces up to four ST506/ST412 Winchester Disk Drives to DEC* MicroVAX II, MICRO/PDP-11, or any LSI-11 Q-bus based computers.

The controller is software compatible with the MSCP driver contained in MicroVMS, DSM, RT-11, RSX-11M+, RSTS and Ultrix operating systems. The controller supports both block mode and non-block mode memory. The transfer rate is 5 MHz per second.

Figure 1-1 is a simplified diagram of a disk system using the controller.

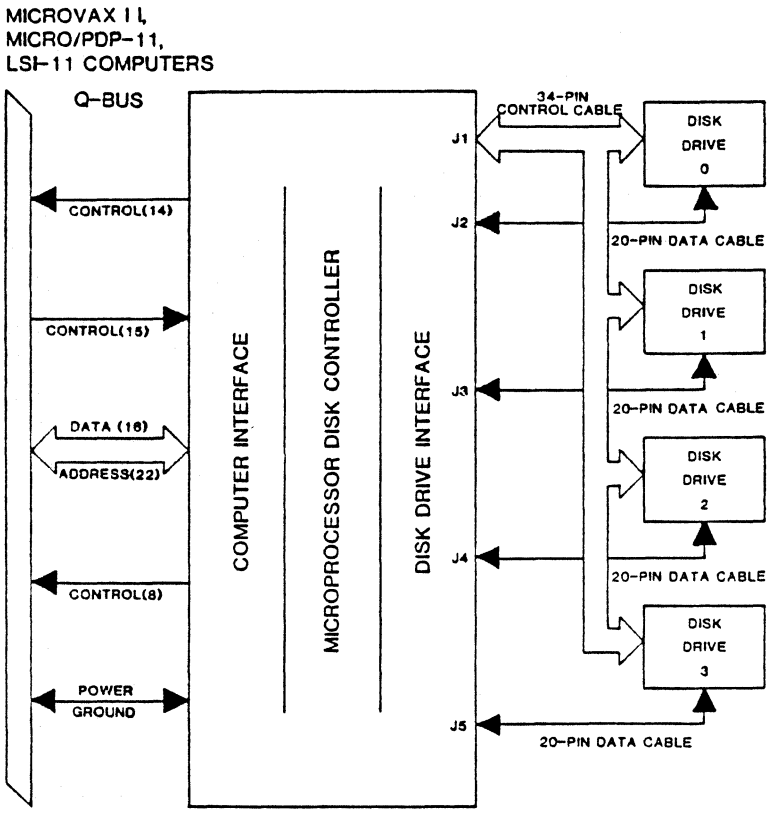


Figure 1-1. Disk System, Simplified

---

* DEC LSI-11, MicroVAX II, MICRO/PDP-11, RT-11, RSX, RSTS, DSM, ULTRIX, and MicroVMS are registered trademarks of Digital Equipment Corporation.

UNIVERSAL FORMATTING is a trademark of Distributed Logic Corp.

CHARACTERISTICS

Characteristics of the controller are as follows:

- DATA BUFFER

  The controller contains an 8 KByte buffer to support a 1 to 1 sector interleave and reduce software generated latencies between the Q bus and disk drive.

- COMMAND BUFFERING

  The controller contains a command queue buffer capable of storing up to 16 commands. The buffer stores all commands received by the controller and queues the commands for the proper order of execution on each drive.

- ELEVATOR SEEK ORDERING ALGORITHM

  The controller uses an elevator seek ordering algorithm to determine the execution order for commands in the command buffer. This algorithm reduces drive seek latencies.

- OVERLAPPED SEEKS

  The controller supports overlapped seeks for four ST506/ST412 drives, with buffered seek capabilities and will start a transfer on the drive whose seek completes first. This feature reduces multiple drive seek latencies.

- 22-BIT ADDRESSING

  The controller supports 16-, 18-, and 22-bit Q-bus addressing.

- INHIBIT DMA INCREMENT

  The controller contains the ability to move blocks of data in or out of a specific memory or I/O address location. This is a special command that is software selectable for applications that require both incremental and non-incremental applications to run concurrently on the same controller.

- NOVRAM (Non-Volatile Random Access Memory)

  The NOVRAM replaces configuration switches typically found in controllers. Controller configuration is now contained within he NOVRAM even when power is removed. Information stored in the NOVRAM includes base address, boot enable/disable, default DMA burst size, DMA dwell time, and logical unit number of the drives connected to the controller.

- DILOG'S UNIVERSAL FORMATTING

  Universal Formatting permits the attachment of drives that have the same or different characteristics, such as number of cylinders, heads, sectors, capacities, and transfer rates, without the need for drive configuration components on the controller. The drive characteristics are stored on the drive itself and are passed to the controller when power is first applied.

- ONBOARD FORMATTING

  The onboard formatter is accessible through the system console. The onboard formatter writes and qualifies the header and data portion of each sector, allocates replacement sectors, and configures the RCT tables. The onboard formatter removes all requirements for distribution media.

- MEDIA FLAW COMPENSATION

  The following four functions are designed to compensate for media defects:

  FIRST, at format time an area is reserved as a spare. DILOG's Universal Formatting system has the ability to reassign spare sectors for defective sectors into this reserved area.

  SECOND, if an error is encountered after the drive is formatted, the controller will try to reread the sector with ECC disabled.

  THIRD, if the error still exists, ECC is used to recover the data. This computer generated 32-bit ECC polynomial is capable of correcting one error per sector that is 11 bits or less in length. Error packets are generated by the controller every time an error recovery operation is performed.

  FOURTH, if the error still exists, reassignment of defective sectors is accomplished through a dynamic replacement scheme controlled by the controller or host software.

- HARDWARE BOOTSTRAP

  The controller contains an onboard bootstrap support for RP02, RL01/02, RM02, RM05, RM80, RK06/07, RX02, TS11, TSV05, TM11, and MSCP devices. When the bootstrap is disabled, the controller will boot from the standard DEC module. Bootstrap address selection and enable/disable are switch selectable.

- AUTOMATIC SELF TEST

  The controller is supplied with an automatic self test function that is initiated each time power is applied. The controller performs additional tests each time it is brought online. A green card-edge LED is lit and remains lit after each successful completion of self test. Should self test fail, the controller isolates the disk drive from the system and the LED is extinguished.

o DISK DRIVES SUPPORTED

The controller is compatible with disk drives from the following manufacturers. Contact the factory for additional drive support.

5-1/4" and 3-1/2"

HITACHI	FUJITSU
PRIAM	MICROPOLIS
CONTROL DATA CORP.	NEC
MAXTOR	SEAGATE
SIEMENS	

o LSI-11 Q-BUS INTERFACE

Commands, data, and status transfers between the controller and the computer are executed via the parallel I/O bus (Q bus) of the computer. Data transfers are direct to memory via the DMA facility of the Q bus; commands and status are under programmed I/O. Controller/Q-bus interface lines are listed in Table 1-1.

o DISK DRIVE INTERFACE

The controller interfaces the drives through one 34-pin cable and up to four 20-pin cables. Signals for the 34-pin cable are listed in Table 1-2. Signals for the 20-pin cables are listed in Table 1-3.

Table 1-1. Controller/Q-Bus Interface Lines (Dual Module)

BUS PIN	MNEMONIC	INPUT/ OUTPUT	DESCRIPTION
AJ1, AM1, BJ1, BM1, BT1, BC2	GND	O	Signal Ground and DC return.
AN1	BDMR L	O	Direct Memory Access (DMA) request from controller; active low.
AP1	BHALT L	N/A	Stops program execution. Refresh and DMA is enabled. Console operation is enabled.
AR1	BREF L	N/A	Memory Refresh. Used for Block Mode DMA.
BA1	BDCOK H	I	DC power OK. All DC voltages are normal.
BB1	BPOK H	I	Primary power OK. When low activates power fail trap sequence.
BN1	BSACK L	O	Select Acknowledge. Interlocked with BDMGO indicating controller is bus master in a DMA sequence.
BR1	BEVNT L	N/A	External Event Interrupt Request.
BV1, AA2, BA2	+5	I	+5 volt system power.
AD2, BD2	+12	N/A	+12 volt system power.
AE2	BDOUT L	I/O	Data Out. Valid data from bus master is on the bus. Interlocked with BRPLY.
AF2	BRPLY L	I/O	Reply from slave to BDOUT or BDIN and during IAK.
AH2	BDIN L	I/O	Data Input. Input transfer to master (states master is ready for data). Interlocked with BRPLY.
AJ2	BSYNC L	I/O	Synchronize: becomes active when master places address on bus; stays active during transfer.
AK2	BWTBT L	I/O	Write Byte: Indicates output sequence to follow (DATO or DATOB) or marks byte address time during a DATOB.
AL2, A1, AB1, BP1	BIRQ4-7 L	O	Interrupt Request 4-7.
AM2 AN2	BIAK1I L BIAK1O L	I O	Serial Interrupt Acknowledge Input and output lines routed from Q Bus, through devices, and back to processor to establish an interrupt priority chain.
AT2	BINIT L	I	Initialize. Clears devices on I/O bus.
AU2, AV2, BE2, BF2, BH2, BJ2, BK2, BL2, BM2, BN2, BP2, BR2, BS2, BT2, BU2, BV2	BDAL0 L through BDAL15 L	I/O	Data/address lines, 0-15
AR2 AS2	BDMG1I L BDMG1O L	I O	DMA Grant Input and Output. Serial DMA priority line from computer, through devices and back to computer.
AP2	BBS7 L	I/O	Bank 7 Select. Asserted by bus master when address in upper 4K bank is placed on the bus. Also asserted for Block Mode DMA.
AC1, AD1, BC1, BD1, BE1, BF1	BDAL16 L -BDAL21 L	O	Extended Address Bits 16-21

Table 1-2. Drive Control Cable - Controller to Drive - J1

Pin No.	Term	Description	Source
2	RWC/HSEL3 L	Reduce Write Current or Head Select 3	Controller
4	XHSEL2 L	Head Select 2	Controller
6	WGATE L	Write Gate	Controller
8	SKCPL L	Seek Complete	Drive
10	TRK00 L	Track 0	Drive
12	FAULT L	Write Fault	Drive
14	XHSEL0 L	Head Select 0	Controller
16	Not Used		
18	XHSEL1 L	Head Select 1	Controller
20	INDEX L	Index	Drive
22	READY L	Ready	Drive
24	STEP L	Step	Controller
26	DSEL0 L	Drive Select 0	Controller
28	DSEL1 L	Drive Select 1	Controller
30	DSEL2 L	Drive Select 2	Controller
32	DSEL3 L	Drive Select 3	Controller
34	DIR L	Direction	Controller

Note: All odd pins are DC ground.

Table 1-3. Drive Data Cable - Controller to Drive - J2, J3, J4, J5

Pin No.	Term-J2	Term-J3	Term-J4	Term-J5	Description	Source
1	DSEL02 L	DSEL03 L	DSEL04 L	DSEL05 L	Drive Selected	Drive
2					Ground	
3					NOT USED	
4					Ground	
5					NOT USED	
6					Ground	
7					NOT USED	
8					Ground	
9					NOT USED	
10					NOT USED	
11					Ground	
12					Ground	
13	WDATA2 H	WDATA3 H	WDATA4 H	WDATA5 H	Write Data High	Controller
14	WDATA2 L	WDATA3 L	WDATA4 L	WDATA5 L	Write Data Low	Controller
15					Ground	
16					Ground	
17	RDATA2 H	RDATA3 H	RDATA4 H	RDATA5 H	Read Data High	Drive
18	RDATA2 L	RDATA3 L	RDATA4 L	RDATA5 L	Read Data Low	Drive
19					Ground	
20					Ground	

CONTROLLER SPECIFICATIONS *

MECHANICAL

The controller is completely contained on a dual-height module 13.2 cm. (5.22 in.) wide by 22.8 cm. (8.88 in.) deep and plugs into one standard Q-bus dual-height slot.

BASE ADDRESS

Factory select 172150, user selectable from 160000 to 177774.

INTERRUPT VECTOR ADDRESS

Programmable by software.

PRIORITY LEVEL

BR5 in etch; BR4, BR6, and BR7 by jumpers.

DMA BURST SIZE

User Selectable 1-8 words.

DISK TRANSFER RATES

5 MHz

DISK DRIVE I/O

One 34-pin flat ribbon cable and four 20-pin flat ribbon cables.

POWER

+5 volts at 2.5 amps.

ENVIRONMENT

Operating temperature 50 degrees F. (10 degrees C.) to 104 degrees F. (40 degrees C.); Humidity 10-90% non-condensing.

SHIPPING WEIGHT

5 pounds including documentation and cables.

MTTR

Less than 0.5 hours.

* Specifications subject to change without notice.

SECTION 2

INSTALLATION

INSPECTION

The padded shipping carton that contains the controller board also contains cabling for the disk drives, as specified on the sales order. The controller is completely contained on the dual-height printed circuit board. Inspect the controller and cables for damage.

CAUTION

IF DAMAGE TO ANY OF THE COMPONENTS IS NOTED, DO NOT INSTALL. IMMEDIATELY INFORM THE CARRIER AND DILOG.

Figure 2-1 shows the switch and jumpers locations.

Table 2-1 describes the switch settings and jumper priority levels. Installation instructions for the drives are contained in the disk drive manuals.

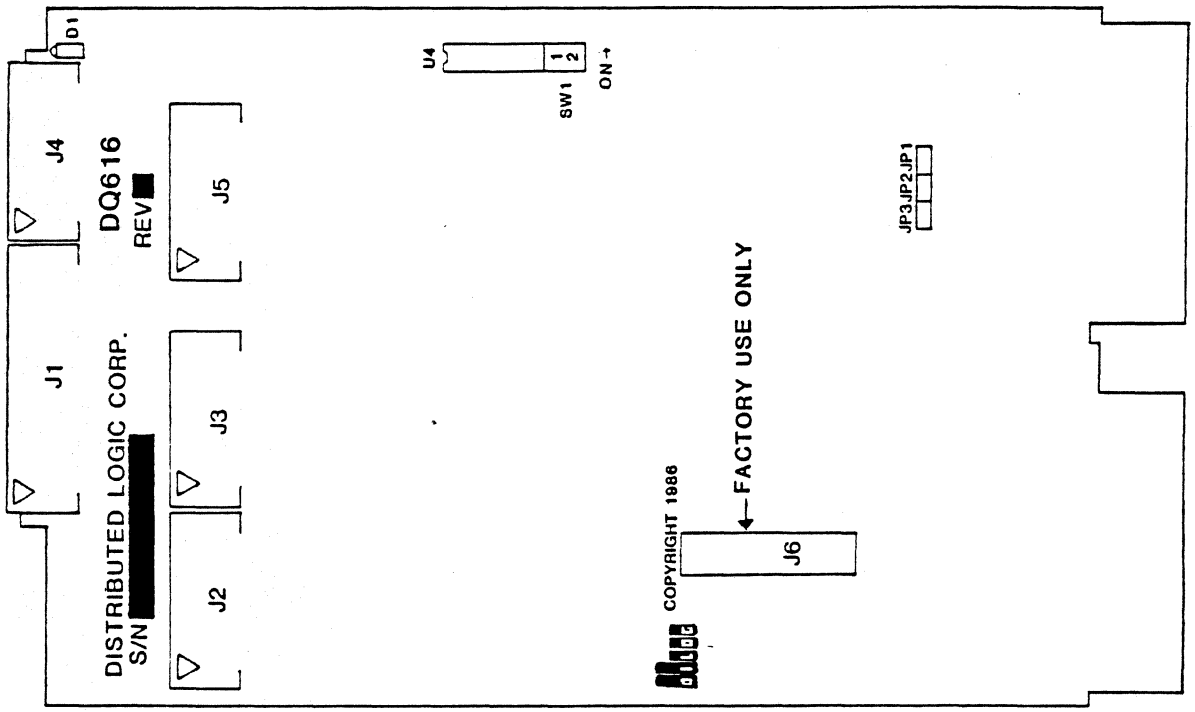


Figure 2-1. Controller Configuration

Table 2-1. Switch and Jumper Settings

Switch SW1 - Location U4

SW1-1 SELECT BOOT ADDRESS

ON = 175000
✓OFF = 173000

SW1-2 BOOT ENABLE

✓ON = Boot Enable
OFF = Boot Disable

Jumper Priority Levels

	JP3	JP2	JP1	Level
	Installed	Installed	Installed	BR4
✓	Removed	Installed	Installed	BR5 (standard etch)
	Installed	Removed	Installed	BR6
	Installed	Removed	Removed	BR7

Other options, such as addresses, are stored in the firmware and are selected from the terminal as described in Section 3.

Figures 2-2, 2-3, and 2-4 are examples of DILOG's recommendations for drive switch settings for hard disk drives. Consult the drive manufacturer's manual for other drives or more detailed information.

NOTE

A terminator is installed on the last drive only.

MANUFACTURER - Control Data Corporation
MODEL NO. - 94155-86 (Wren II)

CAPACITY - 86 MB (Unformatted)
CYLINDERS - 925
HEADS - 9

1	2	3	4	5
O	O	X	X	O

Note: Remove terminating resistor pack except for last disk in daisy chain.

O = Open (Off)
S = Shorted (On)
X = User definable drive select

Figure 2-2. Hard Drive Switches - CDC

MANUFACTURER - MAXTOR
MODEL NO. - Model XT1000/2000 Series

CAPACITY - 140 MB (for Model XT 1140)
CYLINDERS - 918 (for Model XT 1140)
HEADS - 15 (for Model XT 1140)

Drive Select Jumper Options
(Location J7):

4	C	3	2	C	1

OR: (Alternate)

1	2	3	4	5	6

FUNCTION	JUMPER PIN FROM	TO	ALTERNATE JUMPER PIN FROM	TO
Drive Select 0	1	C	5	6
Drive Select 1	2	C	4	5
Drive Select 2	3	C	2	3
Drive Select 3	4	C	1	2

Figure 2-3. Hard Drive Jumpers - MAXTOR

MANUFACTURER - Fujitsu
MODEL NO. - 2241AS, 2242AS, 2243AS

CNH3

2241AS
2242AS

10	8	6	4	2
9	7	5	3	1
0	0	0	0	S

CNH3

2243AS

10	8	6	4	2
9	7	5	3	1
0	0	0	S	0

2241AS
2242AS
2243AS

SW1

DS0	DS1	DS2	DS3	RADIAL	MOT ON ENA	MOT ON DISA	FULL BUFFER
1	2	3	4	5	6	7	8
0	0	X	X	0	S	0	0

O = Open (Off)
S = Shorted (On)
X = User definable drive select

Figure 2-4. Hard Drive Switches - Fujitsu

CONTROLLER INSTALLATION

Install the controller as follows:

CAUTION

ENSURE ALL POWER IS OFF BEFORE INSTALLING THE CONTROLLER OR CABLES.

DAMAGE TO THE BACKPLANE ASSEMBLY WILL OCCUR IF THE CONTROLLER IS PLUGGED IN BACKWARDS.

1. Select the backplane location into which the controller is to be inserted. There are several backplane assemblies available from DEC and other manufacturers. Figures 2-5 and 2-6 show typical backplane configurations.

   It is important that all options slots between the processor and the disk controller be filled to ensure that the daisy-chained interrupt (BIAK) and DMA (BDMG) signals be complete to the controller slots. If there must be empty slots between the controller and any option board, the following backplane jumpers must be installed.

FROM	TO	SIGNAL
CO x NS	CO x M2	BIAK1/LO
CO x S2	CO x R2	BDMG1/LO

2. Before installing the controller, connect the 34-pin signal cable to J1 on the controller. Connect J2, J3, J4, and J5 on the controller if four drives are used, or as applicable. Ensure Pin 1 on the cable is matched with the triangle on the connector as indicated on Figure 2-1.

3. Ensure the controller is oriented with the components facing row one, the processor, and gently press both sides until the module connectors are firmly seated in the backplane.

4. Connect the J1 cable to the drive or drives if daisy-chained. Connect the J2, J3, J4 and J5 cables to the drives as applicable.

5. Refer to the disk drive manuals for operating instructions, and apply power to the computer and drive(s).

6. The system is ready for configuration and formatting as described in Section 3.

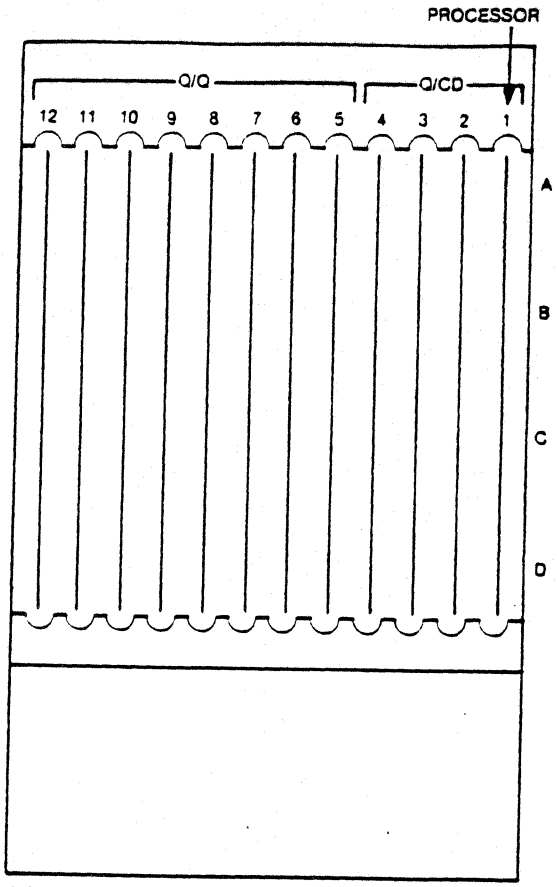


Figure 2-5. MicroVAX II Backplane (Typical)

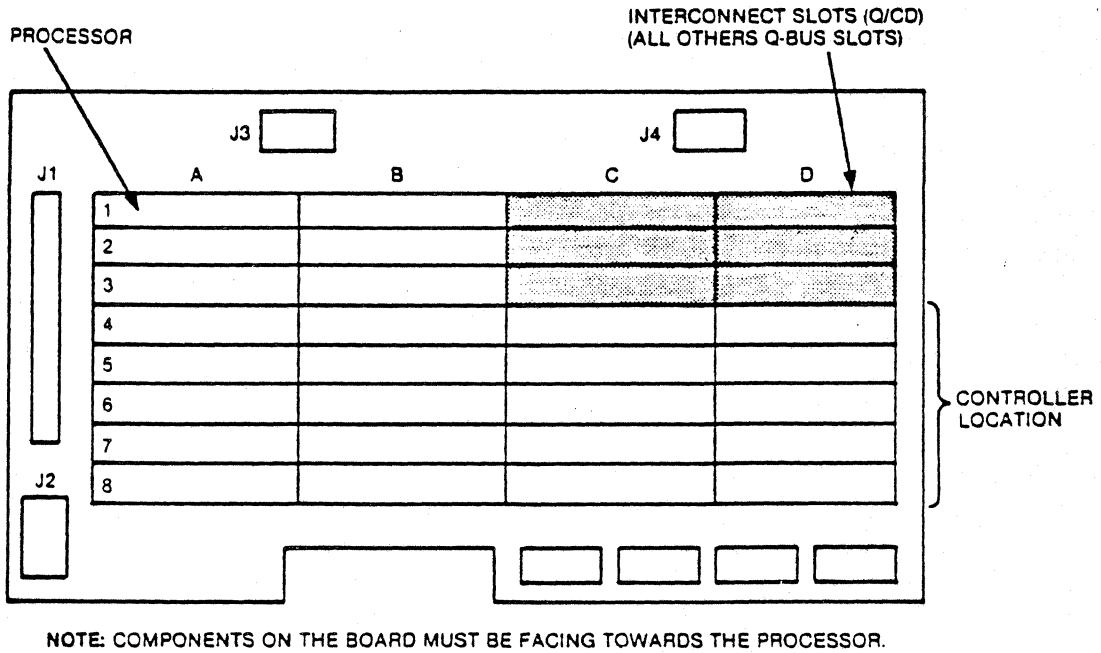


Figure 2-6. MicroVAX II H9278 Backplane

SECTION 3

OPERATION

The operation of the controller includes bootstrapping the system, setting the controller parameters and formatting the hard disk drives.

There are several methods for bootstrapping and communicating with the formatting program:

- o DILOG LSI-11 Bootstrap procedure
- o Onboard Formatting procedure (FT)
- o Standard DU Emulation
- o Boot Disable/Enable
- o Autoboot
- o MicroVAX II Communications procedure

In the Formatting program, the Main Menu offers the selections of the Format Utility, the Controller Utility, and display mode of the CRT or printer.

The first time the controller is powered up, the addresses will be:

```
IP REGISTERS = 772150
AUTOBOOT WILL BE DISABLED
```

The IP/SA address may be changed by the controller utility program. The current addresses will be displayed on the logo. The boot address is set via SW1-1 (see Table 2-1).

DILOG LSI-11 BOOTSTRAP PROCEDURE

The following assumes the system is in ODT mode. Note that the bootstrap can be used under processor Power Up Mode 2 conditions. Refer to the appropriate DEC manual for a discussion of the Power Up modes. Further note that the disk drive does not need to be READY to enter the bootstrap.

Boot Disable/Enable

The bootstrap is enabled or disabled via SW1-2 (see Table 2-1).

If the bootstrap is disabled, load the controller IP address with 0. Load the SA address (IP + 2) with 77777 (octal). Enter 2000G. For example, if the IP address is 172150 (SA = 172152), proceed as follows:

```
@    17772150/000000  0  <CR>
@    17772152/005400  77777 <CR>
@    2000G
*
```

Boot the device as described below.

If the bootstrap is enabled and the boot address is 175000, proceed as follows (enter):

```
@    17775000G
     (Enter 17773000G, if the bootstrap address is 173000.)
*
```

Autoboot

If Autoboot is enabled, load the IP address with 0. Load the SA address (IP + 2) with 77777 (octal). Load location 0 with the controller IP address, enter 2000G. For example, if the IP address is 172150, proceed as follows:

```
@    17772150/000000  0  <CR>
@    17772152/005400  77777  <CR>
@    0/172151  172150  <CR>
@    2000G
*
```

Boot the device as described below.

Onboard Formatter

The controller not only supports standard DEC devices, but also allows the use of the onboard formatter. When DU is used, the standard DEC emulation is called. When FT is used, the onboard formatter is enabled for use through the system console.

```
*    Enter one of the following: DMO, DPO, DLO, DRO, MSO,
     MTO, DYO, DU, or FT <CR>
```

Definitions are as follows:

```
DM = RK06/07 Disk          MT = Tape
DP = RP02/03 Disk          MU = (TMSCP) Tape
DL = RL01/02 Disk          DY = RX02 Floppy Disk
DR = RM03/05/80 Disk       DU = DU emulation
MS = TS11 Tape             FT = Enable onboard formatter
                                through system console
```

MICROVAX II COMMUNICATIONS PROCEDURE

A unique code is loaded into the SA register causing the controller to act as a UART. Proceed as follows:

1. On the MicroVAX II, perform INIT by depressing the RESTART switch.

2. Enter the code below. (Underlined values are outputs to the terminal.) The values of XXXXXXXX are hex values of the controller address of the SA register and are listed below:

   >>>D/P/L 20088004 80000001 <CR>

   >>>D/P/W 20001F40 20 <CR>

   >>>D/P/W XXXXXXXX 3FFF <CR>

   >>>S 200 <CR>

   NOTE

   When a GPX (Graphics Work Station) is used enter >>>S 218 <CR> instead of 200.

The hex values of the addresses are as follows:

IP REGISTER OCTAL ADDRESS	SA REGISTER OCTAL ADDRESS	SA REGISTER HEX ADDRESS ENTERED
772150	772152	2000146A
760334	760336	200000DE
760340	760342	200000E2
760344	760346	200000E6
760354	760356	200000EE
760360	760362	200000F2
760374	760376	200000FE
760400	760402	20000102

For addresses other than the above (address range 160000...177774) perform the following:

1. Add 2 to the octal value of the IP register (SA address)

2. Convert the 4 LSB's in octal to hexadecimal.

3. Add 20000000.

For example, if the IP register is 160000, the hex value is obtained as follows:

1. 160000 + 2 = 160002 (octal).

2. 0002 (octal) = 002 (hex).

3. 20000000 + 002 = 2000002.

An optional step may be used to examine the values entered. After the first three lines are entered and before S200 starts, examine by entering and checking for the following:

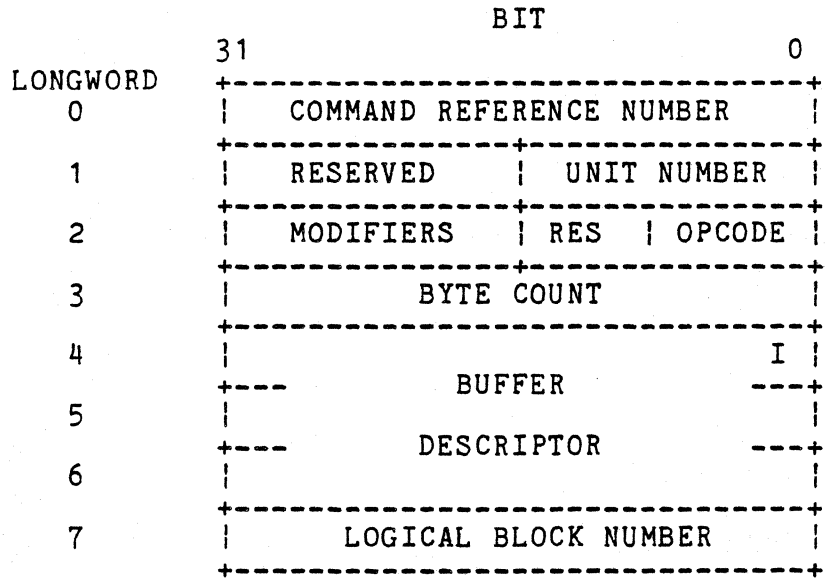
>>>E/P/W XXXXXXXX 800D

DILOG INHIBIT DMA ADDRESS INCREMENT IMPLEMENTATION

The Inhibit DMA Address Increment function gives the user the option of doing Read or Write operations from or to an I/O page address. Thus the disk controller can read or write one special hardware register (that behaves like Q-bus memory) without having to pass the data through Q-bus memory first. This functionality is ideal for graphics, imaging, or high speed data acquisition hardware that resides on the Q-bus and is accessed through the I/O page.

The invocation method is quite simple and is the same for all MSCP I/O commands. It should be noted that this capability is not supported by the MSCP protocol and therefore users wishing to utilize it must be prepared to modify the MSCP driver. The Inhibit DMA Address Increment functionality is turned on by setting the least significant bit in the MSCP command buffer descriptor. Since the controller requires that all transfers begin on an even byte boundary the setting of bit 0 of the buffer descriptor enables the Inhibit DMA Address Increment capability for that command only. Thus commands requiring data to be directed to and from Q-bus memory can be interspersed with commands requiring the Inhibit DMA Address Increment functionality. The following MSCP transfer command packet description is included to show where the Inhibit DMA Address Increment flag (the I in the buffer decriptor field) is located relative to the other fields in the packet.

MSCP TRANSFER COMMAND (READ AND WRITE) COMMAND FORMAT



CONTROLLER UTILITY AND FORMAT PROGRAMS

After communication is established, the program is ready to select controller options and to format the disks.

The formatter's terminal I/O interface supports the following keys:

- DELete/Back Space: Delete the previous character input
- CTRL-U: Delete the entire input
- CTRL-C: Aborts the current process and returns to the menu
- CTRL-P: Prints out current cylinder address on the printer
- CTRL-S: (XOFF, Transmit Off); Stops the display on screen
- CTRL-Q: (XON, Transmit On); Continues display on screen after CTRL-S

Inputs and outputs to or from the program are in decimal with the exception of the following:

- IP/SA and Boot Address registers are displayed in octal.
- Format data pattern is represented in hexadecimal.

With the exception of the priority level and boot address, the characteristics of the controller (such as IP address, and burst size) are set by the program. Drive characteristics (such as number of cylinders, heads, sectors) for hard drives are recorded on the drive.

LOGO AND MAIN MENU

With each menu selected, the logo will appear on the screen displaying the program title, model number, version, and IP/SA and boot addresses. Below the logo will appear which drive is selected or no drive is selected. The first menu to appear will resemble the following:

```
------------------------------------------------------------
  DILOG On-board Disk Formatter          IP/SA Address: 172150
  Model: DQ616     Version: A            Boot Address:  175000
------------------------------------------------------------
                    NO DRIVE IS SELECTED
  MAIN MENU
-------------
 1 - FORMAT UTILITY
 2 - CONTROLLER UTILITY
 3 - SET DISPLAY MODE (CRT)

ENTER A SELECTION:
```

The first time the controller is powered up, the IP/SA register will be 172150. If this address is changed with the controller utility program, the last designated address will appear. The "A" represents firmware revision level.

In the main menu, the format utility program is used for drive selection and configuration; the controller utility is used for controller configuration; the display mode is for selecting either a printer or CRT. If key 3 is pressed, the mode will toggle to either CRT or Printer.

CONTROLLER UTILITY

If a 2 is selected from the Main Menu, the Controller Utility Menu will be displayed after the logo. The menu is as follows:

```
 CONTROLLER UTILITY MENU
--------------------------
 1 - DISPLAY CONTROLLER CHARACTERISTICS
 2 - SET CONTROLLER CHARACTERISTICS
 0 - EXIT MENU

ENTER A SELECTION:
```

If 1, Display Controller Characteristics, is selected, a display similar to the following will appear:

```
 DISPLAY CONTROLLER CHARACTERISTICS
-------------------------------------
  IP ADDR:                   172150
  DWELL TIME:                001
  DEFAULT BURST SIZE:        008
  BASE DU UNIT NUMBER:       000
  AUTO-BOOT:                 DISABLED

 ** ** ** PRESS <CR> TO CONTINUE ** ** **
```

The dwell time is the time between DMA bursts in microseconds. The options are 1, 2, 4, 8, and 16 microseconds.

The default burst size is the number of DMA words for a block transfer. The burst size may be from 2 to 8 words.

The Base DU Unit Number is the logical unit number of a drive; this number may range from 0 to 252.

If 2, Set Controller Characteristics, is selected, a query session and responses similar to the following will appear:

```
   CONTROLLER CHARACTERISTICS QUERY SESSION
-----------------------------------------------
(CTRL-C ABORTS TO THE MENU)

IP ADDR (160000...177774):              <172150>
DWELL TIME (1,2,4,8,16):                <002>
DEFAULT BURST SIZE (002...008):         <008>
BASE DU UNIT NUMBER (0...252):          <000>
AUTO-BOOT (ENABLE/DISABLE):             <D>

MODIFY ABOVE PARAMETERS (Y/N)? <N> NO
SAVE CONTROLLER PARAMETERS (Y/N)? <Y> YES
NOVRAM UPDATED.

** ** **  PRESS <CR> TO CONTINUE  ** ** **
```

NOTE

For the above changes to take effect, the controller must be powered down and powered up.

The ranges of values are in parenthesis. The default values are in carrots <> and will be the last selection made. The first four prompts, IP, Dwell, Default, and Base DU, are described above.

FORMAT UTILITY

If 1 is selected from the Main Menu, the Format Utility Menu will be displayed after the logo. The menu is as follows:

```
  FORMAT UTILITY MENU
-----------------------
 1 - SELECT DRIVE
 2 - DISPLAY DRIVE CONFIGURATION
 3 - FORMAT DRIVE
 4 - BAD-BLOCK SCAN
 5 - REBUILD UNIT CONTROL BLOCK
 6 - REPLACE BAD-BLOCKS
 0 - EXIT MENU

 ENTER A SELECTION:
```

Select Drive

A drive must be selected before other items may be entered.

When a disk is selected, the parameters are read from the UCB on the disk. If the UCB cannot be read from the drive, the program will present a query session. An example of a query session follows:

```
  DRIVE CHARACTERISTICS QUERY SESSION
---------------------------------------
(CTRL-C ABORTS TO THE MENU)

DRIVE NAME: XYZ
NUMBER OF CYLINDERS: 615
NUMBER OF HEADS: 4

WRITE PRECOMP CYLINDER (0...00615): <00615>
CURRENT REDUCTION CYLINDER (0...00615) <00615>
DYNAMIC BAD-BLOCK REPLACEMENT INITIATOR:
     1) HOST
     2) CONTROLLER
     3) NONE
ENTER A SELECTION: <001> 1

RBN/LBN RATIO (001...050): <002>

PERFORMS BUFFERED SEEK (Y/N)? Y
```

The above queries are explained after Display Drive Configuration.

Display Drive Configuration

If 2, Display Drive Configuration, is selected from the Format Menu, the display will be similar to the example below.

This example is based on the previous query session:

```
                DRIVE 002 SELECTED              (XYZ)

        DISPLAY DRIVE CONFIGURATION
      --------------------------------

       DRIVE NAME:                          XYZ
       NUMBER OF CYLINDERS:                 00615 - Drive Performs Buffered
                                                    Seek
       NUMBER OF HEADS:                     004
       NUMBER OF SECTORS PER TRACK:         017

       WRITE PRECOMP CYLINDER:              NONE
       CURRENT REDUCTION CYLINDER:          NONE

       RBN/LBN RATIO:                       002      (0.2%)
       NUMBER OF RBNS ALLOCATED:            00000136 (002 CYL)
       BAD-BLOCK REPLACEMENT INITIATOR:     HOST

       HOST AREA SIZE (BLOCKS):             00076512
       DIAGNOSTIC PARTITION SIZE (CYL):     00001

       ** ** **   PRESS <CR> TO CONTINUE   ** ** **
```

The drive name, number of cylinders, and heads may be obtained from the drive manufacturer's manuals. The numbers of sectors per track are fixed at 17. Write precompensation cylinder and current reduction may be obtained from the drive manufacturer's manuals. Use the value of all the cylinders if these functions are performed internally by the drive; for example, if there is no write precompensation and the drive has 615 (0-614) cylinders, enter 615. If the drive has more than 8 heads, current reduction will be performed by the drive internally; therefore, it will not be prompted for.

If the drive performs buffered seeks, a step rate is not required. If the response to Performs Buffered Seek is No, the drive step rate is required. The prompt will be: "Step Rate (1...7)". The step rate is the time it takes to move a head from one cylinder to another. The values entered in the program and the disk step rates are as follows:

	STEP RATES
PROGRAM VALUE	5.25 IN. HARD DISK
7	12.8 ms
6	6.4 ms
5	3.2 ms
4	1.6 ms
3	0.8 ms
2	0.4 ms
1	0.2 ms

The Dynamic Bad-Block Replacement Initiator determines whether the host or controller will replace bad-blocks or if bad-blocks will be replaced at all. Furthermore, if the user selects None for Dynamic Bad-Block Replacement, there will be no RCT and RAM allocated for the unit.

If the controller is selected to replace bad-blocks, the replacement will be accomplished by the controller, and the replacement cycle will be transparent to the host.

If the host is selected to replace bad-blocks, the host must perform the algorithm which requires greater system overhead.

For the next two items, Host Area Size and Diagnostic Partition, there are three partitions per drive, the Unit Control Block, the Host Partition, and the Diagnostic Partition. The Host Partition consists of the Host Area, the RCT, and the RBN. Figure 3-1 illustrates partitioning, and also if the Dynamic Bad Block Replacement Initiator is None.

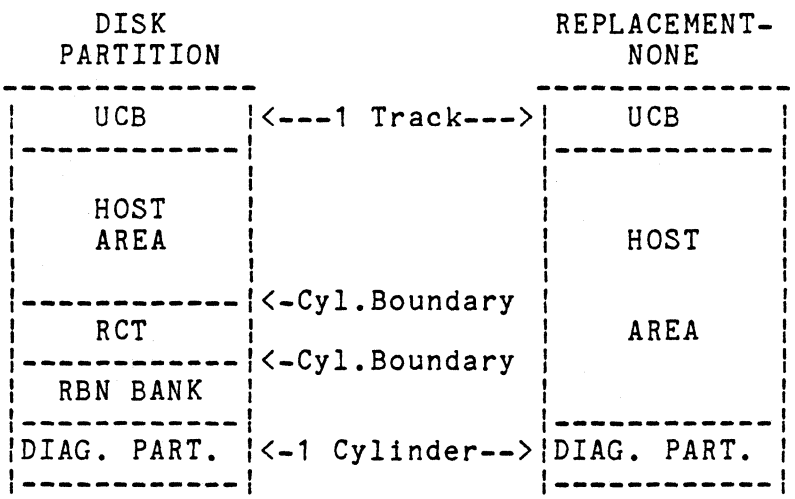


Figure 3-1. Drive Partitioning

The number of cylinders allocated for the RCT depends on the size of the host area but is usually 1 or 2 cylinders. The Bank of Replacement Block Numbers (RBN) is selectable; this area may be between 0.1% and 5% of the Host Area as specified by the user. This RBN/LBN Ratio is the number of replacement blocks allocated for each thousand logical blocks. The default value is 2. In the above example, the ratio is approximately 0.2% of the host area of the drive. The Diagnostic Partition size is 1 cylinder and is at the end of the disk drives.

The UCB is the area where drive parameters are retained. The Host Area is the user area. The RCT (Replacement and Caching Table) is used for listing bad-media replacement. The RBN Bank (Replacement Block Number) contains the replacement blocks for the Host Area.

Format Drive

After selection and configuration of the drives, they are ready for formatting, Item 3 from the Format Utility menu.

The program writes headers and a data pattern on the UCB. Then, the program writes drive parameters. Next, the drive parameters are read and validated.

The host format partition consists of the host area, the RCT, and the RBN bank. The sequence is: first, headers and a data pattern are written to the host partition. Second, the RCT is initialized (if an RCT has been allocated). During RCT initialization, the RBN area is scanned for bad blocks, and the bad RBN's are marked unusable in the RCT. Third, after RCT initialization, the host area is scanned for bad blocks. If bad blocks are found, they will be reported to the user, and the program will replace the bad LBN's with an RBN. If the user responds "N" to the prompt, Replace Bad Blocks, the bad blocks will not be replaced.

The Format menu is as follows:

```
                DRIVE 002 SELECTED              (XYZ)

      FORMAT MENU
    ---------------
     1 - FORMAT ENTIRE DRIVE
     2 - FORMAT DIAGNOSTIC PARTITION
     0 - EXIT MENU

    ENTER A SELECTION:  1
```

If 1, Format Entire Drive, is selected, the program will prompt for the data pattern and for replacing bad-blocks automatically. If 2 is selected, data on the host partition will not be affected.

When the format is complete, a pattern similar to the following will appear:

```
                DRIVE 002 SELECTED              (XYZ)

      FORMAT DRIVE 002 (XYZ)
    -------------------------
    (CTRL-C ABORTS TO THE MENU)

     DATA PATTERN (0000...FFFF): <AA55>
     REPLACE BAD-BLOCKS (Y/N)? <Y>

    *** *** ***  CAUTION  *** *** ***
      IF YOU CONTINUE, ALL DATA WILL
      BE LOST ON THE SELECTED UNIT!
    *** *** ***  *** ***  *** *** ***

     WOULD YOU LIKE TO CONTINUE (Y/N)? <N>  YES

     FORMAT UCB PARTITION:
         Writing headers/data
         Writing Drive Parameters
         Reading Drive Parameters

     FORMAT HOST PARTITION:
         Writing headers/data at cylinder: 00610
         Initializing RCT to No defect state ...
              RBN 00000015 is unusable.
         Bad-Block Scan at cylinder 00610
         Host Area Size (Blocks): 00041531

     FORMAT DIAGNOSTIC PARTITION:
         Stepping to Diagnostic Partition...
         Writing headers/data at cylinder: 00614
         Diagnostic Partition Size (cylinders):  00001

     FORMAT OPERATION COMPLETE

    ** ** **  PRESS <CR> TO CONTINUE  ** ** **
```

NOTE

Rolling cylinder addresses will not be printed if the display mode is set for PRINTER.

As each header is written, the rolling address of the cylinder is displayed. If a bad sector is found during bad-block scan, the error is reported.

Bad-Block Scan

If Item 4, Bad-Block Scan, is selected from the Format Utility Menu, the program will scan for bad-blocks.

The function of a bad-block scan is to locate and replace bad blocks on the selected unit.

When a drive is selected, a display similar to the following will appear:

```
              DRIVE 002 SELECTED              (NEC)

       READ DRIVE 002 (NEC)
     ------------------------
     (CTRL-C ABORTS TO THE MENU)

      REPLACE BAD-BLOCKS (Y/N)? <Y>  NO
      BAD-BLOCK SCAN AT CYLINDER 00610

     ** ** **  PRESS <CR> TO CONTINUE  ** ** **
```

If the response is Yes, the following will appear:

```
     *** *** ***  CAUTION  *** *** ***
        NON-RECOVERABLE BAD-BLOCKS
        ARE REPLACED WITH FORCED
        ERROR FLAG SET.
     *** *** ***  *** ***  *** *** ***

      WOULD YOU LIKE TO CONTINUE (Y/N)?  <N>  YES

      SCAN HOST PARTITION:
          Bad-Block Scan at cylinder 00610
          Bad-Block found at LBN 0000L46 (Cyl: 00003, Head: 002,
          Sector: 008)
               Error Type: Correctable Data Field Error.
               Replacing LBN 00000L46 with RBN 00000005 (Non-Primary)
               Data Status: Recoverable

     ** ** **  PRESS <CR> TO CONTINUE  ** ** **
```

Rebuild Unit Control Block

If 5, Rebuild Unit Control Block, is selected, the UCB is rebuilt by: First, the program reads and tests the drive parameters and reports the status of the UCB to the operator; second, the program formats the UCB, rewrites drive parameters, and reads back the drive parameters for verification. Data from the host partition in the drive is not affected during this operation. After 5 is selected from the main menu, the first display will be as follows:

```
TESTING UNIT CONTROL BLOCK ...
```

If the test is successful, the following will appear:

```
UCB is OK.
```

If the test fails, a display similar to the following will appear:

```
UCB is CORRUPTED.

***** UCB READ ERROR: Non-correctable Data Field Error *****
** ** ** ** **     PRESS <CR> TO CONTINUE     ** ** ** ** **
```

The above error message indicates the reason for the failure. Furthermore, the error type corresponds to the error generated by reading the last UCB copy. Errors are listed below after the Replace Bad-Blocks section.

The next display is:

```
*** *** ***   CAUTION   *** *** ***
IF YOU  CONTINUE, UNIT CONTROL BLOCK ON
THE SELECTED DRIVE WILL BE OVERWRITTEN.
*** *** *** *** *** *** *** ***

WOULD YOU LIKE TO CONTINUE (Y/N)? <N>
```

If the response is No, the program will exit to the main menu. If the response is Yes, the program displays the current drive parameters and permits the user to modify the parameters, followed by:

```
RECOVERING DRIVE PARAMETERS ... REBUILD OPERATION
```

If rebuild failed, a display similar to the following will appear:

```
REBUILD OPERATION FAILED.

*****  UCB READ:  Non-correctable Data Error  *****
** ** ** ** ** PRESS <CR> TO CONTINUE ** ** ** ** **
```

NOTE

The Unit Control Block must be rebuilt with the same drive parameters with which it has been formatted previously.

Replace Bad-Blocks

If 6, Replace Bad-Blocks, is selected, the following menu will appear:

```
              DRIVE 002 SELECTED          (XYZ)

       REPLACE BAD-BLOCK
     --------------------
      1 - REPLACE BFI
      2 - REPLACE LBN
      3 - REPLACE SECTOR
      0 - EXIT MENU

      ENTER A SELECTION:
```

Bad-blocks are replaced in the following sequence: First, the desired sector is read and the status of the sector is reported. Second, the program replaces the bad-block with an RBN as described in Item 4 of the Format Utility Menu, Bad-Block Scan.

Replace BFI, Bytes From Index, refers to the location of the bad media (e.g., 135 bytes from the index). Refer to the Media Defect List supplied by the drive manufacturer. Replacement may also be by LBN, Logical Block Number, or by physical sector.

If 1, Replace BFI, is selected, the following will appear:

```
              DRIVE 002 SELECTED          (XYZ)

       REPLACE BFI
     ---------------
     (CTRL-C ABORTS TO THE MENU)

      DESIRED CYLINDER (0...610): <000>  3
      DESIRED HEAD (000...001): <000>  3
      DESIRED BFI (00009...09741):  4600
          READING LBN 00000246 (CYL: 00003, HEAD: 003, SECT: 008)
          - NO ERROR REPORTED

     ***  ***  ***  CAUTION   ***  ***  ***
       NON-RECOVERABLE BAD-BLOCKS ARE RE-
       PLACED WITH FORCED ERROR FLAG SET.
     ***  ***  ***  ***  ***  ***  ***  ***

      WOULD YOU LIKE TO CONTINUE (Y/N)?  YES

          REPLACING LBN 00000246 WITH RBN 00000012 (NON-PRIMARY)
          DATA STATUS:  RECOVERABLE

      REPLACE MORE BAD-BLOCKS (Y/N)? <Y>
```

If 2, Replace LBN, is selected, the following will appear:

```
                DRIVE 002 SELECTED              (XYZ)

      REPLACE LBN
    ---------------
    (CTRL-C ABORTS TO THE MENU)

     DESIRED LBN (0...00041530):  0
         READING LBN 00000000 (CYL: 00000, HEAD: 001, SECT: 000)
         ERROR TYPE:  FORCED ERROR

    ***  ***  ***  CAUTION   ***  ***  ***
      NON-RECOVERABLE BAD-BLOCKS ARE RE-
      PLACED WITH FORCED ERROR FLAG SET.
    ***  ***  ***  ***  ***  ***  ***  ***

     WOULD YOU LIKE TO CONTINUE (Y/N)? <N>  YES

         REPLACING LBN 00000000 WITH RBN 00000000 (PRIMARY)
         DATA STATUS: RECOVERABLE (FORCED ERROR SET)

     REPLACE MORE BAD-BLOCKS (Y/N)? <Y>
```

If 3, Replace Sector, is selected, the following will appear:

```
                DRIVE 002 SELECTED              (XYZ)

      REPLACE SECTOR
    ------------------
     DESIRED CYLINDER (0...00610): <000>  003
     DESIRED HEAD: (001...003): <002>
     DESIRED SECTOR (0...016):  8

         READING LBN 00000229 (CYL: 00003, HEAD: 002, SECT: 008)
         - ERROR TYPE:  SECTOR NOT FOUND

    ***  ***  ***  CAUTION   ***  ***  ***
      NON-RECOVERABLE BAD-BLOCKS ARE RE-
      PLACED WITH FORCED ERROR FLAG SET.
    ***  ***  ***  ***  ***  ***  ***  ***

     WOULD YOU LIKE TO CONTINUE (Y/N)?  Y

         REPLACING LBN 00000229 WITH RBN 00000010 (NON-PRIMARY)
         DATA STATUS: NON-RECOVERABLE (FORCED ERROR SET)

     REPLACE MORE BAD-BLOCKS (Y/N)? <Y>  N
```

Error types and contexts are listed below. Error context describes what function was being performed when the error occurred. If the error occurred during the Replace cycle, the Replace step will be displayed as part of the error context. Error Type describes the error which caused the process to be aborted. Errors are divided into four categories: Recoverable (R), Non-Recoverable (N), Hard (H), and Fatal (F) errors.

Below is an example of an error which occurred when attempting to access the RCT partition. The error type indicates that the controller was not able to read any of the multiple copies of the RCT; furthermore, the error generated from reading the last copy was Sector Not Found.

****** RCT READ ERROR: Sector Not Found *****

Error Type	Description
CORRECTABLE DATA FIELD ERROR (R)	Bad media in data field; error is corrected using ECC.
NON-CORRECTABLE DATA FIELD ERROR (R)	Bad media in data field; length of error is too large to be corrected.
FORCED ERROR (R)	Data written with Forced Error Flag; therefore data is questionable.
SECTOR NOT FOUND (N)	Unable to locate a sector or header miscompare--probably bad media in header.
NO DATA SYNC FIELD (N)	Data Sync Field changed due to bad media.
HEADER CRC ERROR (N)	Error in header.
UNIT NOT SELECTED (H)	Drive is not selected --possible bad connection, drive now powered up, or drive is not properly set.
MULTIPLE UNIT SELECTED (H)	More than one drive has the same physical unit number--check drive setup.

Error Type	Description
DRIVE NOT READY (H)	Drive did not spin up--perhaps drive power problem.
WRITE FAULT (H)	Drive reported write fault.
UNIT WRITE PROTECTED (H)	The drive is write protected.
UNIT OFFLINE (H)	Unit is offline (via remote panel).
SEEK OPERATION FAILED (H)	Drive was not able to complete the seek, or the seek was to a wrong or nonexistent cylinder--check drive parameters.
SEEK TIME-OUT (H)	Seek command to drive not completed within the timeout period.
RCT ACCESS FAILED (H)	RCT partition corrupted.
INVALID DRIVE CHARACTERISTICS (H)	Drive characteristics read from the drive are invalid. Could be unit control block is corrupted (use 5 from the Main Menu to rebuild Unit Control Block), or drive has not been formatted via Universal Formatter.
ABORT UPON OPERATOR REQUEST (H)	Operator pressed CNTRL-C keys to abort operation.
DATA RETRIEVAL FAILED (H)	After host data is saved on the diagnostic partition, the program verifies that the data can be retrieved from the diagnostic partition. If verification fails, this error is returned and host data is unaffected.
MEDIA FORMAT ERROR (ID/SYNC) (H)	Controller could not locate header sync on the current cylinder--Drive may not be formatted.
MEDIA FORMAT ERROR (ID/CRC) (H)	Controller could not locate valid header on the current track--Drive may not be formatted.
MEDIA FORMAT ERROR (VF/SYNC) (H)	Controller could not find sync on track during verification cycle--Drive may not be formatted.
REPLACE COUNTER EXHAUSTED (H)	During the replace cycle, up to 5 consecutive RBN's were allocated for the bad LBN. If all 5 RBN's are bad, this error is posted.

Error Type	Description
UDC TIME-OUT (H)	Integrated circuit in controller timed out--repeat operation.
FATAL UDC-RIC ERROR (F)	Fatal error--contact DILOG Customer Service.
ILLEGAL INTERRUPT ACKNOWLEDGE (F)	Fatal error--contact DILOG Customer Service.
FIFO DATA LOST (F)	Fatal error--contact DILOG Customer Service.
SOFTWARE DETECTED FATAL ERRORS (F) 01,02,03,04,05	Fatal error--contact DILOG Customer Service.

Error Context	Description
UNKNOWN	Operation unknown when error occurred.
UNIT SELECT	Error occurred during unit select.
UCB READ	Error occurred when reading drive parameters from Unit Control Block; unable to read any of the multiple copies.
UCB WRITE	Error occurred when writing drive parameters to Unit Control Block; unable to write any of multiple copies.
RCT READ	Error occurred during reading an RCT block. Unable to read any of multiple copies.
RCT WRITE	Error occurred during writing to RCT block. Unable to write any of multiple copies.
READ	Error occurred during reading data from the host area.
WRITE	Error occurred during writing data to the host area.

Error Context	Description
FORMAT	Error occurred during formatting (writing headers) to the host area.
REPLACE	The error occurred when the program attempted to replace the bad LBN with an RBN.

Stand-Alone Errors	Description
INPUT OUT OF RANGE	Input is not within the expected range.
INPUT IS REQUIRED	No default for prompt.
RCT IS FULL	The Replacement Caching Table (RCT) on the selected drive is full. The drive should be reformatted.
INVALID DWELL TIME	Dwell time not 1, 2, 4, 8, or 16 ms.
INVALID IP ADDRESS	IP address must be on longword boundary.
INVALID OPTION, NO RCT HAS BEEN ALLOCATED	Option attempted on a unit with no RCT.
Q-BUS POWER FAILURE DETECTED	Program detected power failure. At this time any drive that is selected will be deselected and the controller will isolate the drives and the host.
RCT SIZE CONFLICT	Either unit size too small or selected RBN/LBN ratio too large. Change RBN/LBN ratio.

SECTION 4

DIAGNOSTICS

Two DEC RC25 diagnostics may be used to test the controller. They are ZRCFB3, Front End Test; and ZRQAH0, RD/RX Disk Exerciser. Error messages are listed at the end of this section.

SETUP AND SELF TEST

Install the controller as described in Section 2. Apply power to the system, and verify that the green LED lights. Install the XXDP+ diagnostic floppy in the floppy drive and boot the system. When the boot switch on the system is toggled, the LED will go out, but will light again when the controller is brought online by the diagnostic.

When booting is completed, the XXDP+ sign-on will appear:

```
XXDP-SM SMALL MONITOR VERSION 2
BOOT FROM DY0
28KW MEMORY
UNIBUS SYSTEM

RESTART ADDR: 152010
THIS IS XXDP-SM  TYPE "H" OR "H/L" FOR HELP

(NOTE:  28KW = 28 Kilowords)
```

FRONT END TEST - ZRCFB3

The controller will only support tests 1-8 which must be selected by the user. These tests will bring the controller through initialization several times and do extensive checks on the DMA capability. Once the prompt "." has appeared, type the following command line to start ZRCFB3 diagnostic:

```
.R ZRCFB3
```

The system will echo the filename to let the user know that the file is being loaded.

```
.R ZRCFB3
ZRCFB3.BIN
```

When the diagnostic has been loaded, the diagnostic startup message will appear on the user's console.

```
DRSSM-FO
CZRCF-A-0
RC25 FRONT END/HOST DIAGNOSTIC
UNIT IS AZTEC RC25 PLATTER
RSTRT ADR 145676

DR>
```

The diagnostic can be started by typing the following command line:

```
DR>START/TEST:1-8<CR>
```

The above command line instructs the diagnostic supervisor to start the test but initiate only tests 1 through 8. The supervisor will then prompt the user for hardware or software changes.

```
     CHANGE HW (L)  ?
```

The diagnostic must be informed of the hardware parameters of the system under test. Enter the following information.

```
CHANGE HW (L)  ? Y<CR>
```

Enter the number of controllers that are being tested.

```
# UNITS (D)  ? 1<CR>
```

The diagnostic will then prompt the user to enter the following information for the number of units that have been selected. The following is an example:

```
UNIT 0
IP ADDRESS (O)  172150  ? <CR>
VECTOR (O)  154  ? <CR>
BR LEVEL (O)  5  ? <CR>
PLATTER ADDRESS[ES] (D)  ? 0<CR>
```

The platter address is the unit number of the disk drive under test. Since the controller does not support the tests which require a disk, this question is not appropriate but must be answered to start the diagnostic. Once the hardware questions are answered, the supervisor will prompt for software changes.

```
CHANGE SW (L)  ?
```

The software question can be answered NO because the controller does not support the tests which require a disk drive.

```
CHANGE SW (L)  ? N<CR>
```

The diagnostic will print each test as it runs and will inform the user of any errors that occur.

```
TESTING UNIT #:   0     IP_REGISTER:172150      PLATTER #: 0

TEST  1  REGISTER EXISTENCE TEST
TEST  2  STEP 1 READ/WRITE POWERUP DIAGNOSTICS
TEST  3  DIAGNOSTIC WRAP TEST
TEST  4  VECTOR AND BR LEVEL TEST
TEST  5  STEP 1-3 READ/WRITE DIAGNOSTIC
TEST  6  PURGE POLL TEST
TEST  7  SMALL RING TEST
TEST  8  LARGE RING TEST
```

When the diagnostic has completed all the tests, the end of pass message will be printed and the diagnostic will be restarted.

```
DZRCF    EOP     1
   0  TOTAL ERRORS
DR>EXIT<CR>
```

DISK EXERCISER - ZRQAH0

The controller also exercises RQDX or RUX50. No patch is required.
Enter the values, or <CR> as described below:

```
.R ZRQAH0
ZRQAH0.BIN

DRSSM-F0
ZRQA-H-0
RD/RX EXERCISER
UNIT IS RQDX OR RUX50
RSTRT ADR 145676
DR>STA

CHANGE HW (L)  ?  Y

# UNITS (D)  ?  2

*UNIT 0
IP address (O)  172150  ? <CR>
Vector (O)  154  ?  <CR>
BR Level [usually 4-RQDX 5-RUX50]  (O)  4  ?  5
Drive number (D)  0  ?  0
Test entire customer area of this disk  (L)  Y  ?  Y
Lower octal word of beginning LBN address  (O)  0  ?  <CR>
Higher octal word of beginning LBN address  (O)  0  ?  <CR>
Lower octal word of ending LBN address  (O)  177777  ?  <CR>
Higher octal word of ending LBN address  (O)  0  ?  <CR>
Write on customer data area of this disk unit (L)  ?  Y
** WARNING - CUSTOMER DATA AREA MAY BE OVERWRITTEN!...CONFIRM (L) ? Y


*UNIT 1
IP address (O)  172150  ? <CR>
Vector (O)  154  ?  <CR>
BR Level [usually 4-RQDX 5-RUX50]  (O)  5  ?  <CR>
Drive number (D)  0  ?  1
Test entire customer area of this disk  (L)  Y  ?  Y
Lower octal word of beginning LBN address  (O)  0  ?  <CR>
Higher octal word of beginning LBN address  (O)  0  ?  <CR>
Lower octal word of ending LBN address  (O)  177777  ?  <CR>
Higher octal word of ending LBN address  (O)  0  ?  <CR>
Write on customer data area of this disk unit (L)  ?  Y
** WARNING - CUSTOMER DATA AREA MAY BE OVERWRITTEN!...CONFIRM (L) ? Y

CHANGE SW (L)  ?  Y


*Logical DU Unit Number
```

```
Enter time as HHMM (example: 1505) (D)  0  ?  <CR>
Hard error limit (D)  32  ?  <CR>
Transfer limit in megabytes (0 for quick pass) (D)  0  ?  2
Percentage of "Fixed Disk" operations out of total operations
                                                    (D) 99 ? <CR>
Clear statistical tables after printing (L)  N  ?  <CR>
Rewrite blocks when "Forced Error" detected on reads (L) Y ? <CR>
Halt on bad-block hard errors (#s 35, 38)  (L)  Y  ?  <CR>
Halt on other hard errors (#s 31-34, 36-37, 39-45) (L) Y ? <CR>
Halt on soft errors (#s 50-54)  (L)  N  ?  <CR>
Random seek mode  (L)  Y  ?  <CR>
Read-compares performed at the controller  (L)  Y  ?  <CR>
Running under the A.P.T. Monitor  (L)  N  ?  <CR>
```

The remaining questions only apply to unprotected disk units

```
Write-compares performed at the controller  (L)  N  ?  <CR>
Check all writes at host by reading  (L)  Y  ?  <CR>
User-defined data pattern  (L)  N  ?  <CR>
Select pre-defined data pattern (0 for sequential selection)
                                                    (D) 0 ? <CR>
Manufacturing Test  (L)  N  ?  <CR>
Enable Host Memory (MSV11-P,L,J)  Parity  (L)  Y  ?  <CR>
```

```
FUNCTIONAL TEST STARTED
```

Error messages for the disk subsystem are as follows:

ERROR MESSAGE NUMBER	DESCRIPTION
0	Undefined error
1	Invalid Command
2	Command Aborted
3	Unit Offline
4	Unit Available
5	Media Format Error
6	Write Protected
7	Compare Error
8	Data Error
9	Host Buffer Access Error
10	Controller Error
11	Drive Error
12	Invalid CPU Type
13	Controller/drive contains unreasonable error rate
14	Cylinder 0 cannot be formatted
15	RCT area cannot be formatted
16	Drive not formatted